

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger / Ron Boyce	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday January 4, 2012 9:00am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 6845

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Chum Update - Paul Wagner, NOAA Fisheries
3. Other
 - a. Set agenda and date for next meeting - **January 18, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger / Ron Boyce	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday January 11, 2012 9:00am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 6845

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Update on Water Supply Forecast - Doug Baus, COE-RCC
 - a. [NRCS SNOTEL](#)
 - a. [RFC Snow](#)
 - a. [RFC January Final Forecast](#)
3. Chum Update - Paul Wagner, NOAA Fisheries
4. Other
 - a. Set agenda and date for next meeting - **January 18, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

January 11, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired and facilitated by Doug Baus, COE. Representatives of Oregon, NOAA, CRITFC, Idaho, Washington, BOR, USFWS, COE and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Update on Water Supply Forecast

The forecasting data posted in three links to this agenda item all indicate that water supplies across the region are below normal, Baus reported. This includes data from the NRCS SNOTEL site, RFC snow data, and the RFC final January forecasts for The Dalles and Grand Coulee dams. However, the RFC 10-day forecast indicates significant rain is coming, Karl Kanbergs, COE, said. The BPA and Weather Service forecasts both indicate precipitation will begin sometime next week.

3. Chum Operations Update

FPAC discussed chum operations yesterday and is awaiting updated information on redd locations from surveys done by the state of Washington, Paul Wagner said. Until a change is reported, the current operation should continue. TMT will revisit chum operations next week.

4. Next TMT Meeting

TMT will meet at NOAA's Portland office on January 18 to check in on the chum operation and updated water supply forecast information.

<i>Name</i>	<i>Affiliation</i>
Rick Kruger	Oregon
Paul Wagner	NOAA
Tom Lorz	CRITFC
Russ Kiefer	Idaho
Charles Morrill	Washington
Heather Dohan	Puget
Russ George	WMC
Don Tinker	SCL
Bruce McKay	hydro consultant
Margaret Filardo	FPC
Rob Allerman	Deutsch Bank

John Roache
David Wills
Karl Kanbergs

BOR
USFWS
COE

 [Header for Water Supply Information](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(BRNI1) SNAKE - BROWNLEE DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-01-03 Issue Date: 2012-01-04

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	5355	6308	81	7478	7801
APR-JUL	4161	4921	78	6043	6313
JAN-JUL	7816	8788	82	10365	10700

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

 [Water Supply Plot for SNAKE - BROWNLEE](#)

For Data Used In Plot Click Here: [CSV](#)

[✖ Header for Water Supply Information Page](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(DWRI1) CLEARWATER - DWORSHAK DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-01-03 Issue Date: 2012-01-04

[✖ Water Supply Plot for CLEARWATER - DWORSHAK DAM](#)For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	1603	2104	75	2889	2803
APR-JUL	1483	1987	75	2749	2644
JAN-JUL	2011	2689	76	3677	3547

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

 [Header for Water Supply Information](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(GCDW1) COLUMBIA - GRAND COULEE DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-01-03 Issue Date: 2012-01-04

 [Water Supply Plot for COLUMBIA - GRAND COULEE DAM](#)

For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	49787	55415	87	64274	63990
APR-JUL	40202	45058	84	53826	53850
APR-AUG	46136	51789	86	60423	60290
JAN-JUL	47257	52250	83	61546	62900

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

[Header for Water Supply Information Page](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(HHWM8) SF FLATHEAD - HUNGRY HORSE DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-01-03 Issue Date: 2012-01-04

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	1169	1535	72	1920	2124
APR-JUL	1077	1439	72	1806	1997
APR-AUG	1126	1496	72	1874	2070
JAN-JUL	1342	1709	77	2117	2224

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

[Water Supply Plot for SF FLATHEAD - HUNGRY HORSE DAM](#)For Data Used In Plot Click Here: [CSV](#)

 [Header for Water Supply Information Page](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(LYDM8) KOOTENAI - LIBBY DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-01-03 Issue Date: 2012-01-04

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	4382	5413	82	6901	6638
APR-JUL	3735	4604	82	5944	5642
APR-AUG	4119	5109	82	6555	6248
JAN-JUL	4349	5296	84	6623	6306

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

 [Water Supply Plot for KOOTENAI - LIBBY DAM](#)

For Data Used In Plot Click Here: [CSV](#)

 [Header for Water Supply Information Page](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(TDAO3) COLUMBIA - THE DALLES DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-01-03 Issue Date: 2012-01-04

 [Water Supply Plot for COLUMBIA - THE DALLES DAM](#)

For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	71623	84788	86	96321	98650
APR-JUL	58590	70212	83	80969	84650
APR-AUG	65800	78844	85	89345	93090
JAN-JUL	76172	88653	83	103555	107300

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

 [Header for Water Supply Information](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(GCDW1) COLUMBIA - GRAND COULEE DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-01-05 Issue Date: 2012-01-06

 [Water Supply Plot for COLUMBIA - GRAND COULEE DAM](#)

For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	49595	55130	86	63284	63990
APR-JUL	39898	44509	83	52660	53850
APR-AUG	45675	51209	85	59584	60290
JAN-JUL	46665	51594	82	60894	62900

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

 [Header for Water Supply Information Page](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(TDAO3) COLUMBIA - THE DALLES DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-01-05 Issue Date: 2012-01-06

 [Water Supply Plot for COLUMBIA - THE DALLES DAM](#)

For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	71201	83047	84	92912	98650
APR-JUL	58348	68402	81	79039	84650
APR-AUG	65447	77401	83	87184	93090
JAN-JUL	74806	86041	80	101038	107300

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

Prepared by the USDA/NRCS National Water and Climate Center
Portland, Oregon <http://www.wcc.nrcs.usda.gov/gis/>
Based on data from <http://www.wcc.nrcs.usda.gov/reports/>
Science contact: Jim.Marron@por.usda.gov 503 414 3047

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger / Ron Boyce	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday January 18, 2011 9:00am - 12:00pm

NOAA Fisheries
1201 NE Lloyd Blvd, St. Helens Room
Portland, OR 97232

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 6845

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review December 14, 21, 28, and January 11 Meeting Minutes [\[Meeting Minutes\]](#)
3. NWRFC Forecasting - Stephen King, NWRFC
4. Chum Update - Paul Wagner, NOAA Fisheries
5. Operations Review
 - a. Reservoirs
 - b. Fish
 - c. Water Quality

- d. Power System
- 6. Other
 - a. Set agenda and date for next meeting - **January 25, 2012**
 - b. [\[Calendar 2011\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger / Ron Boyce	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday January 25, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 6845

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

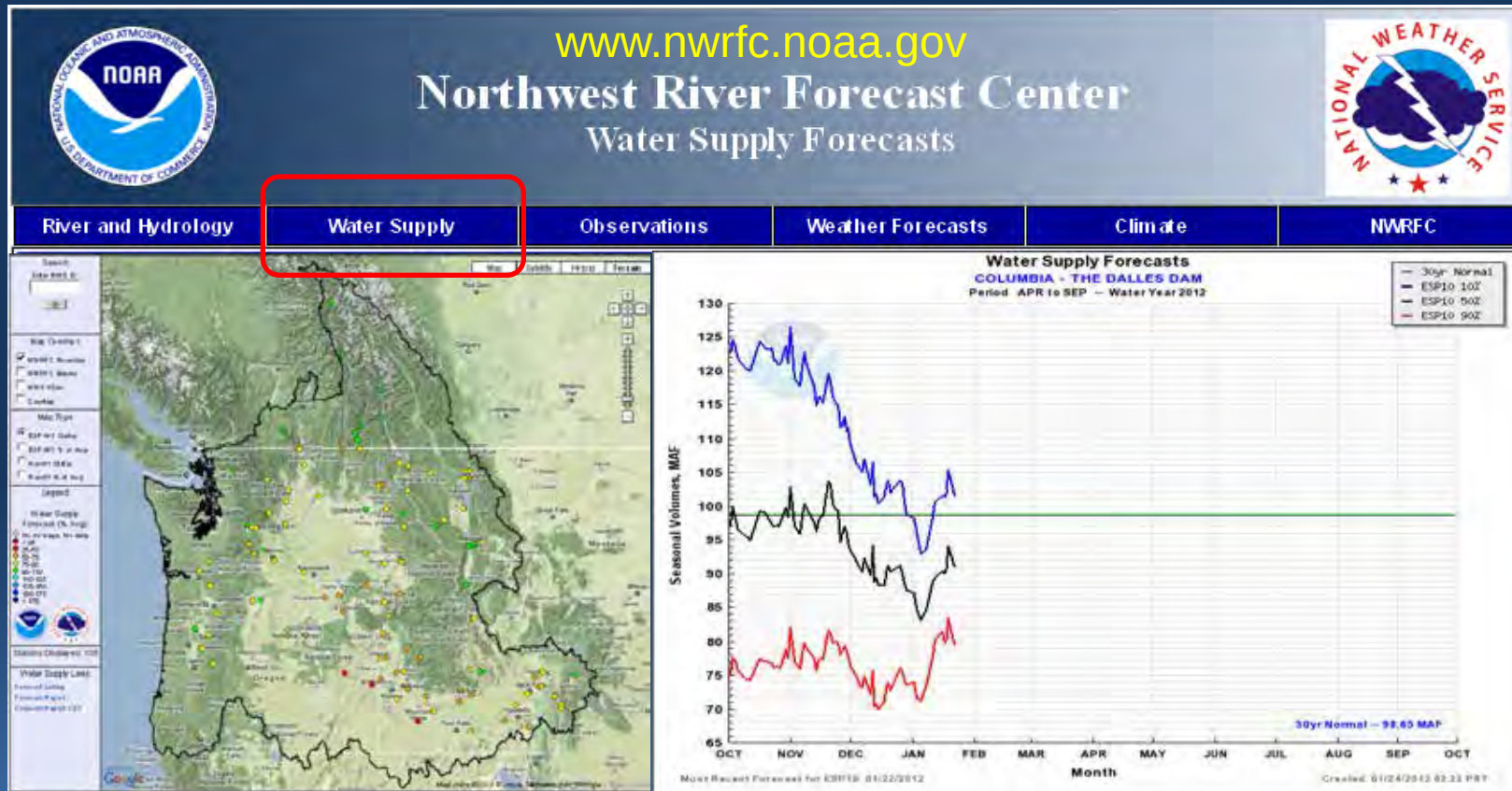
AGENDA

1. Welcome and Introductions
2. Review December 7, 14, 21, 28, and January 11 Meeting Minutes [\[Meeting Minutes\]](#)
3. NWRFC Forecasting - Stephen King, NWRFC
 - a. [Water Supply Update](#)
4. Chum Update - Paul Wagner, NOAA Fisheries
5. Operations Review
 - a. Reservoirs
 - b. Fish

- c. Water Quality
- d. Power System
- 6. Other
 - a. Set agenda and date for next meeting - **Feb 1, 2012**
 - b. [\[Calendar 2011\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

NWRFC January 2012 TMT Briefing



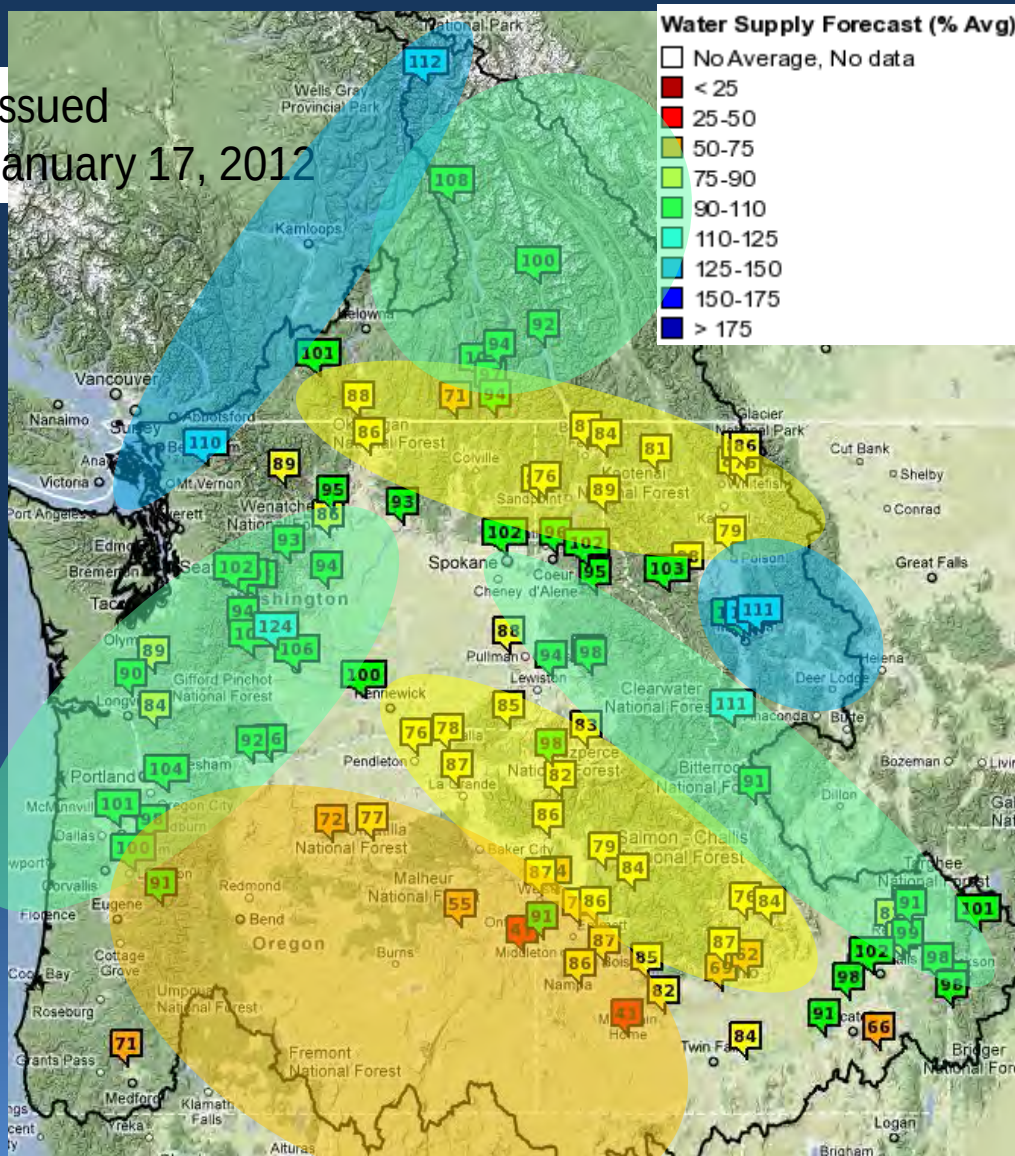
Steve King, NWRFC
Stephen.King@noaa.gov
(503)326-7291



Water Supply Summary



Issued
January 17, 2012



Most Apr-Sep forecasts are
near or below normal

Wettest forecasts:

- British Columbia
- Clark Fork/Western Montana
- Western Washington
- Idaho Panhandle
- Upper Snake/Eastern Idaho

Driest Forecasts:

- US-CAN Border
- Southern Oregon
- Southern Idaho



Observed Conditions



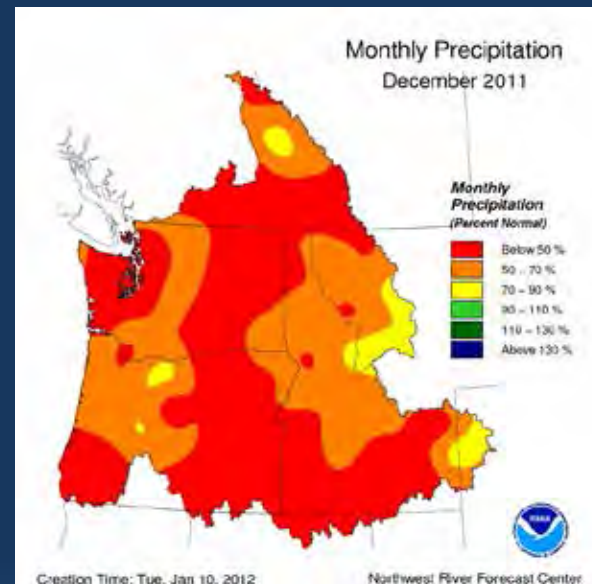
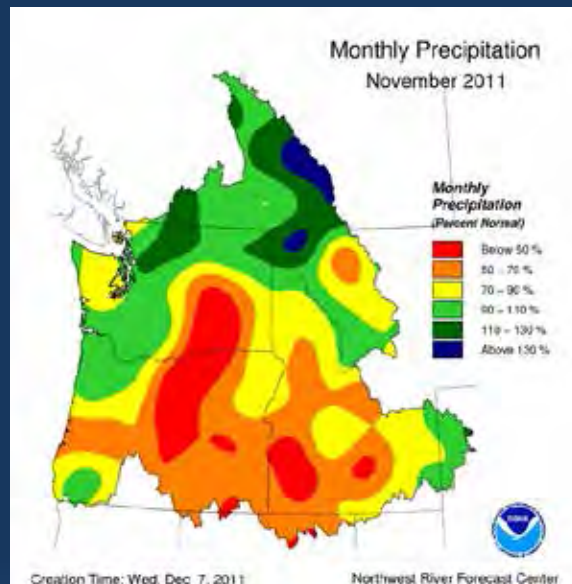
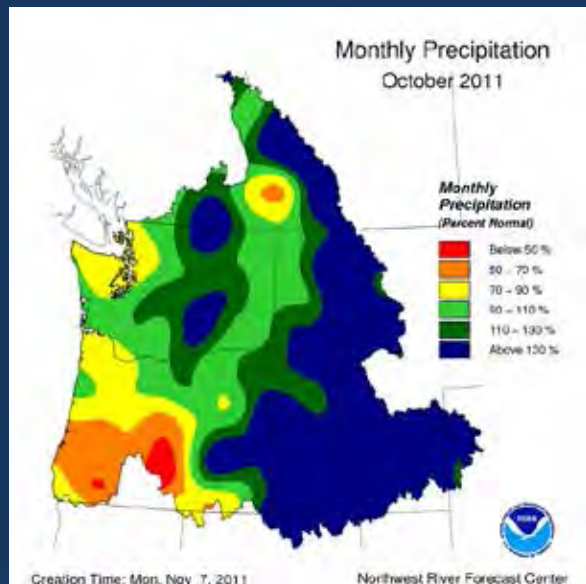
Precipitation

Snowpack

Runoff



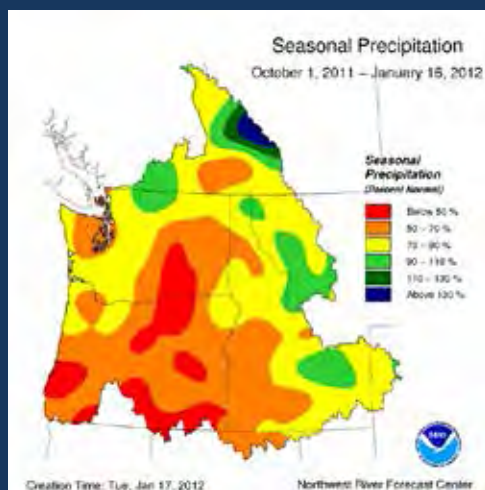
Observed Monthly Precipitation



Observed Jan 1 -23 precipitation
above Grand Coulee = 111%
above Ice Harbor = 147%
above The Dalles = 119%

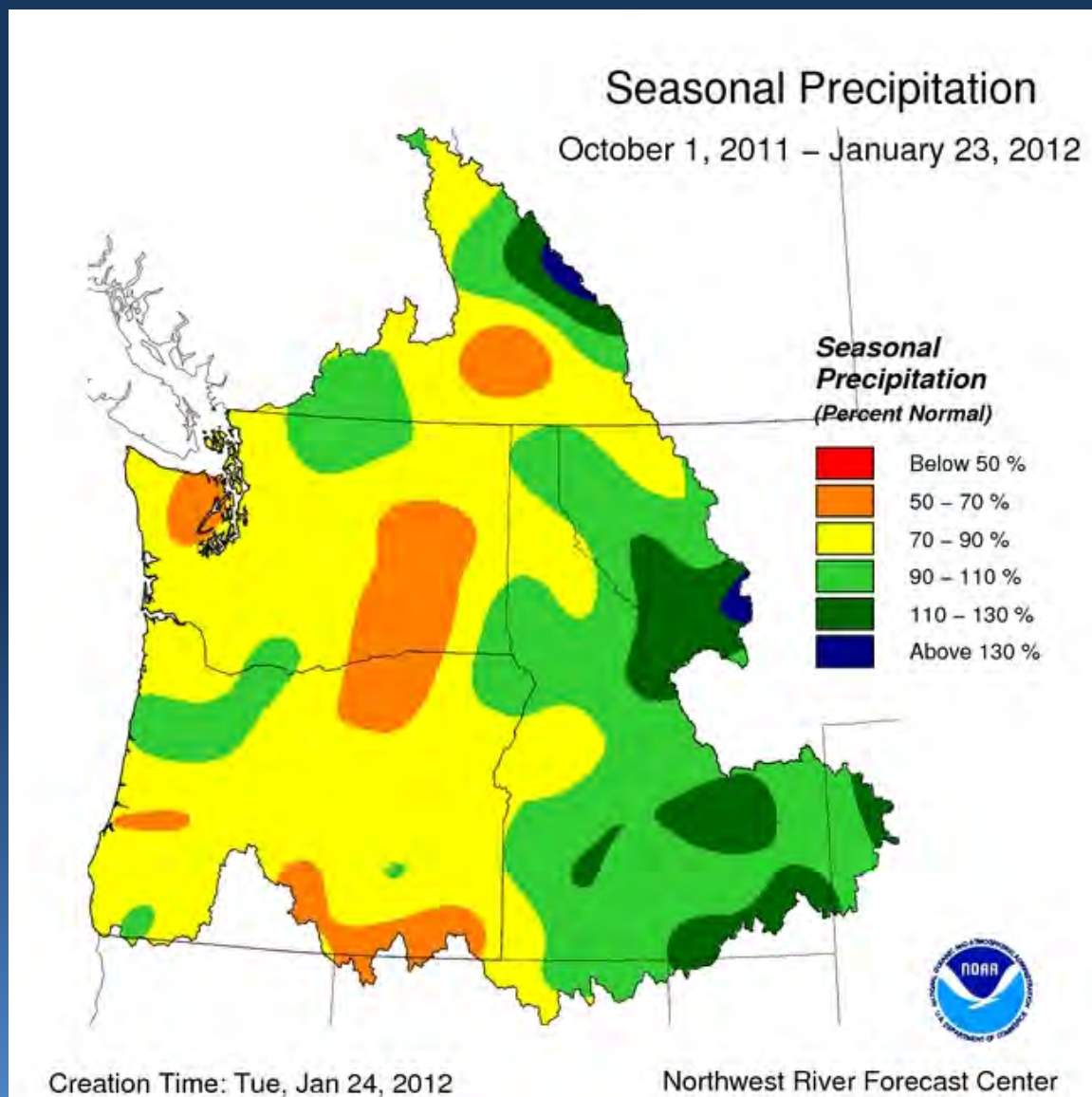


Observed Seasonal Precipitation



Observed Oct 1-January 23th
Precipitation

above Grand Coulee = 95%
above Ice Harbor = 98%
above The Dalles = 94%



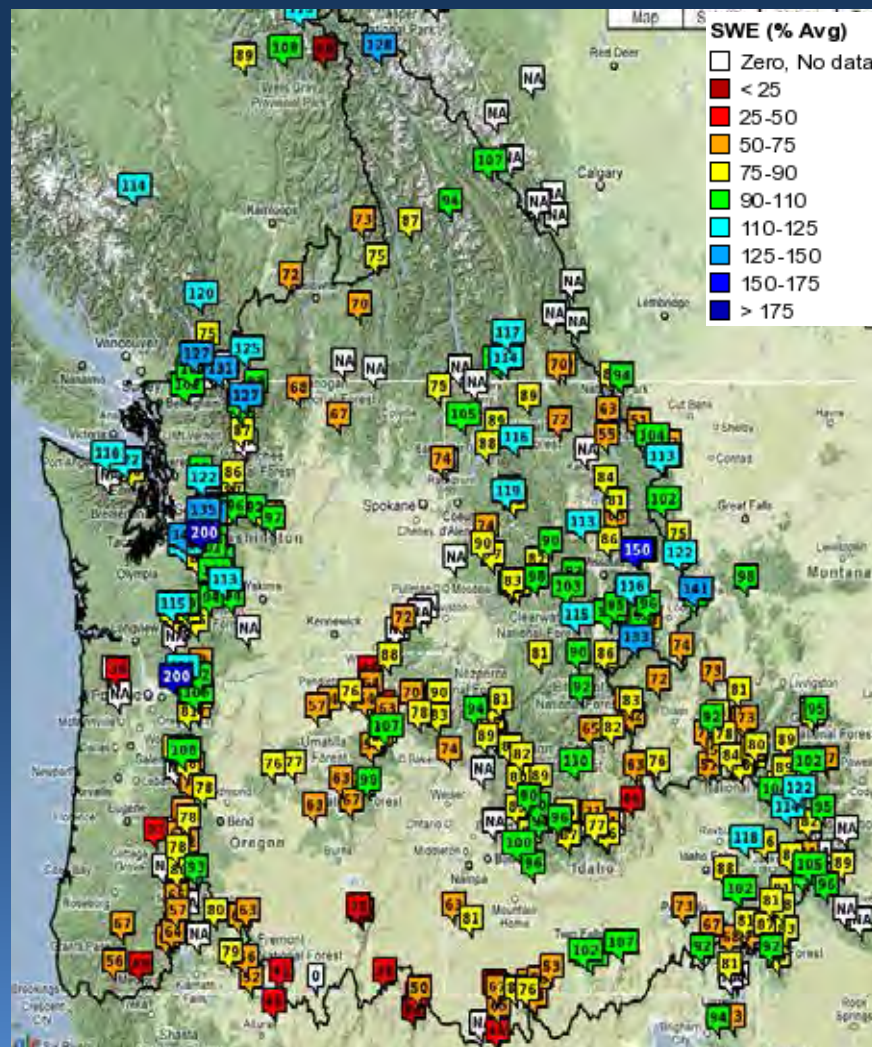
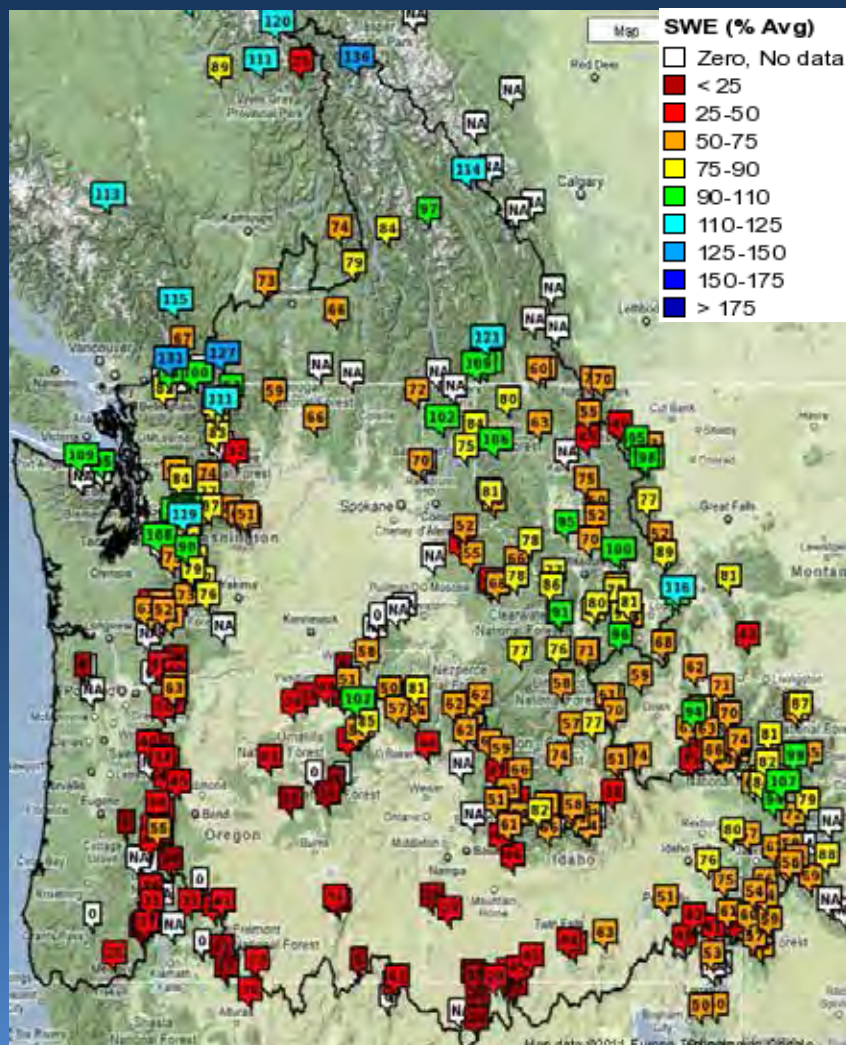


Current Snow Conditions



Jan 7, 2012

Jan 24, 2012



Upper Columbia Snow Conditions

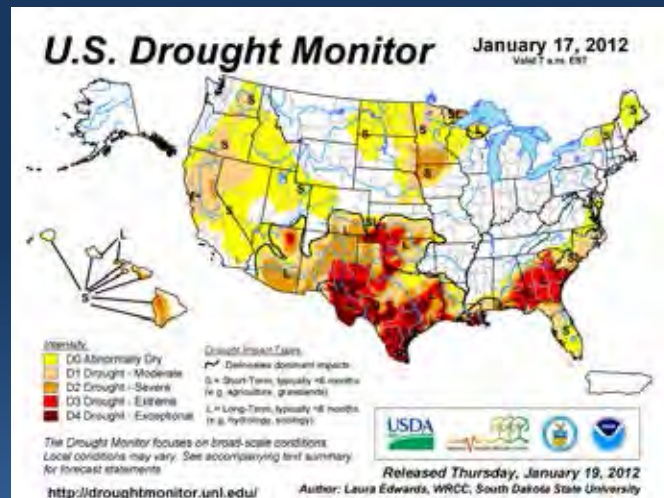
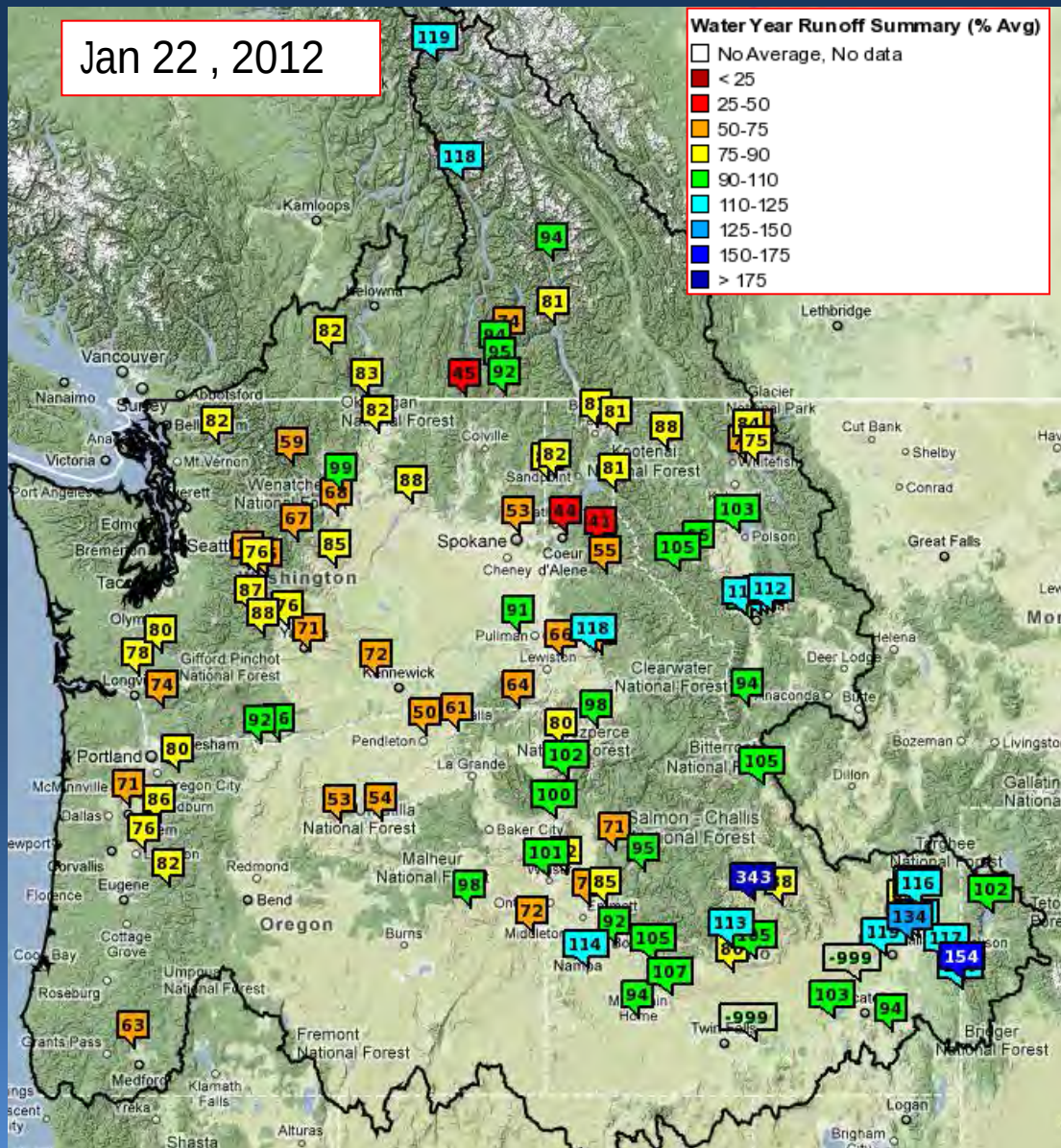


Snake River Snow Conditions



Lower Columbia Snow Conditions

Current Runoff Conditions





Future Conditions



Climate Outlooks

10 Day Precipitation Forecast

Water Supply Forecasts

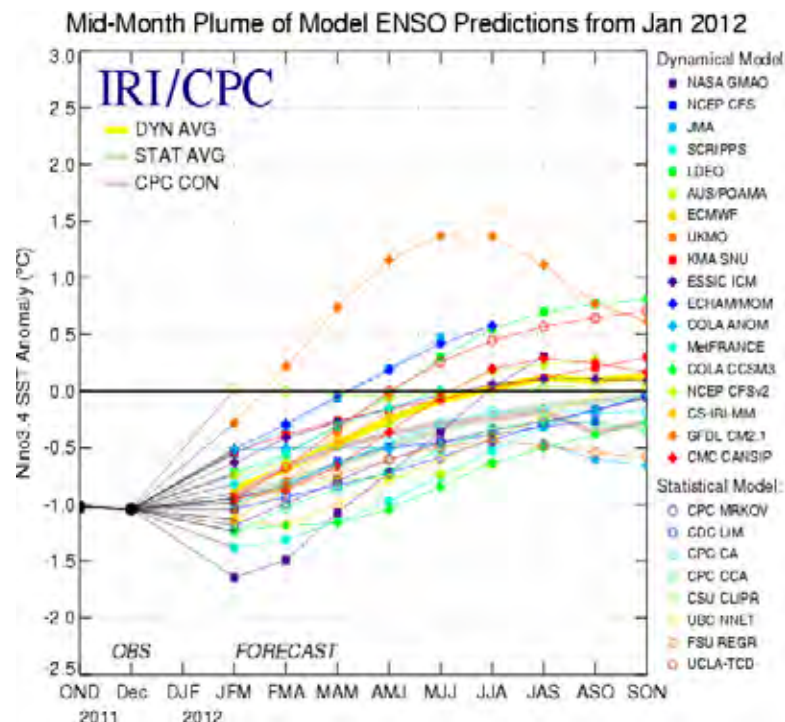
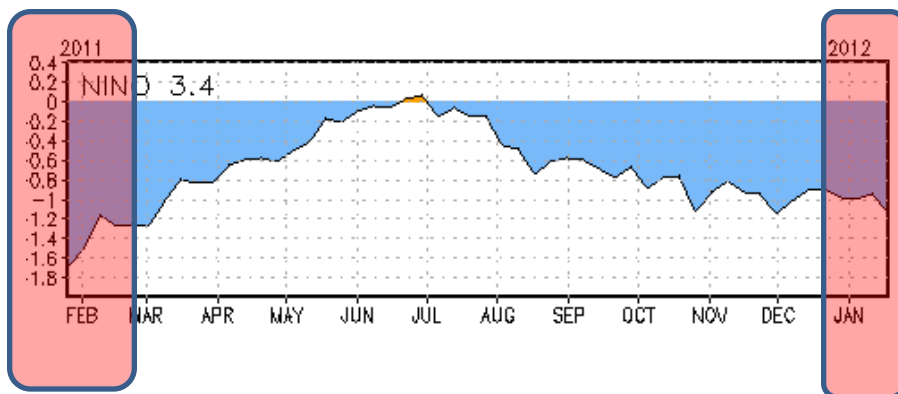


Enso: Observed and Forecast

SST Anomaly (Deg C)



Latest observed: SST 3.4 ~ -1.1 Deg C



CPC Synopsis: moderate La Niña is present and continues into spring 2012

Source: Climate Prediction Center Weekly ENSO Update

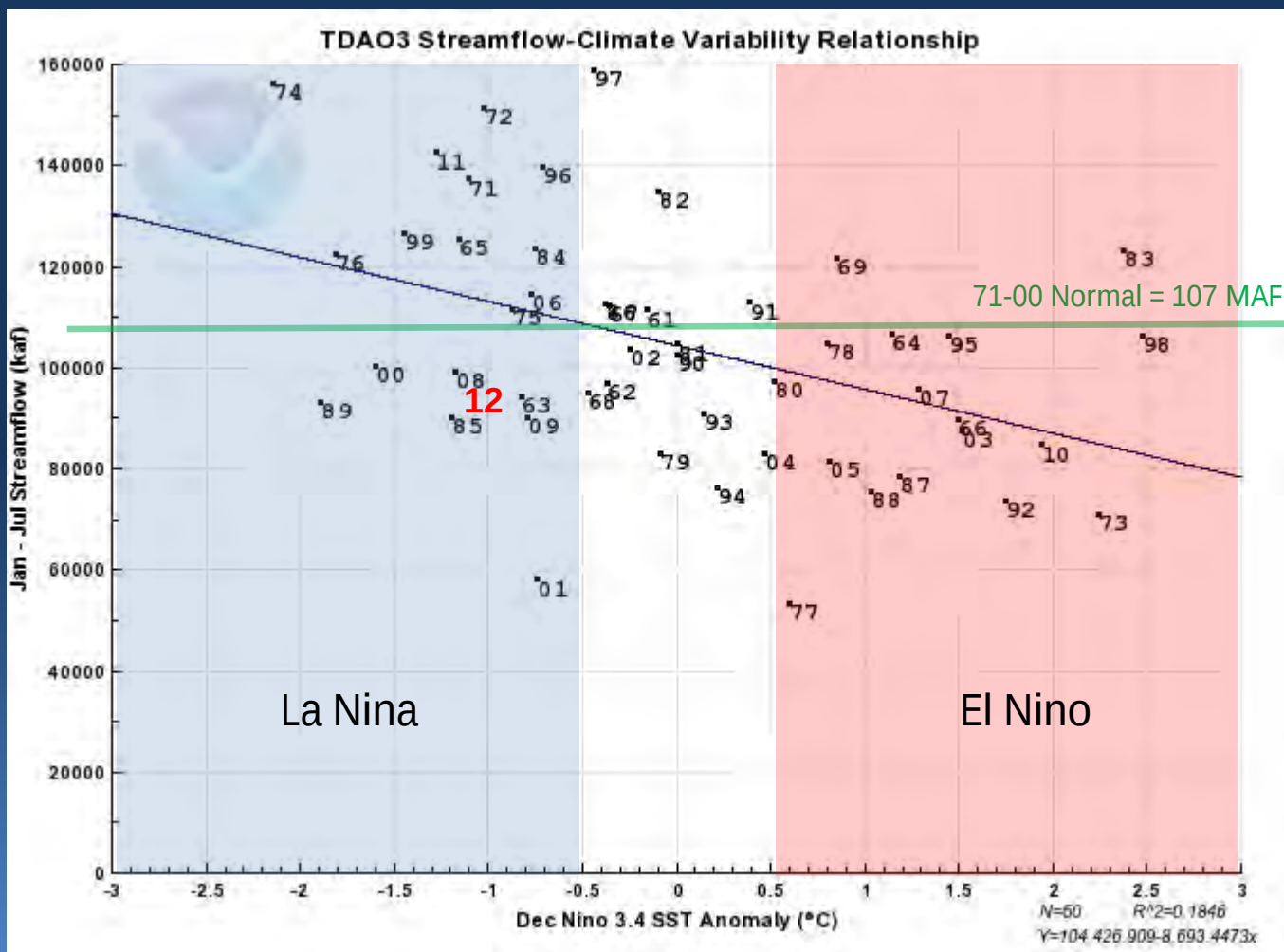
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf

UPDATE



SST Anomaly vs Streamflow

Columbia River near The Dalles

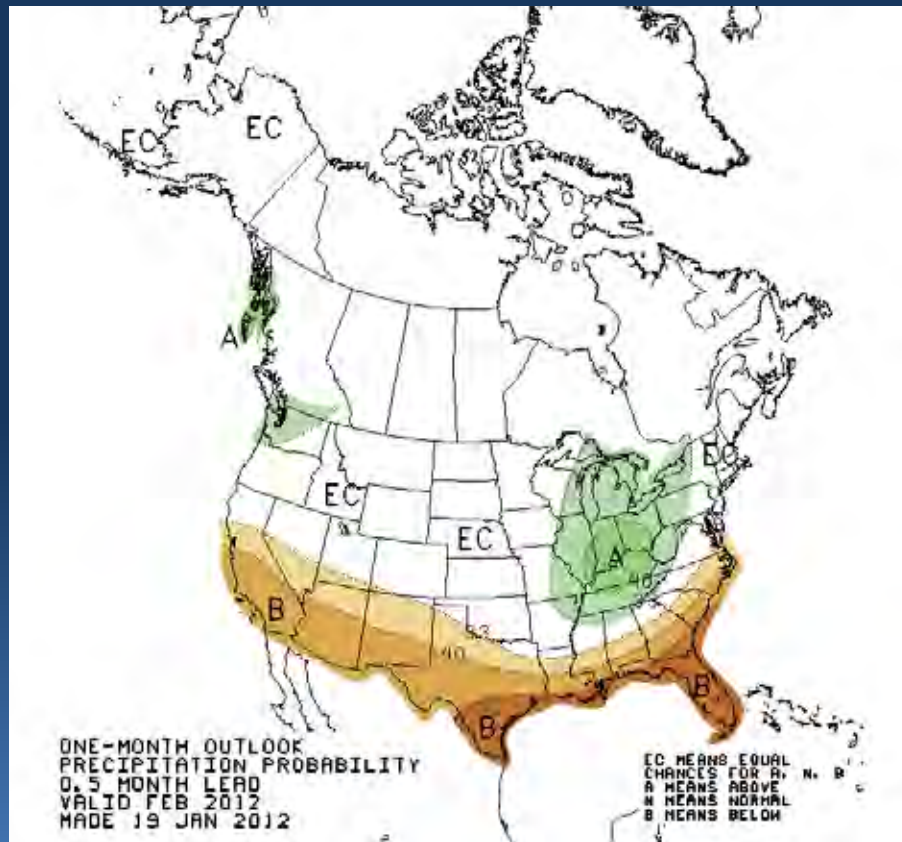




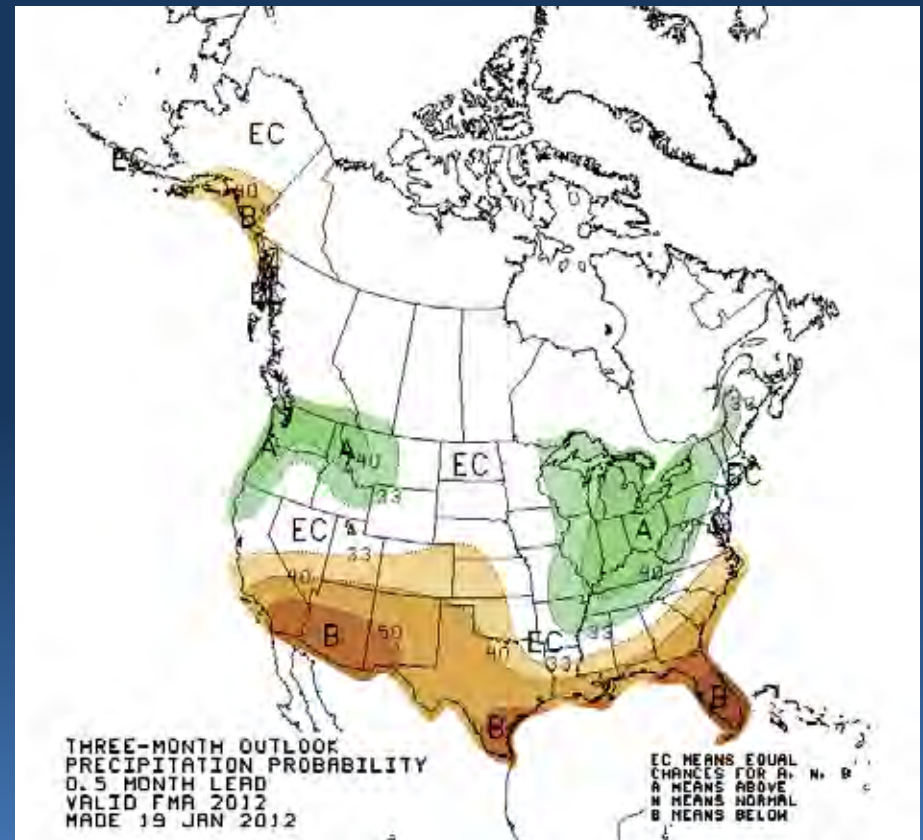
Climate Outlook: Precipitation



Current Month Outlook



Three Month Outlook

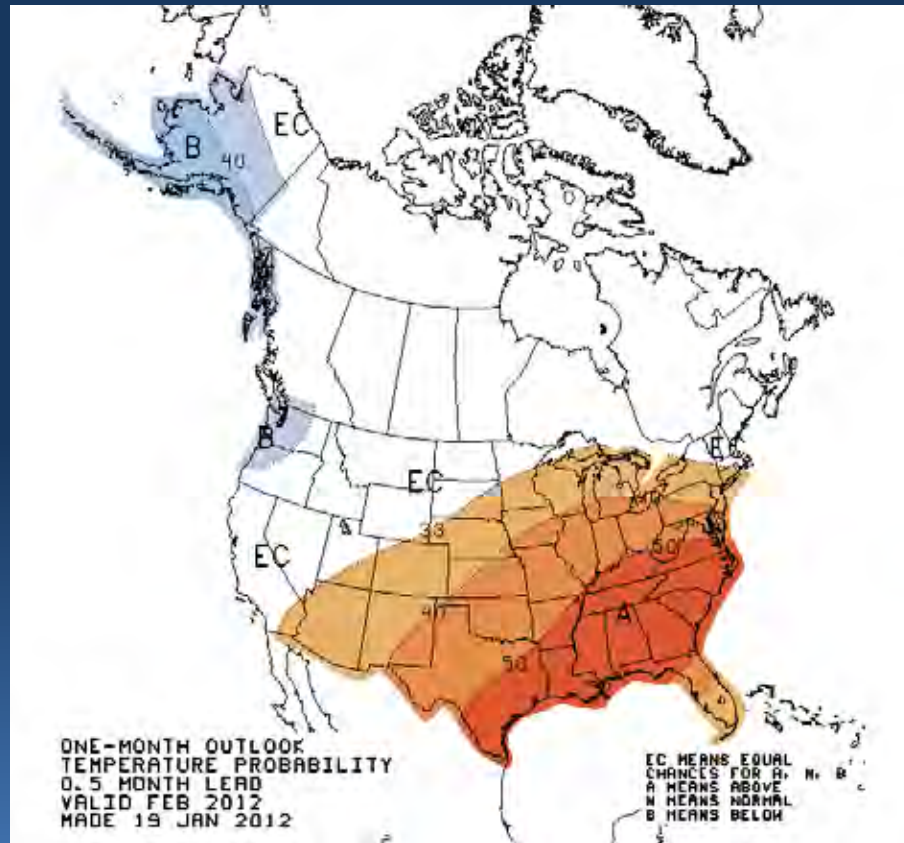




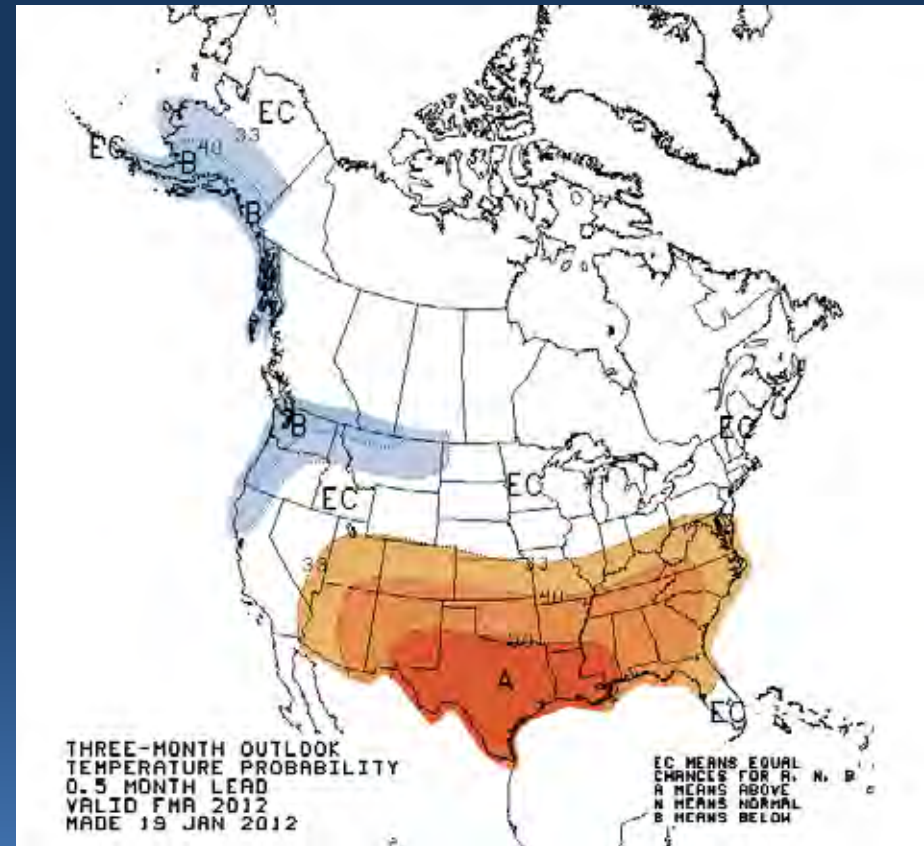
Climate Outlook: Temperature



Current Month Outlook



Three Month Outlook

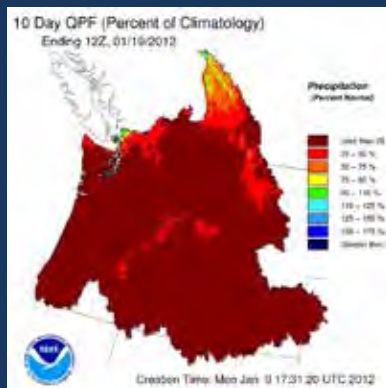




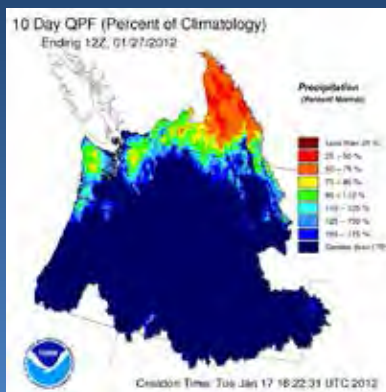
ESP 10 Day Precipitation Forecast



Previous Forecast Issued Jan 9th

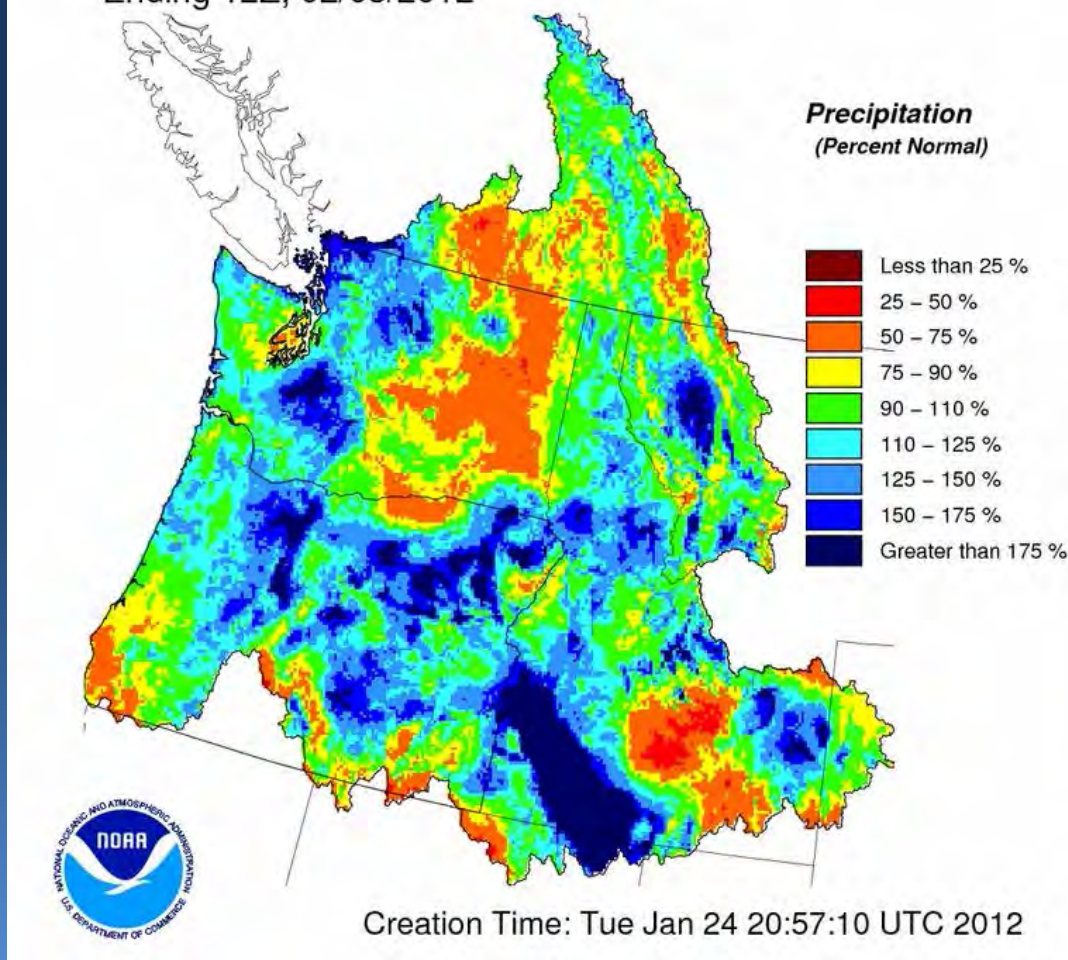


Previous Forecast Issued Jan 17



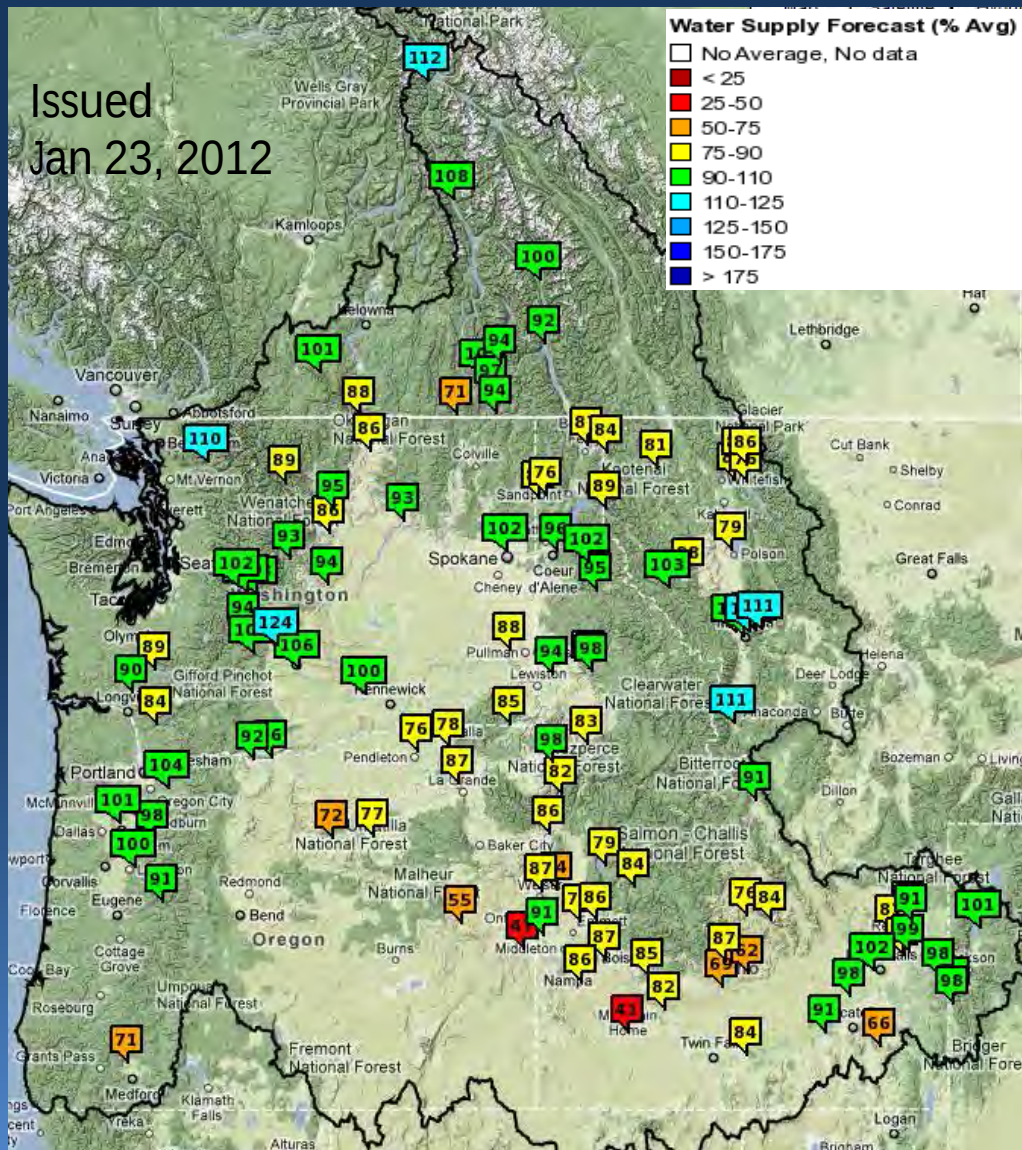
Forecast used in Jan 24 ESP Run

10 Day QPF (Percent of Climatology) Ending 12Z, 02/03/2012





Water Supply Forecasts



NWRFC Forecasts
Agency Collaborated

Ensemble Streamflow Procedure
Jan 22th Ensemble Date
Issued Jan 23th

Forecasts updated weekly/daily
All forecasts are 'official'

Forecasts include 10 days of
deterministic forecast
precipitation

Model States/Snow/Runoff
updated continuously through
month



Update NWRFC Water Supply Product

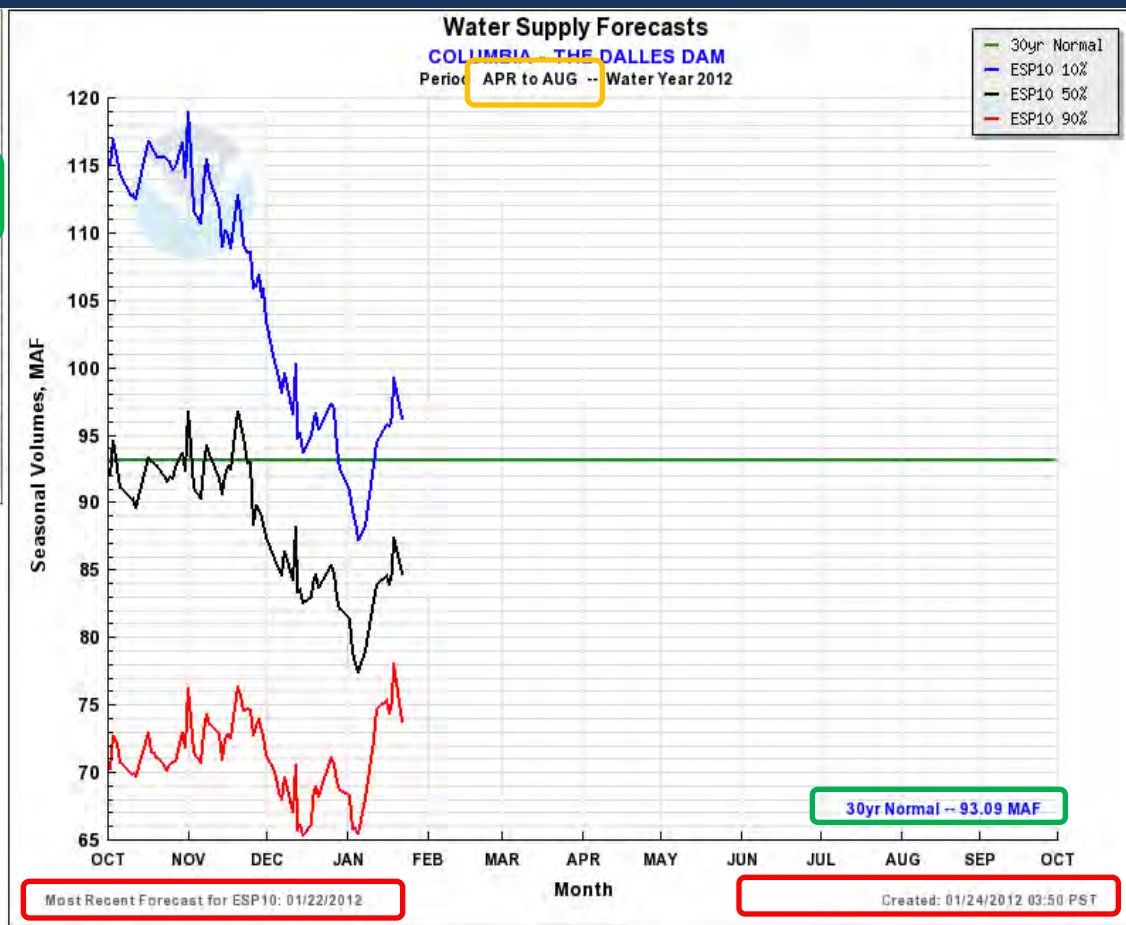


(TDAO3) COLUMBIA - THE DALLES DAM					
Forecasts for Water Year 2012					
Ensemble Date: 2012-01-22 Issue Date: 2012-01-23					
Official Forecast with 10 days of QPF					
Forecasts Are in KAF					
Forecast Period	90 %	50 %	% Average	10 %	71-'00 30 Year Average
APR-SEP	79588	91139	92	101652	98650
APR-JUL	66386	75754	89	86635	84650
APR-AUG	73797	84682	91	96220	93090
JAN-JUL	83533	93219	87	107430	107300
with 3 days of QPF Forecast Not Available					
with 0 days of QPF Forecast Not Available					

Move the mouse over the desired "Forecast Period" to display a graph.

Variety of addition formats:

- Text
- CSV
- Report
- Listing
- Map



90% -> 9 in 10 chance of volume being exceeded (quite likely)
10% -> 1 in 10 chance of volume being exceeded (a possibility)
50% -> 5 in 10 chance of volume being exceeded (most expected)



Water Supply Forecast: Upper Columbia



Rank: 40/52

81%



Rank: 34/42

76%



Rank: 22/42

96%



Rank: 35/52

88%



Water Supply Forecast: Snake



Rank: 19/52

101%



Rank: 20/42

98%



Rank: 27/42

86%



Rank: 26/52

87%



Water Supply Forecast: Lower Columbia



Rank: 27/52

86%



Rank: 18/42

101%



Rank: 34/42

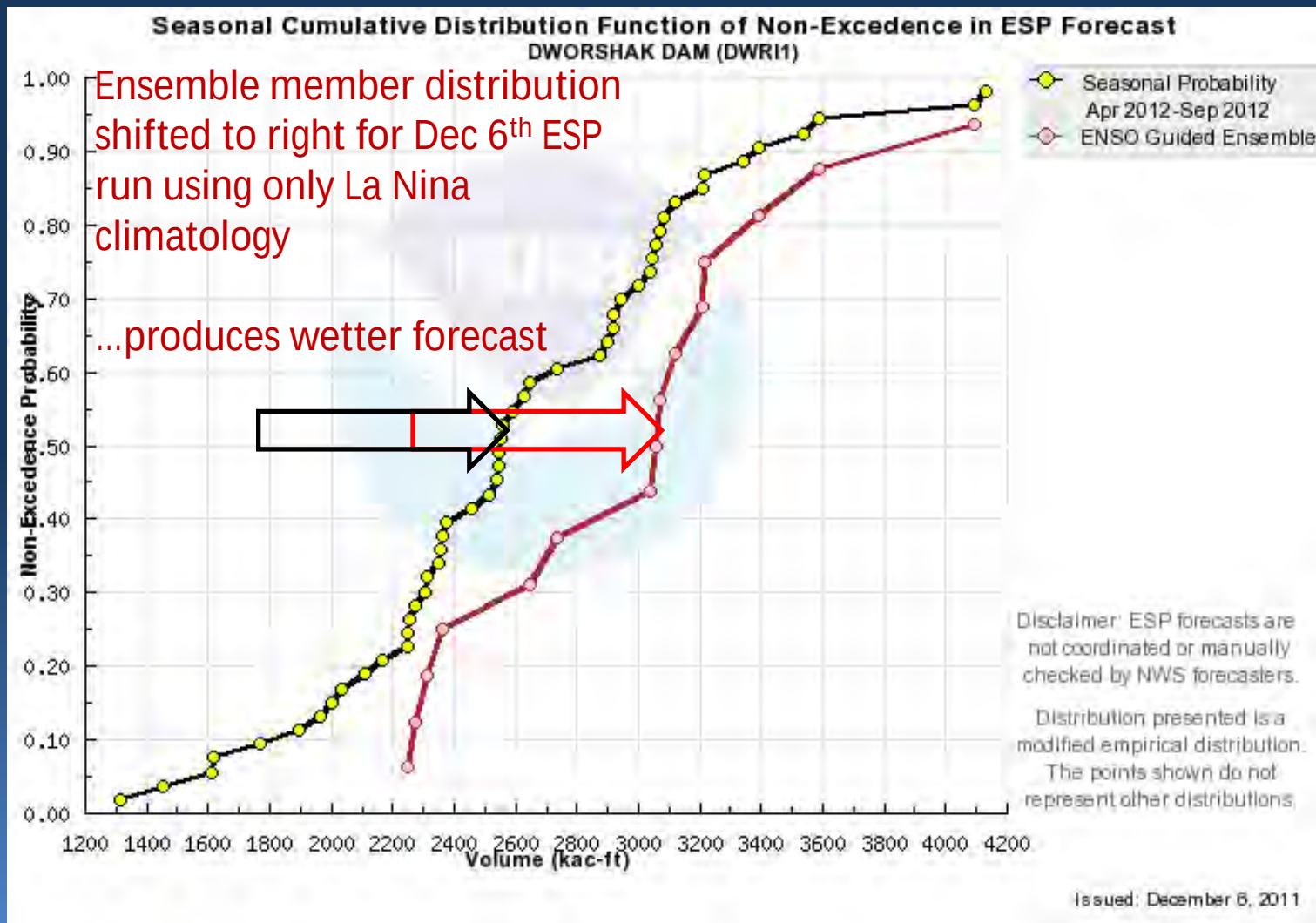
71%



Rank: 35/52

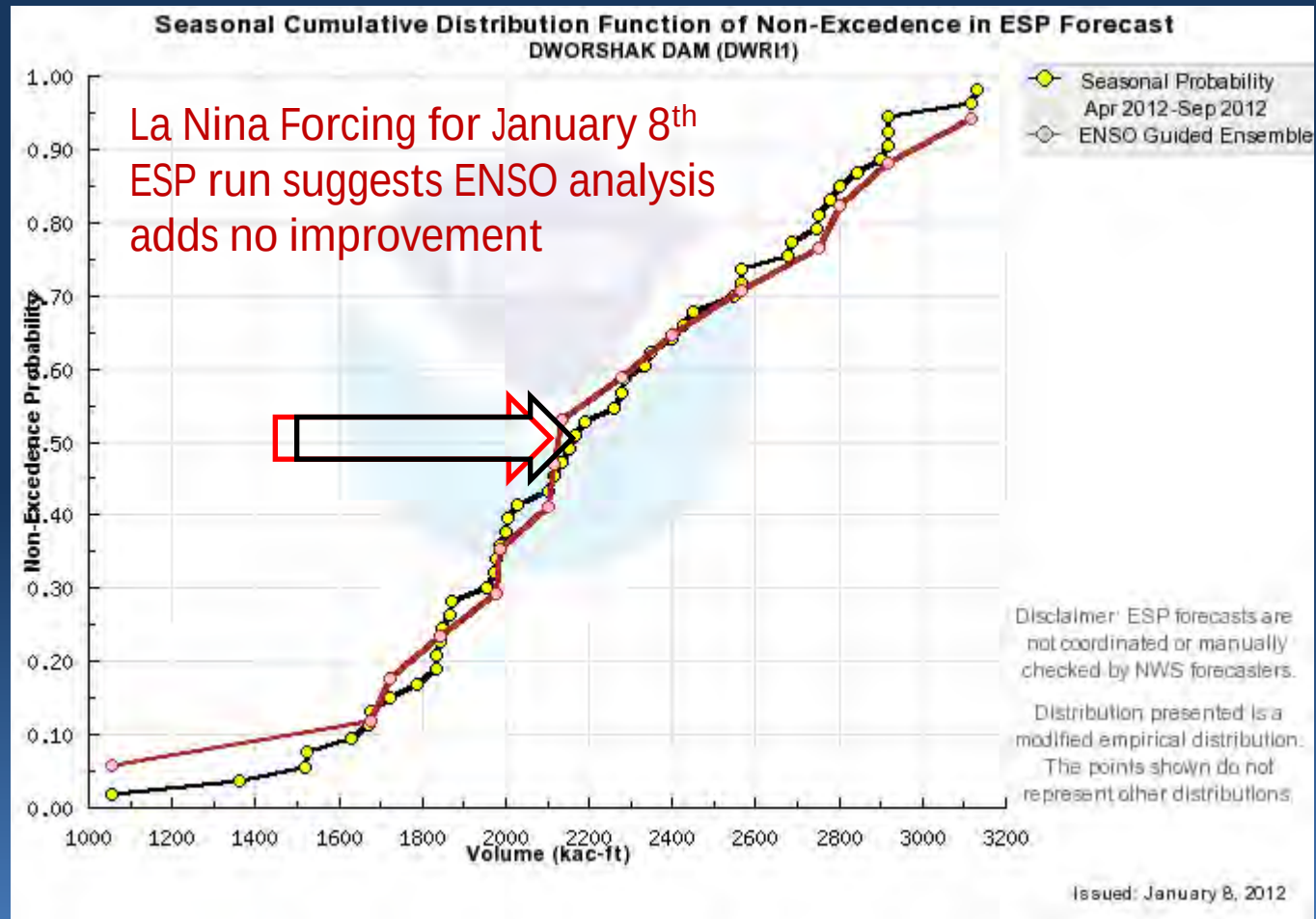
87%

ESP Analysis using La Nina Year Forcings





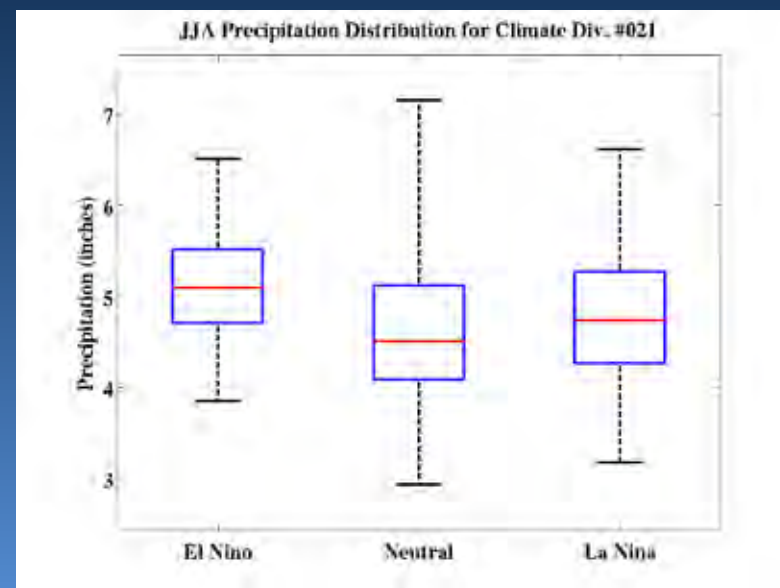
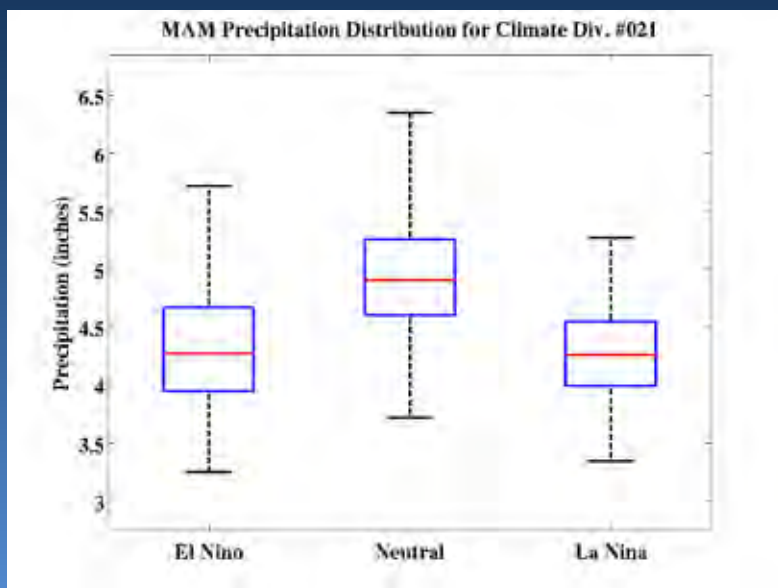
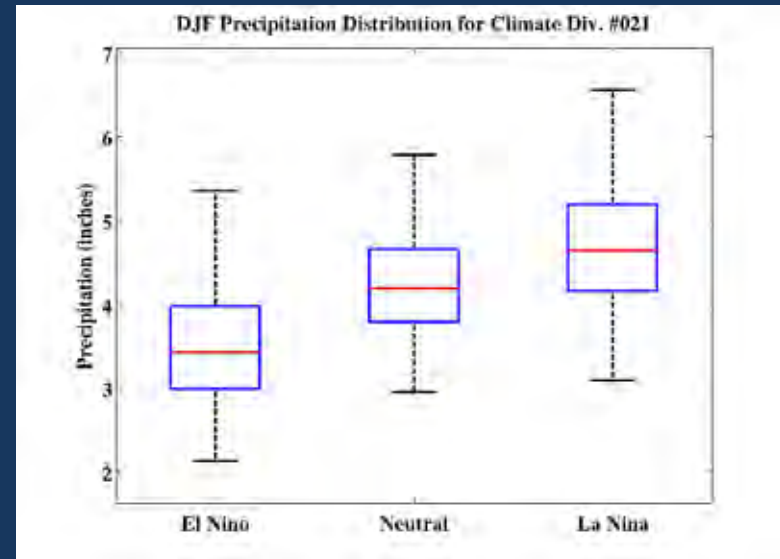
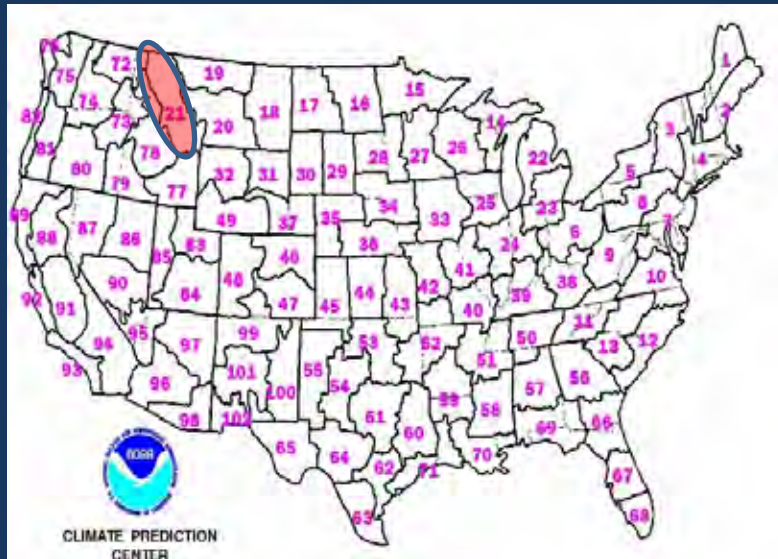
ESP Analysis using La Nina Year Forcings





ENSO Box and Whiskers Analysis

3 month Precipitation Distribution



NWRFC Water Supply Webpage

http://www.nwrfc.noaa.gov/water_supply/ws_schd.cgi



COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

January 25, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Meeting Minutes/Notes Review

The Official Minutes and Facilitator's Notes from all December, 2011 and January 11, 2012 TMT meetings were reviewed.

- o Official Minutes, December 7, 2011 Year End Review Section 4a: The White Salmon Work Group members are representatives from USFWS, Yakama Nation, NOAA Fisheries, USGS, US Forest Service, WDFW and PacifiCorp (not those listed in the notes).

With the above correction, and with no further edits, the notes were considered final.

NWRFC Water Supply Forecast

Stephen King, Northwest River Forecast Center, shared information with TMT about major shifts in the modeling methodology and website format, and reviewed the latest water supply forecasts. He reminded everyone that the RFC has shifted from using a regression based model procedure to now using ESP to model and issue forecasts. He invited TMT to ask questions and offer suggestions for improving products.

Observed conditions – Precipitation: October saw good rain, with a drier November and very dry December. January precipitation was below average for Grand Coulee, Ice Harbor and The Dalles, however the seasonal precipitation October-current is near normal. Snow pack: Raw data showed a 'dry' regional snow pack for January 7, with some increases showing up on the January 24 reading. Stephen also displayed some individual snow stations to show the variability and also the upward trend in accumulating snow pack. Runoff: Runoff is showing up low for the entire water year – this was a surprising finding.

Future conditions – ENSO predicts a La Nina year now through the Spring, but not as extreme as last year's La Nina condition. The correlation at The Dalles predicts a below normal runoff. Stephen noted that 'normals' will be recalibrated next year based on the most recent 30XX years' of data. The precipitation outlook shows a 'weak' signal toward slightly above normal and cooler temperatures over the next three months.

Changes to modeling/website – the ESP 10-day forecasts are updated daily and are agency *collaborated*, meaning there is information exchange, but no direct data input to the ESP model as was done in the past through agency *coordination*. All forecasts are considered official and are issued at least weekly, some daily – and moving toward a more consistent daily issuance. The forecasts include 10 days of QPF (deterministic

forecast for precipitation and temperature). As the season progresses, there should be less variability in the forecasts since it is not a regression model but adds in observed runoff. The RFC is working to get adequate software to be able to issue forecasts with 3 days and 0 days of QPF in addition to 10 days. Stephen asked for stakeholder input on specific needs for this, e.g. for long term forecasting.

Forecasts – The following are the current water supply forecasts (issues 1/23):

- o Upper Columbia: Libby 81% of normal; Hungry Horse 76%; Coeur D Alene 96%; Grand Coulee (Jan-July) 88%
- o Snake: Jackson Lake 101% of normal; Irwin 98%; Clearwater 86%; Lower Granite 87%
- o Lower Columbia Lake Chelan 86% of normal; Willamette 101%; Rogue 71%; The Dalles 87%

Stephen added that there is the capability to use climate forcings as a function of forecasting but it is not currently included in the official forecast. Most of the influence happens in mid-Winter, so that by January and on, there is not much difference in forecasts including vs. not including the La Nina condition.

Questions/comments –

- o Are you running the ESP in parallel with the regression model? Response: Yes, as back up, but not published. Eventually, the regression model will become the RFC's legacy model.
- o COE comment: The official forecast used by the Action Agencies will be the NWRFC forecast that is available on the NWRFC website on the fourth work day of the month at 5 pm PST.
- o While there is no need to obtain this product more often for use as an official forecast, the region may find it useful to view the more regularly issued forecasts.
- o It would be helpful for TMT to see The Dalles water supply in an April-August time frame.

For ongoing updates, anyone can join Stephen's monthly live water discussions. The next one is scheduled for 2/8.

Chum Update

Paul Wagner, NOAA, reported that the salmon managers discussed the possibility of lowering the tailwater elevation to 11.7 feet if conditions necessitate it. Recent data collection revealed a potential risk to dewatering redds if the tailwater is dropped below the 12' elevation, so the salmon managers recommended that the current 12 foot tailwater elevation be maintained while there is adequate water supply. Paul added that Battelle is working on a 3-dimensional analysis of the 2-D GPS data and will be able to share mapping of the redds in the near future.

Action: WDFW will follow up with Battelle on the mapping and report back to TMT ASAP.

Operation: John Roache, Reclamation, said given no Grand Coulee storage has or will be used to maintain the current elevation at Bonneville, Reclamation was supportive of the operation. Doug Baus, COE, said the action agencies will continue the current operation and revisit with TMT next week.

Operations Update

Reservoirs – John Roache reported on Reclamation projects. Grand Coulee was at elevation 1280 feet, passing inflow to support chum. Hungry Horse was at elevation 3537.39 feet with 2.5 kcfs outflows and 1 kcfs inflows, operating to meet Columbia Falls minimums. The Reclamation official forecast for Hungry Horse was 92% of normal. Banks Lake refill is going well and is about 9-10 feet from reaching operating range. Lisa Wright reported on COE projects. Libby was at elevation 2410.65 feet with 2.5 kcfs inflows and 4.0 kcfs outflows. Albeni Falls elevation was 2052.2 feet with 15.2 kcfs inflows and 13.0 kcfs outflows. Priest Rapids elevation was 486.6 feet with 107.3 kcfs inflows. Dworshak was at elevation 1523.1 feet with 1.7 kcfs inflows and 1.5 kcfs outflows. Lower Granite outflows were 32.4 kcfs; McNary outflows were 132.4 kcfs; and Bonneville outflows were 162.4 kcfs.

Fish – Paul Wagner, NOAA, said chum are doing well given the conditions and operations provided to support them this year.

Water quality – Laura Hamilton, COE, reported that there were problems with some of the gauges in January so the report shows missing data, indicated by a red box with a dot. Dworshak, Lower Granite, Little Goose, John Day, The Dalles and Warrendale gauges were effected, and have all been recovered. The problem was likely due to the rains and high flows. In response to a request, Laura said she would reformat the report to distinguish those gauges that were not operating due to seasonal outage from those that were not operating because of a break down in the reporting system.

Next Meeting, 2/1 Conference Call, 9:00 am: Chum operations will be discussed. Please check the website for updates on schedule and meeting cancellations. If the Wednesday meeting is cancelled, a notice will be posted to the TMT page by 3:30 pm the Tuesday before.

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

January 25, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of the COE, Oregon, NOAA, BOR, Washington, CRITFC, BPA, Idaho, Montana and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review December 7, 14, 21, 28 and January 11 Meeting Minutes

David Wills, USFWS, corrected the list of White Salmon Working Group members in the first paragraph of section 4a of the official minutes for the December 7 TMT year end review. The seven members are USFWS, Yakama Tribe, NOAA, USGS, U.S. Forest Service, WDFW and PacifiCorp. With this change, all of the above notes and minutes were declared final.

3. NWRFC Forecasting Update

Stephen King, NWRFC, gave a presentation on the River Forecast Center's new method of forecasting and showed TMT how to navigate the updated RFC website. King showed TMT the latest weather projections and trends as of January 23, 2012.

At present, conditions are wetter in the northern tier of the Columbia basin than in the south. Observed water year precipitation shows a pattern of extreme dryness from the end of November to mid December. However, as of January 23, seasonal precipitation was 95% of normal above Grand Coulee, 98% of normal above Ice Harbor and 94% of normal above The Dalles. King noted that, on average, about 30% of the flow through The Dalles comes from the headwaters in British Columbia, with strong upstream contributions also from western Montana.

King showed plots of snowpack on January 7 vs. January 24, with a visible increase in areas where snowpack is greater than 110% of normal. Conditions in the Columbia basin have clearly improved, and many areas have gone from having below normal to almost normal water supplies. In the lower Columbia, the Cascade Range in Washington is generally above normal, while conditions are dry in Oregon. The driest areas are in southeast Oregon.

Regional observed runoff has been low in 2012 and a bit surprising after the enormous runoff for water year 2011. Drought conditions have crept into the Northwest as depicted by the US Drought Monitor product.

The Northwest is in a La Nina pattern as it was in 2011, but the current episode is milder than last year's. The sea surface temperature anomaly for the El Nino 3.4 region is -1.1 C; last year it was -1.8 C. Most of the models indicate that La Nina conditions will continue through the spring of 2012 and revert to neutral conditions by summer or fall. King showed TMT a scatter plot of La Nina vs. El Nino years that directly correlates La Nina episode to higher runoff volumes at The Dalles. However, he noted that there the relationship is weak and contains considerable scatter.

Average runoff for The Dalles is 107 MAF for the Jan-Jul period. Every 10 years the RFC updates its historic database. The current definition of normal water supply is based on observed data from 1971-2000. Starting in the 2013 water year, the definition of normal will be based on observed data from 1981-2010.

The 90 day climate outlook for the Northwest shows an increased chance for above normal precipitation. The ESP forecast use a 10-day deterministic forecast for precipitation and temperature and the current forecast was based on a forecast that was near to slightly above normal across the region.

The new RFC forecasting method relies heavily on precipitation and temperature data and is tuned by NWRFC staffed on a daily basis. It takes 24 hours to generate an ESP run. The ensemble date indicates the date when the model was initialized and the issue date is when the forecast was posted to the web. Forecasts will be provided at least once weekly, with the long-term goal of providing daily or near-daily forecasts. In recent months, the RFC has issued updates approximately four times per week. All RFC forecasts posted on the web are considered official; there is no single official forecast for each month.

Baus and Bill Proctor clarified that the Action Agencies are using the RFC forecast provided at 5 pm PST on the fourth working day of each month as the official monthly RFC water supply forecast

Users of the new web-based RFC system can extract data for their own purposes, using creation date to note when they did so, King explained. There was discussion of confidence intervals and the number of days of forecast data used in the forecasts. The RFC uses 10 days of forecast precipitation and temperature and this is combined with approximately 50 years of weather scenarios. The new RFC forecasts include a 50% likelihood (median trace), 90% likelihood and 10% likelihood scenario. King asked TMT to let him know whether intervals of 95% and 5% likelihood would be more useful.

In summary, the region's water supply is still below normal for water year 2012 despite the recent heavy rains. For future conditions, King gave April-August projections:

- Libby – 81% of normal (the 40th driest year of 50 years on record)
- Hungry Horse – 76% of normal (year 34 of 42)
- Coeur D'Alene – 96% of normal (year 22 of 42)
- Grand Coulee (January-July) – 88% of normal (year 35 of 52)
- Upper Snake – 101% of normal (year 19 of 52)
- Palisades – 98% of normal (year 20 of 42)
- Clearwater – 86% of normal (year 27 of 42)
- Lower Granite (January-July) – 87% of normal (year 26 of 52)
- Lower Columbia at Lake Chelan Dam – 86% of normal (year 27 of 52)
- Willamette – 101% of normal (year 18 of 42)
- South Rogue River – 71% of normal
- The Dalles (January-July) – 87% of normal (April-September: 92% of normal)

King asked whether the timeframe matters to TMT. Wagner said April-August is preferable, with April-September acceptable for The Dalles. Wagner asked, will RFC run the new ESP forecasts in parallel with regression forecasts? King said yes, RFC is using a legacy system as an unpublished backup this year.

In terms of climate patterns for La Nina years, King pointed out that most of the increased water supply happens mid-winter in a typical La Nina year. Last year was unusual in that a strong La Nina signal produced fairly dry observed conditions during the winter months. The heavy rains of 2011 came during the spring months, which is not the typical La Nina pattern.

Users of the new website can find registration information for periodic live water supply briefings hosted by the NWRFC. The website also has an archive that includes historical forecasts and how they were verified.

4. Chum Update

Paul Wagner, NOAA, gave an update on the chum operation. Bonneville is still operating in accordance with the 12-foot tailwater operation as previously coordinated, per FPAC's recommendation. There was consideration of dropping the range to 11.7 feet, but field survey crews advised that redds clustered on shoreline edges could be placed at risk by a lower level. Therefore, if water supplies are sufficient to maintain 12 feet, that is the preferred operation. Baus asked the status of Battelle's efforts to plot 3-dimensional redd location maps for 2012. Cindy LeFleur, WDFW, said she will find out when this information will be available.

Flows at Bonneville to support the 12-foot tailwater for chum are not currently dependent on releases from Grand Coulee storage, so BOR supports the current 12-foot operation, John Roache said. The Action Agencies will continue the current 12-foot operation below Bonneville in support of chum, Baus said. TMT will revisit the chum operation in a conference call February 1.

5. Operations Review

a. Reservoirs. Grand Coulee is at 1280 feet elevation, essentially passing inflows for the past few weeks. This operation is expected to continue as no more storage is needed, and local inflows are sufficient to support the chum operation at Bonneville. Banks Lake refill is on track, with a current lake elevation of 1555 feet after drafting down 30-32 feet for maintenance that started last October. BOR has since pumped 15-16 feet back into the lake, bringing the elevation closer to its normal operating range of 1565-1570 feet for this time of year.

Hungry Horse is at 3537.39 feet, with 2.5 kcfs releases and 1 kcfs inflows, drafting slightly to support Columbia Falls minimum flows. The official BOR forecast is 92% of normal water supply. Libby is at 2410.65 feet, with inflows of 2.5 kcfs and releases of 4.0 kcfs. Albeni Falls is at 2042.2 feet, with inflows of 15.2 kcfs and outflows of 13 kcfs. Priest Rapids is at 486.6 feet, with inflows of 107.3 kcfs. Dworshak is at 1523.1 feet, with inflows of 1.7 kcfs and outflows of 1.5 kcfs.

Lower Granite outflows are 32.4 kcfs. McNary outflows are 132.4 kcfs. Bonneville outflows are 162.4 kcfs.

b. Fish. Chum are the only fish active at present, and they are doing fine, Wagner reported.

c. Water Quality. Laura Hamilton, COE, reported that six gages experienced technical problems in January. Dworshak tailwater gage produced no data for January 17-19. Lower Granite tailwater gage produced less than 24 hours of data on January 19, and Little Goose tailwater gage produced no data that day. The gages at John Day, The Dalles, and Warrandale below Bonneville failed to transmit 4 days' worth of data in January. Some of these data are being recovered by USGS, which maintains the gages on the lower Columbia.

It is not yet clear what caused the gage failures. The fact that all four faulty gages on the Lower Columbia quit transmitting data on January 12 at 2400 hours indicates that the DCP transmitter failed.

Hamilton reported that the Cascade Island monitoring station, which was destroyed by the heavy flows of 2011, has been rebuilt at a higher elevation.

Dave Wills, USFWS, suggested that the background colors on the RCC's water quality graphs be changed to distinguish between missing data and gages that are offline for the season.

d. Power System. There was no update today.

4. Next TMT Meeting

A tentative conference call for a chum operations update was scheduled for February 1.

<i>Name</i>	<i>Affiliation</i>
Doug Baus	COE
Rick Kruger	Oregon
Paul Wagner	NOAA
Lisa Wright	COE
Kim Johnson	COE
Greg Bowers	COE
James Manzione	COE
Laura Hamilton	COE
Karl Kanbergs	COE
John McKoskery	COE
Steve King	NWRFC
Bill Proctor	COE

<i>Phone:</i>	
John Roache	BOR
Cindy LeFleur	Washington
Tom Lorz	CRITFC
Scott Bettin	BPA
Russ Kiefer	Idaho
Don Tinker	SCL
Harvey Hall	EWEB
Russ George	WMC
Bruce McKay	hydropower consultant
Steve Hall	COE Walla Walla
Dave Benner	FPC
XX	Merrill Lynch
Tim Baldwin	Energy GPS
John Hart	EWEB
Richelle Beck	Grant PUD
Brian Marotz	Montana

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger / Ron Boyce	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday February 1, 2012 9:00am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 6845

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Chum Update - Paul Wagner, NOAA Fisheries
3. Other
 - a. Set agenda and date for next meeting - **February 8, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger / Ron Boyce	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday February 8, 2012 9:00am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 6845

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Update on Water Supply Forecast - Doug Baus, COE-RCC
 - a. [RFC February Final Forecast](#)
 - a. [NRCS SNOTEL](#)
3. Chum Update - Paul Wagner, NOAA Fisheries
 - a. [Chum Locations](#)
4. Other
 - a. Set agenda and date for next meeting - **February 15, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

February 8, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

February Final Water Supply Forecasts

Doug Baus, USACE, presented the February final forecasts (linked to today's agenda item on the TMT page). The forecast for Grand Coulee April-September was 60,912 kaf (95% of average); for The Dalles April-August was 84,454 kaf (91% of average); and for Lower Granite April-September was 20,713 kaf (86% of average). He also reported on Libby April-August, which showed 5.713 MAF, and Dworshak April-July, showing 2.50 MAF. John Roache added the Hungry Horse May-September official forecast, which was 1,781 kaf (97% of average).

Doug also shared SNOTEL information, noting the variability in snow water equivalent across the Columbia Basin, with North Puget Sound at 106% of normal, northern Idaho at 95% of normal and in Oregon the Willamette was 64% of normal.

Doug clarified that the COE's official monthly forecast is that which is issued by the NW River Forecast Center on the 4th working day of each month.

Chum Update

Paul Wagner, NOAA, shared a chum redds map depicting locations of the redds at different elevations. According to the map red dots indicate redds that would be dewatered at a Bonneville tailwater elevation of 12.0 ft. The map clarified that a group of red dots denoted with a circle are located above a riffle and elevations may not be as accurate, so many of these redds may be covered at a 12.0 ft Bonneville tailwater elevation. Based on these data and the current short and long-term forecasts showing increased precipitation in the region, the Salmon Managers requested that the Corps continue with the current operation of a minimum tailwater elevation of 12.0 ft. during all hours to provide a higher level of certainty that redds will remain watered. Paul added that this operation may also provide some level of protection to redds further downstream near I-205 and Woods Landing. Additionally, they believe continuing the current 12.0 ft minimum Bonneville tailwater operation would not put later spring needs at risk, specifically refill at Grand Coulee.

Action/Planned Operation: With no further questions and agreement from BPA and Reclamation that the 85% probability of refill at Grand Coulee would still be met if the operation continues this week, USACE planned to maintain a 12.0 ft minimum tailwater elevation at Bonneville, and revisit the operation with TMT next week.

Next Meeting, 2/15 Face to Face, 9:00 am

Agenda items include:

- Hanford Reach Update
- Chum Operations Update
- Flood Control Forecasts
- Operations Review

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

February 8, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of Idaho, NOAA, BPA, COE, BOR, USFWS, Washington, the Colville Tribe, CRITFC and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Update on Water Supply Forecast

Baus gave TMT the latest water supply forecasts for Grand Coulee, The Dalles, Lower Granite, Libby, and Dworshak. These forecasts are all posted on the TMT webpage under Water Control Data, then Flood Control, in addition to being linked to today's agenda.

Water supply forecasts as of February 6 are:

- Grand Coulee (April-September) – 60,912 KAF, 95% of average, (NWRFC)
- The Dalles (April-September) – 89,625 KAF, 91% of average, (NWRFC)
- Lower Granite (April-September) – 20,713 KAF, 86% of average, (NWRFC)
- Libby (April-August) – 5,713 KAF (COE)
- Dworshak (April-July) – 2,504 KAF (COE)
- Hungry Horse (May-September) – 1,781 KAF (BOR), 97% of average

Also linked to today's agenda are the latest SNOTEL site readings from the NRCS, displayed on a map of the region. The following sub-basins demonstrate the range of variability of snow water equivalent in percentages of normal throughout the Columbia Basin:

- North Puget Sound – 106% of normal (highest in region)
- Northern Idaho panhandle – 95% of normal
- Willamette River, Oregon – 64% of normal

Ruth Burris, PGE, asked how the COE selects final forecasts for each month now that the RFC publishes its official forecasts daily. The COE uses the forecast posted on the RFC webpage at close of business on the fourth working day of the month, Baus replied.

3. Chum Update

Paul Wagner, NOAA, gave a status update on the chum redds below Bonneville. A spreadsheet showing the GPS coordinates for redds documented during spawning activity this fall is linked to this item on today's agenda. According to the legend red dots on the map indicate redds that would be dewatered at a 12.0 ft. Bonneville tailwater operation. Although denoted on the map the red dots would be dewatered upon further consultation with WDFW there is a significant number of these redds denoted in a circle that would actually be covered at a 12.0 ft. tailwater.

The redds at the northern end of Ives Island, shown as a circled cluster of red dots on the map, are at elevations from 12.5-13 feet, leaving them potentially exposed by the current 12-foot tailwater elevation below Bonneville. However, a plentiful groundwater supply in this area compensates for the discrepancy.

A detailed review of the data in the table suggests that a tailwater elevation of 11.5 feet would keep most existing redds wet. However, Wagner said, the Salmon Managers prefer to continue the 12-foot operation if it doesn't interfere with an 85% probability of meeting the April 10 flood control elevation at Grand Coulee. The current operation provides a high level of certainty that all redds will remain watered, as well as some additional protection for downstream redds in the Multnomah Falls and I-205 areas that receive combined flows from the Columbia and Willamette rivers.

The Action Agencies gave their views of FPAC's recommendation:

- **BPA** – No objection. Operating to 12 feet will not impact Grand Coulee operations at this time.
- **BOR** – No objection. Maintaining 12 feet of elevation below Bonneville does not impact the probability of meeting the April 10 flood control elevation at Grand Coulee, given current projections. This will be monitored and discussed at future TMT meetings.

Hearing these views, the COE will continue the 12-foot tailwater operation below Bonneville. TMT will revisit the chum operation at its next meeting.

4. Next TMT Meeting

TMT will meet in person February 15 at the COE division office in Portland. The agenda will include the year's opening review of Grant PUD's emergence and sampling program in Hanford Reach, as well as a chum update and the regular operations review.

<i>Name</i>	<i>Affiliation</i>
Russ Kiefer	Idaho
Paul Wagner	NOAA
Scott Bettin	BPA
Doug Baus	COE
John Roache	BOR
David Wills	USFWS
Cindy LeFleur	Washington
Harvey Hall	EWEB
Lisa Wright	COE
Margaret Filardo	FPC
Dave Benner	FPC
Heather Dohan	Puget Sound Energy
Don Tinker	Seattle City Light
Mike Shafley	Snohomish PUD
Russ George	WMC
Bruce McKay	hydropower consultant
Rob Allerman	Deutsch Bank
Sheri Sears	Colville
Ruth Burris	PGE
XX	Chelan PUD
Greg Otting	Merrill
Tom Lorz	CRITFC
Steve Hall	COE Walla Walla
Richelle Beck	Grant PUD

[Header for Water Supply Information](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(GCDW1) COLUMBIA - GRAND COULEE DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-02-05 Issue Date: 2012-02-06

[Water Supply Plot for COLUMBIA - GRAND COULEE DAM](#)For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	54393	60912	95	67170	63990
APR-JUL	43930	49620	92	56005	53850
APR-AUG	50663	56788	94	62890	60290
JAN-JUL	50710	56031	89	64672	62900

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

 [Header for Water Supply Information Page](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(TDAO3) COLUMBIA - THE DALLES DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-02-05 Issue Date: 2012-02-06

 [Water Supply Plot for COLUMBIA - THE DALLES DAM](#)

For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	80264	89625	91	100488	98650
APR-JUL	66410	74960	89	85916	84650
APR-AUG	74779	84454	91	94692	93090
JAN-JUL	82723	91246	85	105661	107300

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

 [Header for Water Supply Information](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(LGDW1) SNAKE - LOWER GRANITE DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-02-05 Issue Date: 2012-02-06

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	16933	20713	86	23734	24140
APR-JUL	14877	18282	85	21264	21550
APR-AUG	15913	19551	85	22516	22870
JAN-JUL	21519	24755	82	28601	30020

with 3 days of QPF Forecast Not Available

with 0 days of QPF Forecast Not Available

Move the mouse over the desired "Forecast Period" to display a graph.

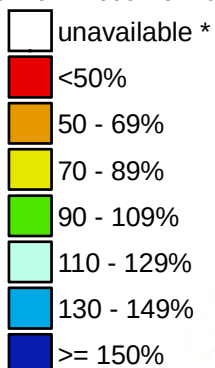
 [Water Supply Plot for SNAKE - LOWER GRANITE](#)

For Data Used In Plot Click Here: [CSV](#)

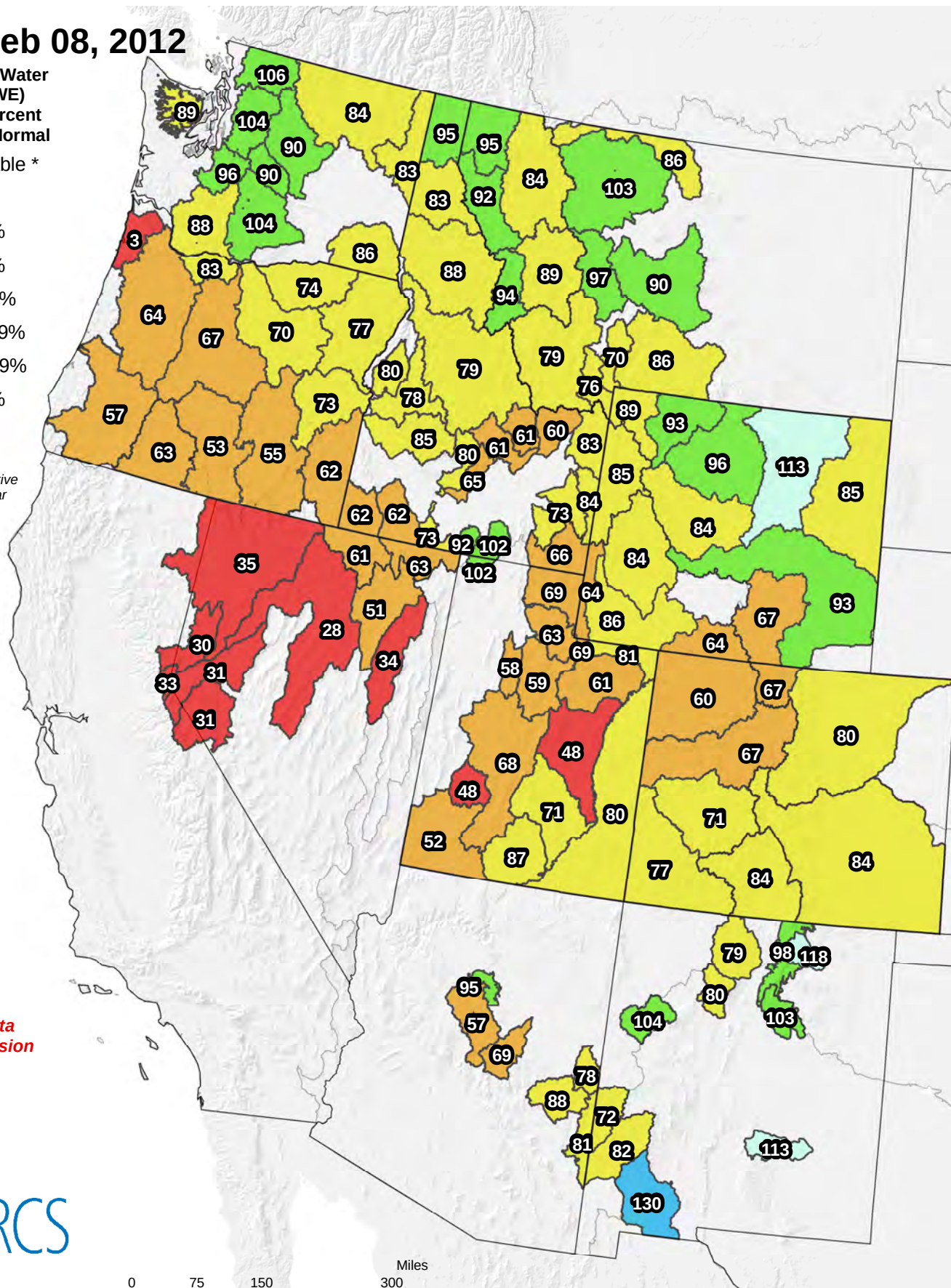
Westwide SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Feb 08, 2012

Current Snow Water Equivalent (SWE)
Basin-wide Percent
of 1971-2000 Normal



* Data unavailable
at time of posting
or measurement
is not representative
at this time of year



Provisional data
subject to revision



The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by the USDA/NRCS National Water and Climate Center
Portland, Oregon <http://www.wcc.nrcs.usda.gov/gis/>
Based on data from <http://www.wcc.nrcs.usda.gov/reports/>
Science contact: Jim.Marron@por.usda.gov 503 414 3047

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday February 15, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 6845

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review February 8 Meeting Minutes [\[Meeting Minutes\]](#)
3. Vernita Bar Update - Russell Langshaw, Grant County PUD
 - a. [Hanford Reach Temperature Update](#)
4. Chum Update - Paul Wagner, NOAA Fisheries
5. Operations Review
 - a. Reservoirs
 - b. Fish

- c. Water Quality
- d. Power System
- 6. Other
 - a. Set agenda and date for next meeting - **Feb 22, 2012**
 - b. [\[Calendar 2011\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

February 15, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Meeting Minutes

There were no suggested revisions to the 2/8/12 TMT Official Minutes or Facilitator's Notes, so both were considered final.

Vernita Bar Update

Russell Langshaw, Grant County PUD, shared information about Hanford Reach operations. He said the operation is on track and the PUD expects rearing period protection to begin on March 8. Russell reported there were currently 922 accumulated temperature units (ATUs). In response to a question, he reported the critical elevation constraint would begin on 4/1. Russ will continue to give a Vernita Bar update to TMT throughout the season.

Chum Update

Paul Wagner, NOAA, reported on behalf of the salmon managers a preference to continue with a minimum 12 foot tailwater elevation at Bonneville to support chum. John Roache, Reclamation, said his agency would support this operation given there would be no impact to Grand Coulee April refill. Everyone agreed it will be important to continue to monitor conditions and be ready to make changes if forecasts indicate a significant change in water supply.

Planned Operation/Next Steps: Doug Baus said the COE would continue to implement the current operation of minimum 12 foot tailwater elevation at Bonneville. TMT members will revisit this issue at their next meeting on 3/7.

Operations Review

Reservoirs – John Roache, Reclamation, reported on projects. Grand Coulee was at elevation 1277.85 feet; using February final forecasts, the flood control target elevation for end of April is 1253.9 feet; with an April 10 target of 1270.9 feet. Hungry Horse was at elevation 3533.93 feet, with 2.5 kcfs outflows and 800 cfs inflows. The current end of April flood control target for Hungry Horse is 3530.5 feet. Lisa Wright, COE, reported on projects. Libby was at elevation 2409.17 feet, with 2.7 kcfs inflows and 4.0 kcfs outflows. Albeni Falls was at elevation 2053.1 feet, with 13.4 kcfs inflows and 13 kcfs outflows. Priest Rapids outflows were 106.5 kcfs. Dworshak was at elevation 1524.8 feet with 2.2 kcfs inflows and 1.5 kcfs outflows. Lower Granite outflows were 30.5 kcfs; McNary outflows were 131.5 kcfs; The Dalles outflows were 130.5 kcfs; and Bonneville outflows were 155.0 kcfs.

Fish – Paul Wagner, NOAA, said the spring migration had not yet begun. Washington will share the adult fish count forecasts for the upcoming season, and Paul will share an ocean conditions update at the next TMT meeting.

Water quality – Nothing to report at this time.

Power system – Nothing to report at this time.

Next Meeting, 3/7 Face to Face, 9:00 am

Agenda items include:

- Hanford Reach Update
- Chum Operations Update
- March Final Water Supply Forecasts
- Operations Review
 - o Flood control targets
 - o Adult fish counts
 - o Ocean conditions
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

February 15, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of the BOR, COE, NOAA, BPA, Montana, Washington, Idaho, the Colville Tribe, CRITFC/Umatilla Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review February 8 Meeting Minutes

There were no changes today so both the facilitator's notes and official minutes for February 8 are considered final.

3. Vernita Bar Update

Russell Langshaw, Grant PUD, gave the first report of the year on the Hanford Reach fall chinook protection program. All is going well to date.

Page 1 of attachment 3a on today's agenda is a table showing the program constraints currently in effect and those anticipated in future. Cells highlighted in yellow indicate areas where the accumulated temperature criteria have been reached. Cells in red indicate areas that are still operating under flow constraints. There are 922 accumulated temperature units in the reach as of February 13.

Page 2 of attachment 3a is a graph comparing this year's temperatures to mean temperatures for the history of the fall chinook protection program, which began in 1988. Overall, temperatures this year have tracked closely with the mean, but a dip earlier this winter reflects the recent cold snap.

The emergence and rearing protection period is expected to begin on March 8. Paul Wagner, NOAA, asked what the difference is between March 8 and April 1, the date on which two areas (4a and 4b on the attached chart) will begin operating under flow constraints. These are selective emergence zones at elevations submerged by flows of 36-50 kcfs, as well as elevations submerged by flows of more than 50 kcfs, Langshaw replied. While the constraints are in effect, discharges are set so as not to drop the river below the critical elevation.

Langshaw will provide biweekly updates on the protection program beginning March 8, or whatever TMT meeting most closely coincides with the start of emergence and rearing protections in Hanford Reach.

4. Chum Update

Paul Wagner, NOAA, said there has been little change in chum conditions since the last TMT meeting. The desired tailwater elevation below Bonneville is still 12 feet, if this operation can be maintained without jeopardizing the April 10 flood control elevation at Grand Coulee.

John Roache, BOR, said maintaining an elevation of 12 feet below Bonneville would not adversely affect the probability of meeting the Grand Coulee April 10 elevation objective, based on current STP projections and system model runs. Thus the **BOR** would not oppose continuing the current Bonneville operation.

The **COE** will continue to maintain a minimum 12-foot tailwater elevation below Bonneville, Baus said. The chum operation and its effect on Grand Coulee will be monitored over the coming weeks.

5. Operations Review

a. Reservoirs. Grand Coulee is at 1277.85 feet elevation, meeting power and chum tailwater elevation requirements below Bonneville, as well as Hanford Reach protection flows. Based on the latest forecasts, the April 30 target elevation for flood control is 1253.9 ft. The April 10 elevation objective is currently 1270.9 feet.

Hungry Horse is at 3533.93 feet elevation, with inflows of 500-800 cfs and outflows of 2.5 kcfs to meet Columbia Falls minimum flows. The reservoir is slowly drafting toward an April 30 flood control target of 3530.5 feet, based on the February water supply forecast. The April 10 elevation objective is currently 3533.7 feet.

Libby is at 2409.17 feet elevation, with inflows of 2.7 kcfs and outflows of 4.0 kcfs. Albeni Falls is at 2053.1 feet elevation, with inflows of 13.4 kcfs and outflows of 13 kcfs. Dworshak is at 1524.8 feet elevation, with inflows of 2.2 kcfs and outflows of 1.5 kcfs.

Priest Rapids outflows are 106.5 kcfs, Lower Granite outflows are 30.5 kcfs, McNary outflows are 131.5 kcfs, and Bonneville outflows are 155 kcfs.

b. Fish. Chum are doing fine, Wagner reported. Adult spring runs are a few months away, probably not occurring until mid-April as adults have been returning later than usual in recent years.

Returns are expected to be strong this year, Charles Morrill, Washington, reported. He will coordinate a forecast of 2012 adult returns to be presented at

the next TMT meeting. Jim Litchfield, Montana, asked for an ocean conditions update at a future TMT meeting.

c. Water Quality. There was nothing to report today.

d. Power System. There was nothing to report today.

4. Next TMT Meeting

A tentative conference call was scheduled for February 22. The next regular TMT meeting in person will be March 7.

<i>Name</i>	<i>Affiliation</i>
Jim Litchfield	Montana
John Roache	BOR
Doug Baus	COE
Lisa Wright	COE
Paul Wagner	NOAA

Phone:

Charles Morrill	Washington
Russ Kiefer	Idaho
Sheri Sears	Colville
Tom Lorz	CRITFC/Umatilla
Scott Bettin	BPA
Harvey Hall	EWEB
Margaret Filardo	FPC
Dave Benner	FPC
Donald Tinker	SCL
Shane Scott	PPC
Heather Dohan	Puget Sound Energy
Rob Allerman	Deutsch Bank
Ruth Burris	PGE
Richelle Beck	Grant PUD
Bruce McKay	hydropower consultant
Russell Langshaw	Grant PUD
Mike Shapley	Snohomish PUD
xxx	PP&L

2011-2012 Hanford Reach Fall Chinook Protection Program (HRFCPP)

HRFCPP Lifestages

	Begin (000 hrs)	End (2400 hrs)
Spawning Period	10/19/2011	11/20/2011
Pre-Hatch Period	10/19/2011	2/20/2012
Post-Hatch Period	11/26/2011	5/12/2012
Emergence Period	3/8/2012	5/13/2012
Rearing Period	3/8/2012	6/16/2012

ATUs (celcius)

	Initiation of spawning	through 02/13/12
<36 kcfs elevation	10/19/2011	921.9
36-50 kcfs elevation	10/26/2011	811.1
>50 kcfs elevation	10/26/2011	811.1
End of spawning	11/20/2011	479.6
Temperature on 02/13/12		3.0
Critical Elevation (kcfs)	65	

HRFCPP Constraint dates

HRFCPP Section	Begin (000 hrs)	End (2400 hrs)	Current constraint as of 02/13/12
C.1(c)	10/19/2011	11/20/2011	
C.2	10/19/2011	12/7/2011	
C.3(a)	12/8/2011	3/31/2012	Y
C.3(b)	12/8/2011	3/31/2012	Y
C.4(a)	4/1/2012	5/13/2012	
C.4(b)	4/1/2012	5/13/2012	
C.5(b)(1-5)	3/8/2012	6/16/2012	
C.5(b)(6)	4/21/2012	5/13/2012	

Current date

2/14/2012

[Link to TU data](#)

Data through:

2/13/2012

[Link to discharge data](#)

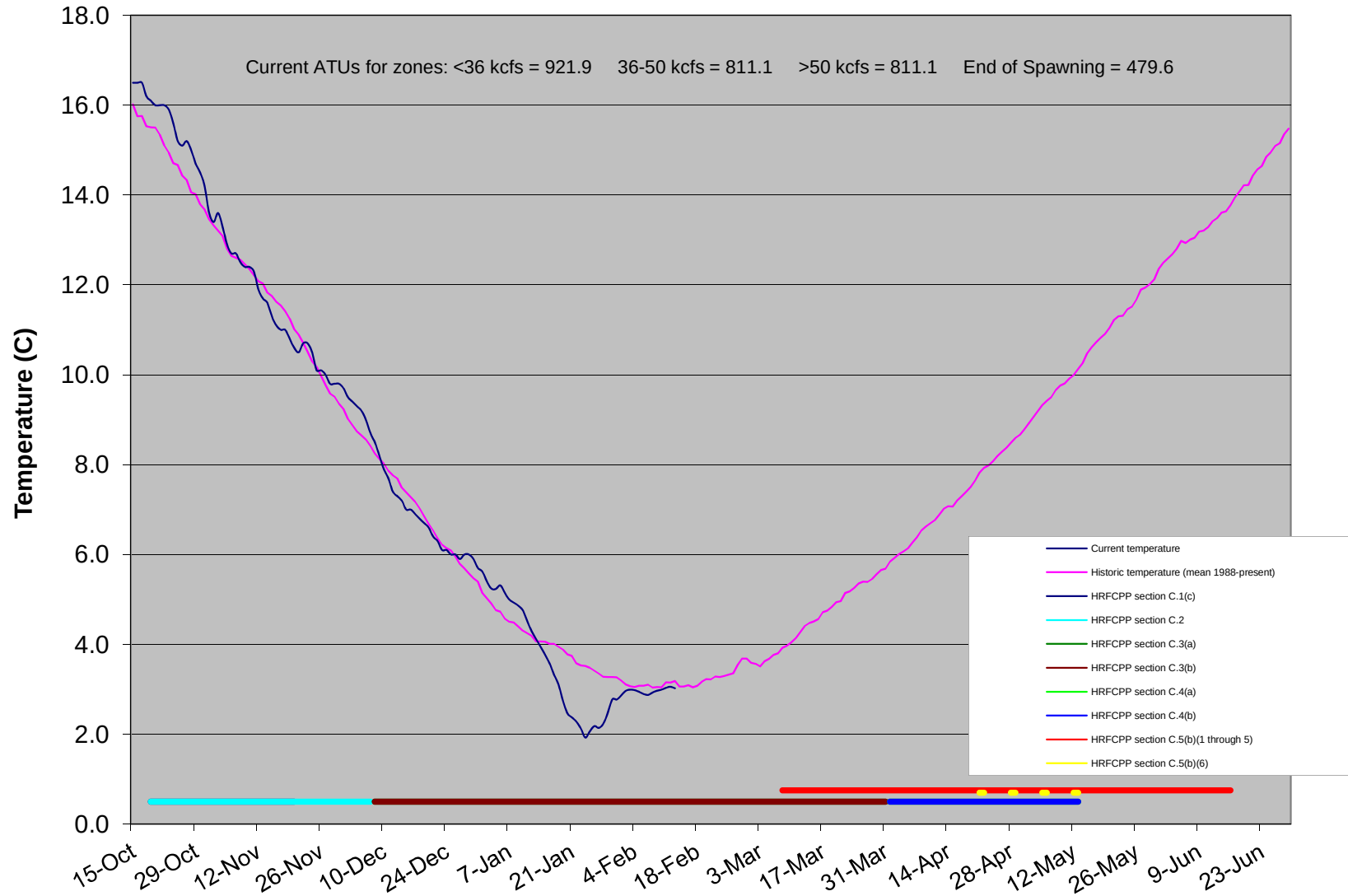
Exceedances: 0

Cell are highlighted in yellow when ATU criteria are met.

Cell are highlighted in red when these constraints are currently in effect

Dates with red text are predicted based on current conditions and data from 1988 to present

2011-2012 PRD Tailrace Temperatures and HRF CPP constraints



TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger / Ron Boyce	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday February 22, 2012 9:00am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 6845

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Update on Water Supply Forecast - Doug Baus, COE-RCC
 - a. [RFC February Final Forecast](#)
 - a. [NRCS SNOTEL](#)
3. Chum Update - Paul Wagner, NOAA Fisheries
 - a. [Chum Locations](#)
4. Other
 - a. Set agenda and date for next meeting - **March 7, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday March 7, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 6845

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnv.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review February 15 Meeting Minutes [\[Meeting Minutes\]](#)
3. Vernita Bar Update - Russell Langshaw, Grant County PUD
 - a. [Hanford Reach Update](#)
4. March Final Water Supply Forecasts - Doug Baus, Corps and John Roache, BOR
 - a. [NRCS SNOTEL](#)
5. Chum Update - Paul Wagner, NOAA Fisheries
6. Adult Forecast - Charles Morrill, WDFW

- a. [Columbia River Salmon and Steelhead Returns](#)
- b. [Ives Chum Redds and Temperature Arrays](#)
- 7. Ocean Conditions - *Paul Wagner, NOAA Fisheries*
 - a. [Ocean Conditions](#)
 - b. [Report - Marine Ecology of Juvenile CR Salmon: Synthesis 1998-2011](#)
- 8. Operations Review
 - a. Reservoirs
 - b. Fish
 - c. Water Quality
 - d. Power System
- 9. Other
 - a. Set agenda and date for next meeting - **March 14, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

March 7, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Meeting Minutes

There were no suggested revisions to the 2/15/12 TMT Official Minutes or Facilitator's Notes, so both were considered final.

Vernita Bar Update

Russell Langshaw, Grant County PUD, provided an update for Hanford Reach operations, saying the emergence protection operation was scheduled to begin tomorrow, 3/8. Russell showed graphs depicting temperature unit accumulations, and also said a report from 2011 had been submitted by Grant PUD and was available for review.

Action: Russell will include excerpts from the 2011 report in his next update to TMT on 4/4. (*Note – The meeting schedule was inaccurately reported and a follow up email was sent to confirm that the meeting will be held on 3/28 instead of 4/4.)

Water Supply Forecasts

John Roache, Reclamation, reported that the March final Hungry Horse water supply forecast for March-July is 1,984 kaf (95% of average) and May-September, which drives its flood control elevation, is 1,739 kaf (95% of average). He also reported that Grand Coulee flood control elevations are set based on The Dalles water supply, and currently the April-August forecast is 90.6 MAF (97% of average). Doug Baus, COE, added that the Lower Granite April-August forecast is 20.4 MAF (89% of average); Libby April-August is 5,635 kaf (96% of average); and Dworshak April-July is 2,585 kaf (96% of average). He showed a SNOTEL graph and said the latest forecasts here are trending toward normal conditions. A question was asked about how close the COE and NOAA forecasts are lining up. TMT may revisit this comparison later this year.

Chum Update

Charles Morrill, Washington, provided a map depicting chum redd locations and temperature gauges, a second graph comparing 2006-2007 data (to show the wide range of variability in emergence timing) and a third page containing data for the current year. Chum emergence is expected to be 50% complete by March 21-28, about a week earlier than last year which, it was noted, was a cool year. Paul Wagner, NOAA, added that the pre-season forecast assumed 'normal' conditions and indicated the peak of chum emergence to be around April 3.

Given all this, Doug Baus, COE, said the operation at Bonneville would continue at 12' tailwater minimum until TMT revisits during their 4/4 (*again, this date was later corrected to 3/28) meeting. TMT discussed that TDG in the system might increase when

the B2 Corner Collector begins operating, and this will need to be monitored to avoid negative impacts to chum. If an issue such as this arises before TMT meets again, a conference call may be scheduled to discuss in-season management.

Planned Operation/Next Steps: NOAA will send an email to indicate when the end of chum emergence has officially occurred, and this will indicate to the action agencies there is no longer a need to maintain a 12' minimum tailwater elevation at Bonneville to protect emerging chum.

Adult Forecast

Charles Morrill, Washington, shared a power point developed by his colleague Cindy LeFleur of the current 2012 adult return forecasts. Most forecasts have gone up from last year, most notably sockeye, except Snake River sockeye (slightly down from last year) and Summer steelhead. The final two slides re-capped the 2011 non-Indian fisheries and Treaty Indian fisheries. Charles said TAC would be updating their forecast in late April/early May, and that he or Cindy would provide an update to TMT later in May.

Ocean Conditions

Paul Wagner, NOAA, shared information about NOAA's work on ocean conditions and adult return predictions. The main indicators for these predictions are the Pacific Decadal Oscillations (PDO) index and copepod biodiversity. Paul showed ocean condition indicators for previous years and resulting Spring Chinook adult return predictions for 2012 (150,000) and 2013 (233,000) – not quite as optimistic as what was reported earlier from Washington. Paul emphasized that this work is still in an 'experimental phase' and NOAA plans to track how well these predictions line up with actuals to determine how accurate and useful the tool will be. He also said a synthesis report with an analysis of years 1998-2011 has just been completed and describes the methodology and observations to date. NOAA will continue working with TAC on ways to integrate this tool into their forecasting methods, and said NOAA hopes to be able to do in-season forecasts in the future that can inform in-season management.

Action: Paul will email the synthesis report to Doug Baus for posting to today's TMT agenda.

Operations Review

Reservoirs – John Roache, Reclamation, reported on projects. Hungry Horse was at elevation 3530.29 feet, with 2.3 kcfs outflows, about 1 kcfs inflows, and operating to meet Columbia Falls minimums. Grand Coulee was at elevation 1275.1 feet; the flood control target will be set later this week. Lisa Wright, COE, reported on projects. Libby was at elevation 2407.4 feet, with 3.6 kcfs inflows and 4.0 kcfs outflows. Albeni Falls was at elevation 2051.9 feet, with 18.8 kcfs inflows and 17.0 kcfs outflows. Priest Rapids outflows were 105.7 kcfs. Dworshak was at elevation 1526.8 feet with 3.0 kcfs inflows and 5.6 kcfs outflows. Lower Granite outflows were 36.1 kcfs; McNary outflows were 146.8 kcfs; and Bonneville outflows were 160.6 kcfs.

Fish – Paul Wagner, NOAA, reported that smolt monitoring began at Bonneville; numbers were still few at this point.

Water quality – Scott English, COE, reported that water quality monitoring will go on line a little early this year to allow the action agency to run its newly converted CWMS 2.1 database. He said RCC has been working closely with the Districts, USGS and other service providers to verify that the new system is functioning properly, ahead of spill season. Water quality web reports will convert before spill season so TMT should not notice any changes – if there are any changes in the plan, TMT will be notified.

Power system – Tony Norris, BPA, reported about a recent peak high wind generation of over 3,900 MW in the power system.

Other – Rick Kruger, Oregon, requested a status update on the Fish Operations Plan. Doug Baus, COE, responded that RIOG met on this topic and were reviewing the draft plan. When it is finalized, it will be posted to the TMT page.

Next Meeting, 3/14; 9:00 am

Agenda items had not yet been identified. Participants were asked to send agenda items to the facilitator and chair in advance of the next meeting.

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

March 7, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of the COE, Oregon, BPA, NOAA, Washington, USFWS, Idaho, the Colville Tribe, BOR, CRITFC/Umatilla Tribe, the Salish-Kootenai Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review February 15 Meeting Minutes

There were no suggested changes today, so the facilitator's notes and official minutes for February 15 are considered final.

3. Vernita Bar Update

Russell Langshaw, Grant PUD, reported. Protection flows were scheduled to begin today, but a temperature anomaly last weekend delayed the actual start of protection flows until tomorrow. The first page of attachment 3a to today's agenda presents the latest life stage and flow constraint data for the Hanford Reach fall chinook protection program. Temperatures so far this year have been around average. Grant PUD recently completed its 2011 stranding and entrapment report, which Langshaw will provide with his next TMT update in early April.

4. March Final Water Supply Forecasts

Baus and John Roache, BOR, gave March final water supply forecasts for specific projects:

- Hungry Horse (March-July) 1984 KAF, 95% of average.
- Grand Coulee –The water supply forecast for The Dalles, not the forecast for Grand Coulee, determines the flood control space requirement.
- The Dalles (April-August) – 90.6 MAF, up from last month's forecast of 84.5 MAF.
- Lower Granite (April-August) – 20.4 MAF, 89% of average.
- Libby (April-August) – 5635 KAF, 96% of average.
- Dworshak (April-July) – 2585 KAF, 96% of average.

Tony Norris, BPA, pointed out that these forecasts are being measured against an old 30-year norm for historic flows. If compared to the updated 30-year norm, the forecasts would be above average.

5. Chum Update

The minimum tailwater elevation of 12 feet below Bonneville continues, Paul Wagner, NOAA, said. Charles Morrill, Washington, gave TMT a slideshow on chum emergence and the accumulation of temperature units. The data show a great deal of variability in temperature units and relative emergence at different locations. Temperature accumulation data used to predict the 10%, 50% and 90% emergence dates indicate that 90% emergence will occur about a week earlier this year than last year, Morrill said. That would put the 90% emergence date at sometime during the week of March 21-24. Wagner noted that conditions are relatively warmer this year than average, which accounts for the earlier emergence expectations.

The COE will continue to operate Bonneville tailwater to a 12 foot minimum. The Action Agencies requested notification when the Salmon Managers determine the end of the chum operation. Knowing the end of the chum operation is helpful to the Action Agencies when planning other operations. The only potential conflict would be any operation resulting in TDG values that exceed the compensation depth of coverage, Wagner replied. With a minimum depth of 12 feet, TDG levels would have to exceed 110% for the redds to be adversely affected. Operating the Bonneville 2nd powerhouse corner collector is known to cause elevated TDG levels. The default date for beginning corner collector operation is April 10, but it could be earlier if specific triggers are reached. TMT will revisit the chum operation in early April.

6. Adult Return Forecast

Morrill gave TMT a slideshow presentation, linked to this item on the agenda, which provides the latest adult return forecasts for 2012.

- Upper river spring chinook – The forecasted return is 14,200, the 10 year average is 22,700, and the 50% arrival date at Bonneville is May 6. Bill Proctor, COE, asked whether the numbers for 2011 are actual counts or forecasts, and Baus noted the numbers in today's presentation don't look right. Morrill will follow up on this.
- Upper Columbia spring chinook – The forecasted return is 39,000 fish compared to a 10 year average of 37,200 fish.
- Upper Columbia wild spring chinook – The forecasted return is 2,800 fish compared to the 10 year average of 2,300 fish.
- Upper Columbia summer chinook – The forecasted return is 91,200 fish compared to the 10 year average of 62,600 fish.

- Sockeye – The forecasted return is 462,000 fish, well above the previous 10 year average of 413,300 fish.
- Snake River sockeye – The forecasted return is 1,900 fish. Returns over the past 3 years have been 1,600 to 2,600 fish.
- Upriver summer steelhead – The last 10 year average return was 395,000 fish; this year's forecast is 380,300. However, the average percentage of wild summer steelhead arriving at Bonneville for 2011 was 27%; this year's wild percentage is expected to rise to 29%.
- 2011 Non-Indian fisheries – Sport fisheries catches are expected to be 15,900 fish and commercial fisheries about 9,500 fish.
- 2011 treaty Indian fisheries – Tribal fishers are expected to have caught 13,200 spring chinook, 20,600 summer chinook and 1,280 sockeye below Bonneville in 2011.

Morrill will provide an update on adult returns at a TMT meeting near the projected 50% return date of May 6.

7. Ocean Conditions

Wagner gave TMT a recap of NOAA's efforts over the past 12 years to correlate ocean conditions more closely to smolt survival rates. It appears the biggest influence by far is the PDO index, which indicates ocean temperatures. Water temperatures and wind patterns strongly influence ocean productivity, and the strongest indicator of survival is the copepod zooplankton index. The cooler northern currents bring large nutrient-rich copepods from Alaska to the shelf along the Pacific coast for smolts to feed on, while currents from the south bring their less nourishing relatives. Thus, warmer ocean temperatures create conditions in which there is a shortage of food for smolts. Also, the lack of food leads to more predation within the 80 km of shoreline where smolts reside.

Return sizes in a given year reflect the ocean conditions of 2 years ago, so productive ocean conditions in 2011 can be expected to result in healthy adult returns in 2013. However, this year's returns will reflect ocean conditions in 2010, which weren't as good as last year. Negative PDO numbers correlate to abundant conditions while positive numbers are less desirable. There are PDO records going back to 1900.

Predicted returns as of January 2012 based on ocean conditions are 150,000 spring chinook in 2012 and 233,000 spring chinook in 2013. These predictions are based on a principal components analysis, which is a regression analysis. This is covered in depth in a report recently published by the NPCC, titled Marine Ecology of Columbia Basin Salmonids, Research 1988-2011. The

report, which will be linked to today's agenda, describes what is known about ocean conditions and how the knowledge is used to predict adult returns. About 70% of the relationship between ocean conditions and adult returns is driven by the copepod biodiversity index. First-year ocean survival rates are only around 5%, but the likelihood of survival increases after the first year.

Richelle Beck, Grant PUD, asked whether there are any PDO predictions for summer 2012. There is no way to predict PDO conditions because they are based on El Nino and La Nina trends, which aren't known until after the fact, Wagner replied.

8. Operations Review

a. Reservoirs. Grand Coulee is at elevation 1275.1 feet, with an increasing inflow forecast. Flood control elevations will probably drop as a result. Hungry Horse is at elevation 3530.29 feet, with inflows of 800-1,000 kcfs and discharges of 2.3 kcfs to meet Columbia Falls minimum flows.

Libby is at elevation 2407.4 feet with inflows of 3.6 kcfs and releases of 4 kcfs. Albeni Falls is at elevation 2051.9 feet with inflows of 18.8 kcfs and releases of 17 kcfs. Priest Rapids discharges are 105.7 kcfs. Dworshak is at elevation 1526.8 feet with inflows of 3 kcfs and discharges of 5.6 kcfs.

Lower Granite discharges are 36.1 kcfs. McNary discharges are 146.8 kcfs. Bonneville discharges are 160.6 kcfs.

b. Fish. The first smolts of the 2012 passage season are arriving at Bonneville, Wagner reported.

c. Water Quality. Scott English, COE, reported that all monitoring stations are expected to be on line in time for the start of spill season. The COE is in the process of converting its database from CWMS 1.5 to CWMS 2.1, a major transition. The goal is to complete the transition by April 3 when spill starts.

d. Power System. Peak wind generation recently reached 3900 MW, Tony Norris reported.

e. Fish Operations Plan. Rick Kruger, Oregon, asked when the FOP for 2011 will be published. The FOP, which is appendix C of the Fish Passage Plan, will be posted to the TMT site as soon as it is completed, Baus replied.

4. Next TMT Meeting

A tentative meeting was scheduled for March 14.

Name	Affiliation

Rick Kruger	Oregon
Tony Norris	BPA
Lisa Wright	COE
Paul Wagner	NOAA
Charles Morrill	Washington
Doug Baus	COE
Karl Kanbergs	COE
Bill Procter	COE
Laura Hamilton	COE
Kim Johnston	COE
Scott English	COE

Phone:

Dave Wills	USFWS
Russ Kiefer	Idaho
Sheri Sears	Colville Tribe
John Roache	BOR
Tom Lorz	CRITFC/Umatilla Tribe
Stu Leavitt	Salish Kootenai
Margaret Filardo	FPC
Dave Benner	FPC
Heather Dohan	Puget
Shane Scott	PPC
Russ George	WMC
Bruce McKay	hydropower consultant
Greg Larson	Thompson Reuters
Rob Allerman	Deutsch Bank
Barry Espenson	CBB
Richelle Beck	Grant PUD
Russell Langshaw	Grant PUD
Scott Bettin	BPA
Steve Hall	COE
John Redden	Grant PUD

The Marine Ecology of Juvenile Columbia River Basin Salmonids: A Synthesis of Research 1998-2011

Kym Jacobson, Bill Peterson, Marc Trudel, John Ferguson, Cheryl Morgan,
David Welch, Antonio Baptista, Brian Beckman, Richard Brodeur, Edmundo Casillas,
Robert Emmett, Jessica Miller, David Teel, Thomas Wainwright, Laurie Weitkamp,
Jeannette Zamon and Kurt Fresh

Report of the U.S. National Marine Fisheries Service,
National Oceanic and Atmospheric Administration
Fisheries and Oceans Canada
Kintama Research Services, Ltd.
and Oregon State University

to

Northwest Power and Conservation Council
851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204

January 2012

Preface

Beginning in the late 1990s, the Bonneville Power Administration (BPA) funded three multi-year research, monitoring, and evaluation projects to determine the impacts of variable ocean conditions on Columbia River salmon. These projects are referred to collectively as the "ocean projects." They are comprised of the *Ocean Survival of Salmonids Study* by the National Marine Fisheries Service, National Oceanic and Atmospheric Association (NOAA), which began in 1998; the *Canada-USA Salmon Shelf Survival Study*, which has been conducted by the Fisheries and Oceans Canada (DFO) since 1999; and the *Coastal Ocean Acoustic Salmon Tracking* project (formerly Pacific Ocean Shelf Tracking Project), which was initiated by Kintama Research Services Ltd. (Kintama) in 2005.

In 2010, NOAA, DFO, and Kintama submitted independent but highly complementary proposals to address the 2009 *Ocean Strategies of the Columbia River Basin Fish and Wildlife Program* in response to a BPA request for proposals. During the review process, the Independent Scientific Review Panel (ISRP) stressed the importance of increasing the time series of data generated by the ocean projects.

Although each of the three ocean projects received highly favorable reviews from the ISRP and were considered to "meet the scientific review criteria," the ISRP provided a conditional qualification: that a synthesis report for the ocean projects be produced to "develop a strategic plan that prioritizes project hypotheses and management objectives" (ISRP 2010-44B). The ISRP also highlighted the need to "improve coordination and collaboration, standardization of methods (e.g., genetic stock identification), development of simulation and predictive models, and integration of results among Columbia River Basin estuary/ocean projects." In support of these ISRP suggestions, the Northwest Power and Conservation Council (NPCC) stated:

We recommend that project sponsors jointly complete a comprehensive synthesis report per the ISRP comments. An important element to this synthesis report will be the inclusion of potential salmon management implications and recommendations based on the information collected and evaluated....The sponsors should address where appropriate, the qualifications raised by the ISRP in their final review (ISRP 2010-44B). Also we recommend that the proponents ensure data collected is standardized and accessible.

In response to this request, NOAA, DFO, and Kintama have coordinated efforts to produce this synthesis report.

Objectives of this report are to:

- 1) Provide the details of what has been investigated and learned to date, the conclusions that can be drawn from this knowledge now, and the expected time frame for the research to yield further conclusions
- 2) Identify potential salmon management implications, and where possible, provide recommendations for management based on the information collected
- 3) Describe how the complementary research projects will continue to be coordinated and managed from this point forward, including standardized data collection and improved data accessibility.

The document begins with an executive summary and an introduction followed by a discussion of our research results. We continue with a presentation of our forecasts of salmon returns, along with management implications, and conclude with a discussion of data gaps, uncertainties, and future research needs.

For each project, a detailed response to ISRP comments was submitted separately to the NPCC in late 2010. These responses are included in the appendices of this report as supplementary information (Appendix H, I, and J). To keep this report reasonably concise, most technical details on the methods used for data collection and analyses have been omitted. Complete information on these methods and results can be obtained from the annual reports submitted to Bonneville Power Administration by each project sponsor. All reports are readily available online via the BPA Pisces website.

Executive Summary

After decades of harvest, habitat, and hatchery impacts, and the completion of federally constructed hydropower dams in the Columbia River system, populations of Pacific salmon *Oncorhynchus* spp. declined drastically. There are now 13 Evolutionary Significant Units (ESUs) of Pacific salmon listed as either threatened or endangered under the U.S. Endangered Species Act (ESA). During the 1980s and 1990s, mitigation efforts for dwindling salmon and steelhead (*O. mykiss*) stocks focused on improving survival of juvenile migrants through each dam and on restoring freshwater habitats to improve adult spawning opportunities. Despite the relative effectiveness of these mitigations, the 13 ESUs continue to be listed under the ESA.

It is now recognized that during this same period, ocean survival of Columbia River salmon was anomalously low, and likely contributed to the observed declines in salmonid abundance. Poor ocean conditions were thought to be part of the problem. Several studies identified a number of physical oceanographic metrics that were strongly correlated with salmon survival. However, in spite of strong correlations between metrics such as sea surface temperature, upwelling strength, and the Pacific Decadal Oscillation (PDO), no mechanistic link was identified between large-scale physical ocean processes and the local physical and biological conditions that juvenile salmon experience. In the absence of clear and direct mechanistic links, these initial attempts to forecast juvenile salmon survival met with limited success.

To rectify this problem, the Bonneville Power Administration Fish and Wildlife Division (BPA) began an effort in the late 1990s to improve our understanding of how local ocean conditions affect juvenile salmon survival. Three projects have since been initiated to address the role of the ocean in overall survival of Columbia River basin salmonid stocks

Two of these, the *Ocean Survival of Juvenile Salmonids* study and the *Canada-USA Salmon Shelf Survival* study, are research partnerships established between BPA, National Marine Fisheries Service, National Oceanic and Atmospheric Association (NOAA) and Fisheries and Oceans Canada (DFO). These programs study juvenile salmon as they enter the ocean and during their first few months of marine residence, as well as monitor the ocean conditions experienced by these fish. The primary focus of both projects is to determine the physical, biological and ecological mechanisms that control survival of salmon during their early marine life. By collecting comparable and complementary biological and oceanographic data, these projects provide broad coverage of the plume and continental shelf waters exploited by Columbia River juvenile salmon.

A third ocean study (the *Coastal Ocean Acoustic Salmon Tracking* project) was initiated in 2005 by Kintama Research Services, Ltd. (Kintama), in order to better quantify where juvenile salmon mortality occurs. Acoustic tags were used to track juvenile salmon migration and mortality through the Columbia River hydropower system and into the coastal ocean. The information provided by this study is complimentary to that provided by the NOAA and DFO studies because it identified regions of early ocean mortality.

Research by these BPA-funded ocean projects has produced the following new insights as to when mortality occurs during the juvenile migration and which factors affect the survival of Columbia River juvenile salmon during early ocean residence:

- Different populations of Columbia River salmon migrate at different times and speeds. For example, acoustic tagging has shown that spring Chinook salmon (*O. tshawytscha*) migrate rapidly through the estuary; their survival is highest in the estuary, lowest in the Columbia River plume, and similar within the Columbia River hydrosystem corridor and the coastal ocean. Otolith analysis has shown that mean northward migration rates of interior Columbia River yearling Chinook during the first months at sea are higher during years of poor ocean conditions, suggesting juveniles may modify their migratory behavior based on ocean conditions.
- Different species and stocks occupy different habitats in the coastal ocean. Fall-run Chinook are most commonly found in the near-shore areas from the intertidal zone to within a few kilometers of shore. Spring-run Chinook are most often found from the near-shore zone to mid-shelf waters, whereas coho salmon (*O. kisutch*) range across the entire shelf. Some stocks appear to be residents of Pacific Northwest shelf waters (most fall Chinook and coho stocks) while others migrate farther north along the coastal corridor (spring Chinook, sockeye (*O. nerka*), and some coho salmon).
- There are large interannual fluctuations in abundance of juvenile salmon in the ocean that relate to adult returns; these fluctuations persist despite relatively stable production from Columbia River Basin hatcheries. Species and stocks differ as to when year class strength is determined. Our results suggest that juvenile salmon survival is set within the first year of marine residency and is partially related to food-web structure and growth conditions in the plume and coastal ocean.
- Food-web structure is set by large-scale atmospheric forcing associated with the PDO, which appears to control the types of water which feed the northern California Current. When currents flow from the north (coastal Gulf of Alaska), the base of the food web is dominated by lipid-rich northern copepod species; when water originates from the west or the south (subtropical water), the food web is dominated by lipid-poor copepod species. Differences in circulation patterns account for differences in prey abundance, composition, and quality (i.e. lipids) at the lower trophic levels. The distribution and abundance of predators (piscivorous fish and birds) and forage fish (smelts and anchovies) is also influenced by circulation patterns.

- Juvenile salmon need a lipid-rich food supply to realize their growth potential, and such a food supply is a characteristic of good ocean conditions. In contrast, poor ocean conditions result in a lipid-poor food web, which is detrimental for salmon. Juvenile salmon entering the ocean rapidly shift to a diet of primarily fish and krill and preferentially feed on taxa rich in essential fatty acids. Interannual variation in the quantity and type of prey available to juvenile salmon appears to influence the relative survival of Columbia River salmon populations.
- Predation on juvenile salmon varies interannually and spatially thus top down control appears to be mediated in part by oceanographic conditions. Predation by piscine predators (e.g. Pacific hake (*Merluccius productus*)) is higher during years of warm ocean conditions because these oceanic fishes move into warm continental shelf waters. In contrast, avian predation appears to modulate juvenile salmon survival at a local level (in and around the Columbia River plume and associated ocean-plume fronts). The prevalence of the salmon pathogen *Renibacterium salmoninarum* varies interannually by salmon species and stocks, in contrast to the freshwater parasite *Nanophyetus salmincola*, which appears to influence early marine survival of coho salmon irrespective of ocean conditions.
- Growth of juvenile coho, Chinook salmon and steelhead correlates positively with ocean survival and adult returns supporting the growth – survival hypothesis. Mortality of yearling Chinook appears to be regulated by bottom-up processes whereas the smaller subyearlings may be regulated by other factors. Mean body size and early marine growth in yearling Chinook is positively correlated with adult returns; conversely body condition of subyearling Chinook is negatively correlated with adult returns.
- In some years, a larger Columbia River plume (characteristics of which can be predicted from a combination of river discharge and winds over the continental shelf) was associated with higher survival of some salmonid stocks. Acoustic telemetry demonstrates that river and ocean survival rates through the Columbia River hydropower corridor and coastal ocean are similar supporting the hypothesis that early ocean mortality can be substantial.
- Mortality during winter can also be substantial (80-90%), though the cause of this high mortality is unknown at southern latitudes. Size-selective overwinter mortality was apparent at northern latitudes, but not at southern latitudes. Hence, winter mortality is expected to affect different stocks of Columbia River salmon differently based on the migration behavior.

Our work is not finished. The recent variability in the PDO has provided a natural range of experimental conditions with which we can compare the response of juvenile salmon to a large variety of ocean conditions. Specifically, the years 2005 and 2008 provide pronounced contrasts in ocean conditions, with 2005 extremely warm due to a near-

complete lack of upwelling and 2008 anomalously cold due to a strongly negative PDO. In addition, 2001 was a drought year; thus the volume of the Columbia River plume was reduced. We have also sampled during a major El Niño event in 1998 and during two smaller but significant events during 2003-2004 and 2009-2010. As a result, however, over the past 14 years, salmon have not experienced the same combinations of ocean conditions in any given year more than once. A longer time series is needed to track the responses of salmon to these recent high-frequency variations in the PDO and ENSO and associated variations in local ocean conditions. These data are necessary if we are to further explore biological responses to the increasingly variable conditions expected in the future.

This will require continued coordination and collaboration of the sampling programs initiated by NOAA and DFO as well as an integration of the direct area-specific mortality rates measured by Kintama. A coordination meeting will be organized each year and scheduled to coincide with the annual “Salmon Ocean Ecology” workshop, a meeting that NOAA and DFO have organized each spring since 1999.

The ocean projects have produced information that can inform management within the Columbia River Basin in three main areas. First, because of the role of ocean conditions in affecting adult returns, periods of high or low ocean productivity can mask underlying trends in freshwater habitat productivity and could lead to a misinterpretation of the proximate cause of the trend. Knowledge of the response of salmon to ocean conditions is key to providing the proper context for judging the effectiveness of habitat restoration, hatchery reform, harvest management, and hydropower system improvements being implemented to restore listed and wild salmon stocks.

Second, the combination of physical and biological information collected as part of the ocean projects has led to the development of simple models that now provide outlooks of future salmon returns. With a longer time series these metrics are expected to increase the accuracy of current forecasting.

Third, the ocean projects have improved our understanding of the responses of stocks with different life-history characteristics to variable ocean conditions. We anticipate that knowing the mechanisms that link ocean conditions with stock-specific salmon survival will be useful to managers as we jointly seek to identify specific 4-H actions that improve salmon returns in the Columbia River. Thus, we advocate a dialogue between scientists, managers, and policy makers initiated through several workshops to discuss the implications of the results obtained as part of the ocean projects for the management of Columbia River salmon with regards to the 4-H issues.

Contents

Preface.....	ii
Executive Summary	iv
I. Introduction	1
Problem Statement	1
Historical Context	2
Objectives and Scope of the Three BPA Ocean Projects	3
Hypotheses Tested	5
Coordination and Collaboration among Ocean Projects.....	7
Research Synergies with Programs not Funded by BPA.....	8
II. Physical and Biological Oceanographic Processes that Affect Juvenile Salmon	11
California Current	11
Columbia River Plume.....	15
III. Ocean Migration and Distribution of Columbia River Basin Juvenile salmon	16
Coast-Wide Distribution Patterns	16
Fine-Scale (Spatial and Temporal) Habitat Usage Patterns and Factors Affecting Distribution	19
Cross-Shelf Distribution of Tagged Smolts.....	22
IV. Marine Growth and Condition and Linkage to Adult Returns (<i>H1</i>).....	23
Interannual Variation in Salmon Food and Growth.....	24
Marine Growth and Adult Abundance.....	25
Juvenile Chinook Growth and Condition vs. Life History Type	26
Regional Variation in Growth Rates and Survival	27
Winter Growth and Mortality	28
V. Mechanisms Influencing Salmon Growth and Survival	30
Bottom-Up Processes (<i>H1</i>)	30
Stomach Content Analysis.....	30
Stable Isotope Analysis.....	31
The Role of Prey Quality	32
Inferences Based on Trophically Transmitted Parasites.....	32
Top-Down Processes (<i>H2</i>).....	33
Predation in Shelf Environments	33
Predation near the Columbia River Mouth and Plume	34
Pathogens	35
Inferences from Ecosystem Modeling	37
VI. Freshwater and Ocean Survival Estimates	39
Coastal Ocean Acoustic Salmon Tracking (COAST) Objectives.....	39
Survival Estimates in the Columbia River, Estuary, Plume, and Coastal Ocean .	40
In-River and Ocean Survival	40
Survival Rate in Different Habitats.....	43
Plume Survival and Residence Time	45
Testing Delayed and Differential-Delayed Mortality Theories	46
VII. Forecasting and Management Tools.....	48
VIII. Management Implications.....	53
Background.....	53
Ocean Variability as a Context for 4-H Management	54

Improving Recruitment/Return Forecasts.....	56
Other Management Issues.....	57
Ecosystem-based management	57
Life history diversity and salmon population resilience	58
River Flow and the Columbia River Plume.....	59
Addressing “Latent” and “Differential” Mortality	60
Summary	61
IX. Data Gaps, Uncertainties, and Research Needs.....	62
Information Requested by the ISRP	63
Density Dependence	63
Hatchery/Wild Interactions	63
Steelhead Ecology.....	64
Research Needs.....	65
Estuary/plume (<i>H3</i>).....	65
Estuary/Ocean Linkages	65
Additional Acoustic Tagging (<i>H5</i>)	66
Relationship between Ocean Survival and Riverine and Estuary Growth	66
Bottom-Up Processes (<i>H1</i>)	67
Top-Down Processes (<i>H2</i>).....	67
Management Tools.....	68
Other Issues.....	68
Delayed Mortality (<i>H4</i>).....	68
Winter Mortality (<i>H1</i>).....	68
Long-Term Automated Observations	68
Workshops	69
Future coordination and collaboration	69
Acknowledgements.....	71
References.....	72

I. Introduction

Problem Statement

Columbia and Snake River salmonid stocks comprise one of the most valuable commercial and recreational fisheries on the west coast of North America. Annual returns of salmon and steelhead to the Columbia River basin during the late 1800s were on the order of 10-16 million fish. However, after years of over-harvest, habitat destruction, increased hatchery production, and development of the hydropower system, returns declined precipitously to roughly one-half million during the 1980s and 1990s.

Various measures have been implemented to protect and recover the stocks of wild and ESA-listed fish (Pacific salmon listed as either threatened or endangered under the U.S. Endangered Species Act, ESA). These include harvest reduction, habitat restoration, hatchery enhancement and hydropower regulation—often referred to as the four Hs. However, it is now clear that variability in marine ecosystem productivity drives much of the variability in adult salmon returns. Ocean conditions can mask, enhance, or even override actions taken to improve salmon runs in freshwater habitats of the Columbia River basin. Hence, the ocean environment can no longer be treated as a black box and must be considered explicitly by resource managers.

In the mid-1990s, the Northwest Power and Conservation Council (the Council) recognized the need to include the ocean environment in the management of Columbia River Basin salmonids. The Gorton amendment to the Northwest Power Act states: “In making its recommendation to BPA, the Council shall: consider the impact of ocean conditions on fish and wildlife populations...” (Northwest Power Act 1996).

To fulfill this directive, the Council considered the role of the ocean in salmon recruitment and incorporated this role into their research program in three ways. First, they adopted an approach to directly obtain explicit, quantitative information on marine recruitment success. Second, they defined the North Pacific Ocean as "a geographic unit (of the Columbia River basin) that should be considered in research, monitoring, and evaluation actions" (NPPC 2000). Third, they amended the Columbia River Basin Fish and Wildlife Plan to include the need to “understand the relationship between the Columbia River estuary and nearshore ocean, and salmon marine survival.”

In the 2009 Fish and Wildlife Program (NPCC 2009), the Council reiterated that the ocean environment is an integral component of the Columbia River ecosystem and that the marine ecosystem is utilized differently by various salmon species and populations.

Thus, there arose a clear need to better understand the interactions between salmon and the ocean in order to realistically plan goals and management options for the recovery of Columbia River salmon.

Starting in 1998, the Bonneville Power Administration (BPA) funded research by National Marine Fisheries Service, National Atmospheric and Oceanic Administration (NOAA) to quantify interannual variability in marine recruitment success. The objective of this research was to understand the oceanographic mechanisms that affect recruitment in the coastal environment off Oregon and Washington. Management would then use this information to predict and help enhance future adult salmon returns. In 1998, Fisheries and Oceans Canada (DFO) also funded a component of this ocean research. Since 1999, DFO has received funding from BPA to observe and study recruitment processes from Vancouver Island to Southeast Alaska, where large numbers of Columbia River juvenile salmon reside. Starting in 2005, BPA funded acoustic-tagging studies by Kintama Research Services (Kintama) to estimate survival in the hydropower system, estuary, and coastal ocean.

Historical Context

Pearcy and McKinnell (2007) reviewed the long history of research on Pacific salmon in marine environments. This research was conducted through both direct observation (i.e., catching salmon at sea) and tagging studies. Prior to the late 1970s, little research effort was focused on juvenile salmon in coastal U.S. waters during their first year at sea. Studies of juvenile salmon off Oregon and Washington were begun by Oregon State University and NOAA Fisheries in the late 1970s.

Pearcy and others reported on the feeding habits of juvenile coho and Chinook salmon (Peterson et al. 1982; Miller et al. 1983; Emmett et al. 1986), migration speeds and growth rates (Miller et al. 1983; Pearcy and Fisher 1988), and interannual variation in the distribution and abundance of Pacific salmonid species (Dawley et al. 1985; Pearcy and Fisher 1990). Pearcy and Fisher (1990) reported the especially important finding that juvenile salmonids are found primarily in coastal shelf waters, and that there are dramatic differences in abundance and growth among brood years.

William Pearcy had a major influence in beginning ocean research on salmon in the Pacific Northwest. Indeed, several members of the current BPA-funded science team (Brodeur, Emmett, Fisher, and Peterson) contributed to early efforts led by Pearcy. He was the first to coin the term “ocean conditions,” and also to show that multi-year time-series of ocean sampling were needed to unravel the impacts of variable “ocean conditions” on salmon growth and survival. Much of the research summarized in this

report was formulated around issues brought forth in Pearcy's (1992) book, in which he quotes Mathews (1984):

...the causes of mortality are elusive, probably vary from year to year, and depend "on complex interactions involving many fluctuating populations of predators, competitors and forage species." Considering this, he [Mathews] says, "it is not surprising that variability in marine survival is so poorly understood. Therefore, the likelihood seems low of correlating marine survival of any particular stock to single or simple environmental factors well enough or for long enough time periods to be useful in terms of predicting salmon abundance or guiding management decisions."

Pearcy concluded that Mathew's remarks were "a strong argument for formulating testable hypotheses and focusing research on specific processes that affect marine survival of stocks." We followed these recommendations in conceptualizing, developing, and implementing the three BPA ocean projects.

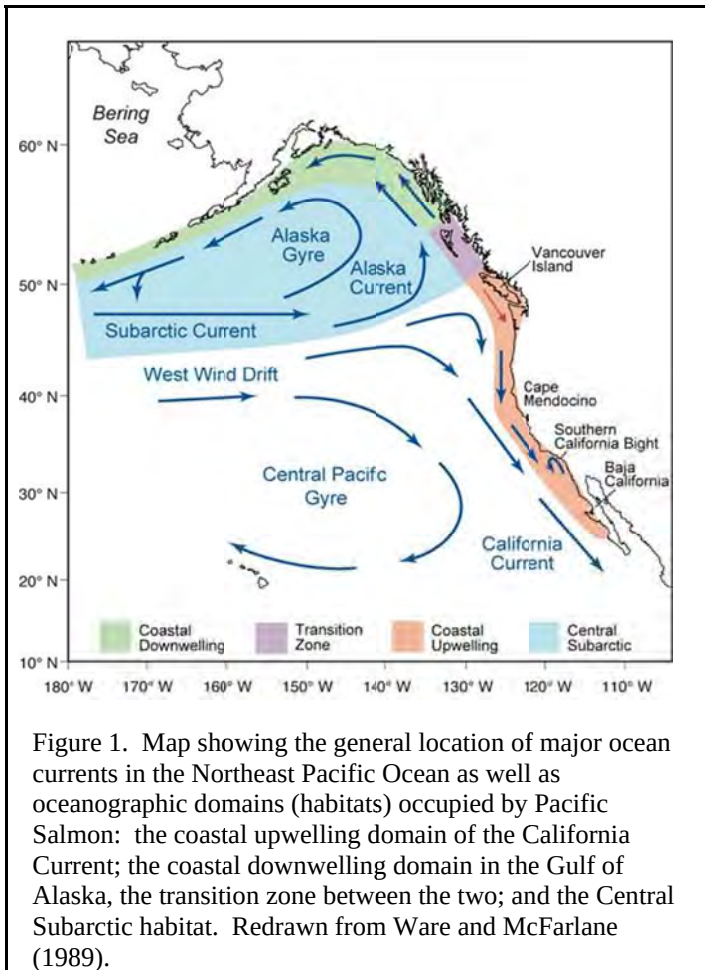
Objectives and Scope of the Three BPA Ocean Projects.

Studies of the relationships between ocean conditions and the ecology of juvenile salmon were initiated in the late 1990s by NOAA and DFO. These two projects were designed to:

- Provide understanding of the role of ocean conditions on growth and survival of juvenile Columbia River salmon.
- Translate this understanding into useful information that would enhance the ability of federal action agencies to address issues related to recovery of salmon populations by accounting for prevailing and evolving ocean conditions.

Our first objective was to coordinate sampling effort so that both groups used similar protocols and sampling gear. This coordination ensured the production of comparable environmental and biological data sets among different geographic areas (Appendix A). For example, the Nordic 264-rope trawl[†] used by scientists from NOAA's Northwest Fisheries Science Center is the same trawl used by colleagues from NOAA's Alaska and Southwest Fisheries Science Centers and is very similar to the Cantrawl 240-rope trawl used by DFO.

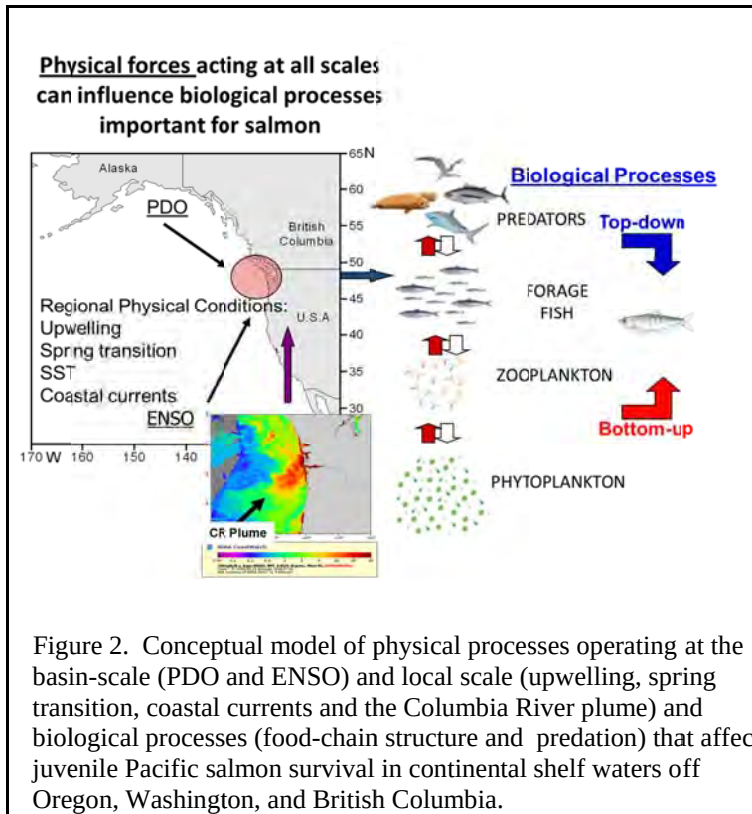
[†] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.



The NOAA and DFO studies encompass three distinct coastal oceanographic domains (Figure 1). Sampling in all three domains provides juvenile salmon from a natural range of contrasting environments that can be used to compare relationships among oceanographic conditions, climate, and the productivity of Columbia River salmon.

The Kintama research project was initiated in 2005 to address specific questions related to river, estuarine, and coastal ocean residency, as well as migration timing and survival.

Kintama's studies complements both the NOAA and DFO projects by providing habitat-specific estimates of juvenile salmon survival and migration timing. Collectively, these research efforts cover over 1,700 km of the continental shelf along the west coast of North America (central Oregon to Southeast Alaska). This area is used extensively by Columbia River salmon as a migratory corridor and rearing area during the first year at sea (Pearcy 1992; Teel et al. 2003; Van Doornik et al. 2007; Trudel et al. 2009; Tucker et al. 2009; Bi et al., 2011b; Fisher et al. In revision). Moreover, both the NOAA and DFO projects overlap geographically with acoustic lines of the Pacific Ocean Shelf Tracking (POST) project. Both the NOAA and DFO studies provide the oceanographic and biological data necessary to interpret region-specific mortality rates identified by the Kintama Coastal Ocean Acoustic Salmon Tracking (COAST) project.



Our joint efforts are built around physical and biological processes related to early ocean growth and survival of Columbia River juvenile salmon (Figure 2). We focus on how growth and survival are influenced by both bottom-up and top-down processes associated with productivity of coastal waters and the Columbia River plume habitat. Table 1 lists the hypotheses developed and tested to evaluate the influence of these processes.

Hypotheses Tested

Some of our testable hypotheses, which are listed in Table 1, were derived from the recommendations of Percy (1992). This group of hypotheses represents an integrated approach to the study of Columbia River salmon. To test these hypotheses, we examined the following:

- 1) Distribution, growth, and condition of juvenile Columbia River salmon in the plume and ocean environments
- 2) Physical and biological properties of the plume and nearshore ocean environment that define stock-specific juvenile salmon habitats
- 3) Relationship between juvenile salmon growth, health, and survival and oceanographic and plume conditions
- 4) Food habits of juvenile salmon and their relationship to the physical and biological oceanography
- 5) Role of predators, pathogens, and alternative prey (forage fish) in influencing salmon marine survival

A major goal is to distinguish how differences in ocean conditions affect different salmon populations and species and how these effects relate to marine growth and survival. This information can contribute to management and recovery efforts for Columbia River Basin salmon only if we can identify mechanistic links between the ocean-caught juvenile salmon and its previous freshwater history and source population or management unit.

Table 1. Summary of hypotheses addressed by the combined NOAA, DFO and Kintama ocean research projects.

H1	Bottom-up processes: Salmon growth and survival are controlled by the quantity and quality of prey resources.
H1₁	Local and basin-scale climate variability affects food availability and quality (i.e., presence and composition of lipid-rich prey).
H1₂	Juvenile salmon growth and survival are affected by food availability.
H1₃	Juvenile salmon growth and survival are affected by food quality.
H1₄	Overwinter energy depletion and mortality is higher in smaller salmon.
H2	Top-down processes: Predators and diseases have indirect and direct effects on salmon survival.
H2₁	Local and basin-scale climate variability affects the abundance and movement of predators.
H2₂	Predators: Salmon survival is lower when piscine and avian predators are abundant.
H2₃	Pathogens: The impact of disease on salmon marine survival is mediated (in part) by bottom-up and top-down processes, which vary depending on ocean conditions. When poor ocean conditions persist, infected fish experience higher mortality; however, under optimal ocean conditions, many infected fish survive.
H2₄	Forage fish: Forage fish mediate predation by providing alternate prey for salmon predators, when forage fish are abundant.
H3	Plume structure: River operations affect the plume structure and its interaction with tides, upwelling, etc., which affect bottom-up processes and thus juvenile salmon success.
H3₁	River operations affect plume structure and its interaction with tides and upwelling.
H3₂	Juvenile salmon success, i.e., growth and/or survival, is related to plume structure.
H4	Hydropower system. Survival of Columbia River salmon is affected by the dams and transportation
H4₁	Downstream and marine survival is affected by the migration through the hydropower system (Delayed Mortality).
H4₂	Smolt transportation (i.e. barging) affect the marine survival of salmon (Differential Delayed Mortality).
H5	Freshwater v Ocean. Smolt survival rates (S) in the ocean (O) are greater than in the freshwater (fw) hydropower system, i.e., $S_o > S_{fw}$

Coordination and Collaboration among Ocean Projects

NOAA and DFO coordinate their sampling programs annually to provide a more comprehensive understanding of the processes regulating ocean survival of different Columbia River salmon Evolutionary Significant Units (ESUs). The two agencies exchange both data and fish tissue; for instance, NOAA has been participating in DFO surveys since 2007 to collect blood plasma for measurements of growth hormones. These analyses will allow NOAA and DFO to map habitat quality (with respect to growth) for juvenile Columbia River salmon over a broad geographic area. These data in turn will help to clarify limits to juvenile salmon production during early marine life.

Annual workshops have been organized for more than a decade by NOAA and DFO. These workshops review the results of the three BPA-funded ocean projects and plan future surveys. They also provide an opportunity to discuss the results of concomitant sampling programs, many of which are conducted outside the survey areas covered by the ocean projects. For example, the Bering Aleutian Salmon International Survey Program has been represented at these workshops. These strategies have led to increased collaboration between the ocean projects: to date, the NOAA and DFO projects have jointly published or submitted 12 manuscripts to peer-reviewed journals. Our collaborative effort on coastal ecosystems and the ocean ecology of juvenile Pacific salmon is reported in these manuscripts (Appendix B).

Ongoing collaboration between the NOAA and DFO field sampling programs provides added value in two important ways. First, if samples were collected only within a small geographic area (e.g., only off the coast of Washington), we could not obtain data on different Pacific salmon species and life-history types during the critical early marine stages. For instance, after ocean entry, the interior Columbia River spring Chinook, coho, and Redfish Lake sockeye salmon quickly undertake a northward migration. These fish are collected off the British Columbia (BC) coast by DFO during early summer, while NOAA is conducting surveys off Washington and Oregon. Fall Chinook salmon remain off Washington and Oregon for extended periods; they do not occur in significant numbers in the DFO survey area until fall.

Second, sampling over a broad geographic area provides a measure of the contrast in oceanographic conditions experienced by Columbia River salmon: these fish occupy different oceanographic domains during the first summer at sea (Figure 1). This broader sampling area increases our ability to detect ocean conditions and compare how they may affect Columbia River salmon. A sampling scheme limited to only the area covered either by NOAA or DFO would diminish our ability to understand these impacts. Third, sampling over a broad geographic area allows for independent confirmation of the observed mechanisms regulating ocean production of Columbia River salmon. By

verifying that these processes are seen in different regions/systems, the reliability of results obtained in both projects is greatly increased.

At the same time, some data are collected by only one of the two groups and shared between groups. For example, growth hormones and parasites are measured only by NOAA; however, by working with DFO, NOAA has obtained samples from beyond the U.S. border. Likewise, winter mortality is determined only by DFO, but both agencies plan to extend the winter mortality survey to the coast of Washington and Oregon to target Columbia River salmon.

Research Synergies with Programs not Funded by BPA

Our interdisciplinary team of scientists has used their expertise of salmon and ecosystem-related problems to obtain additional research funding that complements the funding provided by BPA for the ocean projects.

Newport Hydrographic Line—One core activity funded by other sources has been the biweekly sampling of hydrography and plankton in continental shelf waters off Newport, Oregon. This sampling program along the Newport Hydrographic Line was initiated in 1996 and during this period has been funded by a number of agencies and programs. These include the U.S. Global Ocean Ecosystem Dynamics program (U.S. GLOBEC), which is joint program sponsored by NOAA and the National Science Foundation (NSF) and the NSF sponsored River Influences on Shelf Ecosystems program (RISE). Funding has also been provided by the NOAA Fisheries and The Environment (FATE) program and NOAA Stock Assessment Improvement Plan (SAIP). Biological Opinion (BiOp) funding provided by the NOAA Northwest Regional office has also supported this research.

The time series generated by this program has provided data used in our salmon forecasting efforts described later in this report. Work carried out in this program has had a direct bearing on the BPA study region (Peterson and Keister 2003; Peterson and Schwing 2003; Hooff and Peterson 2006) and has increased our understanding of ocean conditions prior to and during the period of juvenile salmon residency in shelf waters.

U.S. Global Ocean Ecosystem Dynamics (U.S. GLOBEC)—The U.S. GLOBEC program allowed us to expand hydrographic and zooplankton sampling to include offshore waters up to 100 km from shore and transects lines as far south as Eureka, California. One focus of that program was a 2-year study of the ecology of juvenile coho and Chinook salmon in coastal ecosystems from Newport, OR, to Crescent City, CA. This study took place during 2000 and 2002 in an area just south of our BPA sampling

area and led to publications on the distribution (Brodeur et al. 2005; Fisher et al. 2007; Pool et al. 2012), stock structure (Brodeur et al. 2005), and ecology of juvenile salmon and co-occurring species (Reese and Brodeur 2006; Miller and Brodeur 2007; Orsi et al. 2007; Baldwin et al. 2008; Brodeur et al. 2008; Miller et al., 2010c).

U.S. GLOBEC and NOAA/CAMEO—The U.S. GLOBEC and NOAA/CAMEO (Comparative Analysis of Marine Ecosystems Organization) programs funded work that allowed us to define the physical and biological characteristics of continental shelf habitats occupied by juvenile coho and spring Chinook salmon, using data collected during our salmonid trawl surveys (Bi et al. 2007; Peterson et al. 2010; Bi et al. 2011a). We showed that the two species occupied different habitats, with coho found farther offshore than spring Chinook, and that the habitats could be defined from data on water depth, the distribution of chlorophyll-a (a proxy for phytoplankton biomass), and copepod biomass.

National Aeronautics and Space Administration (NASA)—Funding from NASA allowed us to explore the use of NASA’s SeaWiFS satellite, whose sensors could detect the concentration of chlorophyll from space. These data allowed us to present a more detailed spatial representation of salmon habitats in coastal waters off Washington and Oregon (Bi et al. 2008). NASA also funded a study of transport in the northern California Current in which satellite altimeter data (AVISO) were used to calculate geostrophic flows. These data allowed for an estimate the relative amounts of water entering the current from the north and west (Bi et al. 2011b), details of which are discussed in following section on “Physical and Biological Processes Affecting Salmon.”

Pacific Salmon Commission (PSC) and the Canadian Space Agency (CSA)—Funding from the PSC and CSA allowed us to measure growth hormone levels in juvenile Columbia River salmon and assess the origin of juvenile sockeye salmon collected off BC, respectively. These analyses have showed large regional variability in the growth of Columbia River salmon (B. Ferris, in preparation) and that Columbia River sockeye salmon, including Redfish Lake sockeye, are off the British Columbia coast by mid-June (Tucker et al. 2009; Trudel et al. 2010, 2011).

Natural Science and Engineering Council of Canada (NSERC)—Funding from NSERC contributed to measurements of stable isotopes in juvenile pink (*O. gorbuscha*) and chum salmon (*O. keta*) (Jenkins 2011), analyses of otolith microstructure of juvenile Chinook salmon (Middleton 2011), and measurements of fatty acids in juvenile salmon and zooplankton (R. El-Saabawi, in preparation). Although NSERC funding primarily targets salmon of Canadian origin, it allows the development of a framework that can be used for testing specific mechanisms that may regulate the production of Columbia River salmon.

U.S. Army Corps of Engineers (USACE)—Funding from the USACE for implementation of the Biological Opinion (BiOp), along with a previous and separate award from BPA, allowed for studies of juvenile salmon within the Columbia River estuary. These studies have provided information on juvenile salmon residence time within the estuary, habitat use, metrics of growth, condition, diet and stock identification that we compared with our ocean data. One of our initial and important results has been that the common subyearling Chinook salmon stocks in estuary samples are not the dominant subyearling stock groups caught in our near-shore samples. An effort to address this specifically is described later in this report.

River Influences on Shelf Ecosystems (RISE)—The RISE Program (funded by the NSF during 2004-2008) has contributed to our understanding of the impact of the Columbia River on coastal ecosystem dynamics and juvenile salmon habitat. The Columbia River is a significant source of iron (a micronutrient needed by phytoplankton) and plume waters pick up vast amounts of nutrients at the mouth of the estuary and in the nearshore ocean through intense tidal mixing with upwelled waters. Also, the plume is directed offshore and to the south when winds are from the north, but turns north and hugs the coast when winds blow from the south. Thus fertilization of coastal waters by the plume is most evident when the plume moves northward; when the plume is directed southward, fertilization occurs in more offshore waters (summarized in Hickey et al. 2010).

Science and Technology Center for Coastal Margin Observation & Prediction—The NOAA and DFO studies also overlap with the geographic domain of the SATURN Collaboratory (<http://www.stccmop.org/saturn>), maintained by the Science and Technology Center for Coastal Margin Observation & Prediction (CMOP). The SATURN Collaboratory includes a long-term inter-disciplinary observation network, a modeling system (the “Virtual Columbia River”), advanced cyber-infrastructure, and a broad range of scientific and non-scientific user communities that complement the NOAA and DFO studies.

Other Sources of Support—Support for early development of the prototype acoustic telemetry array used by POST was received from the Census of Marine Life (Alfred P. Sloan Foundation) and from the Gordon & Betty Moore Foundation. A number of BC agencies have also helped fund projects or infrastructure operations in the Strait of Georgia/Queen Charlotte Strait. Although funding for research in this region is not used directly in Columbia River salmon studies, it contributes an important component of the overall array because to date it demonstrates that tagged Columbia River smolts do not migrate into the Salish Sea (Strait of Georgia and Puget Sound).

II. Physical and Biological Oceanographic Processes that Affect Juvenile Salmon

California Current

The California Current is an eastern boundary current that flows along the coasts of Vancouver Island, Canada, Washington, Oregon, and California (Figure 1). The current has offshore and inshore arms: the offshore branch is characterized by a meandering flow that is generally southward year-round; the inshore flows alternate seasonally between north and south. In winter, southerly winds result in transport of water northward and shoreward as the Davidson Current, creating “downwelling.” In summer, northerly winds transport water southward and offshore, creating “upwelling.” It is this upwelling that makes the coastal branch of California Current cool, nutrient-rich, and highly productive.

Past research suggested that the upwelling process (and resulting productivity) was important to the growth and survival of juvenile salmonids in the upwelling zone off Washington and Oregon (Nickelson 1986; Fisher and Pearcy 1990; Pearcy 1992; Logerwell et al. 2003). Two aspects of upwelling seemed to be of greatest importance to juvenile salmonids during their first summer at sea: the strength of upwelling (Nickelson, 1986) and the starting date of the upwelling season, also called the date of spring transition (Logerwell et al. 2003). This framework drove early work on juvenile salmonid ecology off Oregon and Washington.

Similarly, in 1999, when the BPA-funded DFO ocean project was initiated in waters off southern BC, salmon production was believed to be regulated by ocean productivity. Ocean productivity in turn was thought to be regulated by the effects of sea surface temperature (SST) on mixed-layer depth (Gargett 1997; Hare et al. 1999; Mueter et al. 2002). Under this hypothesis, production by phytoplankton in the Northern California Current (NCC) System would be limited by nutrients, whereas plankton in the Alaska Coastal Current (ACC) would be limited by sunlight. As such, shoaling of the mixed-layer depth due to increased SST was expected to reduce the upwelling of nutrients to surface waters of the NCC, but to retain primary producers in the euphotic zone of the ACC. Thus, changes in SST were expected to have opposite effects on ocean and salmon productivity in the NCC and ACC.

Earlier suggestions that mixed-layer depth is important to salmon (Gargett 1997) have since been shown to have limited explanatory power. Our surveys have shown that plankton productivity decreases with increasing SST off the west coast of Vancouver Island, but an opposite trend was observed in the ACC (Figure 3).

Moreover, the marine survival of Columbia River summer and fall Chinook and coho salmon are negatively correlated to SST off the west coast of Vancouver Island (Trudel, unpublished data). However, there was no significant correlation between Columbia River salmon survival and phytoplankton or zooplankton biomass, suggesting

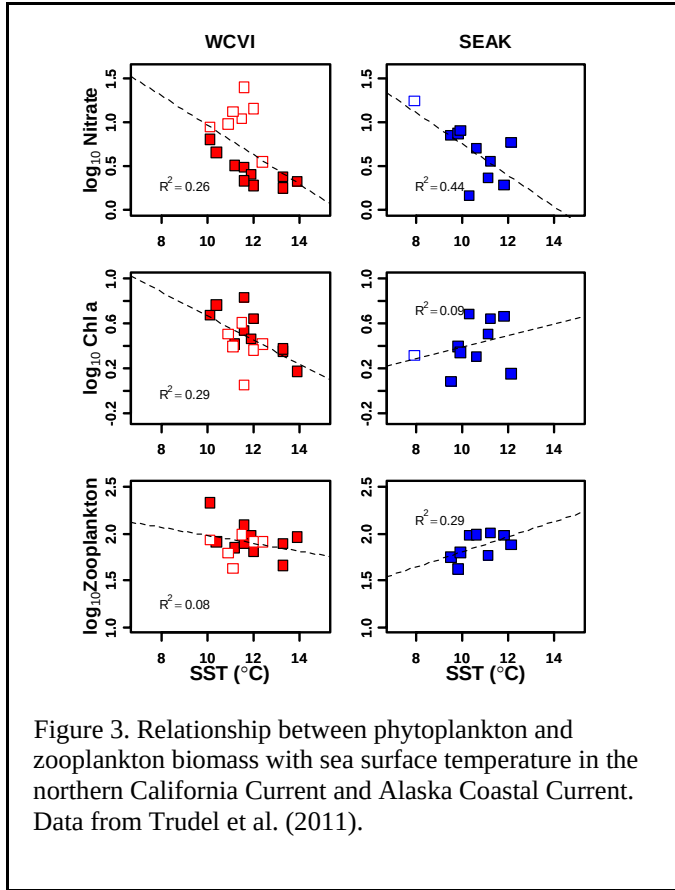
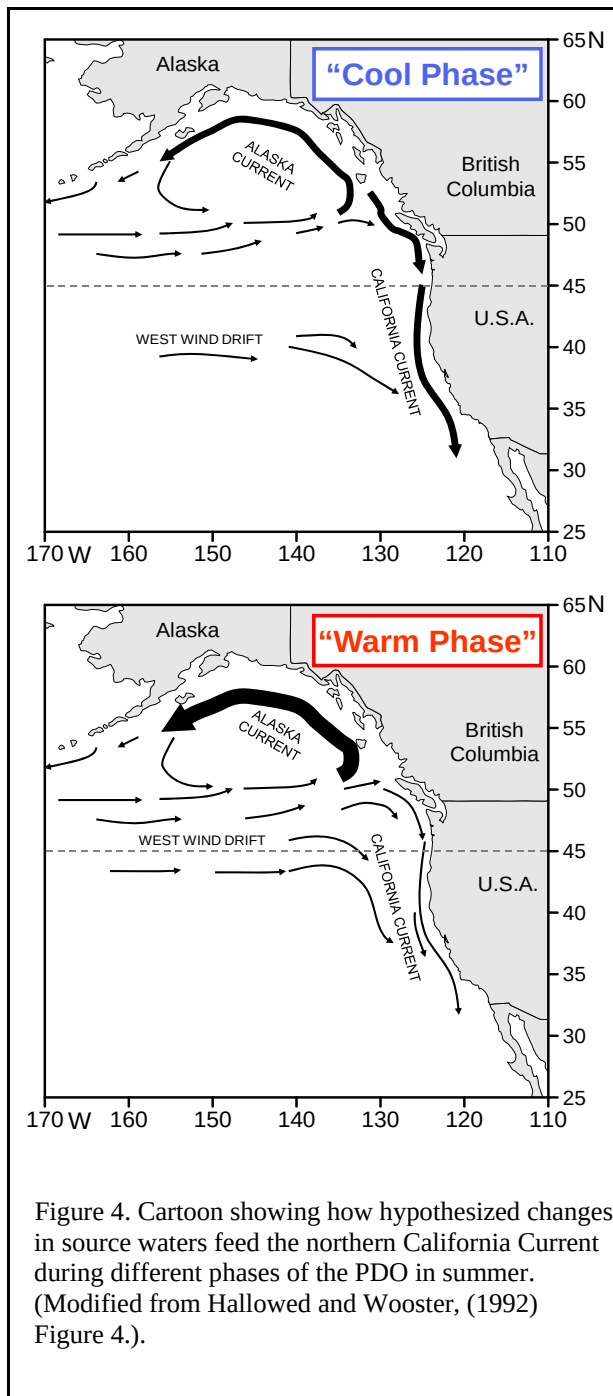


Figure 3. Relationship between phytoplankton and zooplankton biomass with sea surface temperature in the northern California Current and Alaska Coastal Current. Data from Trudel et al. (2011).

that the effect of SST on salmon survival was not mediated by changes in ocean productivity. Further, even though plankton biomass is higher in the NCC than in the ACC (Ware and Thomson 2005), salmon growth and survival is generally higher in the latter (Shaul et al. 2007; Trudel et al. 2011).

A proposed alternate mechanism may be related to the source waters that give rise to the NCC (Figure 1 and 4), and this alternate mechanism may also have cascading effects on food-web dynamics. Differences among years in both the source of waters that feed the California Current and the volume of water transported among years seem to be controlled by the phase of the Pacific Decadal Oscillation (PDO). The PDO is a spatial pattern in sea surface temperature seen across the entire North Pacific Ocean. When the PDO is in a “cold phase,” anomalously cold water is found around the Gulf of Alaska and in the California Current. Conversely, while the PDO is in a “warm phase,” the opposite pattern is seen, with equatorial waters dominating the NCC.



These patterns are driven by winds. During the cold phase, winds tend to be more northerly and westerly, leading to Ekman pumping of offshore waters, upwelling of coastal waters, and a general cooling of surface waters of the Gulf of Alaska and California Current. During the warm phase, winds are more southerly or southwesterly, resulting in the transport of warm subtropical water towards the coast of North America, and creating downwelling.

When the PDO was first described by Mantua et al. (1997) it was noted that the phase of the PDO shifted on decadal time scale (hence the term Pacific Decadal Oscillation). Shifts to a warm phase occurred in 1925 and 1977, while shifts to a cold phase occurred in 1947 and 1998. Since 1998, the phase of the PDO has oscillated with much higher frequency, with a 5-year cool phase during 1998-2002, a 5-year warm phase during 2003-2007. Recently the frequency of the oscillation appears to have increased again, with 2-year cool phase from 2008 to 2009 followed by one warm-phase year (mid-2009 to mid-2010) and one cool year (mid-2010 to 2011).

This recent variability in the PDO has provided us with natural range of experimental conditions with which we can compare the response of juvenile salmon to a large variety of ocean conditions. Specifically, the years 2005 and 2008 provide pronounced contrasts in ocean conditions, with 2005 extremely warm due to a near-complete lack of upwelling and 2008 anomalously cold due to a strongly negative PDO. In addition, 2001 was a drought year; thus the volume of the Columbia River plume was reduced.

Furthermore, we have conducted sampling during a major El Niño event in 1998 and during two smaller but significant events during 2003-2004 and 2009-2010. A longer time series is needed to track these recent high-frequency variations in the PDO and in the associated variations in ocean conditions and salmon survival. These data are necessary if we are to further explore biological responses to the extreme conditions expected in the future.

Widespread ecological changes are associated with shifts in the PDO (Mantua et al. 1997). Such changes include increased salmon landings in the Gulf of Alaska (GOA) and Bering Sea when the PDO is in positive phase, and vice versa. Francis and Hare (1994) noted that the ecosystem response was pronounced in the years when PDO change-points were observed, and that the response occurred in the year of the change. Therefore, they suggested that for salmon, the processes controlling production were acting during their first summer at sea, as also suggested by Pearcy (1992).

Given the strong linkages between the PDO and salmon, and the short time scale (no more than one year) over which ecosystem shifts have been observed, what might be the nature of the mechanism(s) that link PDO with zooplankton and salmon production? Our research suggests that the mechanistic link between PDO and salmon growth and survival is due to shifts at the base of the food chain between lipid-poor and lipid-rich plankton communities. These changes in the food chain lead to changes in feeding conditions for salmon and forage fishes (Peterson and Keister 2003; Peterson and Schwing 2003; Peterson and Hooff 2005; Hooff and Peterson 2006; Daly et al. 2010; Litz et al. 2010; Keister et al. 2011; Bi et al. 2011a).

When the PDO is in a negative (cold) phase, boreal, lipid-rich cold-water copepod species are transported southward out of the Gulf of Alaska (Figure 3) and dominate the lower trophic levels in the California Current. These species are also the dominant zooplankton of the coastal ecosystem of the Bering Sea and coastal Gulf of Alaska (Coyle and Pinchuk 2003, 2005; Coyle et al. 2008) and southern BC (Mackas et al. 2001, 2004).

When the PDO is in positive (warm) phase, warm water, and lipid-poor copepod species become important in the NCC and in some years dominate. These copepods are typical of the subtropical waters that lie offshore and south of Oregon. Also, during the warm phase of the PDO, upwelling tends to develop later in the year and subtropical copepod species that have been transported northwards in winter will linger longer, into the spring and summer months, leading to a "subtropical" copepod community on the shelf.

Shifts in the PDO also result in other changes in the coastal food web. Warm ocean conditions associated with the positive-phase PDO result in changes in the abundance of fish predators and fish prey in coastal waters of the NCC. Adult and juvenile hake (whiting) move up into shelf waters during warm ocean periods, resulting in increased predation on juvenile salmon (Emmett and Krutzikowsky 2008). Forage fishes (anchovy (*Engraulis mordax*) and smelts (Osmeridae)), which as juveniles, are prey of juvenile salmonids tend to be less abundant during warm ocean conditions (Emmett et al. 2006; Emmett and Sampson 2007). Thus, the PDO may affect the survival of Columbia River salmon through both its effects at the base of the food web as well as on salmon predators at higher trophic levels.

Columbia River Plume

The Columbia River is a major oceanographic feature of the Pacific Northwest. The river contributes 70% of the freshwater discharged to the eastern North Pacific between San Francisco and Juan de Fuca Strait. Its plume extends northward to BC or southward to California, depending on the coastal wind regime. The estuary functions as a key bioreactor, modifying biogenic inputs from land before they reach the continental shelf via the plume. Both the estuary and plume are controlled by a combination of large-scale ocean, atmospheric, and hydrologic forcing, all of which vary at scales ranging from tidal to seasonal and interannual.

Our understanding of seasonal and inter-annual variability in the physics of the estuary and plume has increased substantially over the last decade (Chawla et al. 2008; Hickey et al. 2009, 2010; Burla et al. 2010b). This variability is documented by a virtual Climatological Atlas (CMOP 2012), which describes a plume extending southward and offshore in during spring and summer dominated by upwelling. Likewise, a northward-extending and coastally attached plume is described in winters dominated by downwelling. However, the virtual atlas currently fails to capture some dramatic scales of variability in plume characteristics that are potentially relevant to salmon, such as hourly to daily changes in plume direction, which depend upon the speed and direction of coastal winds (Hickey et al. 2009; Burla et al. 2010b). Using plume simulations from the Virtual Columbia River numerical model, Burla et al. (2010b) showed that river discharge explains most of the plume variability (>40%), with coastal winds the next most important factor (>20%).

III. Ocean Migration and Distribution of Columbia River Basin Juvenile salmon

Delineation of the ocean distributions of Columbia River salmon is an important step in understanding mechanistic links between regional ocean conditions and their influence on the growth and survival of specific stocks and life-history types.

First, fish size at ocean capture is used to classify individuals as subyearling or yearling freshwater migrants (Fisher and Pearcy 1995). This terminology specifically applies to the age at which a fish left freshwater and entered the ocean and is a key life history characteristic. Additionally, DNA data are used to identify stock of origin (Seeb et al. 2007; Beacham et al. 2011b). Genetic stock assignments are typically made to an ESU level and therefore provide information on both the geographic region of origin and adult timing of the source population (e.g., Snake River fall run Chinook salmon and Snake River sockeye salmon). Individuals from each source population may adopt either a subyearling or yearling life history pattern.

Another goal of this study is to document life history diversity. Tags, (coded-wire, PIT, or acoustic are detected in a subset of individuals, yielding direct links to population sources (e.g., Trudel et al. 2009). Additionally, the elemental ratio (strontium:calcium) and structure of otoliths have been analyzed on a stock-specific basis. These analyses have generated more specific information on the variation in size and timing of juvenile migration within and among stocks. Finally, marks (e.g., adipose fin clips) are used to identify a larger proportions of hatchery fish (Daly et al. 2011). These data are used here (singly or in combination) to report results by juvenile life history type (subyearling or yearling), by stock or ESU, and by hatchery or natural origin when possible.

Coast-Wide Distribution Patterns

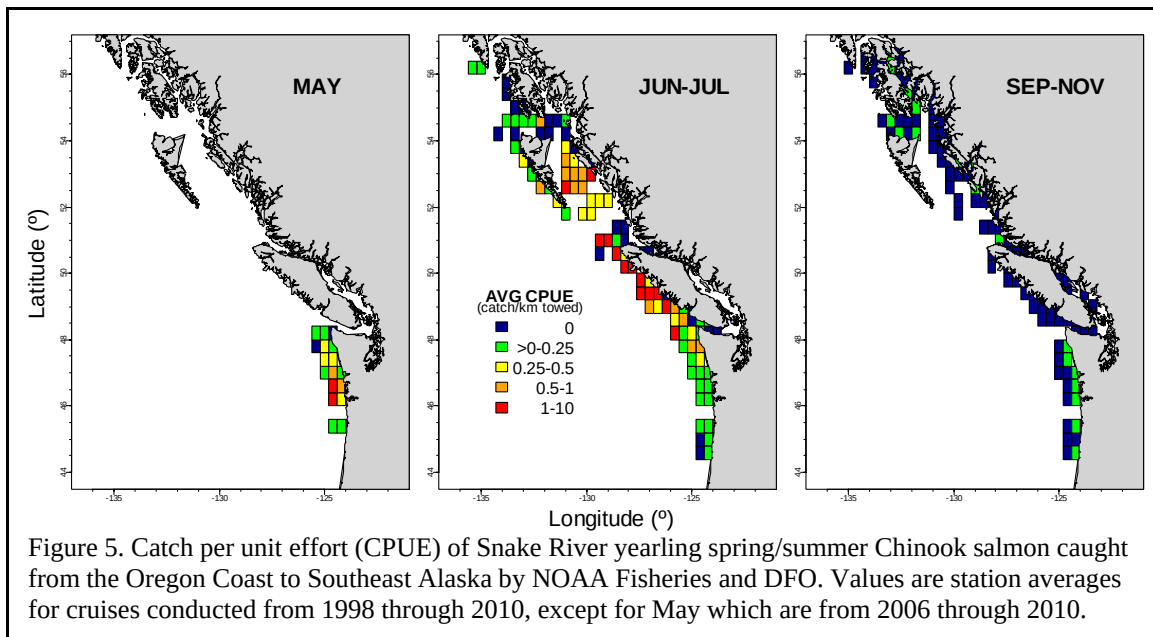
Different stocks and life-history types of Columbia River salmon have strikingly differing ocean distributions during their first weeks and months at sea, and these distributions persist across years. These patterns were evident from both genetic stock identification and coded-wire tag data collected for the NOAA and DFO ocean projects. These differing distributions expose juvenile salmon to different ocean conditions with implications for feeding opportunities, growth and survival.

This observation is in contrast to prior studies, including tagging experiments conducted in the 1960s. Earlier evidence suggested that juvenile spring Chinook, coho, and sockeye

salmon undertake a northward migration upon entering the ocean, though the timing of these migrations was unknown (Hartt and Dell 1986; Healey 1991). In contrast, juvenile fall Chinook salmon were believed to remain in coastal waters for extended periods, though little was known of the distribution for particular stocks (Healey 1991).

Studies conducted in the 1980s revealed that many juvenile hatchery coho and subyearling fall Chinook salmon remained in coastal areas off Oregon and Washington throughout summer (Miller et al. 1983; Percy and Fisher 1988; Fisher and Percy 1995). The COAST study has demonstrated that Columbia River yearling Chinook smolts migrate primarily north upon ocean entry, and that only a very small proportion of these yearlings migrate south off the coast of Oregon before turning north.

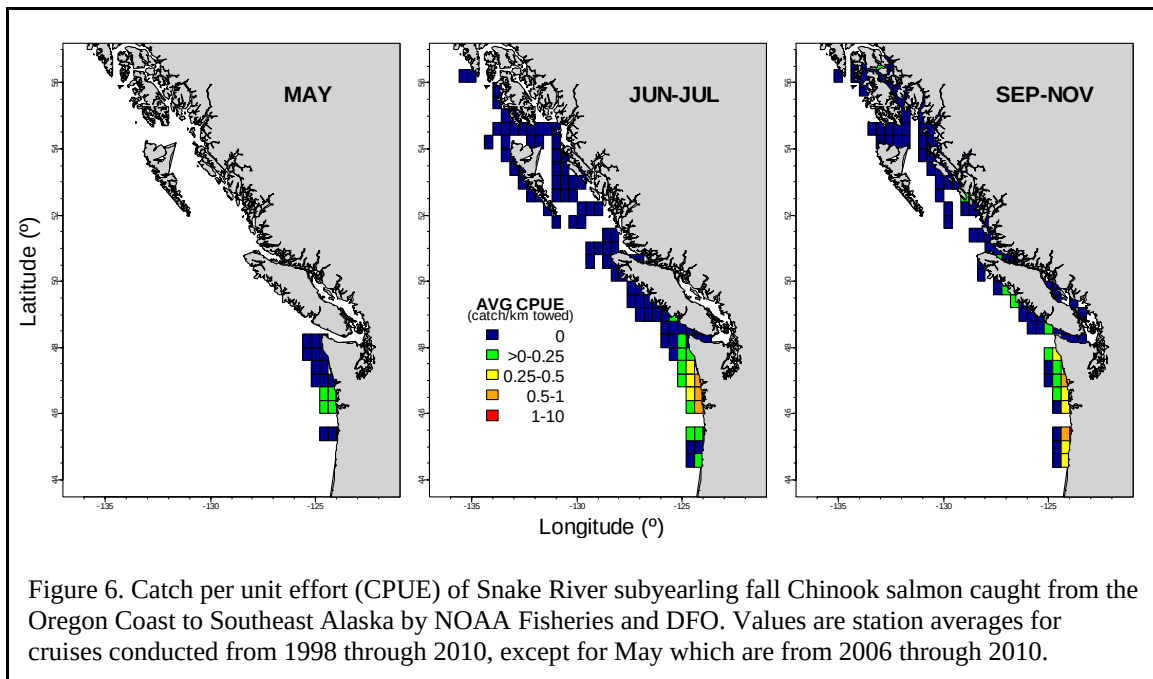
Our ocean studies have identified three patterns of migration. First, some Columbia River basin salmon move rapidly northward soon after they enter the ocean in spring and early summer (Figure 5). By early summer, Snake River spring/summer and Mid and Upper Columbia River spring Chinook salmon are distributed along the entire coast, from the Columbia River to Southeast Alaska (Teel 2004; Trudel et al. 2004, 2009; Rechisky et al. 2009; Payne et al. 2010; Daly et al. 2011; Fisher et al. in revision). By fall, these juveniles are rarely found off Washington and British Columbia (BC), and by winter, they have moved further north and west, no longer present off BC or Southeast Alaska (Figure 5). Columbia and Snake River sockeye salmon show a similar pattern of rapid northward migration (Tucker et al. 2009; Trudel et al. 2010).



Second, other Columbia River Basin juvenile salmon migrate at much slower rates than those of interior-basin spring Chinook and sockeye salmon. For example, spring Chinook

salmon from the lower Columbia River (e.g., from Cowlitz River Hatchery) remain in coastal waters from the Oregon coast to the west coast of Vancouver Island for an extended period (Trudel et al. 2009; Fisher et al. in revision). Similarly, populations of subyearling Snake River fall, Upper Columbia summer/fall, and Lower Columbia River fall Chinook salmon disperse slowly both south and north of the Columbia River following a protracted period of ocean entry that begins in spring and continues into autumn (Brodeur et al. 2004; Teel 2004; Trudel et al. 2004, 2009; Tucker et al. 2011; Fisher et al. in revision; Figure 6). These subyearlings reside in coastal areas off Oregon and Washington throughout summer and fall (Figure 6). A few are caught off Vancouver Island, but only in fall; in winter, they appear to initiate a northward migration (Tucker et al. 2011).

Third, several Columbia River Basin stocks cannot be easily characterized as having either rapid northward migrations or slower migrations with periods of residency. Rather, these stocks exhibit a diversity of dispersal patterns. For example, some Columbia River yearling coho salmon consistently reach Alaska during their first summer and fall at sea; however, many remain in coastal areas from Vancouver Island to central Oregon (Teel et al. 2003; Trudel et al. 2004; Morris et al. 2007; Van Doornik et al. 2007; Fisher et al. in revision). Spring Chinook from the Willamette River, as well as yearling Chinook from Snake River fall and Upper Columbia River summer hatchery programs, show similar complex migration patterns.



These results underline the importance of considering stock-specific spatial and temporal distributions in assessing the effects of ocean conditions on Columbia River salmon. The extent to which various stocks and life history types remain in regions that favor survival differently will determine their adult return rates. For subyearling fall Chinook, ocean conditions appear to be most relevant at the scale of the NCC (i.e., Oregon to the west coast of Vancouver Island), given their tendency to reside in these waters. Broad and more complex spatial and temporal scales must be considered for other Columbia River salmon as the distributions of these fish span both the NCC and ACC systems.

Fine-Scale (Spatial and Temporal) Habitat Usage Patterns and Factors Affecting Distribution

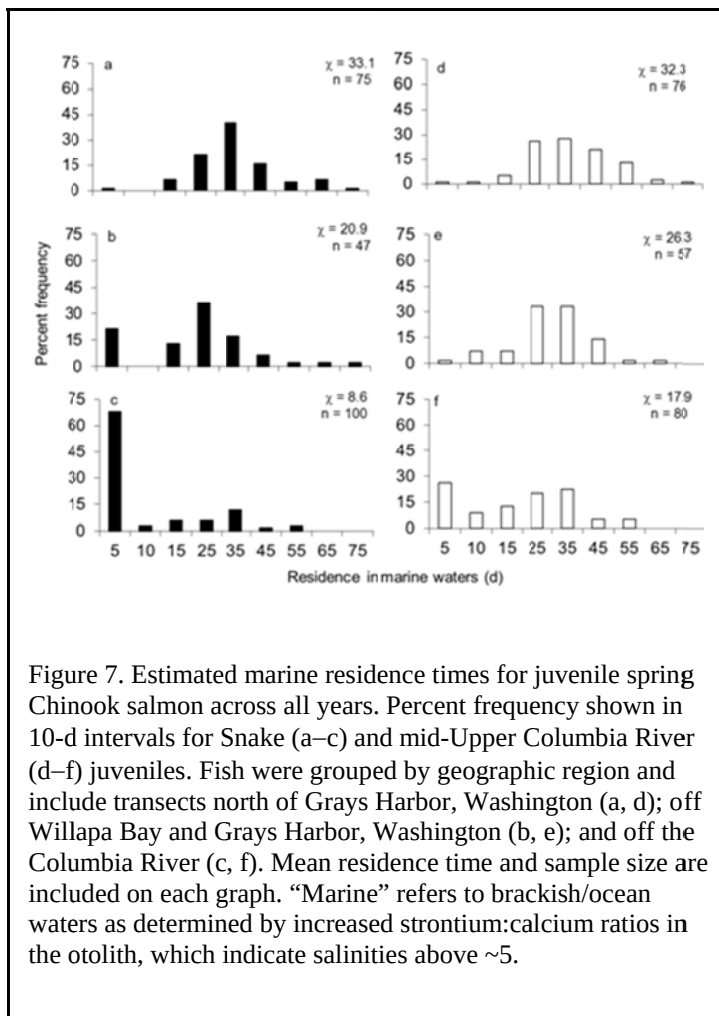
In addition to the coast-wide distribution patterns outlined above, our data also reveal substantial discontinuities in juvenile salmon distribution and abundance at local and regional scales. Juvenile Chinook and coho have been found almost entirely along inner- to mid-shelf areas (Fisher et al. 2007; Peterson et al. 2010), the region of greatest productivity and food biomass (Peterson et al. 2010). Within the continental shelf region, subyearling Chinook is found closest to shore, while coho and yearling Chinook extend much further offshore (Fisher et al. 2007). Similarly, subyearling Chinook is found in cooler waters, while yearling Chinook and coho occupy a broader range of temperatures (Peterson et al. 2010; in prep). Because these patterns are observed consistently from year to year, they suggest adaptive genetic differences. For example, use of different local habitats could have arisen from an evolutionary strategy to avoid competition for food.

Interannual shifts in distribution and abundance at local and regional scales are related to temporal fluctuations in the physical and biological characteristics of local habitats. In our June catches, for example, both coho and yearling Chinook salmon are found further offshore during years of strong upwelling (Peterson et al. 2010): 80% of coho and yearling Chinook were caught at respective depths of 150 and 100 m during years of strong upwelling and 100 and 60 m during year of weak upwelling. This finding implies that strong upwelling tends to disperse juveniles across a greater area of the continental shelf, whereas weak upwelling and its resultant warmer ocean tends to “compact” distributions into a narrower coastal band.

Analyses of yearling Chinook catch data off Oregon and Washington reveal consistent distributional effects of local environmental variables such as temperature and turbidity, even when spatial structure had been taken into account. This suggests that salmon are not passively dispersed by prevailing currents (e.g., upwelling), but actively search out preferred habitat during migration (Trudel et al. 2009).

At the same time, models suggest that for some stocks (e.g., interior basin spring run ESUs), large-scale, geospatial cues such as Earth's magnetic field may be more important than local environmental factors (B. Burke unpubl. data). These stocks may encounter suboptimal habitat during migration due to failure to respond to local conditions, a situation that could be exacerbated by climate change (Tucker et al. In press).

Rapidly migrating stocks of interior spring Chinook reach areas north of Washington by June-July (Figure 5; Trudel et al. 2009; Tucker et al. 2011; Fisher et al. in revision). However, there is some fine-scale interannual variation in this migration pattern. For example, Mid and Upper Columbia River spring Chinook consistently entered marine waters earlier than Snake River spring Chinook (Tomaro et al. in revision, J. Miller, unpubl. data).



This variable marine entry is reflected in the coastal residence of these two stocks: the Mid and Upper Columbia River Chinook salmon collected along the Columbia River had been in marine waters longer than the Snake River spring Chinook salmon (Figure 7).

There was also interannual variation in the marine migration rate of interior spring Chinook. Migration of Mid and Upper Columbia River Chinook was slower during years with a high biomass of lipid-rich, northern copepods; migration of Snake River Chinook was slower during years with extended upwelling seasons (J. Miller, unpubl. data). Although it is

not clear whether these patterns are related to fish behavior or to other physical factors, the net effect is that juveniles move through coastal waters at slower rates when ocean conditions appear favorable for foraging and growth.

Data from Kintama's acoustic tracking show that for interior Columbia River Basin yearling Chinook, plume residence is related to timing of the downstream migration (with the plume defined as the area between Astoria and Willapa Bay acoustic lines.)

After release, tagged yearlings migrate downstream and turn north onto the continental shelf upon ocean entry. At John Day Dam, staggered releases of tagged yearlings covering most of the 2010 migration season indicate that the interval between release and arrival at the river mouth (Astoria) was nearly constant across release dates. However, residence in the plume region was substantially reduced for yearlings released late in May, as seen in the sudden narrowing of the interval between release and arrival at Willapa Bay (Figure 8).

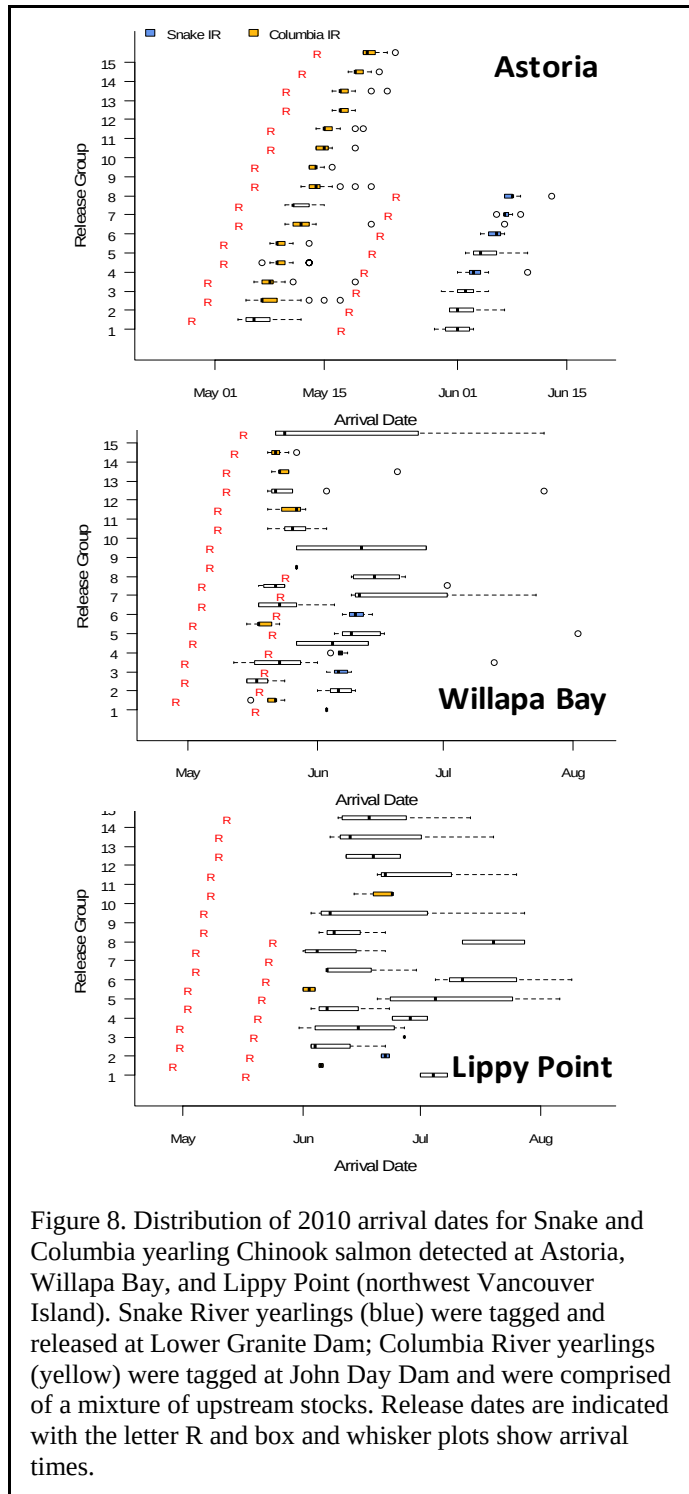


Figure 8. Distribution of 2010 arrival dates for Snake and Columbia yearling Chinook salmon detected at Astoria, Willapa Bay, and Lippy Point (northwest Vancouver Island). Snake River yearlings (blue) were tagged and released at Lower Granite Dam; Columbia River yearlings (yellow) were tagged at John Day Dam and were comprised of a mixture of upstream stocks. Release dates are indicated with the letter R and box and whisker plots show arrival times.

These findings are consistent with estimates of migration rate based on otolith chemical analyses (strontium:calcium) for Mid and Upper Columbia River yearling spring Chinook. These analyses indicate that movements are faster as the summer progresses (Tomaro et al. in revision).

Cross-Shelf Distribution of Tagged Smolts

To date, our acoustic tagging results indicate that the yearling Chinook smolt distribution off Willapa Bay extended farther offshore than our array extended in 2006 (29 km) and also in 2008-2010, when the array was extended to 34 km offshore. In 2011, the array was further extended to 46 km offshore: once again smolts were detected across the entire shelf, including the outer edge of the sub-array (Appendix C, Figure C-3).

Thus, our detection data are consistent with NOAA's yearling Chinook catch data at Willapa Bay. At Lippy Point (NWVI), both the NOAA and CDFO trawl surveys and the distribution of acoustic-tagged smolts indicated that north of Willapa Bay, where the shelf is wider, the distribution is clearly shelf-bound (Appendix C, Figure C-3). Additional analysis using NOAA catches of Chinook smolts off SE Alaska indicates that the Chinook distribution also remains strongly shelf-bound here as well (Porter et al. 2011). As a result, it seems likely that smolts may move farther offshore in the Columbia River plume before turning north after exiting the river.

IV. Marine Growth and Condition and Linkage to Adult Returns (H1)

Early marine mortality is believed to be a function of the growth and condition of individual fish. To understand the effects of ocean conditions on Columbia River salmon survival, we need to examine growth in the marine environment.

Pacific salmon sustain heavy and highly variable losses in the ocean, with natural mortality rates often exceeding 90-95% (Bradford 1995). Most of this mortality is thought to occur in coastal marine ecosystems during two critical periods: an early period of predation-based mortality that occurs within the first few weeks or months of ocean entry, and a later period of starvation-based mortality that occurs following the first winter at sea (Beamish and Mahnken 2001).

Both predation- and starvation-based mortality are size-dependent (Willette et al. 2001; Hurst 2007). Therefore, ocean conditions that lead to slower growth likely increase mortality during these critical periods of marine life, thereby reducing adult returns (Pearcy 1992; Beamish et al. 2004). Slower marine growth may also reduce the ability of adult salmon to complete their spawning migration (Crossin et al. 2004). Production in freshwater and riparian ecosystems may consequently be reduced through a reduction in marine-derived nutrients (Cederholm et al. 1999). Moreover, smaller adult fish tend to produce smaller eggs and fry, which are more vulnerable to predation than larger cohorts (Ruggerone and Rogers 1993; Quinn et al. 2004).

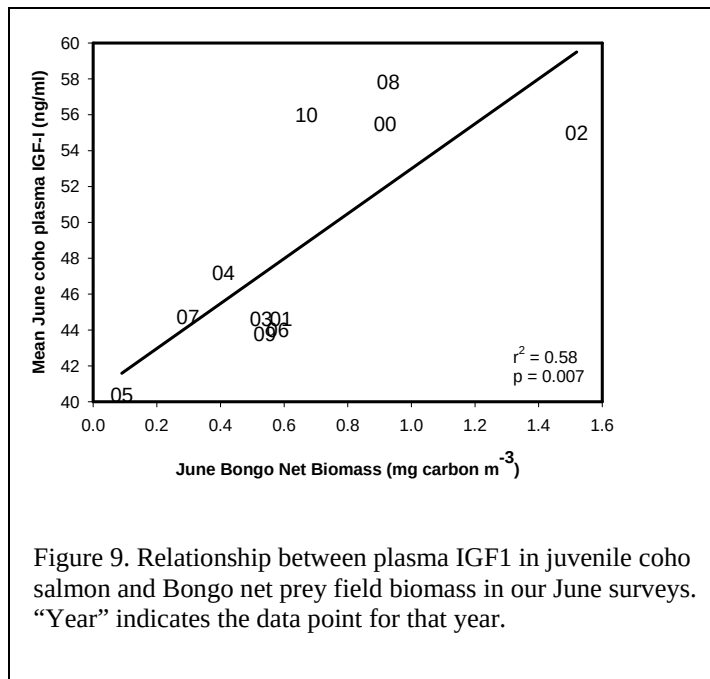
We have estimated length, mass, body condition, and growth for fish caught in the May and June NOAA ocean surveys. These surveys occur within weeks of ocean entry for yearling Chinook and coho and within weeks-to-months for subyearling Chinook. For several populations of Columbia River Chinook salmon, growth has been estimated by measuring otolith growth after seawater entry (Tomaro et al. in revision). Coho and Chinook salmon growth has also been indexed by measures of the hormone, insulin-like growth factor 1 (IGF1; Beckman 2011). Otolith growth is measured to estimate marine growth rate over a period of weeks to months (entire seawater history before the fish was captured), whereas measures of IGF1 relate to growth for approximately one week. Fish size, mass, and body condition (defined as the residuals of the mass-length relationship) can each provide a different perspective on overall fish health. In addition, somatic growth (May-October) has been estimated by DFO using smolt size and ocean entry date for juvenile salmon caught during the first fall at sea (Trudel et al. 2007b, 2011b).

Interannual Variation in Salmon Food and Growth

Field estimates of salmon prey abundance and growth rate have varied interannually, with high estimates of both in 1999-2002 and 2008. Lower rates of salmon food abundance and growth rate were especially evident in 2005 (Figure 9), a year of known low ocean ecosystem productivity (AGU 2006).

Overall, estimates of salmon food availability are positively and significantly related to June growth rates for both juvenile coho (Figure 9) and Mid and Upper Columbia River and Snake spring Chinook salmon. Somatic growth in juvenile coho and Chinook salmon is positively correlated with both food consumption rates and the carbon/nitrogen (C/N) ratio of ocean zooplankton off Vancouver Island and Southeast Alaska (Trudel et al. 2011). The C/N ratio is an indicator of lipid

concentration in aquatic animals such as zooplankton (Post et al. 2007). Thus, this latter relationship indicates that juvenile salmon growth is affected by both prey abundance and quality (Trudel et al. 2011).



Marine Growth and Adult Abundance

Perhaps the best test of whether bottom-up processes regulate marine survival and abundance is whether juvenile growth is related to adult abundance for Columbia River salmon. We have evaluated this question for both coho and Chinook salmon, including several independent populations of Chinook salmon. In every case we have found a positive and significant relationship between growth and adult abundance (Table 2).

Table 2. Relationships between post-ocean entry growth and adult abundance for yearling salmon for several populations of salmonids from the Columbia River basin.

Species	Population	Ocean entry years	n	Growth estimate	Abundance estimate**	<i>P</i>	<i>R</i> ²
Chinook	Snake River spring	1999-2000, 2002-2004, 2006-2008	8*	otolith	Adults at Lower Granite Dam (stock specific)	< 0.01	0.49
Chinook	Mid-upper Columbia River spring	1999-2000, 2002-2004, 2006-2008	8*	otolith	Adults at Priest Rapids Dam (stock specific)	< 0.01	0.58
Coho	Columbia River (composite)	2000-2010	11	June IGF1	Oregon Production Index (hatchery) coho survival	< 0.01	0.82
Chinook	Mid and Upper Columbia River Snake spring (composite)	2000-2009	10	June IGF1	Spring Chinook adults at Bonneville Dam	< 0.01	0.79
Chinook	Willamette River spring	2006-2009	4*	May IGF1	Spring Chinook adults at Willamette Falls	0.08	0.85
Steelhead	Columbia River (composite)	2006-2009	4*	May IGF1	Steelhead adults at Bonneville Dam	< 0.01	0.82

* Not enough Chinook otoliths were collected in 2001 and 2005; analysis of Willamette River Chinook and Steelhead were first initiated in 2006.

** Adult return is considered to be an indicator of marine survival for Columbia River salmon (Appendix D and E).

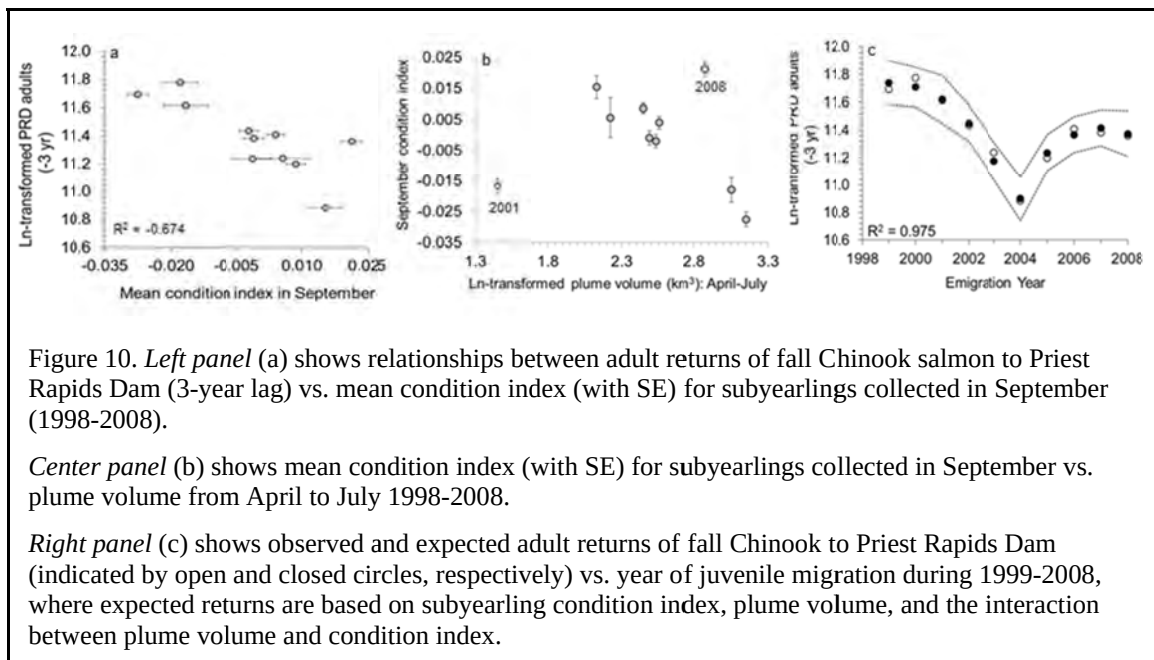
Together, these data present strong evidence that variation in marine productivity directly controls marine abundance of Columbia River salmon. Moreover, these data suggest that estimates of juvenile salmon growth soon after ocean entry may be used to estimate adult salmon returns.

Juvenile Chinook Growth and Condition vs. Life History Type

In the previous section, we reported the differing ocean migration and distribution patterns observed for different stocks of spring- and fall-run Chinook salmon. Different populations and life-history types of Chinook salmon also display different responses to early marine residence.

For interior spring-run Chinook, which migrate predominantly as yearlings, early marine growth leads to interannual differences in body length. Length at capture and subsequent survival (i.e., counts of adults at Columbia River dams) are greater during years when coastal waters are cool and productive, as predicted if bottom-up processes dominate during early marine residence.

A reverse pattern is observed for fall-run subyearlings. During years when the ocean is relatively cool and productive, body condition after the first summer in the ocean is lower for fall-run subyearling Chinook. Two mechanisms may explain the lower mean body condition (based on residuals of mass:length regressions) observed during high survival years (Figure 10a). The first is that more fish survive in years with favorable ocean conditions, including those in poor condition that would not have survived in other years. The second is increased competition for prey in high survival years (a density-dependent effect).



We also found that interannual variation in plume volume (1999-2008) accounts for a high level of the variation in subyearling body condition (Figure 10b) with the notable exceptions of 2001 (drought year) and 2008. In fact, a regression model that included subyearling body condition in September and plume volume during the juvenile migration (and the interaction between them) accounted for more than 97% of the variation in returns of adult fall Chinook to Priest Rapids Dam (Figure 10c). These data indicated that measurement of subyearling body condition in late summer may be useful for hindcasting, and potentially forecasting adult returns, as well as for identifying specific mechanistic links between ocean conditions and early marine survival.

Regional Variation in Growth Rates and Survival

Research conducted by the ocean projects suggests that changes in prey quality affect the growth and survival of salmon in the marine environment. Therefore, the relative survival of different stocks of salmon in the ocean will depend on where they migrate in the ocean and how long they remain within regions of varying ocean productivity. Questions about specific patterns of ocean habitat use are being addressed by the ocean project enhanced telemetry studies. For example, while plankton productivity and temperatures tend to be higher in the Northern California Current (NCC), salmon in the Alaska Coastal Current (ACC) are generally larger and fatter, and have higher growth rates (Figure 11). Similarly, growth hormones measured in juvenile salmon collected in both the NOAA and DFO trawl surveys indicate that growth is generally higher north of Vancouver Island (Figure 12), although there is interannual variation in growth hormones. The poorer growth and condition of salmon in the NCC appears to be related to a calorie-deficient diet rather than to a direct effect of temperature on salmon growth (Trudel et al. 2002).

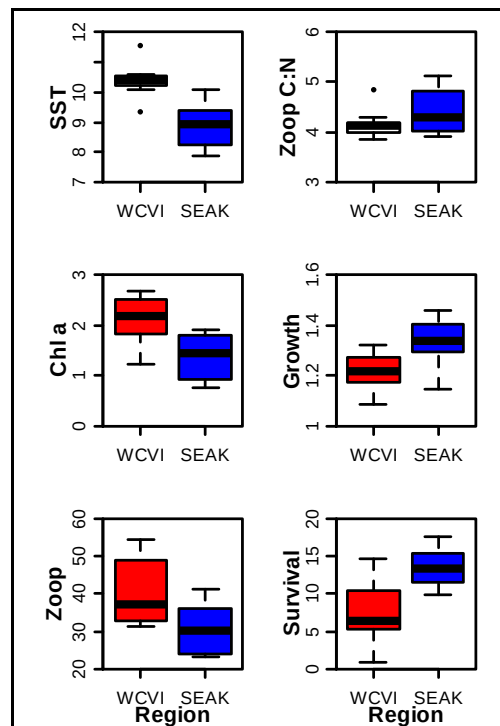
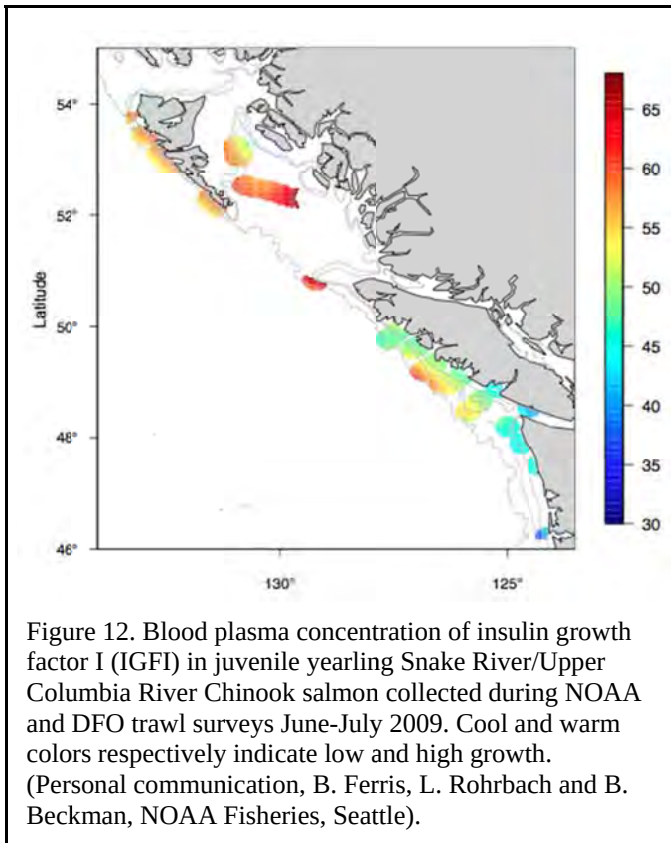


Figure 11. Mean annual sea surface temperature (SST), phytoplankton (Chl a) and zooplankton abundance (Zoop) and C:N ratio (Zoop C:N) vs. growth and survival of coho in the NCC (WCVI) and ACC (SEAK). Data from Trudel et al. 2011a.



Support for this hypothesis was first documented by Peterson and Schwing (2003), who showed that the marine survival of coho salmon in the Oregon Production Index (OPI) was positively correlated with abundance of lipid-rich northern copepods. For Columbia River summer and fall Chinook and Redfish Lake sockeye salmon a similar pattern was observed between summer growth and abundance of northern copepods off Vancouver Island and between summer growth and the C/N ratio in zooplankton (Trudel et al. 2011).

Winter Growth and Mortality

Overwinter survival of juvenile Pacific salmon during the first year at sea has been recognized as an important factor limiting recruitment and has been linked to lipid and energy dynamics (Beamish et al. 2004). Research on size-selective overwinter mortality in juvenile salmon has focused on northern stocks, such as Prince William Sound pink (Moss et al. 2005; Cross et al. 2009) and Bering Sea sockeye (Farley et al. 2011). However, Beamish et al. (2004) also studied a southern stock of coho salmon from the Strait of Georgia.

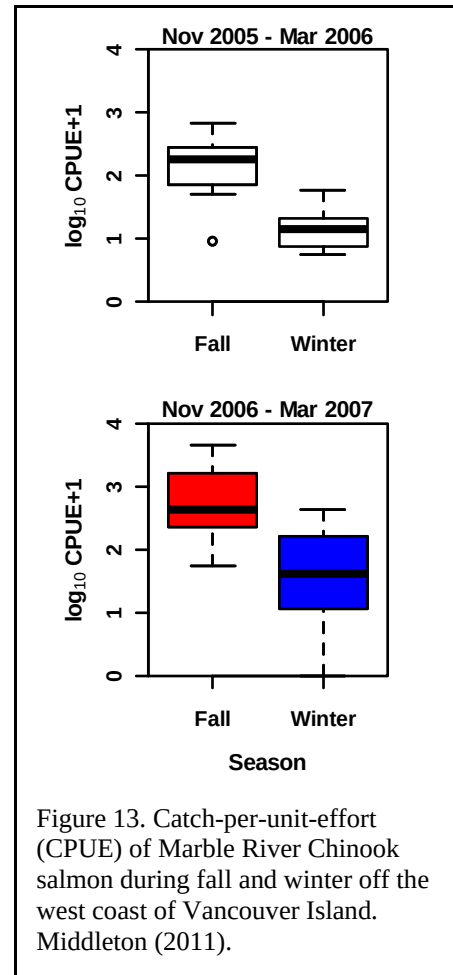
These studies have generally supported the hypothesis that winter mortality is higher in smaller juvenile salmon. However, none of these studies quantified the extent of mortality that occurs during winter, and none have focused on the southern regions of the NCC used by Columbia River salmon.

DFO has conducted trawl surveys during fall and winter since 2000 to assess the extent of size-selective mortality in juvenile Chinook and coho salmon. For Marble River juvenile Chinook salmon from northern Vancouver Island, we observed high mortality (80-90%) between the first fall and winter at sea (Figure 13). However, the cause of this mortality was unknown, as there was little evidence that size-selective mortality occurred in this area during winter.

In a collaborative study with scientists working on the Gulf of Alaska, DFO also observed size-selective overwinter mortality in juvenile Chinook salmon rearing in Gulf of Alaska (Trudel et al. 2011). This mortality may have been due to the reduced availability of food during winter or to the longer winter at northern latitudes or both.

The implications of these results for Columbia and Snake River salmon are as follows:

- 1) Stocks that reside in southern regions of the coast, such as fall Chinook, are unlikely to experience size-selective mortality the first winter at sea; however, they may still sustain high levels of mortality during that period.
- 2) Stocks that rear in the Gulf of Alaska during their first winter, such as sockeye and spring Chinook, are likely to experience significant size-selective mortality during the first winter unless they grow rapidly soon after entering the coastal marine environment (Trudel et al. 2007c).



V. Mechanisms Influencing Salmon Growth and Survival

Pearcy (1992) suggested two types of ecosystem processes that regulate salmon population abundance: bottom-up processes, which affect food supply (*H1*), and top-down processes, which influence mortality (*H2*). In simple terms, bottom-up processes are based upon production at the lower trophic levels, whereas top-down processes are based upon predation or disease. Direct mortality results from starvation; predation by fish, birds, or marine mammals; or weakening of overall fitness due to pathogens. Indirect mortality can result from slowed growth due to inadequate food resources upon ocean entry. Although starvation has not been documented for salmon, food limitation would likely slow growth and swimming speed, thus increasing susceptibility to predation.

Bottom-Up Processes (*H1*)

To understand interannual variation in salmon survival, the ocean projects have focused research on understanding the processes affecting interannual variation in prey quantity and quality (i.e., lipid content). Our hypothesis is that prey quantity and quality are controlled through transport within the California Current, i.e., by the strength and direction of currents. If source waters of the coastal currents originate from the north, then the plankton communities, which anchor the food chain are dominated by “northern” species. Northern copepods have a high fat content, and high levels of omega-3 fatty acids.

Conversely, if source waters of the California Current originate from offshore, the plankton community is dominated by small “subtropical” species with low lipid content. Given that subtropical species are deficient in omega-3 fatty acids and rich in saturated fat (Lee et al. 2006), it is logical to assume that salmon growth and survival is higher during years when lipid-rich northern copepods dominate, since they result in lipid-rich forage fish and krill upon which salmon feed.

Stomach Content Analysis—Comparisons of stomach content have shown that prey consumed by juvenile salmon during early ocean residence is significantly different between year of warm (positive PDO) and cold (negative PDO) ocean conditions ($P = 0.005$). These changes in the diet composition of spring Chinook and coho salmon were significantly related to adult survival. These differences in diet composition were

observed in the stomach of fish caught in May but not June, suggesting that the early summer prey community is the most critical to survival.

In particular, we have found that as salmon grow older (and larger) during their first summer at sea, the incidence of fishes in the stomachs tends to dominate over krill and other invertebrates. This shift to a more piscivorous diet appears to be an important determinant of marine growth and survival for juvenile coho and Chinook salmon (Daly et al. 2009; Trudel et al. 2011). During years of low marine survival, coho salmon consumed fewer and smaller fish, while subyearling Chinook consumed less total food, and more individuals had empty stomachs.

Diets of both juvenile Chinook and coho varied significantly between oceanographic regions (west coast of Vancouver Island vs. Southeast Alaska; $P = 0.022$) and seasons ($P < 0.001$) possibly due to temporal and spatial changes in prey availability (Brodeur et al. 2007; Trudel et al. 2010). However, this finding is compounded by the fact that different salmon stocks have different mean sizes and arrive within a given area of the coastal shelf at different times. Juvenile Chinook and coho salmon are more piscivorous off the west coast of Vancouver Island than Southeast Alaska during summer, but this pattern reverses during the fall. The degree of piscivory declines in both species during winter, with increased proportions of euphausiids eaten at this time. No significant differences in stomach contents were noted between years with differing oceanographic regimes (PDO) in either the region off Vancouver Island or Southeast Alaska.

Stable Isotope Analysis—Stable isotopes of carbon and nitrogen are frequently used to infer feeding relationships in marine and freshwater ecosystems because these isotopes provide a longer-term image of the predator diet (Post et al. 2007). Stable isotope profiles were developed from the diets of juvenile coho and Chinook salmon sampled off Vancouver Island and Southeast Alaska. These profiles differed significantly with salmon species, region, water source (coastal vs. inner shelf), season, year, oceanographic regime (warm vs. cold PDO signal), and body size.

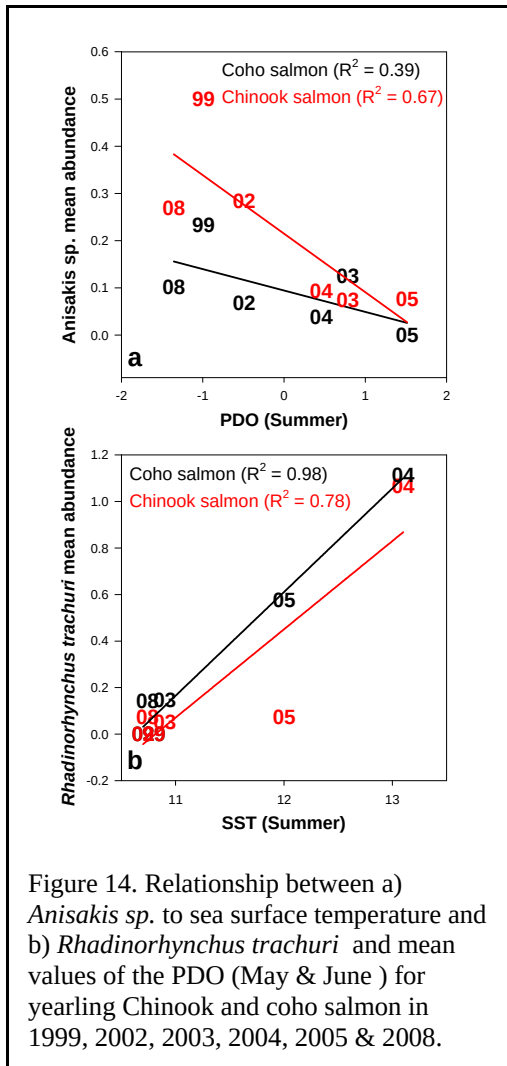
Trophic level, or degree of piscivory, was marginally higher in Chinook than in coho salmon (Miller et al. 2010c). Trophic level also increased with size, and degree of piscivory was generally higher in warmer than colder years for both species. An ongoing coastwide study (central California to Bering Sea) has found large gradients in $\delta^{13}\text{C}$ signatures along a continental spatial scale that corresponds to regional changes in diet and productivity (Mazumder et al. 2011). Taken together, these results suggest that diet is likely affected by processes on a regional basis, and that juvenile Chinook and coho salmon experience similar responses to changes in prey availability.

The Role of Prey Quality—Differences in survival between regimes or geographic regions may be directly related to the quality of prey consumed by salmon (as reflected by lipid and fatty acid composition). The lipid and fatty-acid composition of prey available to juvenile Chinook and coho salmon was examined from samples collected in May and June 2009. Results showed that commonly eaten fish prey had significantly higher levels of specific important essential fatty acids than prey that were also present in the marine environment, yet rarely eaten (Daly et al. 2010).

Lipid contents in zooplankton also differed among regions, with higher lipid concentration off Southeast Alaska than off the west coast of Vancouver Island (Trudel et al. 2011). Thus juvenile Columbia River salmon that migrate north encounter more nutritious prey as they get further north. This suggests that ocean conditions prevailing in the NCC may limit the growth of Columbia River salmon during summer.

Inferences Based on Trophically Transmitted Parasites—Trophically transmitted parasites can provide valuable information on the trophic interactions of juvenile salmon beyond the 24-30 h window allowed by stomach content analysis (Baldwin et al. 2008; Bertrand et al. 2008; Valtonen et al. 2010). These parasites use trophic interactions at multiple levels in a food web to complete their complex life cycles. This life history strategy makes it possible to use parasites as indicators of the diet and habitat used by individuals and populations of salmon.

We found that several metrics of salmon growth and health (IGF1, ocean growth, and Fulton's condition factor) were highest among salmon with high parasite-species richness. This indicates that a diverse diet in both the freshwater and marine environments is important to growth of Chinook and coho salmon (Losee et al. in prep).



In addition, we found that marine parasite communities of juvenile Chinook and coho salmon differ in “cold” vs. “warm” PDO ocean years. This finding reinforced the hypothesis that marine trophic interactions of yearling Chinook and coho salmon vary with ocean conditions. Some parasites recovered from yearling Chinook and coho salmon were present in all years; however, the appearance of several others was directly correlated with local (SST) and basin-scale indices (PDO) of ocean climate (Figure 14). Zooplankton are used as intermediate hosts by these parasites; thus, this pattern was probably due to changes in the abundance and species composition of the marine zooplankton community (Marcogliese 1995) as well as the proportion of fish in the diet (Pascual et al. 1996; Petric et al. 2011).

Top-Down Processes (H2)

Predation in Shelf Environments—Ocean predation appears to be a major driver of salmon mortality during early marine residence (Pearcy 1992; Bax 1998; Emmett 2006). Potential ocean predators of salmon include fishes, birds, mammals, and possibly Humboldt squid. Ocean project research has demonstrated that Pacific hake abundance is usually much higher in the coastal NCC during warm years. Thus we hypothesize that during warm ocean years early marine mortality rates of Columbia River juvenile salmon are influenced by hake and other piscine predators (chub mackerel (*Scomber japonicus*) and jack mackerel (*Trachurus symmetricus*), Humboldt squid (*Dosidicus gigas*); Emmett et al. 2006; Emmett and Sampson 2007; Litz et al. 2011).

Our biweekly survey of fish predators off the mouth of the Columbia River and Willapa Bay have shown that Pacific hake abundance in these areas is related to adult returns, and that measures of hake abundance provide a useful index of predation for coho and fall Chinook salmon (Figure 15).

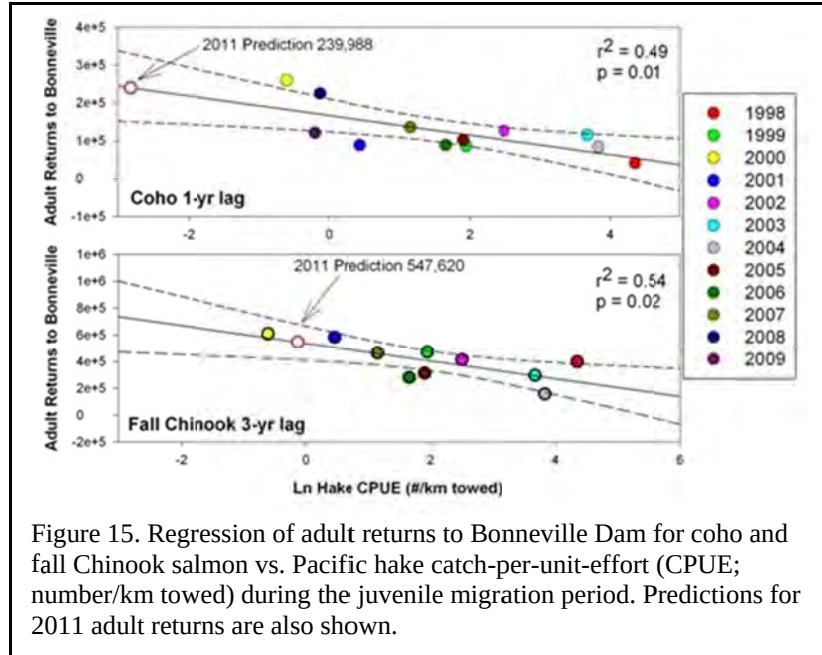


Figure 15. Regression of adult returns to Bonneville Dam for coho and fall Chinook salmon vs. Pacific hake catch-per-unit-effort (CPUE; number/km towed) during the juvenile migration period. Predictions for 2011 adult returns are also shown.

However, the effect of piscivorous predators on juvenile salmon may be modulated by a number of factors, such as environmental conditions or the availability of alternative prey. For example, abundance of forage fish such as northern anchovy, Pacific sardine, Pacific herring, and whitebait smelt varies seasonally (and interannually) off the Columbia River. Juvenile salmon may enter the nearshore ocean during a period before these forage fishes are abundant. If predator abundance is also high during this period, these salmon may sustain higher mortality rates than those of later-migrating conspecifics.

Predation near the Columbia River Mouth and Plume—Results from the ocean project studies suggests that seabird predation is a direct cause of mortality for Columbia River juvenile salmon. Seabird predation may also be a significant top-down cause of post-hydrosystem mortality.

Our initial hypothesis was that the turbid waters of the plume provide juvenile salmon with a refuge from visual predators, but results of the ocean projects research suggest otherwise. We have found that bird predators are significantly more abundant in the plume, and that the plume does not necessarily provide a refuge from bird predation. Telemetry studies have also found that survival in the plume is lower than elsewhere, possibly due to predation by birds and fish.

We have measured densities of the two numerically dominant seabird species: the common murre (*Uria aalge*) and the sooty shearwater (*Puffinus griseus*) in the plume region. Densities of these birds have been found higher in the plume region than elsewhere on the Oregon or Washington continental shelf (30.1 vs. 3.3 murres per km²

and 30.1 vs. 8.5 shearwaters per km²; Zamon et al. in prep). Land-based biweekly surveys 5.5 km from the river mouth showed that bird predators are significantly more abundant during spring tides than neap tides. This means that predation pressure near the river mouth varies significantly with the tides.

We found salmon in 11% of the stomachs of common murrelets sampled (n = 30). We identified remains of Chinook and coho salmon, as well as steelhead, using genetic markers. Salmon have yet to be found in any of the available samples of shearwater diet (n = 37), but a Columbia River steelhead PIT tag was recovered from a shearwater stomach in 2007.

There is a significant linear relationship between the density of birds in May of a given year and adult returns at Bonneville Dam of coho salmon from that migrated as juveniles during that year ($R^2 = 0.56$; $P = 0.05$). No such relationship has been detected for Chinook salmon, or for bird densities in June. Similar relationships have not yet been explored for individual Chinook stocks or for other salmon species because diet sample sizes are too small.

Pathogens—Similar to predators, pathogens can have a significant effect on the survival of juvenile salmon during migration and early marine residence (Jacobson et al. 2008). The outcome of an infection is mediated by interactions among a pathogen, its host, and the environment. A number of pathogens have been reported to affect juvenile salmon during the freshwater migration (Fryer and Sanders 1981; Bartholomew et al. 1992; Stocking et al. 2006; Ferguson et al. 2011), yet little is known about the effects of pathogens on juvenile salmon during early marine residence. Our analyses have focused on several freshwater pathogens that contribute to mortalities of juvenile salmon in estuarine and marine environments.

The freshwater trematode, *Nanophyetus salmincola*, encysts in all tissues and organs of Pacific salmon. We recorded a decline of highly infected coho salmon between early and late summer in our ocean samples, which suggested that approximately 20% of coho salmon mortality during the first months at sea was associated with this parasite (Jacobson et al. 2008). Abundances of this parasite are much lower in yearling and subyearling Chinook salmon, probably due to differences in freshwater residence and exposure to the infective stages of the parasite.

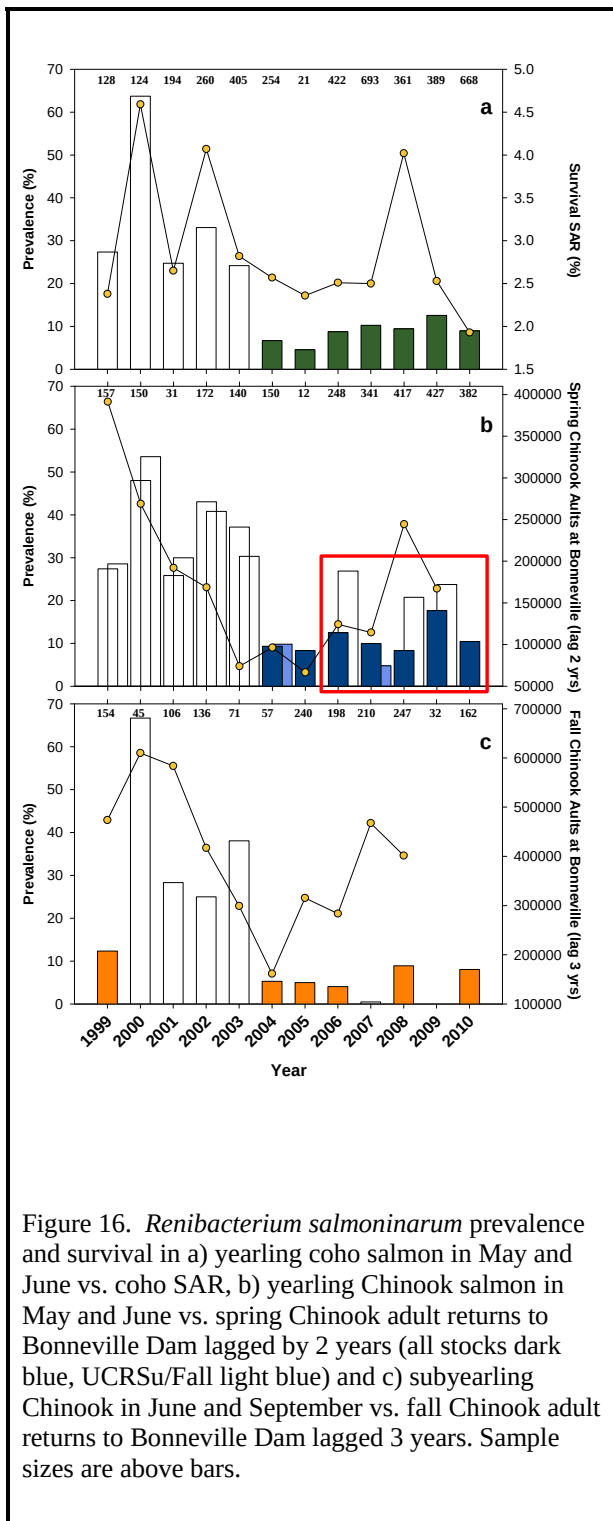


Figure 16. *Renibacterium salmoninarum* prevalence and survival in a) yearling coho salmon in May and June vs. coho SAR, b) yearling Chinook salmon in May and June vs. spring Chinook adult returns to Bonneville Dam lagged by 2 years (all stocks dark blue, UCRSu/Fall light blue) and c) subyearling Chinook in June and September vs. fall Chinook adult returns to Bonneville Dam lagged 3 years. Sample sizes are above bars.

Renibacterium salmoninarum (Rs), the causative agent of bacterial kidney disease (BKD), is the most common freshwater pathogen of Pacific salmon populations (Fryer and Sanders 1981; Elliott et al. 1989). Infections in marine-caught coho and Chinook salmon vary interannually (Figure 16). For coho salmon during 1999-2010, the prevalence of Rs has been positively related to good adult survival ($R^2 = 0.48$; excluding 2008 as an outlier $R^2 = 0.75$). This relationship suggests that during years of good ocean conditions, more infected juvenile coho salmon can survive.

Prior to 2004, overall prevalence of Rs was similar in Chinook and coho salmon and was relatively high. Since 2004, prevalence has been relatively low and we have noted differences among three major stocks of yearling Chinook salmon. The Upper Columbia River summer/fall stock group has had the highest prevalence in most years, and unlike the other stocks, has not continually had low prevalence since 2004 (red box, Figure 16b). Prevalence in this stock is correlated with adult returns ($R^2 = 0.43$).

The prevalence of Rs has also been significantly different among stocks of yearling coho salmon, with Columbia River stocks having the highest prevalence (18.6%). We compared prevalence of Rs in coho salmon caught off Oregon and Washington to the prevalence in the same stocks caught off Vancouver Island (17.6 and 4.9%, respectively, $P < 0.05$). For the Oregon and Washington stocks examined, the much higher prevalence of Rs in fish caught further south indicated that mortalities from BKD may occur during early ocean migration.

To help identify where mortalities occur and the role of freshwater, estuarine, and marine conditions on survival of infected salmon, we began to measure Rs prevalence in juvenile salmon collected at Bonneville Dam and the lower estuary in 2008 and 2009. In 2008, Rs prevalence was low in all habitats. However, in 2009, prevalence of Rs was significantly higher in yearling Chinook salmon originating above Bonneville Dam (44.6%) than in those originating in the lower estuary (10.4%) or ocean (17.6%). This suggests this pathogen had a significant impact on salmon during downstream outmigration in 2009.

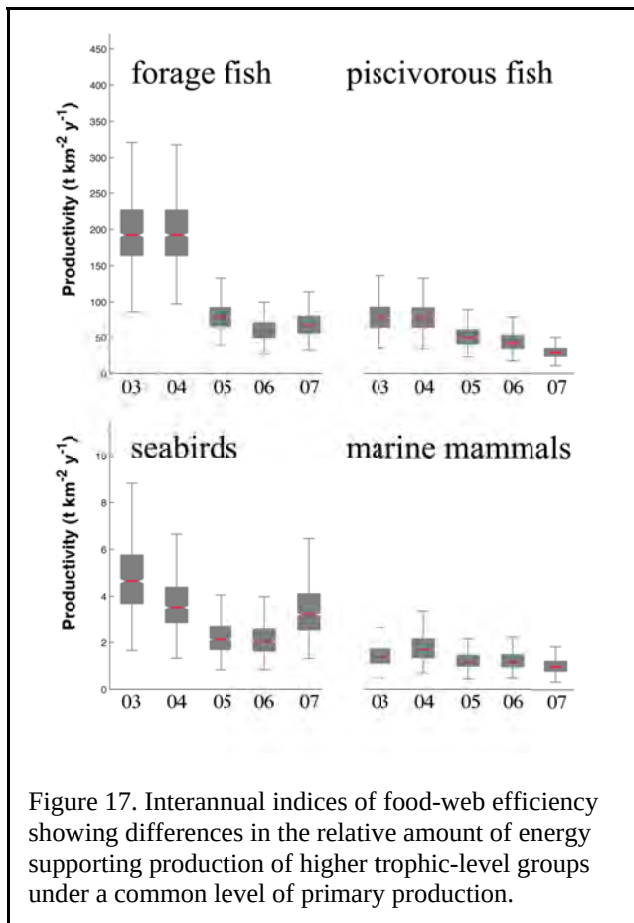
We also record the occurrence the parasitic copepod *Lepeophtheirus salmonis*. As part of a collaboration among NOAA, DFO, and the University of Victoria, BC, we examined fish from areas off Oregon through Alaska coastal waters. We reported that numbers of this lice were relatively low on all salmon species collected (Trudel et al. 2007a). Although this parasite can be a major factor on populations of farmed salmon, at this time it does not appear to be a factor for Columbia River Chinook and coho salmon populations.

Inferences from Ecosystem Modeling

Ecosystem models provide a mechanistic framework to understand the pressures acting upon salmon by integrating observed variability of ecosystem productivity, community structure, and species interactions. We have developed a suite of trophic models using data from pelagic trawl and zooplankton surveys. The goals of the ecosystem modeling are to 1) investigate how interannual changes in pelagic community structure (bottom-up processes) affect the efficiency at which energy is transferred from primary producers to higher trophic levels, 2) estimate predation pressure upon juvenile salmon (top-down processes), and 3) test specific ecosystem state scenarios.

Bottom-up processes—Upwelling supported zooplankton production correlates well with juvenile salmon survival (Ruzicka et al. 2011). However, structural rearrangements among trophic pathways greatly affect the efficiency with which energy is transferred up the food web. For example, in some years jellyfish become major consumers of zooplankton, diverting energy from fish production (Ruzicka et al. 2007; Brodeur et al.

2011). Thus jellyfish may affect juvenile salmon survival, despite a low dietary overlap between these species (Brodeur et al. 2008).



Large interannual differences in food-web transfer efficiency were apparent when different trophic levels were modeled under identical primary production rates (Figure 17). This suite of models can be used to trace the flow of primary production to juvenile salmon through prey of differing food quality.

These models complement existing indices of biological ocean conditions by providing estimates of the efficiency with which lower trophic production is transferred upward in the food chain.

Top-down processes—We are developing an interannual index of marine predation on juvenile salmon based on observed composition of the pelagic community. This index accounts for observational variability and the propagation of parameter uncertainty. Among years modeled so far, 2003-2007, marine predation accounted 75-90% of juvenile salmon production. In other words, 75 to 90% of the prey eaten by juvenile salmon and converted to salmon tissue is in turn consumed by other predators.

Through sensitivity analyses, we are investigating the potential impact of outbreak predators such as Humboldt squid and the role of forage fishes in mediating predation pressure. Our analyses incorporating current information about Humboldt squid diets indicate that as competitors, these squid can be at least as detrimental to juvenile salmon survival as they may be as predators. On the other hand, we find that direct and indirect competition with forage fishes remains very small across the range of interannual abundance observed. As a buffer against predation, forage fishes can potentially benefit juvenile salmon to an extent that overshadows their negative effect as competitors.

VI. Freshwater and Ocean Survival Estimates

Coastal Ocean Acoustic Salmon Tracking (COAST) Objectives

Objectives of the acoustic telemetry project were to:

- i) Demonstrate the technical feasibility of using acoustic tags to determine the mortality and migration of Columbia River Chinook salmon);
- ii) Measure survival in saltwater where other technologies were economically unfeasible;
- iii) Determine freshwater anthropogenic impacts on a key ESA-listed group, Snake River spring Chinook, by conducting a formal experimental test of two important theories (Delayed Mortality: that greater cumulative dam passage reduces estuary/coastal ocean mortality; Differential-Delayed Mortality: that transport via barge reduces estuary/coastal ocean mortality relative to non-transported smolts);
- iv) Establish the first “non-invasive¹” measurements of ocean migration behavior and baseline measurements of coastal ocean survival for comparison with the extensive current understanding of freshwater survival.

Kintama’s acoustic sub-arrays monitored survival of yearling spring Chinook during their seaward migration from the Columbia River basin to as far as Alaska in 2006-2011 (Figure 18). The array allows contrasting mortality in four important habitats: (a) the 8-dam Hydrosystem (release to Bonneville Dam), the unimpounded lower river and estuary (Bonneville Dam to Astoria; 220 km); the “plume” (Astoria to Willapa Bay; 56 km); and the coastal ocean (Willapa Bay to Lippy Point, NW Vancouver Island, 483 km).

Because the array is at fixed geographic locations, there is some inclusion of different habitats within these migration segments. The highly mobile plume region is bracketed between the Astoria and Willapa Bay sub-arrays but the region we label as “Plume” also contains a small amount of the estuary and some of the coastal shelf north of the plume proper. The Pacific Ocean Shelf Tracking (POST) project contributed additional sub-arrays within the Strait of Juan de Fuca/Strait of Georgia/Queen Charlotte Strait regions that are critical to our study because they demonstrate that tagged Columbia River yearling Chinook do not migrate east around Vancouver Island. Within the geographic confines of the array, hydrosystem operations and intrinsic smolt behavior jointly determine the period of time smolts spend in the four environments (“residence time”).

¹ In the sense that individual animals can be followed over multiple arrays without affecting them; conventional trawling results in the death of captured smolts.

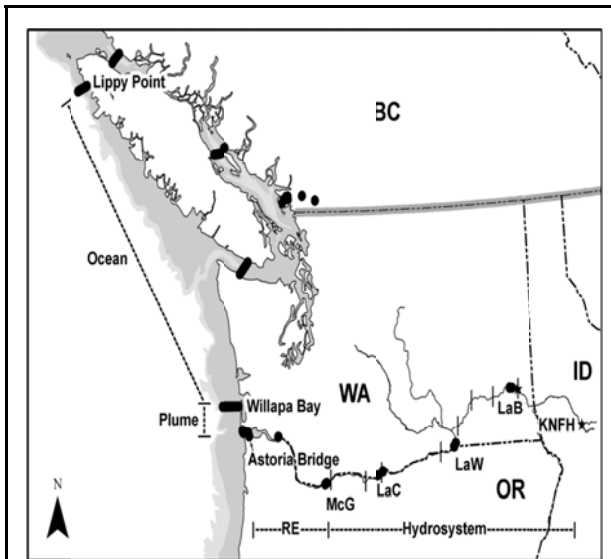


Figure 18. Geographic layout of the acoustic telemetry array; the Alaska sub-array is not shown. Vertical lines show the location of the 8 dams forming the hydrosystem for Snake River smolts. Dots show sub-array locations: McG, McGowan's Channel; LaC, Lake Celilo; LaW, Lake Wallula; LaB, Lake Bryan; KNFH, Kooskia National Fish Hatchery; RE, Lower River/Estuary.

The material reported here summarizes these findings and adds some more recent context on where in the life history most mortality occurs for Columbia Basin salmon stocks. Because few tagged smolts reach Alaska, we limit our survival measurements to Lippy Point, but note that marine migration speeds to Alaska are similar and persist beyond Vancouver Island. This summary of the Kintama study is presented without technical detail of the methods used and most of the underlying assumptions, which are reported in our annual reports to BPA (Porter et al. 2010a, b, 2011) and in Appendix C of this document; the Porter et al. (2010a) report provides a concise multi-year synthesis of the results and implications for policy makers. A comparison with other telemetry systems is Appendix F.

Survival Estimates in the Columbia River, Estuary, Plume, and Coastal Ocean.

In-River and Ocean Survival—In the Columbia River, smolt-to-adult survival rates (SAR) now average about 1% for many salmon stocks, although several decades ago they were much higher. For Snake River spring Chinook, SARs were 3-4% in the 1960s (Williams et al. 2005) and now average 0.5-1.0% for many groups (Tuomikoski et al. 2009), a 6-8 fold decline. For Dworshak spring Chinook, the Snake River stock used for these acoustic tagging studies (2006-2009), SARs are the lowest observed amongst hatchery populations, at approximately 0.5%. Similar declines are also evident for many species in British Columbia: sockeye salmon (Peterman and Dorner, 2011), steelhead (Welch et al. 2000), coho salmon (Beamish et al. 2000), and, possibly, Chinook salmon (English et al. 2008).

Although Snake River spring Chinook experience some of this mortality in the hydrosystem (up to 50%), most of the mortality occurs within and beyond the first 1-2 months in the coastal ocean. Immediately below the hydrosystem, survival in the lower river and estuary for spring Chinook released from hatcheries (2006-2009) and for

yearling Chinook tagged at dams (2010 and 2011) was high (81-99%) regardless of migration timing. In the plume, survival was generally low despite the short migration distance (14-71%). Subsequent survival in the coastal ocean from Willapa Bay to Lippy Point ranged between 2-25% (Porter et al. 2011).

Survival estimates are the metric commonly reported in salmon studies, but can be misleading because survival to adult return is the product of survival in successive life history periods. For example, if mortality through the 8-dam hydropower system is 50% (or half the fish), then it still takes 7.6 successive bouts of 50% mortality to reduce survival to a SAR of 0.5%. From this perspective, mortality in the hydrosystem is 1/7.6, or only 13% of the total mortality, while the remaining mortality from Bonneville Dam to adult return is 87%.

We used our freshwater and early marine survival data to estimate the magnitude of the mortality experienced during the rest of the life history (beyond the area where fish are tracked) using Dworshak and Yakima spring Chinook (and we also include multiple BC salmon stocks to extend the comparison; Table 3). Within the hydrosystem, acoustic estimates of survival closely matched PIT tag estimates of survival in most years (see Appendix C). To evaluate the relative contribution of the later life history period to overall smolt-to-adult survival, we compared the number of animals needed in the early life history period to the number needed later in the life history to produce one survivor. This provides a simple way to evaluate the relative importance of mortality in different parts of the life history.

Assessing mortality ratios for Dworshak spring Chinook for example, mortality still to be experienced beyond the river mouth (Astoria) is 20 times greater than the combined mortality experienced in the hydrosystem and the unimpounded lower river and estuary to Astoria (Table 3); if mortality through the plume to Willapa Bay is included, mortality still to be incurred is 9 times total mortality to this point (reached about one month after release upriver). By the time the smolts reach Lippy Point, the northern end of the California Current region and the start of the region of good growth conditions, the majority of the mortality seems to have been experienced.

For the hydrosystem only, the proportion of total mortality is $1/(24+1)=4\%$, and for the estuary the proportion of total mortality is $1/(154+1)=0.6\%$. For the Columbia River plume (which we operationally define as extending from Astoria to Willapa Bay, 40 km north of the Columbia River mouth), the proportion of total mortality is $1/(33+1)=3\%$. Even if we include all sources of mortality to Willapa Bay, from Table 3 this includes only $1/(9+1)=10\%$ of the total mortality, or SAR, demonstrating that the majority of the

mortality is occurring north of Willapa Bay². Results are similar for Yakima River smolts, a mid-Columbia stock. Freshwater effects (hydrosystem, estuary and plume combined) are small unless the hydrosystem exerts large latent effects on subsequent ocean survival.

Table 3. Comparison of smolt survival in different life history periods. Early survival is calculated as the average across all available years of acoustic tag data.

	Acoustic-tagged smolt early survival (%)	Current SAR (%) ^a	Mortality ratio ^b
Columbia River Chinook			
Snake River (Dworshak spring Chinook)			
Release to Astoria (2008, 2009)	31.5	~0.5	20
Release to Willapa Bay (2006, 2008, 2009)	21	~0.5	9
Release to Lippy Point (2006, 2008, 2009)	2.0	~0.5	0.08
Hydrosystem only (Release to Bonneville, 2006, 2008, 2009)	34.5	~0.5	24
Estuary only (Bonneville Dam-Astoria; 2008, 2009)	87.8	~0.5	154
Plume only (Astoria-Willapa Bay; 2008, 2009)	40.5	~0.5	33
Yakima River (Cle Elum spring Chinook)			
Release to Astoria (2008, 09)	44.0	~2.3	8.4
Release to Willapa Bay (2006, 2008, 2009)	23.2	~2.3	2.3
Release to Lippy Point (2006, 2008, 2009)	1.9	~2.3	0.02
Estuary only (Bonneville Dam-Astoria; 2008, 2009)	93.0	~2.3	38
Plume Only (Astoria-Willapa Bay; 2008-2009)	36.8	~2.3	5.9
British Columbia^c			
Steelhead	17	~1	3
Sockeye	19	~1	3.6
Coho (FW only)	62	~1	38
Chinook (FW only)	27	~1	7

a From Comparative Survival Study and Yakima Nation annual reports to BPA.

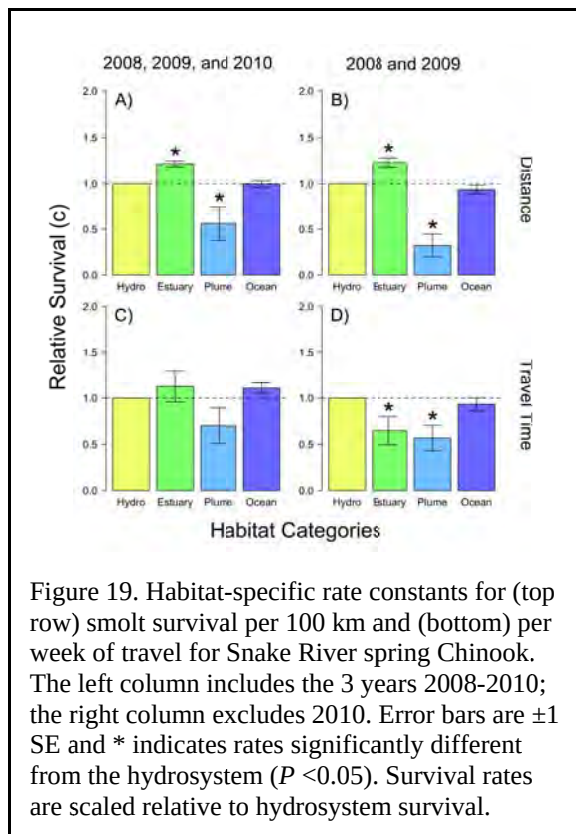
b We compare the ratio of mortalities (m) necessary to yield one survivor in the early and late life history periods. As $SAR = S_{Early} \cdot S_{Late}$, then the mortality ratio, m_{Late}/m_{Early} is $S_{Late}^{-1} / S_{Early}^{-1} = S_{Early} / S_{Late} = S_{Early}^2 / SAR$.

c Survival data are averages from all prior British Columbia acoustic studies, with sockeye & steelhead survival measured for multiple rivers to exit from Salish Sea (Queen Charlotte Strait/Juan de Fuca Strait); for coho & Chinook (only) freshwater survival are measured to Fraser or Squamish River mouth; see (Welch et al. 2011) for details.

² Note that because of the lack of the Astoria sub-array in 2006, survival proportions are based on a varying number of years in Table 3, and thus are not exactly comparable.

Similar results are also evident for British Columbia salmon stocks: the magnitude of the differences in mortality is particularly pronounced when marine mortality is contrasted with freshwater mortality to the river mouth (7-38 times larger). For both British Columbian and Columbia River salmon, most mortality thus occurs whilst the salmon are in the ocean, providing the basic conditions necessary for large differential effects in the ocean to affect different salmon stocks differently—and also great potential for ocean effects to be mistakenly attributed to operation of the hydrosystem. The results also indicate that the majority of mortality forming the SAR occurs by the time the smolts reach the northern terminus of the NCC.

Survival Rate in Different Habitats—A major focus of current management practice involves transferring smolts from the hydrosystem to the ocean as rapidly as possible because of the belief that hydrosystem mortality is high. This approach implicitly assumes that survival beyond the hydrosystem is better. We tested this assumption by comparing survival rates of tagged Snake River yearling Chinook salmon smolts across four different habitats: hydrosystem, lower river and estuary (“estuary”), plume, and coastal ocean as they migrate from fresh water to the ocean. We did this by fitting a survival model with different rate constants for each of the four habitats through which the smolts migrate.



We ran the analysis including 2008-2010, and then again excluding 2010, a year when acoustic tag-based survival estimates for freshwater were lower than independent PIT-tag based survival estimates (Figure 19; note that 2006 is excluded because the Astoria sub-array was not deployed, preventing separate estimates of survival in the estuary and the plume).

Regardless of whether or not 2010 was included, we found survival rates in the hydrosystem and coastal ocean to be nearly equivalent. This also held whether we compared the survival rate per 100-km traveled (Figure 19, top row) or per week of travel time (Figure 19 bottom row; see Porter et al. 2011 for detailed explanation).

When 2010 was excluded, relative ocean survival rates were reduced slightly and became marginally lower than survival in the hydropower system. However, in no case was the ocean survival rate statistically distinguishable from the hydrosystem survival rate. If relative survival in the ocean is not higher than in the hydrosystem, then this raises important questions about the current management philosophy of accelerating smolt movements from the hydrosystem into the ocean.

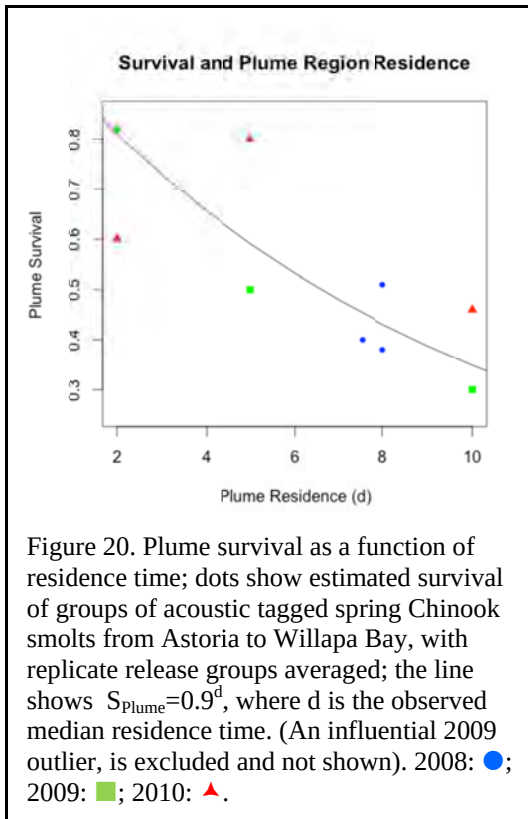
In terms of the remaining habitats (estuary and plume), we found evidence that plume survival rates were lower than hydrosystem survival rates on average, but also variable between years. This was observed whether we modeled survival rate as a function of distance or time and irrespective of whether we included results from 2010. We also found mixed evidence for the estuary survival rate differing from that for the hydrosystem (Figure 19). Survival-by-distance models showed higher survival rates in the estuary (regardless of whether or not 2010 was included), but survival-by-time estimates were more variable and produced survival rates that were higher than hydrosystem if 2010 data was included and lower if 2010 data was excluded. Overall, the results from the acoustic tagging experiments result in strong evidence for lower plume survival rates, but unclear evidence for differences in estuary survival. Plume survival was variable from year to year and, as plume residence by yearling Chinook was relatively short, the overall effect on SARs may be small.

Our acoustic tagging results, made in a period of what appears to be better ocean conditions than occurred in the 1990s (when SARs were substantially lower), indicates that ocean survival rates per day are at best currently only very slightly higher than hydrosystem survival rates (Table 4).

Table 4. Average habitat survival rates (%) per day, averaged across 2008-2010 (2006 was excluded because estuary and plume survival could not be separated).

Habitat	2008, 2009, 2010			2008, 2009 only		
	$\hat{S}$	se ($\hat{S}$)	95% CI	$\hat{S}$	se ($\hat{S}$)	95% CI
Hydrosystem	94.4	0.37	(93.7, 95.1)	95.7	0.31	(95.1, 96.3)
Estuary	96.0	2.05	(92.0, 100)	89.9	2.97	(84.1, 95.7)
Plume	89.8	3.51	(82.9, 96.7)	88.2	3.03	(82.3, 94.2)
Ocean	95.8	0.78	(94.3, 97.3)	94.7	1.00	(92.8, 96.7)

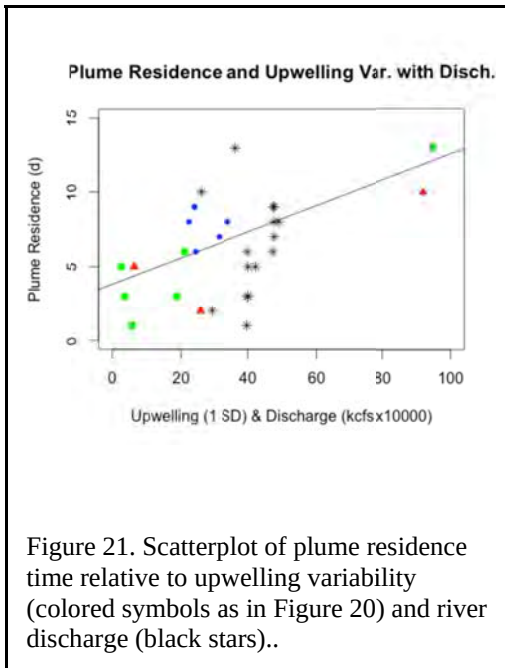
Plume Survival and Residence Time—Plume survival estimated from acoustic telemetry varies substantially within years and between spring Chinook release groups with a mean survival of 56% (SD: 19%).³ When survival is scaled by residence time, a clear overall relationship emerges, with plume residence explaining much of the observed variability (Brosnan unpub.; Figure 20).



Our results demonstrate that overall survival within the plume varies strongly with residency and that once residence time is taken into account, plume survival rates appear to be relatively constant.

As with smolt movement out of the hydrosystem, the importance of the plume environment for salmon recruitment thus depends upon the *relative* survival rate experienced by the migrating smolts in and beyond the plume, since smolts leaving the plume quickly have more exposure to the coastal environment. It follows that attempts to improve plume survival by reducing plume residency should: (1) identify the factors influencing plume residency time and (2) establish *relative* survival in and beyond the plume (because time not spent in the plume is spent in the coastal ocean).

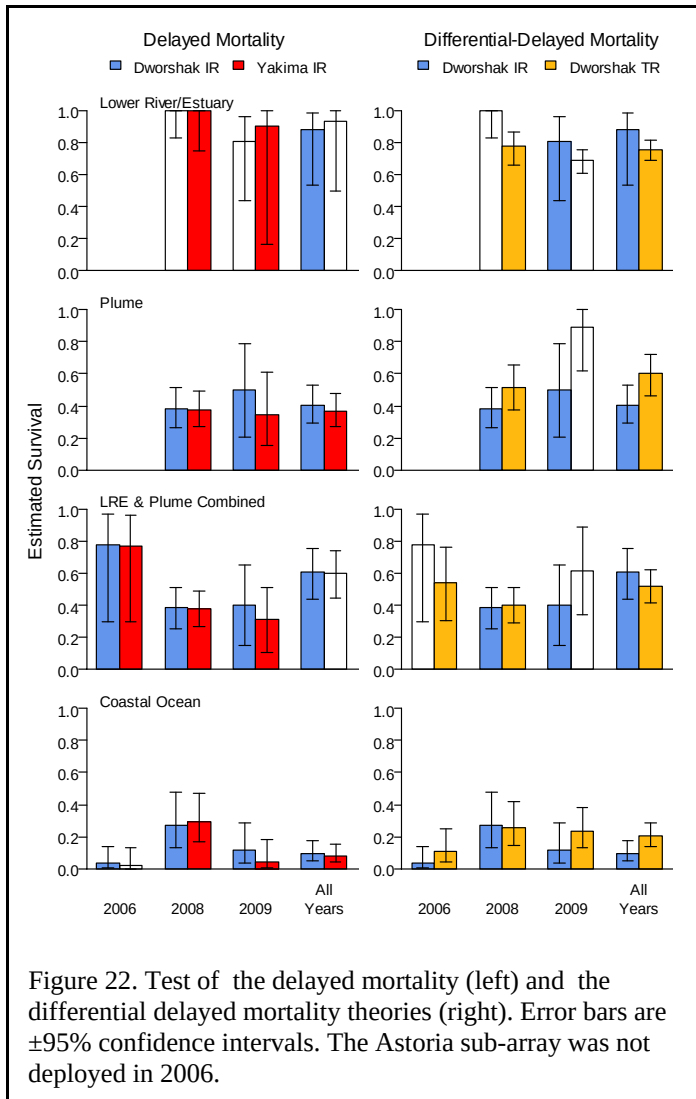
³ This section is part of a Ph.D. thesis by Ian Brosnan at Cornell University, who is examining the potential for remote sensing data on oceanographic conditions to explain measured variation in marine survival of acoustic tagged smolts.



We illustrate here two examples of how physical variables may affect plume residency and thus survival. Plume residence of tagged smolts was essentially invariant with Columbia River discharge (10^7 ft³/s), but shows some covariation with variability in coastal upwelling (but not intensity), particularly for two release groups that had especially long median residence times (Figure 21).

Thus, smolt ocean entry could conceivably be manipulated using spill to better align entry with periods of predicted low upwelling, thereby minimizing plume residence; the graph shows that discharge itself had no discernable influence on residence time. For simplicity, this scenario ignores the much more important survival conditions experienced in the coastal ocean (where the majority of time and thus mortality occurs), but establishes the principle that manipulating smolts to shift them from low to high survival rate environments should bring a net conservation benefit. Other variables examined that might conceivably influence plume residency (river turbidity, SST, daily mean upwelling, the occurrence of downwelling during migration, and the duration of downwelling) had no detectable influence on the duration of plume residence.

Testing Delayed and Differential-Delayed Mortality Theories—Theories concerning the existence of delayed or differential-delayed mortality play large roles in shaping hydrosystem management because of the poorer than expected survival of Snake River salmon, and there has been general acceptance that some form of “latent” mortality occurs (ISAB 2007). In essence, these ideas posit an anthropogenic effect from 1) dams or 2) transportation that is expressed as additional latent mortality after the Snake River smolts pass downstream of Bonneville Dam.



The *delayed mortality* theory was tested by releasing acoustic-tagged Snake River yearling Chinook smolts that migrate in-river, and comparing their survival with size-matched groups of Yakima River smolts which acted as the control group (i.e., they were not exposed to Snake River dam passage). Similarly, the *differential delayed mortality* theory was tested by comparing the survival of transported to in-river migrating acoustic-tagged Snake River spring Chinook salmon smolts over the array.

Our tests of these two hypotheses are graphically summarized in Figure 22. In no individual year or for any of the three habitats studied (lower river/estuary, plume, or coastal ocean) did we find a consistent reduction in survival of Snake River smolts

exposed to additional hypothesized sources of stress (Snake River dams or transport in barges), relative to control groups. Our results therefore provide no support for theories that smolts exposed to greater anthropogenic influence (dams, barges) have substantially reduced subsequent survival (Porter et al. 2010b, 2011; Rechisky et al. Submitted).

These results are specific to Dworshak hatchery-reared spring Chinook (2006, 2008, 2009); however, our more recent work tagging a mixture of smolts at Lower Granite Dam and John Day or Bonneville dams indicates that these results hold more broadly. Results are of direct relevance for Columbia River salmon management because they suggest that hydrosystem operations may not reduce smolt survival in the ocean and, if accepted, should allow managers to focus on direct effects of the dams with reasonable certainty that large latent effects are unlikely.

VII. Forecasting and Management Tools

Earlier in this document we showed several examples of correlations between aspects of fish condition and salmon returns. Here we summarize our efforts to summarize ocean conditions in a given year and illustrate how we produce forecasts of salmon returns. Our forecasts are based on a suite of physical, biological and ecological indicators that describe “ocean conditions” important to juvenile salmon. The indicators are displayed in a stoplight chart (Table 5), with ocean factors in a given year that are known to be good for salmon (i.e., are correlated with salmon returns) are given a “green-light”, intermediate a “yellow-light” and poor “red-light.” These indicators provide outlooks (qualitative forecasts) of survival for Chinook (both fall and spring) and coho salmon and on the number of fish counted at Bonneville Dam.

Table 5. Stoplight chart illustrating variations among years in the indices of ocean conditions used in our salmon forecasting efforts. Red indicates poor ocean conditions; yellow, average; green, good. Note that ocean conditions in 2008 were mostly “good” whereas the years 1998 and 2005 were mostly poor.

Environmental Variables	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PDO (December-March)	13	5	2	9	6	14	8	12	10	7	4	1	11	3
PDO (May-September)	8	3	5	4	9	13	12	14	10	11	1	7	6	2
ONI Jan-June	14	1	1	5	10	11	9	12	6	8	3	7	13	4
SST at 46050 (May-Sept)	12	8	3	4	1	7	14	11	5	13	2	9	6	10
SST at NH 05 (May-Sept)	8	4	1	6	2	5	14	11	7	13	3	12	10	9
SST winter before (Nov-Mar)	14	11	3	5	7	10	12	9	8	2	1	4	13	5
Physical Spring Trans (UI Based)	3	6	13	12	4	9	11	14	9	1	5	2	7	8
Upwelling Anomaly (Apr-May)	7	1	12	3	6	10	9	14	7	2	4	5	11	12
Length of upwelling season (UI Based)	6	2	13	9	1	10	8	14	5	3	7	3	11	12
Deep Temperature at NH 05	14	4	6	3	1	9	10	11	12	5	2	8	7	13
Deep Salinity at NH05	14	3	6	2	5	12	13	8	7	1	4	10	11	9
Copepod Richness Anomaly	14	2	1	6	4	10	9	13	11	7	5	8	12	3
N.Copepod Anomaly	13	9	5	6	3	12	11	14	10	8	2	7	4	1
Biological Transition	13	9	6	5	7	12	8	14	11	2	1	4	10	3
Copepod Community structure	14	4	3	6	1	10	11	13	12	8	2	5	9	7
Winter Ichthyoplankton	14	6	2	4	5	13	12	8	11	10	1	7	3	9
Catches of salmon in surveys														
June-Chinook Catches	13	2	3	11	7	9	12	14	8	6	1	4	5	10
Sept-Coho Catches	10	2	1	4	3	6	11	13	8	9	7	14	12	5
Mean of Ranks of Environmental Data	11.3	4.6	4.8	5.8	4.6	10.1	10.8	12.2	8.7	6.4	3.1	6.5	8.9	6.9
RANK of the mean rank	13	2	4	5	2	11	12	14	9	6	1	7	10	8

Results of these efforts are posted on the NOAA Northwest Fishery Science Center's web-site (<http://nwfsc.noaa.gov> under "Ocean conditions and Salmon Forecasting") and include a diagnosis of past and present ocean conditions, a prognosis of future ocean conditions and qualitative outlooks of salmon returns one to two years in advance.

The ocean indicators include 1) basin-scale physical factors, 2) local physical factors, and 3) local biological factors. Basin-scale factors such as the PDO and the El Niño-Southern Oscillation (indexed by the Oceanic Niño Index) are taken from University of Washington and NOAA websites; local physical factors such as SST, the date when coastal upwelling is initiated each year, the amount of upwelling in spring are from NOAA websites whereas the temperature and salinity of deep waters on the continental shelf are from our biweekly cruises off Newport. Local biological factors including food chain indicators such as zooplankton abundance, species composition and community structure, and ichthyoplankton species composition are all from the Newport biweekly surveys; catches of juvenile salmon are from the BPA-funded trawl surveys.

Figure 23 displays the correlations between salmon returns and a single variable which is very highly-correlated with returns – the Copepod Community structure index. This index is the result of a non-metric multi-dimensional scaling ordination of a 16 year time series of zooplankton samples collected biweekly off Newport, Oregon). Negative values of the index indicate a "cold-water lipid-rich" copepod community; positive values indicate a "warm-water, sub-tropical, lipid-poor" copepod community. This index alone accounts for ~ 70% of the variance in counts of adult spring and fall Chinook passing Bonneville Dam.

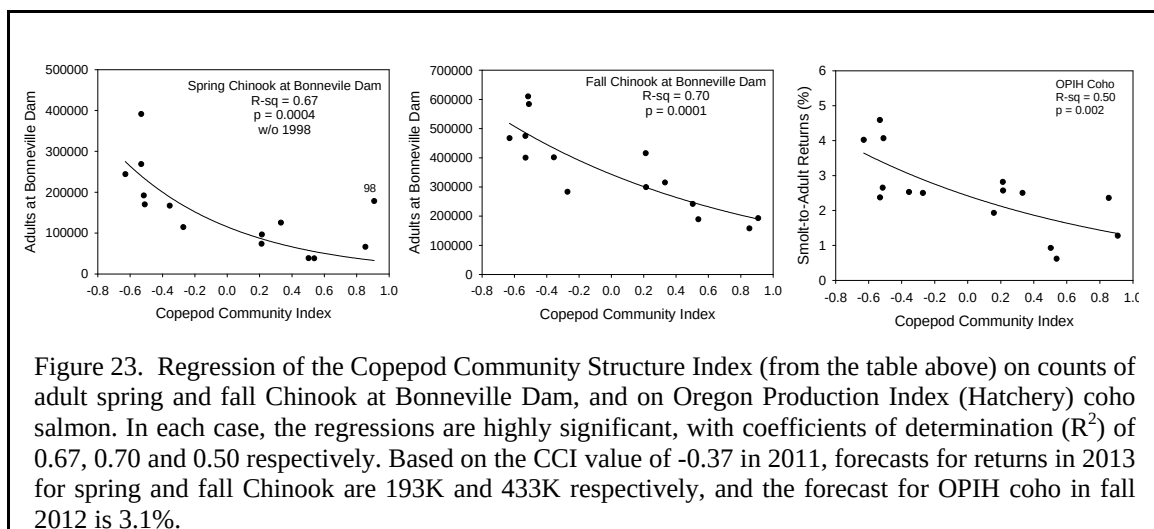
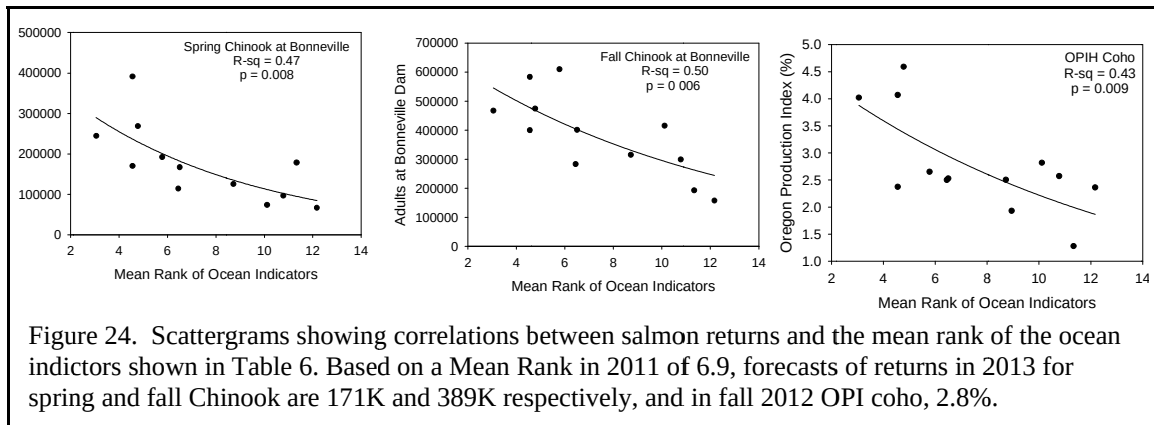
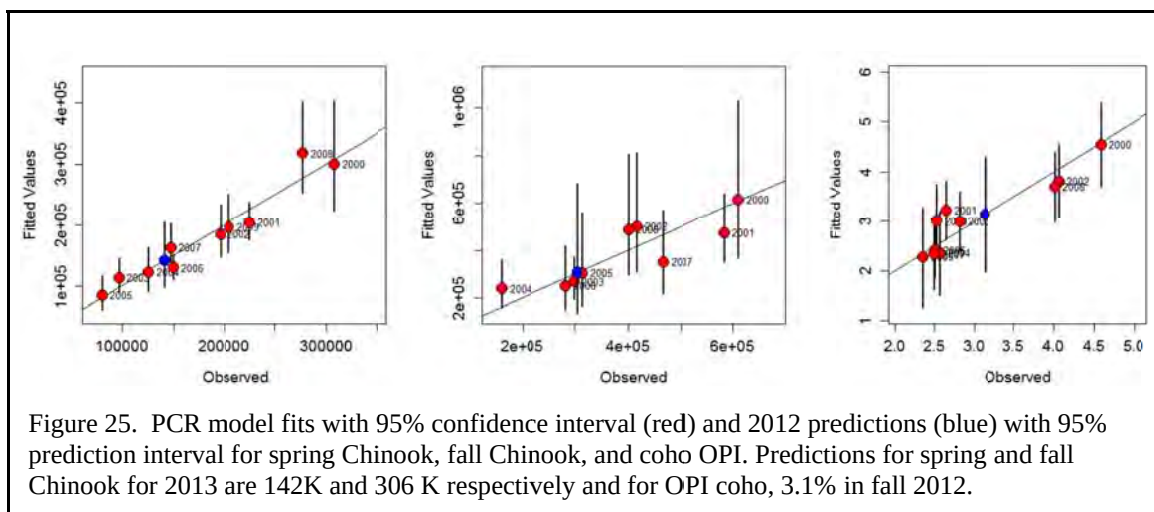


Figure 24 shows correlations between Chinook salmon counts at Bonneville and OPI coho, and a simple composite integrative indicator -- the mean rank of all indicators (the second line from the bottom) in Table 5. This index explains less of the variance in adult counts than the copepod-based index, but still produces highly significant results. However a weakness of this simple non-parametric approach is that each indicator is given equal weight, an assumption that may not be true, therefore we have recently explored a more quantitative analysis of the indicators in Table 5 using principal components analysis (PCA).



PCA was run on the indicator data, a procedure which reduces the number of variables in a dataset as much as possible, while retaining the bulk of information contained in the data (a sort of weighted averaging of the indicators). Another important feature of PCA is that the principal components (PCs) are orthogonal which eliminates one of the original problems with the indicator data set (i.e., multi co-linearity). We used the PCs obtained from the PCA as new predictor variables in a linear regression analysis of adult salmon returns (this process is termed principal component regression, or PCR, Figure 25).



We have recently begun to develop salmon *performance indicators*, which index salmon growth and survival directly based on metrics of the salmon themselves. Some of these indicators have already been discussed in the main body of this Synthesis Report and include metrics such as growth measured by IGF1 and otoliths, condition as length-weight residuals and pathogens such as *Renibacterium salmoninarum*, attributes related to feeding habits, abundance of alternate fish prey such as anchovies, and predators (hake). Preliminary work suggests that analysis of this more complete set of indicators (using PCA) may result in better forecasts because both environmental variability and fish performance will be included in the analysis. Other indicators such as trophically transmitted parasite loads in salmonids, diets of seabirds, and lipid content of salmon prey have only been measured for a short period of time thus more years of work will be required before they can be considered in this new analysis.

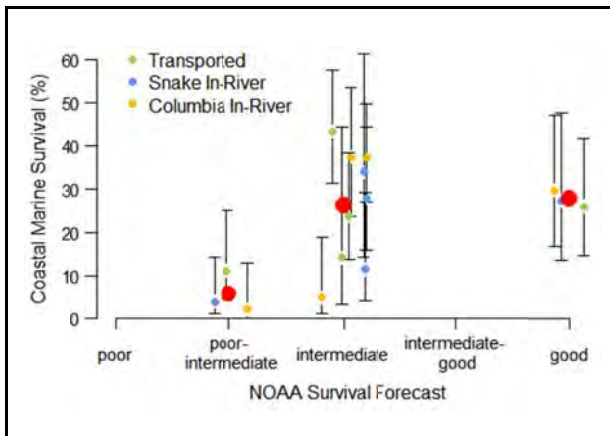


Figure 26. Comparison of NOAA survival forecast and Kintama measured survival in 2006-2011 (2007 excluded, Willapa Bay to Lippy Point; errors are 95% CI). Red dots represent Kintama average survival for each forecast category. Smaller dots are annual average across all releases of a treatment group and obscure within-year differences with time. For example, NOAA observed poor-intermediate ocean conditions until late May and very good conditions in June. Kintama estimates tracked this pattern, with poor survival in May and intermediate survival in early June. Ocean forecasts from NOAA website.

It is also possible to compare NOAA's qualitative measurements of ocean conditions with Kintama's telemetry-based early marine survival estimates (Figure 26). In general, these corroborate the NOAA "report card" (Table 5), showing that in years of poor-intermediate conditions coastal survival was only one-fifth that of years with good environmental conditions.

Similar efforts based on conditions measured off the west coast of Vancouver Island as part of the DFO Study are currently underway for Columbia River spring, summer and fall Chinook salmon, coho salmon, and Redfish Lake sockeye salmon as well as British Columbia salmon (see Trudel et al. 2011). To date, DFO's analysis has been restricted to simple linear

models with a single factor at a time however future effort will include more complex multidimensional models. All of this work will be done in collaboration with the NOAA efforts (Appendix G).

Our forecasting efforts are grounded upon our mechanistic understandings of linkages between physical forcing (associated with the PDO) and biological responses (a lipid rich food chain that leads to higher salmon growth and survival). Our research, which has been focused on specific processes that affect marine survival, is now reaping benefits because it provides a clear understanding of how ocean conditions set salmon survival. However, we caution the reader that as in the past (notably Nickelson 1986, Ward 2000 and Logerwell et al. 2003) our correlations may breakdown over time.

Some would argue that the correlations between physical factors (e.g., coastal upwelling and salmon survival) work well only within a given climate regime, only to break down with a shift to a different regime. Advocates of chaos theory would argue that when the ecosystem flips to a different state, the relative importance of processes affecting salmon survival may differ between states resulting in new and unexplored correlations. For these reasons, we need to continue our work because additional years of data not only increase our degrees of freedom but provide us with the ability to better weight the indicators (i.e., which indicators seem to be most important) under different variable ocean conditions.

Our information on ocean conditions and salmon forecasting is used in a variety of ways. We have met with the TAC on two occasions and they are beginning to use our indicators in their evaluations of the number of salmon expected to return to the mouth of the Columbia River in a given year. We also regularly share data and analyses with coho salmon managers with the States of Oregon and Washington as well as a number of tribes that are interested in coho. Furthermore, NOAA scientists give ~ 10 invited presentations a year using the indicator table to “interested parties” including the Council (three briefings have been made to date), the annual meetings of the Pacific States Marine Fisheries Commission, the Pacific Fisheries Management Council, and watershed councils in Oregon. We have found that our “ocean conditions” indicators are of great interest to managers and the general public because they provide plausible and detailed explanations of how ocean conditions affect salmon survival and why returns of salmon in a given year are better or worse than “normal”. In contrast, there are problems associated with the use of jack salmon to forecast adult returns – in many years jack returns provide a sufficient amount of information for a successful forecast, but in other years, the jack index fails, and no explanation can be offered other than ocean conditions must not have been favorable.

VIII. Management Implications

Background

Our ability to control or manage variability in marine recruitment of Pacific salmon is limited. However, our understanding of the mechanisms affecting this variability, as summarized here, suggests that there are opportunities to exert some control. Most importantly, our current understanding allows salmon management actions and decisions to be undertaken in the context of the full life history. Given the complex, highly evolved life cycle of Pacific salmon, and especially their reliance on anadromy, effective management actions to produce, sustain, recover, and harvest them must consider all aspects of their life cycle.

Management of Columbia River basin salmonids is driven by a number of legal mandates (U.S. Endangered Species Act, Pacific Northwest Electric Power Planning and Conservation Act, Magnuson-Stevens Fishery Conservation and Management Act, etc.). These mandates are implemented through an interacting suite of programs and plans developed by federal, tribal, and state agencies. Most of these programs and plans recognize the importance of marine-phase influences in understanding and implementing freshwater management strategies.

For example, the Fish and Wildlife Program 2009 Amendments (NPCC 2009) concluded that a better understanding of the conditions experienced by salmon and the factors critical to their survival in the Columbia River plume and ocean environment was needed. In addition, the 2008 Federal Columbia River Power System (FCRPS) Biological Opinion and 2010 Adaptive Management Implementation Plan mandate a variety of marine-phase monitoring actions.

Mitigation efforts in the basin are presently centered around the “4-H” approach of simultaneously addressing habitat, hydrosystem, hatchery, and harvest issues (Marmorek and Peters, 2001). Until recently, harvest management was the only focus on the marine life-history phase. Now, there is increasing recognition of the role of ocean variation. This role is important in determining salmon population dynamics (e.g., Beamish et al. 2000; Logerwell et al. 2003; Scheuerell and Williams 2005) and for interpreting the response of populations to management actions (Bradford and Irvine 2000; Kareiva et al. 2000). Thus, the 4-H approach needs to include an ocean perspective, which we call the H₄O approach. The ocean research and monitoring described in this report contributes substantially to this expanded management perspective.

Our contributions to management can be divided into three main areas:

- Information on ocean variability as a context for understanding the response of populations to 4-H actions.
- Information that can improve projections of adult returns; this is valuable for both ocean and in-river harvest planning.
- Incipient information on the responses of stocks with different life-history characteristics to variable ocean conditions.

To date, analysis of management implications has not been an emphasis in the scope of work of the ocean projects. Rather, the ocean studies have focused on improving our understanding of juvenile salmon ecology during early marine residency (e.g., migration, distribution, and the mechanisms linking ocean conditions to juvenile salmon survival) in order to inform rather than direct management efforts. However, our efforts over the years have led to a time series of basic information from which we have built a suite of ocean productivity indicators. The ocean projects have not yet tried to explicitly link these data to discrete management actions, and their contributions presently represent unrealized potential. We anticipate that future ocean work will include effective interactions with the 4-H management and policy communities. To facilitate these interactions, we propose a series of workshops at which research results and needs of managers will be shared and discussed. The result should allow us to modify our research for maximum benefit to the management and policy communities.

Ocean Variability as a Context for 4-H Management

Salmon mitigation and recovery efforts in the Columbia River are substantial and expensive. Efforts are underway to develop the monitoring infrastructure needed to measure the effectiveness of various recovery actions: for example, FCRPS performance measures, the Integrated Status and Effectiveness Monitoring Program (ISEMP), and the Columbia Habitat Monitoring Program. These programs are designed to identify how salmon respond to mitigation and recovery efforts at various levels of organization (population, main population group, or ESU), and how spawning, rearing, and migratory corridor habitat is improving at various spatial scales (site, reach, watershed, and river basin).

Because of the importance of the ocean phase in salmon life history, it is difficult to evaluate freshwater management actions without understanding changes in the ocean. Because ocean conditions affect adult returns periods of high or low ocean productivity can mask underlying trends in freshwater habitat productivity and could lead to a

misinterpretation of the proximate cause of the trend. Information on ocean productivity helps to disentangle marine and freshwater influences, assists in the interpretation of population trend data, and reduces the risk of falsely interpreting the trend data and misconstruing the true cause of an underlying trend in population abundance.

Within the basin, many important management activities consist of a single intervention (such as a mainstem dam modification, change in transportation of juvenile salmon, or change in harvest policy). Many of these activities affect the entire basin, or a substantial part of it, and thus provide no opportunity for statistical replication. In these cases, evaluation depends primarily on before-after (BA) comparisons, which confound the effect of these actions with other contemporary changes in the system. Therefore, to evaluate the effectiveness of a given management action within the basin, measures of these other changes are needed, and ocean conditions are major pieces of that puzzle.

As a more optimistic example, monitoring and evaluation of freshwater or estuarine habitat restoration projects can rely on more informative before-after/control-impact (BACI) studies. It would seem that having side-by-side controls would eliminate any need for ocean information. However, even with controls, statistical analyses can be improved with the use of environmental covariates (Smith et al. 1993) that account for common trends in the data, such as marine survival or climate indicators.

Typically, smolt-to-adult return ratios (SARs) have been used as covariates in such analyses, but SARs do not provide detailed information about a population's response to ocean conditions. For those populations for which these data are available, age-specific SARs can provide some information about marine survival for retrospective evaluation. However, SARs are available only for a very few salmonid populations, and even when available, they do not tell when or where mortality occurred.

SARs provide survival estimates between two points in a complex life-cycle, which includes residence time in river, estuary, early ocean, and long-term ocean habitats, and adults back through the estuary and river. They do not reflect important aspects of population dynamics, such as diversity of responses to changing conditions or sublethal effects on fish health or vitality. Nor do SARs by themselves provide the information needed to conduct prospective evaluations of future management actions or policies—simulating future conditions ideally involves an understanding of the environmental processes that affect the condition, growth, and survival of fish with diverse life-histories.

Our programs of coordinated efforts, which form an ecosystem approach to the study of juvenile salmon migration and early marine residence, include observations on their migration patterns, survival, biology, and the status of their surrounding ecosystem. This approach will over the long-term substantially contribute to our understanding of how

4-H activities in the basin affect salmonid sustainability. In the short-term, these observations can contribute valuable information for monitoring the effectiveness of management actions.

Improving Recruitment/Return Forecasts

Regular monitoring of salmon and their environment during the early marine phase provides a wealth of information that can contribute to stock forecasts. Past studies using ocean climate indicators to forecast salmon stocks have relied on long-term physical indices such as the Pacific Decadal and El Niño Southern Oscillations (Logerwell et al. 2003; Scheuerell and Williams 2005; Rupp et al. 2011). While such models appear to have improved forecasts in the short-term, we do not understand the mechanisms connecting these physical indicators to salmon life histories. Therefore, we cannot rely on these past predictive relationships to continue into the future (Walters 1987; Welch et al. 2000). For example, the model developed by Logerwell et al. (2003) to forecast marine survival of OPI coho salmon provided reasonable accuracy during the first 2 years, but failed afterward.

Our ocean projects provide a number of more proximate measures of conditions directly relevant to salmon. These measures are reported here and include direct survival estimates from acoustic tagging (section VI); abundance indices from trawl surveys (section III); measures of salmon condition (growth, condition index, pathogens) from associated laboratory analyses (sections IV and V); ecosystem conditions; food web structure (section V), and physical oceanography (section II). We have begun using this information to develop new forecasts for salmon returns (section VII); we focus on two examples here.

Forecasts based on a suite of ocean indicators were presented to the US v. Oregon Technical Advisory Committee (TAC) in 2010. The TAC has considered incorporating various river and ocean indicators into models that predict adult escapement levels and are used to establish in-river harvest allocations. Historically, the TAC has relied on traditional cohort relationships when estimating escapement levels of salmon stocks returning to the Columbia River.

As with any predictive model, there has been variation between the forecasts and actual returns, but overall, the models tended to be unbiased, with predictions having an equal likelihood of over or underestimating actual returns. However, in recent years, the actual return has been less than the forecast. In 2011, TAC considered alternative methodologies and criteria for forecasting the upriver spring Chinook return. They reviewed numerous alternative models, including the ocean indicators developed by NOAA, and chose a

range of models that appeared to reflect actual returns reasonably well. Incorporating our suite of ocean ecosystem indicators into the model scenarios was hindered primarily by the indicator time series being shorter than what TAC needed for hindcasting back to the 1980s. Over time, the ocean ecosystem indicator time series will become more informative of recruitment processes, and will be considered by TAC when developing their ensemble of models to improve forecasts of adult returns.

As reported here, NOAA and DFO have both been investigating the relationship between ocean indicators and the return of Columbia River salmon (section VII). For example, NOAA has used ocean indicators to predict returns of upriver spring/summer Chinook salmon above Bonneville Dam. We predicted that between 288,000 and 304,000 spring and summer Chinook salmon would pass Bonneville Dam through 15 June 2010, while the TAC predicted this number to be 470,000. The actual return was 277,389 (CRDART 1995). For the same run in 2011, we predicted between 188,000 and 194,000, while the TAC predicted 198,400; the actual return was 205,431. Similarly, the DFO forecast for fall Chinook salmon at Bonneville Dam was within 2% of the returns in 2010 and 2011 (Trudel et al. 2011, M. Trudel, unpublished). Both projects continue to explore additional multivariate analysis of the indicator data and its utility in predicting adult escapement and for increasing the accuracy of the forecasts. This predictive work cannot continue without continuing long-term observations.

Other Management Issues

Beyond our forecasting efforts and the direct evaluation of 4-H management activities in the context of ocean conditions, there are a number of other ways that our ocean research can contribute to management needs. Specific examples include:

Example 1. Ecosystem-based management—The Pacific Fisheries Management Council (PFMC) is mandated by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act to base fishery management on sound scientific principles and a healthy ecosystem. Information developed by ocean project sponsors is being considered by the PFMC as it develops an ecosystem fishery management plan (EFMP) for the California Current.

In particular, information from our ocean surveys and food-web analyses (section V) was instrumental in informing the Pacific Fishery Management Council's (PFMC) deliberations on whether to adopt a complete ban on commercial fishing for all species of krill in West Coast federal waters. Although there is no fishery for krill in PFMC waters, krill are fished in Antarctica, Japan, and off the west coast of Canada. Because of the importance of krill to the marine food chain, the PFMC took action in March 2006 to ban

krill harvest immediately. This ban will help sustain productivity of the California Current ecosystem for all species, including salmon.

Example 2. Life history diversity and salmon population resilience—The importance of life history diversity to the resilience of salmon populations has become more widely recognized in recent years (Hilborn et al. 2003; Greene et al. 2010; Schindler et al. 2010). Yet studies of the ocean life history of juvenile salmon have lagged far behind freshwater investigations, impeding the development of management strategies to strengthen and conserve diversity in Columbia River populations. Our research programs have developed new tools for investigating marine rearing habitats and migration pathways of individual fish. Tools that can elucidate patterns of life-history diversity include:

- 1) An improved genetic baseline for Columbia River Chinook salmon, to which DFO and NOAA ocean sampling contributed (Beacham et al. 2006);
- 2) Collaborative work among Oregon State University, NOAA, and DFO has applied otolith micro-chemical techniques for reconstructing freshwater and estuarine/ocean life histories (Middleton 2011);
- 3) Kintama has developed improved tagging and detection methods for tracking the migrations of individually tagged fish at sea (section VI).

Together these methods have provided and will continue to provide new insight into the identification of distinct temporal and spatial patterns of juvenile migration, habitat use, and performance among salmonid species and genetic stock groups within a species.

Understanding species- and stock-specific differences in ocean life history is critical to the management and recovery of at-risk Columbia River populations. For example, retrospective studies of the collapse of Sacramento Chinook salmon (Lindley et al. 2009) and Oregon coastal coho salmon (Lichatowich, 1999) suggest that erosion of genetic and life-history diversity weakened population resilience to changing ocean conditions.

River management actions may involve important tradeoffs among species and stocks with different life histories. For example, flow manipulation that modifies plume characteristics could benefit stocks with one migration pattern, while adversely affecting others. Moreover, river management actions directly influence salmon life histories in the ocean. For example, hatchery programs that select for particular freshwater phenotypes also limit ocean life history expression by selecting the timing, sizes, and ages of fish entering the ocean. Monitoring the ocean life histories of salmon provides important clues to marine survival mechanisms and their implications for salmon recovery actions.

Ocean information thus has important implications for the conservation and recovery of Columbia River salmon:

- 1) Genetic and life history indices are long-term indicators of population resilience and should be integrated into salmon monitoring programs along with more traditional short-term performance measures (*i.e.*, abundance, productivity, and survival);
- 2) It is important to maintain and strengthen population resilience during favorable ocean conditions, when opportunities for life history expression are greatest; and
- 3) The risks and uncertainties of future climate change also emphasize the need to continue monitoring stock-specific ocean life histories and minimize the effects of various stressors (*e.g.*, hatchery impacts, habitat loss, flow modifications, etc.) that may limit life-history expression, and could further undermine population viability in a changing environment.

Example 3. River Flow and the Columbia River Plume—An initial focus of our ocean research was the hypothesis that hydrosystem operations affect plume structure and its interaction with tides and local upwelling, and this in turn affects ecosystem productivity processes and juvenile salmon recruitment success. Our ocean study results provide evidence that river flow affects plume structure and salmon recruitment processes. First, we have found that river discharge explains most of the variability of the Columbia River plume, with coastal upwelling an important but distant second. Importantly, we now have the simulation and forecast tools that allow us—within some uncertainty bounds—to correlate past, present and future hydrographs at Bonneville Dam with prevailing plume characteristics during smolt outmigration.

Second, there is an apparent relationship between plume characteristics at time of ocean entry and SARs for steelhead. Steelhead SARs also increase with the size and offshore distance of the plume under favorable large-scale ocean conditions, but did not change when ocean conditions were poor (Burla et al. 2010a).

To the extent that hydrosystem operations influence the seasonal timing of river outflow, these findings, when combined with an understanding of ocean productivity each year, could inform the development of hydrosystem, hatchery, and fish transportation operations that optimize potential survival. These findings could also influence long-term operation policy analysis, such as those needed for the renegotiation of the U.S.-Canada Columbia River Treaty of 1964.

From a management perspective, almost all interventions proposed for the hydropower system involve accelerating the transfer of smolts from the river to the ocean—reducing freshwater exposure at the expense of increasing ocean exposure. For most purposes, then, survival rate comparisons per unit time are of greatest relevance, because hydropower

operations potentially trade off smolt exposure times in different environments: fewer days spent in the river means more time spent in the ocean. Our tagging results indicate that for the plume environment as well, it is important to consider both residence time and survival rate of some yearling Chinook salmon stocks, as it is the product (time × survival rate) that determines overall plume survival. Mortality rate is correlated with residence time, and greater mortality is associated with longer plume residence. More importantly, daily survival rates in the plume appear to generally be lower than in the coastal ocean. Therefore, management actions that can reduce plume residence time (which may conceivably be modified by changing hydrosystem operations) may improve yearling Chinook salmon smolt survival of some stocks by increasing time spent in the coastal ocean and decreasing time spent in the plume. Whether or not hydrosystem operations can actually be effective in achieving this fine level of control over smolt residence time is unclear and would need to be formally tested. Not all salmon species and populations respond to the plume environment in the same way. Fine-scale management that benefits one species may be detrimental to other species or life history types.

Example 4. Addressing *Latent and Differential Mortality*—There is a debate about the degree to which poor survival in the ocean results from direct effects of the ocean or delayed effects of hydrosystem passage—so called *latent* mortality (ISAB 2007; Anderson et al. 2011). The Independent Scientific Advisory Board (ISAB) concluded that the hydropower system causes some fish to experience latent mortality, but strongly advised against continuing to try to measure absolute latent mortality. They explained that “latent mortality relative to a damless reference is not measurable” (ISAB, 2007).

Rather, the ISAB recommended a focus on estimating the total mortality of in-river and transported fish and the processes that can be measured directly, such as in-river vs. transport mortality. This has been accomplished by acoustic tagging efforts (section VI). In addition, the ISAB (2007) recognizes “there will be considerable uncertainty in estimates of post-Bonneville survival,” and recommends that “this uncertainty be accounted for as efforts to reduce it continue. Estimates of uncertainty should be bounded and incorporated in simulation models and annual management planning processes.”

Smolts have been collected at hydropower facilities and trucked or barged downstream below the last Columbia River dam in an effort to reduce the negative effects of the FCRPS on salmon run sizes (Ebel et al. 1973; Ebel 1980; Williams et al. 2005). Studies to evaluate the efficacy of transportation have generally shown a benefit, but adult returns of transported smolts have fallen short of expectations, particularly for wild spring/summer Chinook salmon (Ward et al. 1997; Williams et al. 2005). In-river survival of spring/summer Chinook salmon from the uppermost dam on the Snake River

to below Bonneville Dam has ranged from 45 to 61% in non-drought years and has averaged 49% since 1999 (Williams et al. 2005; Ferguson, 2011), while the survival of smolts transported in barges to below Bonneville Dam is nearly 100% (Budy et al. 2002). If estuary/ocean mortality were equal, then the transport group of fish arriving below Bonneville Dam would have roughly twice the adult return as from those that migrated in-river, but this has not been observed, indicating that transported smolts suffer a higher level of estuarine/ocean mortality than in-river migrants.

This differential survival between transported fish and in-river migrants suggests that mortality events below Bonneville Dam (in the estuary or ocean) differentially affects transported smolts after their release. The ocean projects have addressed the question of *differential* or *delayed* mortality due to transportation. Kintama conducted tagging experiments and observed no evidence that barging of Snake River smolts elevated their mortality after release below Bonneville (section VI).

Summary

Since 1998, the BPA ocean projects have been implemented to aid salmon recovery efforts and address aspects of the Council's Fish and Wildlife Program mandated by the U.S. Congress. The ocean projects have produced information that can inform management within the Columbia River Basin in three main areas. First, because of the role of ocean conditions in affecting adult returns, periods of high or low ocean productivity can mask underlying trends in freshwater habitat productivity and could lead to a misinterpretation of the proximate cause of the trend. Knowledge of the response of salmon to ocean conditions is key to providing the proper context for judging the effectiveness of habitat restoration, hatchery reform, harvest management, and hydropower system improvements in process to restore listed and wild salmon stocks.

Second, the combination of physical and biological information collected as part of the ocean projects has led to the development of simple models that now provide outlooks of future salmon returns. With a longer time series these metrics are expected to increase the accuracy of current forecasting.

Third, the ocean projects have improved our understanding of the responses of stocks with different life-history characteristics to variable ocean conditions. We anticipate that knowing the mechanisms that link ocean conditions with stock-specific salmon survival will be useful to managers as we jointly seek to identify specific 4-H actions that improve salmon returns. Thus, we advocate a dialogue between scientists, managers, and policy makers initiated through several workshops to discuss the implications of our results for the management of Columbia River salmon with regards to the 4-H issues.

IX. Data Gaps, Uncertainties, and Research Needs

The ocean projects have revealed that juvenile salmon marine survival is both complex and dynamic across a range of spatial and temporal scales, and that no single factor consistently influences survival. Only by collecting a time series of ocean/salmon data over a broad geographic area has it been possible to determine and identify these ocean factors. The variability of ocean conditions observed during the 14 years of our work has provided “natural experiments” but the shortness of the time series has only provided limited opportunities for repeat occurrences (like the extremes of 2005 and 2008).

Thus, because of the short time series, uncertainties still exist around the delineation of mechanisms responsible for determining early marine survival of salmon. Additional years of data will not only increase our degrees of freedom but provide us with the ability to better weight the indicators (i.e., which indicators seem to be most important) under different variable ocean conditions. A longer time series is also needed to discern how ocean conditions influence interactions between hatchery and wild salmon, stock specific responses, and potential density-dependence, both intra- and inter-specific.

It is also fortuitous that these projects were started after the 1998 regime shift (Overland et al. 2008). Given that regime shifts are frequently associated with a major internal reorganization of marine ecosystems and functions and that they typically last 10-20 years (Overland et al. 2008), the relative importance of the mechanisms identified in this synthesis report may shift suddenly over time. Thus, it is important to recognize that the simple models developed as part of the ocean projects may fail over time as a result of regime shifts. Furthermore, greenhouse gas forcing may also drive ocean climate back towards a more extreme version of the warmer climate holding through the 1980s and 1990s (IPCC, 2007), and may induce Columbia River salmon to migrate farther north (Welch et al. 1998, Abdul-Aziz et al. 2011).

Previous sections highlighted our various efforts investigating juvenile salmon marine survival. While extensive, there are still many areas of research for which we do not presently have sufficient data to draw definite conclusions, or the resources to directly investigate them. We have been asked by the ISRP to consider several topics that have always been outside of our hypothesis-driven research. Thus below we discuss ISRPs request (for information on density dependence, hatchery/wild interactions, and steelhead ecology. This is followed by a discussion of gaps and uncertainties that we have identified.

Information Requested by the ISRP

Density Dependence—The impact on wild salmon of billions of salmon released to the North Pacific Ocean each year from hatcheries in Korea, Japan, and Russia is poorly understood (Ruggerone et al. 2010). Density-dependent interactions have been documented for pink, chum, and sockeye salmon in the North Pacific (Ruggerone and Nielsen 2004) and Strait of Georgia (Beamish et al. 2010). However, in these regions in the Pacific, salmon are a dominant fish.

A good deal of work has been done to document ocean density-dependence in both growth and survival for pink, chum, and sockeye salmon in the northern North Pacific (Ruggerone et al. 2010, and references therein). However, much less evidence exists for such effects on coho and Chinook salmon in the NCC, probably because salmon are not an abundant species in the NCC relative to other fish species (Orsi et al. 2007).

There are some data suggesting that during years of low productivity Columbia River smolts may experience density-dependent mortality in the ocean (Scheuerell and Williams, 2005). Stable isotope analyses performed by DFO revealed that niche overlap between juvenile pink salmon and chum salmon increased with juvenile salmon density, but decreased with zooplankton abundance (Jenkins 2011). Furthermore, their size generally decreased with juvenile salmon density, suggesting that they may be competing for food in coastal waters. As smaller fish tend to have lower survival rates, increasing juvenile pink salmon and chum salmon abundance through hatchery releases may reduce the productivity of threatened Columbia River chum salmon.

Finally, density-dependence can occur at a number of scales. For example, it could be local such as in the plume or it could occur at the scale of the NCC. Further, the scale at which density dependent mechanisms may operate may vary by species/life history types.

Hatchery/Wild Interactions—Ecological interactions between natural and hatchery juvenile salmon during their early marine residence have received little attention (Rand et al. In press). These interactions may negatively influence survival and hamper the ability of natural populations to recover (Levin et al. 2001). There is high spatial overlap in distribution and diet of both marked (hatchery) and unmarked (i.e., mostly natural) juvenile spring run Chinook salmon (Daly et al. 2011). Similarly, 75-90% of the juvenile Columbia River Chinook salmon caught off British Columbia during summer are marked, indicating that very few wild Chinook salmon are produced in the Columbia River (Trudel et al. 2011). However, hatchery clipping rates that are less than 100% complicate any comparisons between naturally produced and hatchery fish. The incomplete marking

(adipose fin clipping) of hatchery juveniles in the Columbia River Basin largely precludes identifying and therefore studying natural origin salmon in freshwater, estuarine, and ocean habitats. Once hatchery marking is 100%, this data gap can be closed for research on future brood years of juveniles.

In addition, feasibility tests of parentage based tagging (PBT; Garza and Anderson, 2007) are being conducted in Snake River hatcheries and have demonstrated that individual Chinook salmon and steelhead can be genetically identified using single nucleotide polymorphism (SNP) loci (Steele et al. 2011). Juveniles originating from participating hatchery programs can be linked back to a specific hatchery and even to the individual parents of the fish. Basin-wide implementation of PBT therefore offers great potential for the identification of hatchery fish in estuarine and ocean habitats.

Steelhead Ecology—Steelhead marine survival appears to be linked (in some years) to the size of the plume (Burla et al. 2010a). How and why a larger plume size might benefit steelhead is uncertain but may be related to moving them quicker through an area of high predation (i.e, estuary and nearshore coastal shelf) or it allows them to move off the shelf into the deeper North Pacific Ocean, their preferred marine habitat (Myers et al. 1996). Unfortunately, being neustonic, our surface trawl equipment does not sample them as effectively as a purse seine and our sampling program does not sample very far beyond the continental shelf. Prior to 2006 we did not catch enough steelhead to provide any information, but since 2006, for unknown reasons our catches of steelhead have increased substantially. Thus we have initiated studies of the health, growth, and food habits of juvenile steelhead and expect to have greater insights into the marine ecology of this salmonid in the near future.

Collaborating genetics laboratories have recently developed a standardized microsatellite DNA dataset that can be used for stock identification of Columbia River Basin steelhead (Blankenship et al. 2011). NOAA geneticists have now begun to use this baseline to study the timing of the basin's steelhead stocks arrival in the Columbia River estuary. However, baseline data for coastal sources have not yet been collected. Those data, particularly for Oregon and Washington populations, are necessary to estimate the origins of steelhead sampled in our ocean trawls. Attempts to obtain funding to make the necessary expansions to the steelhead baseline have not yet been successful.

Research Needs

Estuary/plume (H3)—We are in the process of creating short-term “watches” and “forecasts” that enable management strategies to be developed for timing of release of smolts, complemented or not, by strategic changes in hydropower operation to improve estuary/plume characteristics at the time of ocean entry. Over the next several years, we anticipate that we will produce 7-day-ahead forecasts of plume conditions designed to guide choices of timing of release of smolts. We also need better information on how long the salmon reside in the estuary, how much they grow, their overall health before migration, and specific migration patterns through the estuary, and how all of this influences overall marine survival.

In addition to short-term watches and forecasts, we are also in the process of defining and simulating scenarios of long-term change of estuary and plume characteristics, associated with change in climate in the coming years. To the extent that we can mechanistically show how plume characteristics are relevant for salmon survival, scenarios of long-term change of those characteristics will offer exceedingly valuable information for long-term planning for the region.

Also, we seek approaches to determine more specifically why high plume volume is correlated with high survival for some taxa. This effort would greatly benefit from some coordination with managers and inland scientists as we should be able to design tractable studies that could address some of these key questions about the potential to influence survival by altering aspects of flow and/or hatchery releases. We hope to address these issues at the workshops proposed for 2012 and out-years.

Estuary/Ocean Linkages (H1 and H2)—Life history diversity spreads mortality risks broadly in time and space and minimizes the likelihood of brood failure in variable environments (Healy 1991, 2011). This diversity is especially important for salmon during their critical transition between estuarine and ocean habitats. In particular, the specific suite of ocean conditions experienced by juvenile salmon varies with time of ocean entry, prey availability and vulnerability to predators. We hypothesize that variability in timing and size at ocean entry leads to variation in marine survival. A recent study (Claiborne et al. 2011) found that tagged fish that were smaller than 150 mm at release in the Columbia River estuary were under-represented in returning adults, suggesting smaller fish had low survival. Furthermore, increased diversity in these parameters (both between and within stocks) is expected to increase the resilience of populations to increasingly variable ocean conditions (Bottom et al. 2009).

Comparisons of the salmon species and stocks caught in the estuary with those in the ocean indicate that although many stocks are well represented in both habitats types,

some are effectively missing from our ocean sampling. In particular, small wild-origin subyearling Chinook salmon (Spring Creek group fall Chinook and West Cascade fall Chinook) that are abundant in shallow waters of the estuary are relatively rare in our trawl surveys. However, we do know from the work of a Ph.D. student at Oregon State University (Marin Jarrin et al. 2009, In Review) that these fish inhabit shallow (<25 m) marine habitats and can even be found in the surf zone. Additional efforts to sample in this shallow marine habitat are planned for summer 2012.

We are undertaking comparisons of juvenile salmon collected in the estuary (through NOAA and FCRPS BiOp funds) with those in the ocean with respect to a suite of factors (e.g., size, conditions, rearing and geographic origins, parasites and pathogens, food habits, etc.). This effort was only recently initiated because estuarine sampling in open waters of the estuary did not commence until 2007, therefore the number of years of data is still relatively small for statistical rigor. These efforts would have to continue to make these comparisons and provide baseline data for the ocean studies.

Additional Acoustic Tagging (H5)—Kintama hopes to extend acoustic tagging to additional stocks of yearling spring Chinook and to fall Chinook (which remain resident for much longer time periods near the Columbia River). This is important for validating the finding that ocean survival rates currently match freshwater survival rates, and should be continued before major changes to management are implemented. Increasing the power of statistical tests to identify which ocean variables truly affect survival in the early life history by relating ocean variables to the mortality occurring at that time will also increase the speed with which answers can be obtained, as can tagging over the entire run, which should capture any sudden changes in ocean conditions that occur during migration.

Relationship between Ocean Survival and Riverine and Estuary Growth—Muir et al. (2006) showed that barging smolts early can sometimes get them to the ocean “too early” for good survival. Claiborne et al. (2011) also showed that marine survival of yearling Chinook salmon benefited by some estuarine growth before entering the ocean. Although we have been conducting some research (NOAA and USACE sponsored) in the estuary, we need to identify the life histories and feeding habits of juvenile Chinook salmon in the estuary and compare with past (1980’s) data and see if there has been a change in their diets which might have influenced their growth. We also need to analyze adult salmon scales to identify how important estuary/river growth might be on marine survival for many different stocks of salmon (i.e., similar to Claiborne et al. 2011). Moreover, there is a need to expand upon research on residence timing, migration timing and growth using otolith microchemistry to examine lower Columbia spring and fall Chinook stock groups to determine if their response to ocean conditions and subsequent survival is consistent with Interior Columbia River populations.

Bottom-Up Processes (H1)—Forage Fishes: While forage fish can act as a buffer for salmon predation, they can also act as competitors during years with poor ocean conditions (Holsman et al. In prep). We have been identifying the abundance of forage fish in the plume – especially in spring. In the past we have conducted stomach analysis of some forage fish species. In the future we hope to conduct stomach analysis of some larger forage fish such as older Pacific sardine.

Additional Diet Studies. We need to more fully address whether juvenile salmon are food limited in their early marine period during times of poor conditions to assess competition from other salmon or non-salmonid planktivores. This can be addressed through direct sampling of salmon prey fields and spatially explicit bioenergetic modeling in and out of the plume.

Top-Down Processes (H2)—Avian predators: Some marine birds are known to prey heavily on juvenile salmon in the Columbia River estuary (Caspian terns). The amount of salmon eaten is influenced by many factors, including alternative prey abundance and oceanographic conditions. To complete the investigation of ocean bird (shearwaters and murre) predation on salmon marine survival, it will be necessary to (1) quantitatively describe the diet of sooty shearwaters and common murre collected in the plume so the frequency of occurrence of salmon species/stocks in ocean bird stomachs can be calculated; (2) determine the abundance of murre on their colonies so that diet frequency data can be "scaled up" to a rough estimate of total mortality of salmonids; and (3) quantify the daytime distribution, abundance, and size composition of forage fishes with newly-available fisheries hydroacoustic, so the relationship of alternative prey availability to bird abundance and the frequency of salmon in bird diet can be estimated.

Marine Mammal Predators: While pinnipeds are known predators on adult and juvenile salmon in rivers and estuaries, we presently do not know if pinnipeds (and harbor porpoises) are significant predators of juvenile salmon in the ocean. Similar to marine birds, this is difficult to assess because we cannot directly sample their stomachs. However, we have been recording their abundance on our cruises.

Cannibalism: Adult salmon are frequently abundant off the Columbia River and other coastal areas where juvenile salmon also reside, and are thought to feed on juvenile salmon. We are interested in pursuing this avenue of research. Although we do not have the permits necessary to collect adult salmon or their stomachs, it is possible to obtain stomachs from fishers.

Pathogens: Future efforts need to examine salmon collected in freshwater as well as the estuary and ocean to provide a baseline and better identify the mechanisms influencing *R.*

salmoninarum infections and its effects on species of salmonids and stock groups, and differences between natural and hatchery-produced salmon. In addition, there is a need to add stock specific data to preliminary observations of other pathogens, such as *Ceratomyxa shasta*, which among the few years studied we noted in fairly high prevalence in the Columbia River estuary, but was virtually absent from ocean samples.

Management Tools—As noted above, our work has not focused on products that target specific management needs. We have outlined several areas where we believe results from our monitoring and research activities can assist with policy and management decisions in the Columbia River Basin, and advocate future work to incorporate this information into management tools. Potential new efforts include modeling of river flow effects on plume structure in relation to hydrosystem operations, continued improvements of stock forecasts using ocean climate indicators, further investigation of the effects of river discharge timing on plume characteristics and salmonid recruitment, and incorporating ocean information and full-system survival estimates (combining data from CWTs, PIT tag, COAST, and Juvenile Salmon Acoustic Telemetry System (JSATS)) efforts into life-cycle models. Planning this work will require close collaboration between the ocean research and the management communities, which can be initiated in the workshops described below and elsewhere.

Other Issues—

Delayed Mortality (H4). The ISAB recognizes that resolving the issue of delayed mortality will require further research on how the plume and the hydropower system affect smolt survival upon entering the ocean. Other than our studies, no other work is being conducted to collect empirical information and measure coastal ocean survival directly (although there are JSAT measurements for the lower river and estuary). As a result, no further progress can be made toward resolving the role of delayed hydropower system mortality for the 2008 BiOp or future Biological Opinions without additional data collection and analysis similar to that reported here.

Winter Mortality (H1). Substantial mortality seems to occur during winter, however to resolve better this issue, it will be necessary to sample in winter off Washington and Oregon (and continue the ongoing sampling off BC) to determine how variable this mortality is among years, and the mechanisms that are involved with winter mortality.

Long-Term Automated Observations. To make the research programs stronger in the future we need to continue to analyze our existing data and incorporate new information and technologies. The addition of oceanographic sensors associated with the incipient Integrated Ocean Observing System (IOOS, <http://www.ioos.gov/>) will provide specific temporal and spatial observation's on a scale which we have been unable to conduct (i.e.,

primarily due to limitations of ship time). Furthermore, as part of IOOS, high-resolution physical oceanographic models will become available for our use and these should be useful as we construct new cutting-edge habitat models for juvenile salmon. We will also more closely integrate information on salmon during their riverine, estuarine, and oceanic life histories to begin to understand how salmon must integrate these various habitats into their life history to return as adults to the Columbia River.

Workshops—Our research is now sufficiently mature to allow us to provide information and advice on a variety of management actions. However, specific actions are not discussed here because of the complexity of the 4-H issues. We advocate a dialogue between scientists and managers that is best addressed through several workshops to be initiated in 2012. Moreover, to increase the relevance of the ocean projects to BPA, BiOp, and the Fish and Wildlife Program, it will be necessary to effectively communicate the prognosis regarding the likely impacts of ocean conditions on Columbia River salmon to BPA and to various organizations involved with the restoration of the freshwater and estuarine environment. An additional workshop on full-system survival estimates (combining info from the various tagging efforts) will help connect and integrate estimates and mechanisms across habitats. The workshops would serve as a forum for all involved and could be jointly organized by NOAA and the Council. It is time to move towards a predictive science and initiate discussions with BPA, NWPCC and hatchery managers as to how they might modify the operations of the hydropower system, barge transportation, and timing-of-release of smolts to improve the survival of salmon in the marine environment (i.e. operational oceanography).

Future coordination and collaboration among the ocean projects.

The importance of coordinating the ocean projects to provide a comprehensive understanding of the processes regulating the survival of different Columbia River salmon ESUs in the ocean has long been recognized by NOAA and DFO. The coordination and collaboration between NOAA and DFO that started with the inception of these projects is expected to continue in the future, as the integration of efforts from both projects has already yielded fruitful results and joint publications (Appendix B). Coordination of the projects will be performed annually, at a minimum, coinciding with attendance at the annual “Salmon Ocean Ecology Meeting” that NOAA and DFO have organized each year since the late 1990s. In addition, communication and data exchange among scientists of both programs occurs throughout the year with phone, emails, and web conferencing. Future collaboration will include participation of DFO scientists on NOAA surveys and vice versa, as well as joint winter surveys that extend from the west coast of Vancouver Island to Oregon.

Collaboration between the NOAA and DFO projects with the Kintama project has been somewhat limited to date, due to the shorter Kintama time series. However, because the NOAA and DFO surveys overlap in space with the Kintama acoustic arrays, it is expected in a few years that the area-specific mortality rates estimated by Kintama using acoustic telemetry will be overlaid with the ocean conditions measured by NOAA and DFO along the coast and Columbia River plume. This should also allow a more statistically powerful analysis of cause and effects than using adult returns alone.

In combination, the ocean projects provide a promising avenue of future collaboration and increases our ability to understand the response of Columbia River salmon to changing ocean conditions. By distinguishing between hydrosystem-induced mortality and ocean effects, the cause of poor adult returns can be properly identified and direct measurements of early marine survival can help quickly test theories about how regional ocean conditions influence juvenile survival without waiting three years for adult salmon to return.

Acknowledgements

These ocean projects would not have been possible without the generous financial contributions of the Bonneville Power Administration, NOAA, Fisheries and Oceans Canada, the Canadian Space Agency, the Pacific Salmon Commission, and the Natural Sciences and Engineering Council of Canada, as well as other agencies listed earlier in the report for contributing to our increased understanding of the dynamic Northern California Current ecosystem.

We thank the many people who have spent countless hours *doing a great job* in the lab, field, and office in support of this project: Y. Jung, D. Mackas, H. Maclean, J. Morris, M. Thiess, S. Tucker, and T. Zubkowski (*Fisheries and Oceans Canada*); I. Brosnan, P. Callow, W. Challenger, M. Jacobs-Scott, A. Porter, E. Rechisky, and P. Winchell (*Kintama Research Ltd.*); P. Bentley, C. Bucher, B. Burke, A. De Robertis, S. Hinton, and D. Van Doornik (*NOAA*); M. Burla, S. Frolov, K. Rathmell, C. Seaton, P. Turner, M. Wilkin, and J. Zhang (*Oregon Health Sciences Research, Center for Coastal Margin Observation & Prediction*); R. Baldwin, E. Daly, J. Fisher, T. Guy, C. Johnson, D. Kuligowski, G. Krutzikowsky, J. Lamb, M. Litz, J. Losee, W. Pearcy, J. Popp, M.B. Rew, J. Ruzicka, T. Sandell, R. Schabetsberger, L. Tomaro, and J. Waddell (*Oregon State University and Cooperative Institute for Marine Resources Studies*); A. Claiborne (*Pacific States Marine Fisheries Commission*); E. Phillips and L. Rohrbach (*University of Washington School of Aquatic and Fisheries Science*); E. Jenkins, A. Mazumder, and K. Middleton (*University of Victoria*). In addition, we have benefitted by the assistance of other volunteer colleagues, and especially students, too numerous to count.

Special thanks to the captains and crews who have made this project so successful: FV *Cape Windy*, FV *Chasina*, FV *Chellissa*, FV *Frosti*, FV *Lady Law*, RV *Miller Freeman*, FV *Miss Sue*, FV *Ocean Harvester*, FV *Ocean Selector*, FV *Pacific Fury*, FV *Pacific Sun IV*, FV *Piky*, FV *Sea Eagle*, FV *Snow Drift*, and the FV *Viking Storm*, CCGS *WE Ricker*, and the FV *Westbank*.

We also thank a number of staff of the BPA and Northwest Power and Conservation Council, in addition to other individuals they recruited, for their valuable comments on earlier drafts of this report, including: Jim Anderson, Jim Geiselman, Al Giorgi, Stacy Horton, Nancy Leonard, Patty O'Toole, Jim Ruff, Alan Ruger, and, Barbara Shields, as well as JoAnne Butzerin (*NOAA*) for her technical editing.

Finally, we thank Anne Creason, Barbara Shields, Tracey Yerxa, and Ben Zelinski at BPA for all their support with contracting and reporting to BPA.

References

- Abdul-Aziz, O.I., Mantua, N.J. and Myers, K.W. (2011) Potential climate change impacts on thermal habitats of Pacific salmon (*Oncorhynchus* spp.) in the North Pacific Ocean and adjacent seas. *Can. J. Fish. Aquat. Sci.*, **68**, 1660-1680.
- AGU (American Geophysical Union) (2006) Warm ocean conditions in the California Current in spring/summer 2005: causes and consequences. *Geophys. Res. Lett.*, **33(22)**, L22S01-L22S11.
- Anderson, J., Ham, K. and Gosselin, J. (2011) Snake River Basin differential delayed mortality synthesis, 95% progress report dated September 2011. Walla Walla District, Walla Walla, WA, Prepared for the U.S. Army Corps of Engineers.
- Baldwin, R.E., Miller, T.W., Brodeur, R.D. and Jacobson, K.C. (2008) Expanding the foraging history of juvenile Pacific salmon: combining stomach-content and macroparasite-community analyses for studying marine diets. *J. Fish Biol.*, **72**, 1268-1294.
- Bartholomew, J.L., Fryer, J.L. and Rohovec, J.S. (1992) Impact of the myxosporean parasite, *Ceratomyxa shasta*, on survival of migrating Columbia River basin salmonids. In Proceedings of the 19th US. and Japan meeting on Aquaculture ISE, Mie Prefecture, Japan. October 29-30, 1990. US Dept. of Commerce NOAA Technical Report NMFS 111.
- Bax, N.J. (1998) The significance and prediction of predation in marine fisheries. *ICES J. Mar. Sci.*, **55**, 997-1030.
- Beacham, T.D., Candy, J.R., Jonsen, K.L., Supernault, J., Wetklo, M., Deng, L.T., Miller, K.M., Withler, R.E. and Varnavskaya, N. (2006) Estimation of stock composition and individual identification of Chinook salmon across the Pacific Rim by use of microsatellite variation. *Trans. Am. Fish. Soc.*, **135**, 861-888.
- Beacham, T.D., Wetklo, M., Deng, L. and MacConnachie, C. (2011) Coho Salmon Population Structure in North America Determined from Microsatellites. *Trans. Am. Fish. Soc.*, **140**, 253-270.
- Beamish, R.J., McFarlane, G.A. and King, J.R. (2000) Fisheries climatology: understanding decadal scale processes that naturally regulate British Columbia fish populations. In: *Fisheries Oceanography: an integrative approach to fisheries ecology and management*. P.J. Harrison and T.R. Parsons (eds). pp. 94-139.
- Beamish, R.J. and Mahnken, C. (2001) A critical size and period hypothesis to explain natural regulation of salmon abundance and the linkage to climate and climate change. *Prog. Oceanogr.*, **49**, 423-437.
- Beamish, R.J., Mahnken, C. and Neville, C.M. (2004) Evidence that reduced early marine growth is associated with lower marine survival of Coho salmon. *Trans. Am. Fish. Soc.*, **133**, 26-33.

- Beamish, R.J., Sweeting, R.M., Neville, C.M. and Lange, K.L. (2010) Competitive interactions between pink salmon and other juvenile Pacific salmon in the Strait of Georgia. NPAFC Doc. 1284. 26pp.
- Bertrand, M., Marcogliese, D.J. and Magnan, P. (2008) Trophic polymorphism in brook charr revealed by diet, parasites and morphometrics. *J. Fish Biol.*, **72**, 555-572.
- Bi, H., Ruppel, R.E. and Peterson, W.T. (2007) Modeling the pelagic habitat of salmon off the Pacific Northwest (USA) coast using logistic regression. *Mar. Ecol. Prog. Ser.*, **336**, 249-265.
- Bi, H., Ruppel, R.E., Peterson, W.T. and Casillas, E. (2008) Spatial distribution of ocean habitat of yearling Chinook (*Oncorhynchus tshawytscha*) and coho (*Oncorhynchus kisutch*) salmon off Washington and Oregon, USA. *Fish. Oceanogr.*, **17**, 463-476.
- Bi, H., Peterson, W.T., Lamb, J. and Casillas, E. (2011a) Copepods and salmon: characterizing the spatial distribution of juvenile salmon along the Washington and Oregon coast, U.S.A. *Fish. Oceanogr.*, **20**, 125-138.
- Bi, H., Peterson, W.T. and Strub, P.T. (2011b) Transport and coastal zooplankton communities in the northern California Current system. *Geophys. Res. Lett.*, **38**.
- Blankenship, S.M., Campbell, M.R., Hess, J.E., Hess, M.A., Kassler, T.W., Kozfkay, C.C., Matala, A.P., Narum, S.R., Paquin, M.M., Small, M.P., Stephenson, J.J. and Warheit, K.I. (2011) Major lineages and metapopulations in Columbia River *Oncorhynchus mykiss* are structured by dynamic landscape features and environments. *Trans. Am. Fish. Soc.*, **140**, 665-684.
- Bradford, M.J. (1995) Comparative review of Pacific salmon survival rates. *Can. J. Fish. Aquat. Sci.*, **52**, 1327-1338.
- Bradford, M.J. and Irvine, J.R. (2000) Land use, fishing, climate change, and the decline of Thompson River, British Columbia, coho salmon. *Can. J. Fish. Aquat. Sci.*, **57**, 13-16.
- Brodeur, R.D., Fisher, J.P., Teel, D.J., Emmett, R.L., Casillas, E. and Miller, T.W. (2004) Juvenile salmonid distribution, growth, condition, origin, and environmental and species associations in the Northern California Current. *Fish. Bull.*, **102**, 25-46.
- Brodeur, R.D., Fisher, J.P., Emmett, R.L., Morgan, C.A. and Casillas, E. (2005) Species composition and community structure of pelagic nekton off Oregon and Washington under variable oceanographic conditions. *Mar. Ecol. Prog. Ser.*, **298**, 41-57.
- Brodeur, R.D., Daly, E.A., Sturdevant, M.V., Miller, T.W., Moss, J.H., Thiess, M.E., Trudel, M., Weitkamp, L.A., Armstrong, J. and Norton, E.C. (2007) Regional comparisons of juvenile salmon feeding in coastal marine waters off the west coast of North America. *Am. Fish. Soc. Symp.*, **57**, 183-203.
- Brodeur, R.D., Suchman, C.L., Reese, D.C., Miller, T.W. and Daly, E.A. (2008) Spatial overlap and trophic interactions between pelagic fish and large jellyfish in the northern California Current. *Mar. Biol.*, **154**, 649-659.

- Brodeur, R.D., Ruzicka, J.J. and Steele, J.A. (2011) Investigating alternate trophic pathways through gelatinous zooplankton and planktivorous fishes in an upwelling ecosystem using end-to-end models. In: *Interdisciplinary Studies on Marine Environmental Modeling & Analysis*. K. Omori, X. Guo, N. Yoshie, N. Fujii, I.C. Handoh, A. Isobe and S. Tanabe (eds). TERRAPUB. pp. 57-63.
- Budy, P., Thiede, G.P., Bouwes, N., Petrosky, C.E. and Schaller, H. (2002) Evidence linking delayed mortality of snake river salmon to their earlier hydrosystem experience. *N. Am. J. Fish. Manage.*, **22**, 35-51.
- Burla, M., Baptista, A.M., Casillas, E., Williams, J.G. and Marsh, D.M. (2010a) The influence of the Columbia River plume on the survival of steelhead (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*): a numerical exploration. *Can. J. Fish. Aquat. Sci.*, **67**, 1671-1684.
- Burla, M., Baptista, A.M., Zhang, Y.L. and Frolov, S. (2010b) Seasonal and interannual variability of the Columbia River plume: A perspective enabled by multiyear simulation databases. *J. Geophys. Res. (C Oceans)*, **115**.
- Cederholm, C.J., Kunze, M.D., Murota, T. and Sibatani, A. (1999) Pacific salmon carcasses: Essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. *Fisheries*, **24**, 6-15.
- Chawla, A., Jay, D.A., Baptista, A.M., Wilkin, M. and Seaton, C. (2008) Seasonal variability and estuary-shelf interactions in circulation dynamics of a river-dominated estuary. *Estuar. Coast.*, **31**, 269-288.
- Claiborne, A.M., Fisher, J.P., Hayes, S.A. and Emmett, R.L. (2011) Size at Release, Size-Selective Mortality, and Age of Maturity of Willamette River Hatchery Yearling Chinook Salmon. *Trans. Am. Fish. Soc.*, **140**, 1135-1144.
- CMOP (Center for Coastal Margin Observation & Prediction) (2012) Virtual Columbia River Climatological Atlas. Interactive data site of the Center for Coastal Margin Observation and Prediction. Available www.stccmop.org/datamart/virtualcolumbiariver/simulationdatabases/climatologicalatlas (January 2012).
- Coyle, K.O. and Pinchuk, A.I. (2003) Annual cycle of zooplankton abundance, biomass and production on the northern Gulf of Alaska shelf, October 1997 through October 2000. *Fish. Oceanogr.*, **12**, 327-338.
- Coyle, K.O. and Pinchuk, A.I. (2005) Seasonal cross-shelf distribution of major zooplankton taxa on the northern Gulf of Alaska shelf relative to water mass properties, species depth preferences and vertical migration behavior. *Deep-Sea Res, Part II*, **52**, 217-245.
- Coyle, K.O., Pinchuk, A.I., Eisner, L.B. and Napp, J.M. (2008) Zooplankton species composition, abundance and biomass on the eastern Bering Sea shelf during summer: The potential role of water-column stability and nutrients in structuring the zooplankton community. *Deep-Sea Res, Part II*, **55**, 1775-1791.
- Cross, A.D., Beauchamp, D.A., Myers, K.W. and Moss, J.H. (2008) Early marine growth of pink salmon in Prince William Sound and the coastal Gulf of Alaska during years of low and high survival. *Trans. Am. Fish. Soc.*, **137**, 927-939.

- Crossin, G.T., Hinch, S.G., Farrell, A.P., Higgs, D.A. and Healey, M.C. (2004) Somatic energy of sockeye salmon *Oncorhynchus nerka* at the onset of upriver migration: a comparison among ocean climate regimes. *Fish. Oceanogr.*, **13**, 345-349.
- Daly, E., Brodeur, R., Fisher, J., Weitkamp, L., Teel, D. and Beckman, B. (2011) Spatial and trophic overlap of marked and unmarked Columbia River Basin spring Chinook salmon during early marine residence with implications for competition between hatchery and naturally produced fish. *Environ. Biol. Fishes*, 1-18.
- Daly, E.A., Brodeur, R.D. and Weitkamp, L.A. (2009) Ontogenetic Shifts in Diets of Juvenile and Subadult Coho and Chinook Salmon in Coastal Marine Waters: Important for Marine Survival? *Trans. Am. Fish. Soc.*, **138**, 1420-1438.
- Daly, E.A., Benkwitt, C.E., Brodeur, R.D., Litz, M.N.C. and Copeman, L.A. (2010) Fatty acid profiles of juvenile salmon indicate prey selection strategies in coastal marine waters. *Mar. Biol.*, **157**, 1975-1987.
- Dawley, E.M., Ledgerwood, R.D. and Jensen, A. (1985) Beach and purse seine sampling of juvenile salmonids in the Columbia River estuary and ocean plume, 1977-1983. Vol. I: Procedures, sampling effort and catch data. Seattle, WA, U.S. Dep. Comm. NOAA Tech. Memo. NMFS F/NWC no.74. 260 pp.
- Ebel, W.J., Park, D.L. and Johnson, R.C. (1973) Effects of transportation on survival and homing of Snake River Chinook salmon and steelhead trout. *Fish. Bull.*, **71**, 549-563.
- Ebel, W.J. (1980) Transportation of Chinook salmon, *Oncorhynchus tshawytscha*, and steelhead, *Salmo gairdneri*, smolts in the Columbia River and effects on adult returns. *Fish. Bull.*, **78**, 491-506.
- Elliott, D.G., Pascho, R.J. and Bullock, G.L. (1989) Developments in the control of bacterial kidney disease of salmonid fishes. *Dis. Aquat. Org.*, **6**, 201-215.
- Emmett, R.L., Miller, D.R. and Blahm, T.H. (1986) Food of juvenile Chinook, *Oncorhynchus tshawytscha*, and coho, *Oncorhynchus kisutch*, salmon off the Northern Oregon and Southern Washington coasts, May - September 1980. *Calif. Fish Game*, **72**, 38-46.
- Emmett, R.L. (2006) The relationships between fluctuations in oceanographic conditions, forage fishes, predatory fishes, predator food habits, and juvenile salmonid marine survival off the Columbia River. Fisheries and Wildlife. Corvallis, OR, Oregon State University, Ph.D. Thesis, 312 pp.
- Emmett, R.L., Krutzikowsky, G.K. and Bentley, P. (2006) Abundance and distribution of pelagic piscivorous fishes in the Columbia River plume during spring/early summer 1998-2003: Relationship to oceanographic conditions, forage fishes, and juvenile salmonids. *Prog. Oceanogr.*, **68**, 1-26.
- Emmett, R.L. and Sampson, D.B. (2007) The relationship between predatory fish, forage fishes, and juvenile salmonid marine survival off the Columbia River: a simple trophic model analysis. *CALCOFI Rep*, **48**, 96-105.

- Emmett, R.L. and Krutzikowsky, G.K. (2008) Nocturnal feeding of Pacific hake and jack mackerel off the mouth of the Columbia River, 1998-2004: Implications for juvenile salmon predation. *Trans. Am. Fish. Soc.*, **137**, 657-676.
- English, K.K., Glova, G.J. and Blakley, A.C. (2008) *An Upstream Battle: Declines in 10 Pacific Salmon Stocks and Solutions for Their Survival*. David Suzuki Foundation, Vancouver, B. C., 49pp.
- Farley, E.V., Starovoytov, A., Naydenko, S., Heintz, R., Trudel, M., Guthrie, C., Eisner, L. and Guyon, J.R. (2011) Implications of a warming eastern Bering Sea for Bristol Bay sockeye salmon. *ICES J. Mar. Sci.*, **68**, 1138-1146.
- Ferguson, J. (2011) Preliminary survival estimates for passage during the spring migration of juvenile salmonids through Snake and Columbia River reservoirs and dams, 2011. Memorandum to Bruce Suzumoto. Seattle, WA, NOAA Northwest Region, dated September 13, 2011. Available from NOAA's Northwest Fisheries Science Center.
- Ferguson, J.A., Rossignol, P.A., Jacobson, K.C. and Kent, M.L. (2011) Mortality in coho salmon (*Oncorhynchus kisutch*) associated with burdens of multiple parasite species. *Int. J. Parasitol.*, **41**, 1197-1205.
- Fisher, J.P. and Percy, W.G. (1990) Spacing of scale circuli versus growth rate in young coho salmon. *Fish. Bull.*, **88**, 637-643.
- Fisher, J.P. and Percy, W.G. (1995) Distribution, migration, and growth of juvenile Chinook salmon, *Oncorhynchus tshawytscha*, off Oregon and Washington. *Fish. Bull.*, **93**, 274-289.
- Fisher, J.P., Trudel, M., Ammann, A., Orsi, J.A., Piccolo, J., Bucher, C., Casillas, E., Harding, J.A., MacFarlane, R.B., Brodeur, R.D., Morris, J.F.T. and Welch, D.W. (2007) Comparisons of the coastal distributions and abundances of juvenile Pacific Salmon from central California to the Northern Gulf of Alaska. In: *The ecology of juvenile salmon in the northeast Pacific Ocean: regional comparisons*. C.B. Grimes, R.D. Brodeur, L.J. Haldorson and S.M. McKinnell (eds). American Fisheries Society, Symposium 57, Bethesda. pp. 31-80.
- Fisher, J.P., Hinton, S.A., Teel, D.J., Trudel, M., Weitkamp, L.A., Morris, J.F.T., Thiess, M.E., Sweeting, R.M., Orsi, J.A. and Farley, E.V. (In revision) Patterns of early ocean dispersal and growth among Columbia River Chinook and coho salmon stock groups. *Trans. Am. Fish. Soc.*
- Francis, R.C. and Hare, S.R. (1994) Decadal-scale regime shifts in the large marine ecosystems of the North-east Pacific: A case for historical science. *Fish. Oceanogr.*, **3**, 279-291.
- Fryer, J.L. and Sanders, J.E. (1981) Bacterial kidney disease of salmonid fish. *Annu. Rev. Microbiol.*, **35**, 273-298.
- Gargett, A.E. (1997) The optimal stability 'window': a mechanism underlying decadal fluctuations in North Pacific salmon stocks? *Fish. Oceanogr.*, **6**, 109-117.

- Garza, J.C. and Anderson, E. (2007) Large scale parentage inference as an alternative to coded-wire tags for salmon fishery management. *In: PSC Genetic Stock Identification Workshop (May and September 2007): Logistics Workgroup final report and recommendations*. Vancouver, British Columbia, Canada. Available at http://www.psc.org/info_genetic_stock_id.htm#REPORTS, Pacific Salmon Commission. 48-55pp.
- Greene, C.M., Hall, J.E., Guilbault, K.R. and Quinn, T.P. (2010) Improved viability of populations with diverse life-history portfolios. *Biol. Lett.*, **6**, 382-386.
- Hallowed, A.B. and Wooster, W.S. (1992) Variability of winter ocean conditions and strong year classes of Northeast Pacific groundfish. *ICES Mar. Sci. Symp.*, **195**, 433-444.
- Hare, S.R., Mantua, N.J. and Francis, R.C. (1999) Inverse production regimes: Alaska and West Coast Pacific salmon. *Fisheries*, **24**, 6-14.
- Hartt, A.C. and Dell, M.B. (1986) Early oceanic migrations and growth of juvenile Pacific salmon and steelhead trout. *Int. N. Pac. Fish. Comm.*, **46**, 105pp.
- Healey, M.C. (1991) Life History of Chinook Salmon (*Oncorhynchus tshawytscha*). *In: Pacific salmon life histories*. C. Groot and L. Margolis (eds). University of British Columbia Press, Vancouver, Canada. pp. 311-394.
- Hickey, B., McCabe, R., Geier, S., Dever, E. and Kachel, N. (2009) Three interacting freshwater plumes in the northern California Current System. *J. Geophys. Res. (C Oceans)*, **114**.
- Hickey, B.M., Kudela, R.M., Nash, J.D., Bruland, K.W., Peterson, W.T., MacCready, P., Lessard, E.J., Jay, D.A., Banas, N.S., Baptista, A.M., Dever, E.P., Kosro, P.M., Kilcher, L.K., Horner-Devine, A.R., Zaron, E.D., McCabe, R.M., Peterson, J.O., Orton, P.M., Pan, J. and Lohan, M.C. (2010) River Influences on Shelf Ecosystems: Introduction and synthesis. *J. Geophys. Res. (C Oceans)*, **115**.
- Hilborn, R., Quinn, T.P., Schindler, D.E. and Rogers, D.E. (2003) Biocomplexity and fisheries sustainability. *Proc. Nat. Acad. Sci. USA*, **100**, 6564-6568.
- Holsman, K.M., Scheuerell, M.D., Buehle, E. and Emmett, R.L. (In prep) Interacting management practices modify subsequent effects of biotic and abiotic factors on marine survival of threatened Chinook salmon. *Conserv. Biol.*
- Hooff, R.C. and Peterson, W.T. (2006) Copepod biodiversity as an indicator of changes in ocean and climate conditions of the northern California current ecosystem. *Limnol. Oceanogr.*, **51**, 2607-2620.
- Hurst, T.P. (2007) Causes and consequences of winter mortality in fishes. *J. Fish Biol.*, **71**, 315-345.
- Independent Scientific Advisory Board (ISAB) (2007) Latent Mortality Report. Review of Hypotheses and Causative Factors Contributing to Latent Mortality and their Likely Relevance to the "Below Bonneville" Component of the COMPASS Model.: Northwest Power and Conservation Council., Document No. ISAB 2007-1, <http://www.nwcouncil.org/fw/isab/Default.asp>

- Intergovernment Panel on Climate Change (IPCC) (2007) Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernment Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds). Cambridge University Press, Cambridge.
- Jacobson, K.C., Teel, D., Van Doornik, D.M. and Casillas, E. (2008) Parasite-associated mortality of juvenile Pacific salmon caused by the trematode *Nanophyetus salmincola* during early marine residence. *Mar. Ecol. Prog. Ser.*, **354**, 235-244.
- Jenkins, E. (2011) Trophic niche and foodweb dynamics within and among juvenile salmon in years of contrasting ocean conditions. Victoria, British Columbia, University of Victoria, M.Sc. Thesis, 129 pp.
- Kareiva, P., Marvier, M. and McClure, M. (2000) Recovery and management options for spring/summer chinook salmon in the Columbia River Basin. *Science*, **290**, 977-979.
- Keister, J.E., Di Lorenzo, E., Morgan, C.A., Combes, V. and Peterson, W.T. (2011) Zooplankton species composition is linked to ocean transport in the Northern California Current. *Global Change Biol.*, **17**, 2498-2511.
- Lee, R.F., Hagen, W. and Kattner, G. (2006) Lipid storage in marine zooplankton. *Mar. Ecol. Prog. Ser.*, **307**, 273-306.
- Levin, P.S., Zabel, R.W. and Williams, J.G. (2001) The road to extinction is paved with good intentions: negative association of fish hatcheries with threatened salmon. *Proc. R. Soc. Lond., Ser. B: Biol. Sci.*, **268**, 1153-1158.
- Lindley, S.T., Grimes, C.B., Mohr, M.S., Peterson, W.T., Stein, J., Anderson, J.T., Botsford, L.W., Bottom, D.L., Busack, C.A., Collier, T.K., Ferguson, J., Garza, J.C., Grover, A.M., Hankin, D.G., Kope, R.G., Lawson, P.W., Low, A., Mcfarlane, R.B., Moore, K., Palmer-Zwahlen, M., Schwing, F.B., Smith, J., Tracy, C., Webb, R., Wells, B.K. and Williams, T.H. (2009) What caused the Sacramento River fall Chinook stock collapse? , NOAA Technical Memorandum: NOAA-TM-NMFS-SWFSC-447. 61pp.
- Litz, M.N.C., Brodeur, R.D., Emmett, R.L., Heppell, S.S., Rasmussen, R.S., O'Higgins, L. and Morris, M.S. (2010) Effects of variable oceanographic conditions on forage fish lipid content and fatty acid composition in the northern California Current. *Mar. Ecol. Prog. Ser.*, **405**, 71-85.
- Litz, M.N.C., Phillips, A.J., Brodeur, R.D. and Emmett, R.L. (2011) Seasonal occurrences of Humboldt squid (*Dosidicus gigas*) in the northern California Current System. *CALCOFI Rep*, **52**, 97-108.
- Logerwell, E.A., Mantua, N., Lawson, P.W., Francis, R.C. and Agostini, V.N. (2003) Tracking environmental processes in the coastal zone for understanding and predicting Oregon coho (*Oncorhynchus kisutch*) marine survival. *Fish. Oceanogr.*, **12**, 554-568.
- Losee, J.P., Baldwin, R.E., Fisher, J., Teel, D.J. and Jacobson, K.C. (In prep) Growth of juvenile coho salmon (*Oncorhynchus kisutch*) relates to species richness of trophically-transmitted parasites. *Proc. R. Soc. Lond., Ser. B: Biol. Sci.*

- Mackas, D.L., Thomson, R.E. and Galbraith, M. (2001) Changes in the zooplankton community of the British Columbia continental margin, 1985-1999, and their covariation with oceanographic conditions. *Can. J. Fish. Aquat. Sci.*, **58**, 685-702.
- Mackas, D.L., Peterson, W.T. and Zamon, J.E. (2004) Comparisons of interannual biomass anomalies of zooplankton communities along the continental margins of British Columbia and Oregon. *Deep-Sea Res., Part II*, **51**, 875-896.
- Mantua, N.J., Hare, S.R., Zhang, Y., Wallace, J.M. and Francis, R.C. (1997) A Pacific interdecadal climate oscillation with impacts on salmon production. *Bull. Am. Meteorol. Soc.*, **78**, 1069-1079.
- Marcogliese, D.J. (1995) The role of zooplankton in the transmission of helminth parasites to fish. *Rev. Fish Biol. Fish.*, **5**, 336-371.
- Marin Jarrin, J.R., Miller, D.R. and Teel, D.J. (In Review) Distribution and densities of juvenile Chinook salmon in sandy beach surf zones. *Mar. Ecol. Prog. Ser.*
- Marin Jarrin, J.R., Shanks, A.L. and Banks, M.A. (2009) Confirmation of the presence and use of sandy beach surf-zones by juvenile Chinook salmon. *Environ. Biol. Fishes*, **85**, 119-125.
- Marmorek, D. and Peters, C. (2001) Finding a PATH towards scientific collaboration: Insights from the Columbia River Basin. *Conserv. Ecol.*, **5(2)**, 8.
- Matthews, S.B. (1984) Variability of marine survival of Pacific salmonids: A review. In: *The Influence of Ocean Conditions on the Production of Salmonids in the North Pacific*. W.G. Pearcy (ed.) Oregon State University Sea Grant Program, Corvallis, OR. pp. 161-182.
- Mazumder, A., Brodeur, R.D., Eisner, L.B., Farley, E.V., Harding, J.A., Moss, J.H. and Trudel, M. (2011) Continental-scale comparative analyses of foodweb feeding and resource ecology of juvenile Chinook salmon along the coastal North Pacific, presented at the American Fisheries Society Annual Meeting, Seattle, WA, Available at: <http://afs.confex.com/afs/2011/webprogram/Paper3999.html>.
- Middleton, K.R. (2011) Factors affecting overwinter mortality and early marine growth in the first ocean year of juvenile Chinook salmon in Quatsino Sound, British Columbia. University of Victoria, M.Sc. Thesis, 116 pp.
- Miller, D.R., Williams, J.G. and Sims, C.W. (1983) Distribution, abundance and growth of juvenile salmonids off the coast of Oregon and Washington, summer 1980. *Fish. Res.*, **2**, 1-17.
- Miller, T.W. and Brodeur, R.D. (2007) Diets of and trophic relationships among dominant marine nekton within the northern California Current ecosystem. *Fish. Bull.*, **105**, 548-559.
- Miller, T.W., Brodeur, R.D., Rau, G. and Omori, K. (2010) Prey dominance shapes trophic structure of the northern California Current pelagic food web: evidence from stable isotopes and diet analysis. *Mar. Ecol. Prog. Ser.*, **420**, 15-26.

- Morris, J.F.T., Trudel, M., Thiess, M.E., Sweeting, R.M., Fisher, J., Hinton, S.A., Ferguson, J.A., Orsi, J.A., Farley, E.V. and Welch, D.W. (2007) Stock-specific migrations of juvenile coho salmon derived from coded-wire tag recoveries on the continental shelf of western North America. In: *The ecology of juvenile salmon in the northeast Pacific Ocean: regional comparisons*. C.B. Grimes, R.D. Brodeur, L.J. Haldorson and S.M. McKinnell (eds). American Fisheries Society, Symposium 57, Bethesda, MD. pp. 81-104.
- Moss, J.H., Beauchamp, D.A., Cross, A.D., Myers, K.W., Farley, E.V., Murphy, J.M. and Helle, J.H. (2005) Evidence for size-selective mortality after the first summer of ocean growth by pink salmon. *Trans. Am. Fish. Soc.*, **134**, 1313-1322.
- Mueter, F.J., Peterman, R.M. and Pyper, B.J. (2002) Opposite effects of ocean temperature on survival rates of 120 stocks of Pacific salmon (*Oncorhynchus* spp.) in northern and southern areas. *Can. J. Fish. Aquat. Sci.*, **59**, 456-463.
- Muir, W.D., Marsh, D.M., Sandford, B.P., Smith, S.G. and Williams, J.G. (2006) Post-hydropower system delayed mortality of transported snake river stream-type Chinook salmon: Unraveling the mystery. *Trans. Am. Fish. Soc.*, **135**, 1523-1534.
- Myers, K.W., Aydin, K.Y., Walker, R.V., Fowler, S. and Dahlberg, M. (1996) Known ocean ranges of stocks of Pacific salmon and steelhead as shown by tagging experiments, 1956-1995. University of Washington, Fisheries Research Institute, Seattle, Rep. FRI-UW-9614.
- Nickelson, T.E. (1986) Influences of upwelling, ocean temperature, and smolt abundance on marine survival of coho salmon (*Oncorhynchus kisutch*) in the Oregon production area. *Can. J. Fish. Aquat. Sci.*, **43**, 527-535.
- Northwest Power Act (1996) No. 5093 July 26, 1996 Amendment to the Pacific Northwest Electric Power Planning and Conservation Act. Section (4)(g)(4)(vi) of U.S. Code Chapter 12H (1994 and Supplement/1995). Statute 2697. Public Law No. 96-501, S. 885.
- Northwest Power and Conservation Council (NPCC) (2000) Columbia River Basin Fish and Wildlife Program. Council Document 2000-19. Northwest Power and Conservation Council, Portland, Oregon. 76pp.
- Northwest Power and Conservation Council (NPCC) (2009) Columbia River Basin Fish and Wildlife Program: 2009 Amendments. Council Document 2009-09. Northwest Power and Conservation Council, Portland, Oregon. 98pp.
- Orsi, J.A., Harding, J.A., Pool, S.S., Brodeur, R.D., Haldorson, L.J., Murphy, J.M., Moss, J.H., Farley, J.E.V., Sweeting, R.M., Morris, J.F.T., Trudel, M., Beamish, R.J., Emmett, R.L. and Fergusson, E.A. (2007) Epipelagic fish assemblages associated with juvenile Pacific salmon in neritic waters of the California Current and the Alaska Current. In: *The ecology of juvenile salmon in the northeast Pacific Ocean: regional comparisons*. C.B. Grimes, R.D. Brodeur, L.J. Haldorson and S.M. McKinnell (eds). American Fisheries Society, Symposium 57, Bethesda. pp. 105-155.
- Overland, J., Rodionov, S., Minobe, S. and Bond, N. (2008) North Pacific regime shifts: Definitions, issues and recent transitions. *Prog. Oceanogr.*, **77**, 92-102.

- Pascual, S., Gonzales, A., Arias, C. and Guerra, A. (1996) Biotic relationships of *Illex condetii* and *Todaropsis eblana* (Cephalopoda, Ommastrephidae) in the Northeast Atlantic: evidence from parasites. *Sarsia*, **81**, 265-274.
- Payne, J.C., Andrews, K., Chittenden, C., Crossin, G., Goetz, F.A., Hinch, S.G., Levin, P., Lindley, S.T., McKinley, S., Melnychuk, M.C., Nelson, T., Rechisky, E.L. and Welch, D.W. (2010) Tracking Fish Movements and Survival on the Northeast Pacific Shelf. In: *Life in the World's Oceans: Diversity, Distribution, and Abundance*. A.D. McIntyre (ed.) Blackwell Publishing Ltd. pp. 267-290.
- Pearcy, W.G. and Fisher, J.P. (1988) Migrations of coho salmon, *Oncorhynchus kisutch*, during their 1st summer in the ocean. *Fish. Bull.*, **86**, 173-195.
- Pearcy, W.G. and Fisher, J.P. (1990) Distribution and abundance of juvenile salmonids off Oregon and Washington, 1981-1985. NOAA Tech. Rep. NMFS. 83pp.
- Pearcy, W.G. (1992) *Ocean ecology of North Pacific salmonids*. Washington Sea Grant Program, University of Washington Press, Seattle, WA, 179pp.
- Pearcy, W.G. and McKinnell, S.M. (2007) The ocean ecology of salmon in the northeast Pacific Ocean - an abridged history. *Am. Fish. Soc. Symp.*, **57**, 7-30.
- Peterman, R.M. and Dorner, B. (2011) Fraser River sockeye production dynamics. Vancouver, B.C., Cohen Commission. Tech. Rep. 10. 134pp.
- Peterson, W.T. and Keister, J.E. (2003) Interannual variability in copepod community composition at a coastal station in the northern California Current: a multivariate approach. *Deep-Sea Res, Part II*, **50**, 2499-2517.
- Peterson, W.T. and Schwing, F.B. (2003) A new climate regime in northeast pacific ecosystems. *Geophys. Res. Lett.*, **30**.
- Peterson, W.T. and Hooff, R.C. (2005) Long term variations in hydrography and zooplankton in coastal waters of the northern California Current off Newport Oregon, In Proceedings of International Symposium on Long-term variations in the Coastal Environments and Ecosystems. 27-28 September 2004, Matsuyama, Japan, pp. 36-44.
- Peterson, W.T., Morgan, C.A., Fisher, J.P. and Casillas, E. (2010) Ocean distribution and habitat associations of yearling coho (*Oncorhynchus kisutch*) and Chinook (*O. tshawytscha*) salmon in the northern California Current. *Fish. Oceanogr.*, **19**, 508-525.
- Peterson, W.T., Morgan, C.A. and Fisher, J.P. (In prep) Habitat characteristics of sub-yearling Chinook salmon during their first summer at sea in continental shelf waters off Washington and Oregon U.S.A.
- Petric, M., Mladineo, I. and Sifner, S.K. (2011) Insight into the short-finned squid *Illex coindetii* (Cephalopoda: Ommastrephidae) feeding ecology: is there a link between helminth parasites and food composition? *J. Parasitol.*, **97**, 55-62.
- Pool, S., Reese, D. and Brodeur, R. (2012) Defining marine habitat of juvenile Chinook salmon, *Oncorhynchus tshawytscha*, and coho salmon, *O. kisutch*, in the northern California Current System. *Environ. Biol. Fishes*, **93**, 233-243.

- Porter, A.D., Welch, D.W., Rechisky, E.L., Jacobs, M.C., Lydersen, H., Winchell, P.M., Kroeker, D.W., Neaga, L., Robb, J.D. and Muirhead, Y.K. (2010a) 2006-09 Multiyear Summary & Key Findings from the Pilot-Stage Acoustic Telemetry Study on Hydrosystem and Early Ocean Survival of Columbia River Salmon. . Fish & Wildlife (ed.) Portland, Oregon: Report to the Bonneville Power Administration by Kintama Research Corporation. p. 46 pages.
- Porter, A.D., Welch, D.W., Rechisky, E.L., Jacobs, M.C., Lydersen, H., Winchell, P.M., Kroeker, D.W., Neaga, L., Robb, J.D. and Muirhead, Y.K. (2010b) Marine and freshwater measurement of delayed and differential-delayed mortality of Snake River spring Chinook smolts using a continental-scale acoustic telemetry array, 2009. Report to the Bonneville Power Administration by Kintama Research Corporation, Contract No. 46389, Project No. 2003-114-00. 361 pages.pp.
- Porter, A.D., Welch, D.W., Rechisky, E.L., Challenger, W.O., Scott, M.C.J., Lydersen, H., Winchell, P.M., Neaga, L., Robb, J.D. and Muirhead, Y.K. (2011) Marine and freshwater measurement of delayed and differential-delayed mortality of Columbia & Snake River yearling Chinook smolts using a continental-scale acoustic-telemetry array, 2010. Portland, Oregon: Report to the Bonneville Power Administration by Kintama Research Services Ltd., Contract No. 46389, Project No. 2003-114-00. p. 492 pp.
- Post, D.M., Layman, C.A., Arrington, D.A., Takimoto, G., Quattrochi, J. and Montana, C.G. (2007) Getting to the fat of the matter: models, methods and assumptions for dealing with lipids in stable isotope analyses. *Oecologia*, **152**, 179-189.
- Quinn, T.P., Vollestad, L.A., Peterson, J. and Galluci, V. (2004) Influence of freshwater and marine growth on egg size-egg number tradeoffs in coho and Chinook salmon. *Trans. Am. Fish. Soc.*, **133**, 55-65.
- Rand, P.S., B., B., Bidlack, A., Bottom, D.L., Gardner, J., Kaeriyama, M., Lincoln, R., Nagata, M., Pearsons, T., Schmidt, M., Smoker, W., Weitkamp, L.A. and Zhivotovsky, L.A. (In press) Ecological interactions between wild and hatchery salmon and key recommendations for research and management actions in selected regions of the North Pacific. *Environ. Biol. Fishes*.
- Rechisky, E.L., Welch, D.W., Porter, A.D., Jacobs, M.C. and Ladouceur, A. (2009) Experimental measurement of hydrosystem-induced delayed mortality in juvenile Snake River spring Chinook salmon (*Oncorhynchus tshawytscha*) using a large-scale acoustic array. *Can. J. Fish. Aquat. Sci.*, **66**, 1019-1024.
- Rechisky, E.L., Welch, D.W. and Porter, A.D. (Submitted) A test of the Differential-delayed mortality theory that transportation reduces survival of Snake River Spring Chinook. *Nat. Commun.*
- Reese, D.C. and Brodeur, R.D. (2006) Identifying and characterizing biological hotspots in the northern California Current. *Deep-Sea Res, Part II*, **53**, 291-314.
- Ruggerone, G.T. and Rogers, D.E. (1993) Predation on sockeye salmon fry by juvenile coho salmon in the Chignik Lakes, Alaska: implications for salmon management. *N. Am. J. Fish. Manage.*, **12**, 87-102.

- Ruggerone, G.T. and Nielsen, J.L. (2004) Evidence for competitive dominance of Pink salmon (*Oncorhynchus gorbuscha*) over other Salmonids in the North Pacific Ocean. *Rev. Fish Biol. Fish.*, **14**, 371-390.
- Ruggerone, G.T., Peterman, R.M., Dorner, B. and Myers, K.W. (2010) Magnitude and trends in abundance of hatchery and wild pink salmon, chum salmon, and sockeye salmon in the North Pacific Ocean. *Mar. Coast. Fish.*, **2**, 306-328.
- Rupp, D.E., Wainwright, T.C., Lawson, P.W. and Peterson, W.T. (2011) Marine environment-based forecasting of coho salmon (*Oncorhynchus kisutch*) adult recruitment. *Fish. Oceanogr.*, **21**(1), 1-19.
- Ruzicka, J.J., Brodeur, R.D. and Wainwright, T.C. (2007) Seasonal food web models for the oregon inner-shelf ecosystem: Investigating the role of large jellyfish. *CALCOFI Rep*, **48**, 106-128.
- Ruzicka, J.J., Wainwright, T.C. and Peterson, W.T. (2011) A model-based meso-zooplankton production index and its relation to the ocean survival of juvenile coho (*Oncorhynchus kisutch*). *Fish. Oceanogr.*, **20**, 544-559.
- Scheuerell, M.D. and Williams, J.G. (2005) Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). *Fish. Oceanogr.*, **14**, 448-457.
- Schindler, D.E., Hilborn, R., Chasco, B., Boatright, C.P., Quinn, T.P., Rogers, L.A. and Webster, M.S. (2010) Population diversity and the portfolio effect in an exploited species. *Nature*, **465**, 609-612.
- Seeb, L.W., Antonovich, A., Banks, A.A., Beacham, T.D., Bellinger, A.R., Blankenship, S.M., Campbell, A.R., Decovich, N.A., Garza, J.C., Guthrie, C.M., III, Lundrigan, T.A., Moran, P., Narum, S.R., Stephenson, J.J., Supernault, K.J., Teel, D.J., Templin, W.D., Wenburg, J.K., Young, S.E. and Smith, C.T. (2007) Development of a standardized DNA database for Chinook salmon. *Fisheries*, **32**, 540-552.
- Shaul, L., Weitkamp, L.A., Simpson, K. and Sawada, J. (2007) Trends in abundance and size of coho salmon in the Pacific Rim. *N. Pac. Anadrom. Fish Comm. Bull.*, **4**, 93-104.
- Smith, E.P., Orvos, D.R. and Cairns, J. (1993) Impact assessment using the before-after-control-impact (BACI) model: concerns and comments. *Can. J. Fish. Aquat. Sci.*, **50**, 627-637.
- Steele, C., Ackerman, M., McCane, J., Cambell, M., Hess, M., Cambell, N. and Narum, S. (2011) Parentage Based Tagging of Snake River Hatchery Steelhead and Chinook salmon. Annual Report of research to Bonneville Power Administration, contract No. 4838, Project No. 2010-031-00. Available at <http://efw.bpa.gov/searchpublications/>.
- Stocking, R.W., Holt, R.A., Foott, J.S. and Bartholomew, J.L. (2006) Spatial and Temporal Occurrence of the Salmonid Parasite *Ceratomyxa shasta* in the Oregon-California Klamath River Basin. *J. Aquat. Anim. Health*, **18**:3, 194-202.

- Teel, D.J., Van Doornik, D.M., Kuligowski, D.R. and Grant, W.S. (2003) Genetic analysis of juvenile coho salmon (*Oncorhynchus kisutch*) off Oregon and Washington reveals few Columbia River wild fish. *Fish. Bull.*, **101**, 640-652.
- Teel, D.J. (2004) Genetic mixed stock analysis of juvenile Chinook salmon in coastal areas of western North America. N. Pac. Anadrom. Fish Comm, Tech. Rep. 47-48pp.
- Tomaro, L.T., Teel, D.J., Peterson, W.T. and Miller, J.A. (In revision) Early marine residence of Columbia river spring Chinook salmon: when is bigger better? *Mar. Ecol. Prog. Ser.*
- Trudel, M., Tucker, S., Zamon, J.E., Morris, J., Higgs, D.A. and D.W. Welch, D. (2002) Bioenergetic response of coho salmon to climate change. N. Pac. Anadrom. Fish Comm, Tech. Rep. 59-61pp.
- Trudel, M., Welch, D.W., Morris, J.F.T., Candy, J.R. and Beacham, T.D. (2004) Using Genetic Markers to Understand the Coastal Migration of Juvenile Coho (*Oncorhynchus kisutch*) and Chinook Salmon (*O. tshawytscha*). N. Pac. Anadrom. Fish. Comm., Tech Rep, 5. 52-54pp.
- Trudel, M., Jones, S.R.M., Thiess, M.E., Morris, J.F.T., Welch, D.W., Sweeting, R.M., Moss, J.H., Wing, B.L., Farley, E.V., Jr., Murphy, J.M., Baldwin, R.E. and Jacobson, K.C. (2007a) Infestations of motile salmon lice (*Lepeophtheirus salmonis*) on Pacific salmon along the west coast of North America. In: *The ecology of juvenile salmon in the northeast Pacific Ocean: regional comparisons*. C.B. Grimes, R.D. Brodeur, L.J. Haldorson and S.M. McKinnell (eds). American Fisheries Society, Symposium 57, Bethesda, MD. pp. 157-182.
- Trudel, M., Thiess, M.E., Bucher, C., Farley, E.V., Jr., MacFarlane, R.B., Casillas, E., Fisher, J., Morris, J.F.T. and Murphy, J.M. (2007b) Regional variation in the marine growth and energy accumulation of juvenile Chinook salmon and coho salmon along the west coast of North America. In: *The ecology of juvenile salmon in the northeast Pacific Ocean: regional comparisons*. C.B. Grimes, R.D. Brodeur, L.J. Haldorson and S.M. McKinnell (eds). American Fisheries Society, Symposium 57, Bethesda, MD. pp. 205-232.
- Trudel, M., Thiess, M.E., Morris, J.F.T., Candy, J.R., Beacham, T.D., Higgs, D.A. and Welch, D.W. (2007c) Overwinter mortality and energy depletion in juvenile Pacific salmon off the west coast of British Columbia and Alaska. *N. Pac. Anadrom. Fish Comm. Tech. Rep.*, **7**, 61-63.
- Trudel, M., Fisher, J.P., Orsi, J.A., Morris, J.F.T., Thiess, M.E., Sweeting, R.M., Fergusson, A. and Welch, D.W. (2009) Distribution and migration of juvenile Chinook salmon derived from coded wire tag recoveries along the continental shelf of western North America. *Trans. Am. Fish. Soc.*, **138**, 1369-1391.
- Trudel, M., Tucker, S. and Candy, J.R. (2010) Ocean distribution of two depressed stocks of sockeye salmon stocks. Canadian Science Advisory Research Document 2010/053. 94-95pp.
- Trudel, M., Thiess, M.E., Morris, J.F.T., Zubkowski, T. and Mackas, D.L. (2011a) Canada-USA Salmon Shelf Survival Study. Annual Report submitted to the Bonneville Power Administration. 117pp.

- Trudel, M., Thiess, M.E., Tucker, S., Zubkowski, T., Jung, Y. and Baillie, S. (2011b) Reduced caches of juvenile salmon off WCVI in 2010 relative to 2009, but improved growth. Canadian Science Advisory Research Document 2010/054. 72-75pp.
- Tucker, S., Trudel, M., Welch, D.W., Candy, J.R., Morris, J.F.T., Thiess, M.E., Wallace, C., Teel, D.J., Crawford, W., Farley, E.V. and Beacham, T.D. (2009) Seasonal Stock-Specific Migrations of Juvenile Sockeye Salmon along the West Coast of North America: Implications for Growth. *Trans. Am. Fish. Soc.*, **138**, 1458-1480.
- Tucker, S., Trudel, M., Welch, D.W., Morris, J.F.T., Candy, J.R., Wallace, C. and Beacham, T.D. (2011) Life-history and seasonal stock-specific ocean migration of juvenile Chinook salmon. *Trans. Am. Fish. Soc.*, **140**, 1101-1119.
- Tucker, S., Trudel, M., Welch, D.W., Candy, J.R., Morris, J.F.T., Thiess, M.E., Wallace, C. and Beacham, T.D. (In press) Annual coastal migration of juvenile Chinook salmon; static stock-specific patterns in a highly dynamic ocean. *Mar. Ecol. Prog. Ser.*
- Tuomikoski, J., McCann, J., Berggren, T., Schaller, H., Wilson, P., Haeseker, S., Petrosky, C.E., Tinus, E., Dalton, T., Ehlke, R. and DeHart, M. (2009) Comparative Survival Study (CSS) of PIT-tagged Spring/Summer Chinook and Summer Steelhead-2009 Annual Report: Portland, Oregon, Fish Passage Center. 265pp.
- Valtonen, E.T., Marcogliese, D.J. and Julkunen, M. (2010) Vertebrate diets derived from trophically transmitted fish parasites in the Bothnian Bay. *Oecologia*, **162**, 139-152.
- Van Doornik, D.M., Teel, D.J., Kuligowski, D.R., Morgan, C.A. and Casillas, E. (2007) Genetic analyses provide Insight into the early ocean stock distribution and survival of juvenile coho salmon off the coasts of Washington and Oregon. *N. Am. J. Fish. Manage.*, **27**, 220-237.
- Walters, C.J. (1987) Nonstationarity of production relationships in exploited populations. *Can. J. Fish. Aquat. Sci.*, **44(Suppl. 2)**, 156-165.
- Ward, B.R. (2000) Declivity in steelhead (*Oncorhynchus mykiss*) recruitment at the Keogh River over the past decade. *Can. J. Fish. Aquat. Sci.*, **57**, 298-306.
- Ward, D.L., Boyce, R.R., Young, F.R. and Olney, F.E. (1997) A review and assessment of transportation studies for juvenile Chinook salmon in the Snake River. *N. Am. J. Fish. Manage.*, **17**, 652-662.
- Ware, D.M. and McFarlane, G.A. (1989) Fisheries production domains in the Northeast Pacific Ocean. In: *Effects of ocean variability on recruitment and an evaluation of parameters used in stock assessment models*. R.J. Beamish and G.A. McFarlane (eds). Canadian Special Publications of Fisheries and Aquatic Sciences, 108. pp. 359-379.
- Ware, D.M. and Thomson, R.E. (2005) Bottom-up ecosystem trophic dynamics determine fish production in the northeast Pacific. *Science*, **308**, 1280-1284.

- Welch, D.W., Ishida, Y. and Nagasawa, K. (1998) Thermal limits and ocean migrations of sockeye salmon (*Oncorhynchus nerka*): long-term consequences of global warming (vol 55, pg 937, 1998). *Can. J. Fish. Aquat. Sci.*, **55**, 1996-1996.
- Welch, D.W., Ward, B.R., Smith, B.D. and Eveson, J.P. (2000) Temporal and spatial responses of British Columbia steelhead (*Oncorhynchus mykiss*) populations to ocean climate shifts. *Fish. Oceanogr.*, **9**, 17-32.
- Willette, T.M., T., C.R., Patrick, V., Mason, D.M., Thomas, G.L. and Scheel, D. (2001) Ecological processes influencing mortality of juvenile pink salmon (*Oncorhynchus gorbuscha*) in Prince William Sound, Alaska. *Fish. Oceanogr.*, **10(suppl 1)**, 14-41.
- Williams, J.G., Smith, S.G., Zabel, R.W., Muir, W.D., Scheuerell, M.D., Sandford, B.P., Marsh, D.M., McNatt, R.A. and Achord, S. (2005) Effects of the federal Columbia River power system on salmonid populations. *NOAA Technical Memorandum NMFS-NWFSC*, **63**.
- Zamon, J.E., Phillips, E.M. and Guy, T.J. (Submitted) Marine bird aggregation at tidally-driven plume fronts of the Columbia River. *Deep Sea Res (Part II, Top.Stud. Oceanogr., Fronts, Fish, and Top Predators)*.

Appendices

**This document contains appendices (A - J) that contain supplementary materials
referred to in the report:**

The Marine Ecology of Juvenile Columbia River Basin Salmonids: A Synthesis of Research 1998-2011

Kym Jacobson, Bill Peterson, Marc Trudel, John Ferguson, Cheryl Morgan,
David Welch, Antonio Baptista, Brian Beckman, Richard Brodeur, Edmundo Casillas,
Robert Emmett, Jessica Miller, David Teel, Thomas Wainwright, Laurie Weitkamp,
Jeannette Zamon and Kurt Fresh

Report of the U.S. National Marine Fisheries Service,
National Oceanic and Atmospheric Administration
Fisheries and Oceans Canada
Kintama Research Services, Ltd.
and Oregon State University

to

Northwest Power and Conservation Council
851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204

January 2012

Table of Contents

Appendix A. Region, periods, and metrics covered by NOAA and DFO ocean projects.....	1
Appendix B. Joint Publications	2
Appendix C. Technical feasibility of using acoustic telemetry for assessing the mortality and migration of Spring Chinook salmon	4
Appendix D. Smolt-to-Adult Return Indices.....	7
Appendix E. Basin-Wide Hatchery Chinook Releases, 1998 - 2009	9
Appendix F. Comparison with other telemetry systems.....	10
Appendix G. Ocean conditions off the west coast of Vancouver Island	11
Appendix H. NOAA's response to ISRP comments on the <i>Ocean Survival of Salmonids Study</i>	13
Appendix I. DFO's response to ISRP comments on the Canada-USA <i>Salmon Shelf Survival Study</i>	34
Appendix J. Kintama's response to ISRP comments on the <i>Coastal Ocean And Salmon Tracking Study</i>	49
References.....	64

Appendix A. Region, periods, and metrics covered by NOAA and DFO ocean projects

Feature	NOAA	DFO
Geographic area	45-48°N (Columbia River Estuary and Plume, Oregon and Washington Coasts)	48-56°N (West coast of Vancouver Island to Southeast Alaska, including inlets and straits)
Years	1998-2011	1998-2011
Sampling Period	May June September --	-- June-July October-November February-March
Oceanography		
- T, S, D, pH, O ₂ , Trans, Fluoro	CTD @ 0-200m	CTD @ 0-250m
- Nutrients	Niskin Bottle @ 3m	Niskin Bottle @ 10m
- Chlorophyll	Niskin Bottle @ 3m	Niskin Bottle @ 10m
- Zooplankton	Bongo net @ 20-30m Vertical net @ 0-100m	Bongo net @ 0-150m
Trawl		
- Manufacturer	Nordic 264	Cantrawl
- Dimension	30 m wide x 20 m high	30 m wide x 12 m high
- Tow speed	4 knots (~7.4 km/h)	5 knots (~9.3 km/h)
- Tow duration	30 min	30 min
Stock ID Baseline		
- Chinook*	GAPS ¹	DFO ⁴
- Coho	NOAA ²	DFO ⁵
- Sockeye	NOAA ³	DFO ⁶
Diet	Stomachs, Stable Isotopes, Fatty Acids, Parasites	Stomachs, Stable Isotopes, Fatty Acids
Growth	Otolith microstructure IGF-1	IGF (since 2007 in collaboration with NOAA Fisheries), Size-based
Food consumption rates	--	Mass balance model of inert chemical tracers
Modeling	Linear/non-linear regressions PATH Analyses Structural Equation Modeling Bayesian Beliefs Network Green-Yellow-Red light traffic system	Linear/non-linear regressions PATH Analyses Structural Equation Modeling Bayesian Beliefs Network Green-Yellow-Red light traffic system
Marine Survival	Adult count to Bonneville ⁷ Adult count Lower Granite ⁷ Smolt released above Bonneville ⁷ Smolt count at Lower Granite ⁷ OPI Coho SAR	Adult count to Bonneville ⁷ Adult count Lower Granite ⁷ Smolt released above Bonneville ⁷ Smolt count at Lower Granite ⁷ OPI Coho SAR

* The microsatellite DNA baselines used by NOAA and DFO provide similar allocation at the ESU level (Hanson et al., 2010; S. Tucker, unpublished). References: ¹(Seeb et al., 2007); ²(Van Doornik et al., 2007); ³(Iwamoto et al., In press); ⁴(Beacham et al., 2006b); ⁵(Beacham et al., In press); ⁶(Beacham et al., 2011); ⁷See Appendices B

Appendix B. Joint Publications

2004

Mackas, D.L., Peterson, W.T., and Zamon, J.E. 2004. Comparisons of interannual biomass anomalies of zooplankton communities along the continental shelf margins of British Columbia and Oregon. *Deep-Sea Res. II* 51: 875-896.

2006

Brodeur, R.D., Ralston, S., Emmett, R.L., Trudel, M., Auth, T.D., and Phillips, A.J. 2006. Recent trends and anomalies in pelagic nekton abundance, distribution, and apparent recruitment in the Northeast Pacific Ocean. *Geophys. Res. Lett.*
Doi:10.1029/2006GL026614.

2007

Trudel, M., Thiess, M.E., Bucher, C., Farley, E.V., Jr., MacFarlane, B., Casillas, E., Fisher, J., Morris, J.F.T., Murphy, J.M., and Welch, D.W. 2007. Regional variation in the marine growth and energy accumulation of juvenile Chinook salmon and coho salmon along the west coast of North America. *Am. Fish. Soc. Symp. Ser.* 57: 205-232.

Brodeur, R.D., Daly, E.A., Studervant, M.V., Miller, T.W., Moss, J.H., Thiess, M., Trudel, M., Weitkamp, L.A., Armstrong, J., and Norton, E.C. 2007. Regional comparisons of juvenile salmon feeding in coastal marine waters off the West Coast of North America. *Am. Fish. Soc. Symp. Ser.* 57: 183-203.

Trudel, M., Jones, S.R.M., Thiess, M.E., Morris, J.F.T., Welch, D.W., Sweeting, R.M., Moss, J.H., Wing, B.L., Farley, E.V., Jr., Murphy, J.M., Baldwin, R.E., and Jacobson, K.C. 2007. Infestations of motile salmon lice on Pacific salmon along the west coast of North America. *Am. Fish. Soc. Symp. Ser.* 57: 157-182.

Orsi, J.A., Harding, J.A., Pool, S.S., Brodeur, R.D., Haldorson, L.J., Murphy, J.M., Moss, J.H., Farley, E.V., Jr., Sweeting, R.M., Morris, J.F.T., Trudel, M., Beamish, R.J., Emmett, R.L., and Fergusson, E.A. 2007. Epipelagic fish assemblages associated with juvenile Pacific salmon in neritic waters of the California Current and Alaska Current. *Am. Fish. Soc. Symp. Ser.* 57: 105-155.

Morris, J.F.T., Trudel, M., Thiess, M., Sweeting, R.M., Fisher, J., Hinton, S., Ferguson, E.A., Orsi, J.A., Farley, E.V., Jr., and Welch, D.W. 2007. Stock-specific migrations of juvenile coho salmon derived from coded-wire tag recoveries on the continental shelf of western North America. *Am. Fish. Soc. Symp. Ser.* 57: 81-104.

Fisher, J., Trudel, M., Ammann, A., Orsi, J., Piccolo, J., Bucher, C., Harding, J., Casillas, E., MacFarlane, B., Brodeur, R., Morris, J., and Welch, D. 2007. Regional comparisons of distribution and abundance of juvenile salmon along the West Coast of North America. *Am. Fish. Soc. Symp. Ser.* 57: 31-80.

2009

Trudel, M., Fisher, J., Orsi, J., Morris, J.F.T., Thiess, M.E., Sweeting, R.M., Hinton, S., Fergusson, E., and Welch, D.W. 2009. Distribution and migration of juvenile Chinook salmon derived from coded-wire tag recoveries along the continental shelf of western North America. *Trans. Am. Fish. Soc.* 138: 1369-1391.

Tucker, S., Trudel, M., Welch, D.W., Candy, J.R., Morris, J.F.T., Thiess, M.E., Wallace, C., Teel, D.J., Crawford, W., Farley, E.V. Jr., and Beacham, T.D. 2009. Seasonal stock-specific migrations of juvenile sockeye salmon along the west coast of North America: Implications for growth. *Trans. Am. Fish. Soc.* 138: 1458-1480.

2010

Nance, S.L., Riederer, M.m Zubkowski, T., Trudel, M., and Rhodes, L.D. 2010. Interpreting dual ELISA and qPCR data for bacterial and kidney disease of salmonids. *Dis. Aquat. Org.* 91: 113-119.

Accepted with Revisions

Fisher, J.P., S.A. Hinton, D.J. Teel, M. Trudel, L. Weitkamp, J.F.T. Morris, M.E. Thiess, R.M. Sweeting, J.A. Orsi, and E.V. Farley, Jr. Patterns of early ocean dispersal and growth among Columbia River Chinook and coho salmon stock groups. *Trans. Am. Fish. Soc.* (submitted in June 2011).

In prep

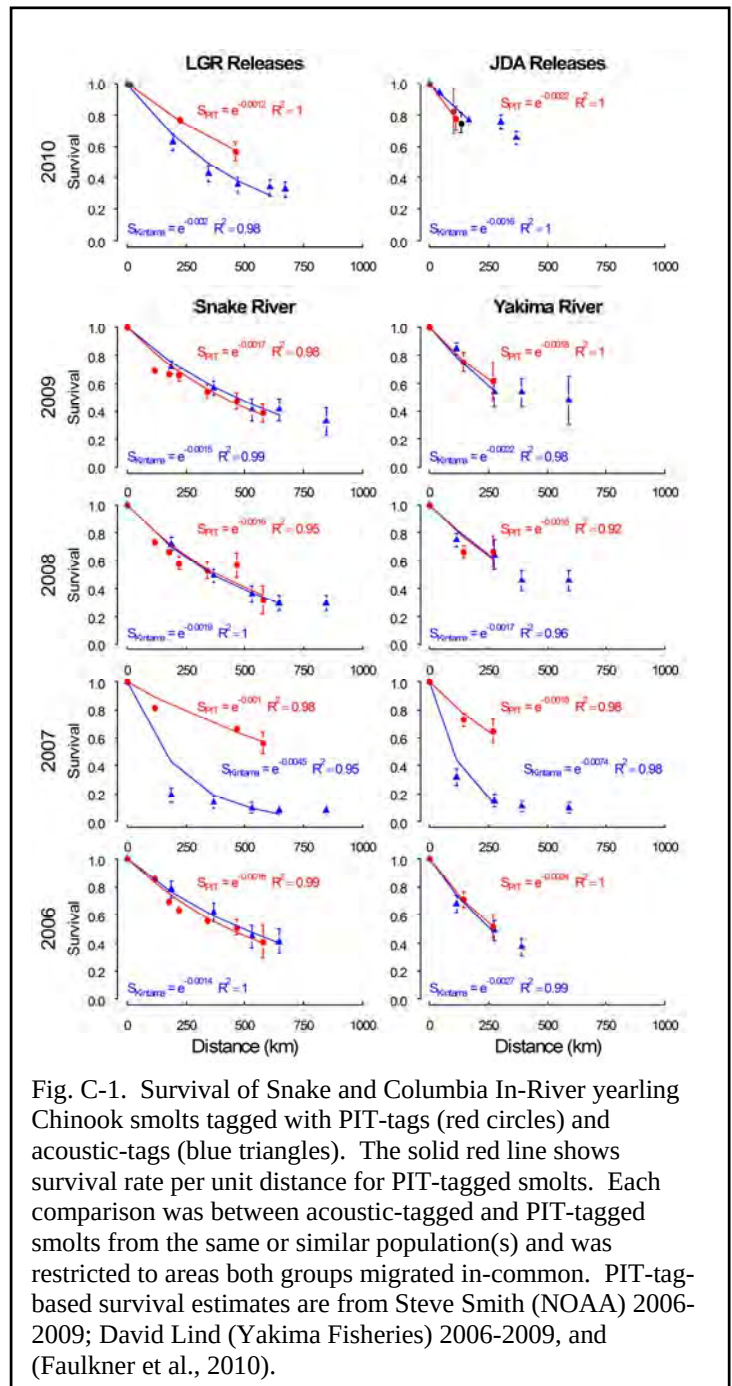
Morgan, C.A., W. T. Peterson, M.V. Sturdevant, J.A. Keister, M. Galbraith, J.F. Lamb, D.L. Mackas, J.A. Orsi, M.E. Thiess, M. Trudel, B.L. Wing, and D.W. Welch. Latitudinal comparisons of copepod community composition in the Northern California Current and S. Gulf of Alaska during years of varying ocean conditions. *Mar. Ecol. Prog. Ser.*

Appendix C. Technical feasibility of using acoustic telemetry for assessing the mortality and migration of Spring Chinook salmon

1. Accuracy of Survival Estimates

The use of a telemetry system critically hinges on whether the data is credible; if post-release survival is compromised by surgical tagging procedures or if the implanted tag is too big, then survival may be reduced relative to untagged smolts. Alternatively, if larger smolts have different (higher) survival rates, the results for larger “taggable” smolts may be inaccurate for the entire population. Detailed assessment of the accuracy and precision of the telemetry-based survival estimates are reported in (Porter et al., 2011); we report here just the key biological findings.

The statistical experiments reported in document rely on comparing the relative proportion of two groups (Treatment and Control) that are detected after release, and an absolute estimate of survival is not in principle necessary. However, in practice having highly accurate data is desirable. To assess these questions we examined the relative survival of acoustic tagged smolts with independent releases of PIT-tagged smolts (Figure C-1). In 2006 and 2008-09 PIT and acoustic tagged smolts had indistinguishable survival rates with distance (see also Rechisky & Welch, 2010), while in 2007 (a year when smolts were repeatedly drugged and handled to find sufficient individuals meeting the size criteria), acoustic tagged smolt survivals differed from that of PIT-tagged spring Chinook. In 2010, when tagging was moved to the dams and smolts were handled and anaesthetized in



the bypass collection systems before being provided to Kintama for repeat anesthesia and surgical implantation, some reduction in survival relative to PIT tags is again evident, suggesting handling stress contributed to reducing survival after release. These results are consistent with previous findings on handling-related stress for BC smolts (Welch et al., 2004), and indicate that when smolt handling can be minimized, survival estimates are accurate (unbiased).

2. Size-dependent effects of acoustic tagging

The second biological consideration is whether smolts of different sizes survive at different rates, because larger smolts may either be better able to avoid predators or because the implanted tag is a smaller burden. Figure C-2 compares the size at release of tagged smolts and the size at release of the smolts surviving to reach the Willapa Bay sub-array ca. one month later. No distortion is seen in the mean, variance, or higher order moments of the two size distributions, as shown by the QQ plots (Porter et al., 2011), so tagging did not distort survival characteristics, at least for the size range of smolts tagged ($FL \geq 14$ cm in 2006; $FL \geq 13$ cm in 2008-11).

3. Cross-shelf distribution of tagged smolts

If smolts permanently emigrate off-shelf after entering the ocean until adult return then survival estimates using a shelf-based array will be biased low, because progressive disappearance of smolts as they migrate north will reflect both off-shelf emigration and along-shelf mortality. On the other hand, if off-shelf emigration is only temporary and smolts simply move north in a migration extending further offshore than the sub-arrays, survival estimates will be unaffected because the degradation of the sub-array detection efficiency will be identified at the subsequent sub-array smolts encounter and survival estimates will be adjusted upwards to reflect this degradation when analysis is done within a CJS framework. (This statement assumes that the smolt's off-shelf movements are random and that they migrate back far enough inshore to be detected by subsequent sub-arrays; smolts that migrate on-shelf but consistently offshore of all array elements will be classed as permanent emigrants).

To date, our results (Figure C-3) indicate that off Willapa Bay the smolt distribution extends farther offshore than our array extends (≤ 200 m in 2006, ≤ 280 m bottom depths in 2008-10; ≤ 500 m in 2011) indicating a more extensive offshore distribution in this region of the shelf than either the NOAA or CDFO surveys have documented. However, both the NOAA and CDFO trawl surveys and the acoustic tagged smolt distribution at Lippy Point (NWVI; Figure C-3) indicate that north of

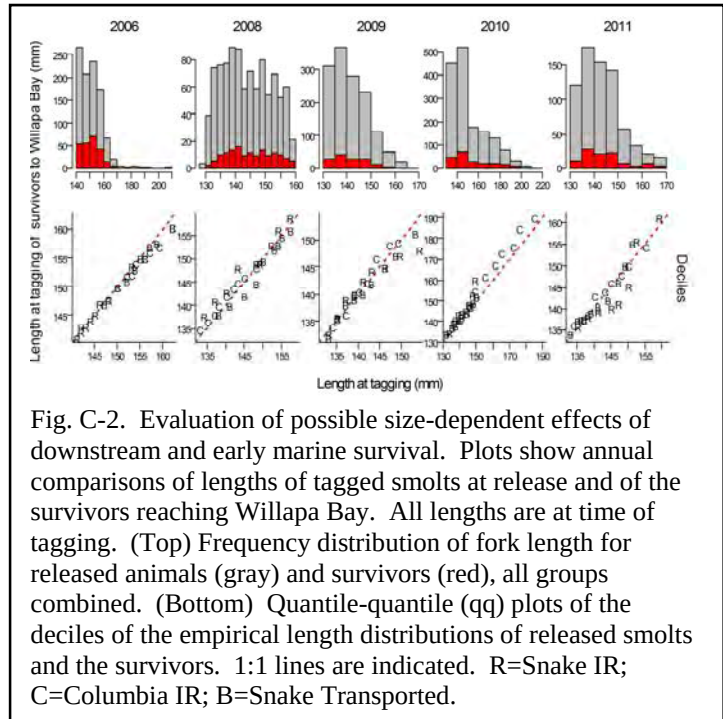
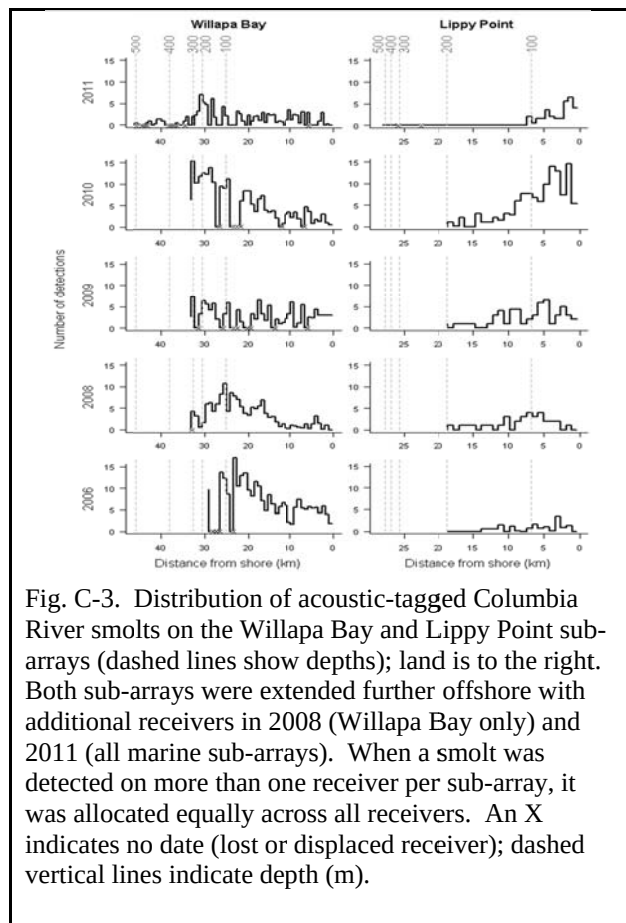


Fig. C-2. Evaluation of possible size-dependent effects of downstream and early marine survival. Plots show annual comparisons of lengths of tagged smolts at release and of the survivors reaching Willapa Bay. All lengths are at time of tagging. (Top) Frequency distribution of fork length for released animals (gray) and survivors (red), all groups combined. (Bottom) Quantile-quantile (qq) plots of the deciles of the empirical length distributions of released smolts and the survivors. 1:1 lines are indicated. R=Snake IR; C=Columbia IR; B=Snake Transported.

Willapa Bay the distribution is clearly shelf-bound. Additional analysis using NOAA catches of Chinook smolts off SE Alaska indicates that the Chinook distribution also remains strongly shelf-bound here as well (Porter et al., 2011). As a result, it seems likely that smolts may move farther offshore in the Columbia River plume before turning north after exiting the river; the location of the Willapa Bay sub-array just 40 km to the north of the Columbia River mouth and at the head of a significant submarine canyon also means that the shelf extends farther offshore both north and south of the sub-array (See Porter et al., 2011 for further discussion). An additional piece of evidence, (not available when the Porter et al., 2011 was prepared) is that in 2011 the extended Willapa Bay sub-array had a ca. 75% detection efficiency based on the proportion of smolts detected at Lippy Point; this estimate of detection efficiency for V7-tagged smolts is almost identical to estimates made for BC-tagged smolts exiting over the northern Strait of Georgia where the migration path is bounded on both sides by land. In summary, the available evidence indicates that Chinook smolts remain shelf-bound and that the numerical decrease in smolt numbers as the migration progresses reflect mortality processes and not off-shelf emigration. This conclusion is, however, important to continue to evaluate because one of the key findings from the telemetry array work is that mortality rates are closely similar in the hydrosystem and the coastal ocean.

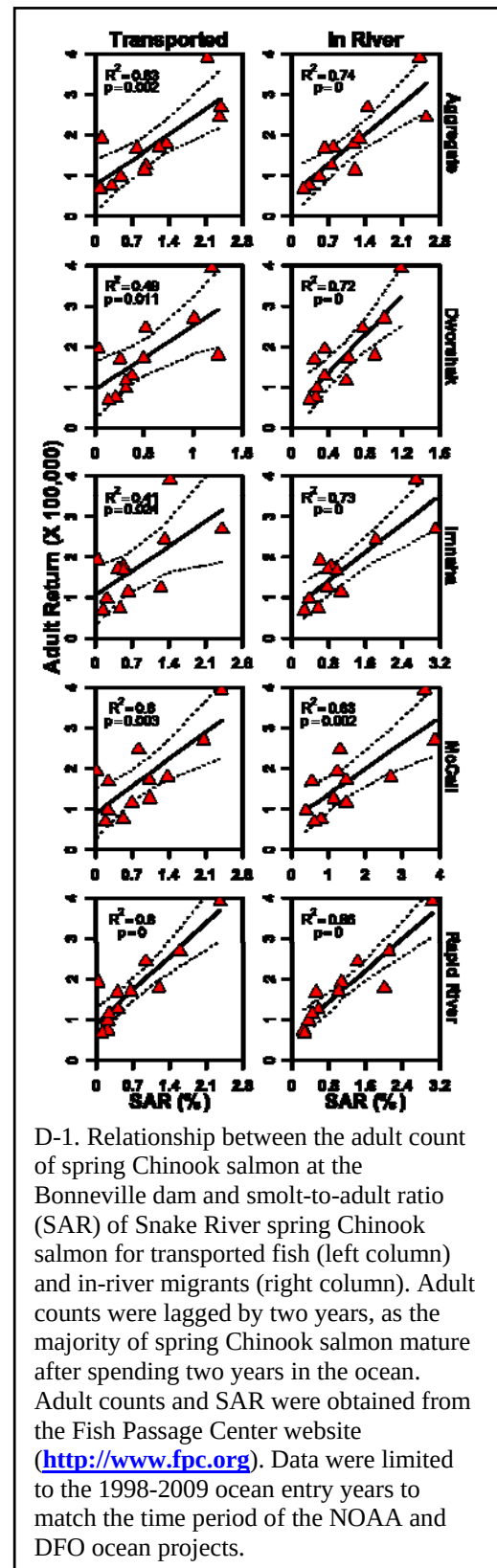


Appendix D. Smolt-to-Adult Return Indices

To examine the response of Columbia River salmon to changes in ocean conditions, it is necessary to use an appropriate response variable for Columbia River salmon. The marine survival of yearling Chinook salmon derived by Kintama using acoustic tags is likely the most promising response variable that could be integrated with the ocean conditions measured by the NOAA and DFO studies and used to evaluate the effects of ocean conditions on Columbia River salmon. However, the Kintama time series is currently too short to derive any meaningful relationships between survival and ocean conditions. An alternative would be to use smolt-to-adult returns (SAR) as a response variable. However, they are available for a limited number of stocks. Furthermore, to get a representative sample of each of these stocks in the marine environment, sampling effort would need to be increased considerably and the DNA baselines currently used by NOAA and DFO would need to be extended to include all the stocks of salmon within the Columbia River basin. Both of these strategies would incur significant costs to the ocean project.

As a result, the NOAA and DFO studies have attempted to use holistic response variables for Columbia River salmon in their ocean projects to reflect the common response of the majority of the Columbia River salmon stocks. Two indices of Columbia River salmon production are currently used by these ocean projects: 1) adult counts to Bonneville dam, and 2) a Bonneville-Bonneville survival index.

Adult counts at Bonneville dam are lagged by 1-3 years to reflect the time it takes for a smolt¹ to become adult. Because the Columbia River salmon fishery has been severely curtailed during the last 10-20 years to allow the recovery of ESA listed stocks, adult counts are expected to be a reasonable indicator of salmon production in the Columbia River during

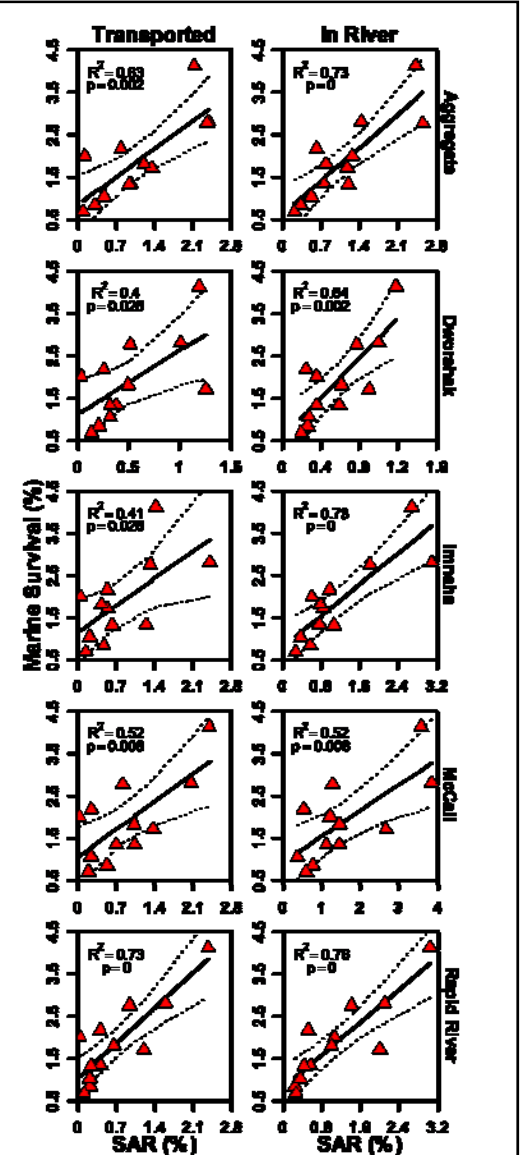


D-1. Relationship between the adult count of spring Chinook salmon at the Bonneville dam and smolt-to-adult ratio (SAR) of Snake River spring Chinook salmon for transported fish (left column) and in-river migrants (right column). Adult counts were lagged by two years, as the majority of spring Chinook salmon mature after spending two years in the ocean. Adult counts and SAR were obtained from the Fish Passage Center website (<http://www.fpc.org>). Data were limited to the 1998-2009 ocean entry years to match the time period of the NOAA and DFO ocean projects.

¹ Lag differs among species: 1 year for coho, 2 years for sockeye and spring Chinook, and 2-3 years for fall Chinook

the time frame of the NOAA and DFO studies (1998 to present). To evaluate the performance of this indicator, we correlated the count of spring Chinook salmon at the Bonneville Dam with Snake River spring Chinook salmon SAR for both transported fish and in river migrants. Adult return correlated positively and significantly with all the SAR values (Figure D-1), suggesting that adult count at Bonneville dam is a reasonable holistic indicator for the production of Columbia River salmon.

A Bonneville-Bonneville survival index has also been derived by dividing adult counts to Bonneville dam by the number of smolts released by the hatcheries above the Bonneville dam. This index attempts to correct adult counts for variable smolt outputs in the Columbia River. As the 75-95% of the juvenile Columbia River salmon caught in the research surveys conducted by NOAA and DFO are of hatchery origin (Teel et al., 2003, Abdul-Aziz et al., 2011, Litz et al., 2011, Trudel et al., 2011), the number of smolts produced by hatcheries is expected to be a reasonable surrogate for the number of smolts produced within the Columbia River. To evaluate the performance of this indicator, we correlated Bonneville-Bonneville survival index of spring Chinook salmon with Snake River spring Chinook salmon SAR for both transported fish and in river migrants. The Bonneville-Bonneville survival index correlated positively and significantly with all the SAR values (Figure D-2), suggesting that the Bonneville-Bonneville survival index is a reasonable holistic indicator for the production of Columbia River salmon.



D-2. Relationship between the Bonneville-Bonneville survival index (referred to as Marine Survival) for spring Chinook salmon and smolt-to-adult ratio (SAR) of Snake River spring Chinook salmon for transported fish (left column) and in-river migrants (right column). Adult counts were lagged by two years, as the majority of spring Chinook salmon mature after spending two years in the ocean. Adult counts and SAR were obtained from the Fish Passage Center website (<http://www.fpc.org>). Data were limited to the 1998-2009 ocean entry years to match the time period of the NOAA and DFO ocean projects.

Appendix E. Basin-Wide Hatchery Chinook Releases, 1998 - 2009

Number of Chinook salmon smolts released into the Columbia River Basin above the Bonneville Dam between 1998 and 2009. Release data compiled from the Regional Mark Processing Center database (www.rmpc.org). Adult return data obtained from the Columbia River DART website (www.cbr.washington.edu/dart/adult_annual.html).

Release Year	Smolt Releases Above Bonneville Dam	Return Year	Adult Returns to Bonneville Dam	Estimated Marine Survival (%)
Spring Chinook salmon				
1998	10,422,024	2000	178,336	1.71
1999	9,494,912	2001	391,818	4.13
2000	9,584,032	2002	269,428	2.81
2001	9,607,395	2003	195,671	2.04
2002	9,402,576	2004	170,291	1.81
2003	8,763,791	2005	74,052	0.84
2004	9,230,612	2006	96,457	1.04
2005	9,812,051	2007	66,644	0.68
2006	9,393,292	2008	125,582	1.34
2007	8,620,951	2009	114,548	1.33
2008	8,821,245	2010	244,418	2.77
2009	7,698,007	2011	167,146	2.17
Summer Chinook salmon				
1998	3,652,469	2000	30,616	0.84
1999	3,110,214	2001	76,156	2.45
2000	2,703,997	2002	127,436	4.71
2001	4,300,349	2003	114,808	2.67
2002	3,550,929	2004	92,143	2.59
2003	2,980,069	2005	79,208	2.66
2004	3,501,855	2006	97,519	2.78
2005	3,469,099	2007	47,882	1.38
2006	3,914,208	2008	78,271	2.00
2007	2,834,424	2009	81,936	2.89
2008	3,764,044	2010	97,604	2.59
2009	3,267,245	2011	108,279	3.31
Fall Chinook salmon**				
1998	37,995,720	2000	192,815	0.51
1999	32,893,073	2001	400,410	1.22
2000	39,738,186	2002	474,648	1.19
2001	32,232,995	2003	610,336	1.89
2002	37,352,702	2004	583,493	1.56
2003	34,767,456***	2005	417,142	1.20
2004	33,877,257	2006	299,637	0.88
2005	33,381,571	2007	161,550	0.48
2006	31,947,590	2008	315,080	0.99
2007	35,620,573	2009	283,787	0.80
2008	29,826,072	2010	467,732	1.57
2009	31,613,299	2011	401,704*	1.27*

* Incomplete record

** Includes Fall and Late Fall runs.

Includes

Hybrid

runs.

Appendix F. Comparison with other telemetry systems

In the early 2000s, only HTI, LOTEK, and VEMCO acoustic components were available to potentially build large-scale telemetry systems. VEMCO's technology was found to be clearly superior to the other two systems in terms of low per-unit cost, long deployment capability (low current consumption, limiting battery changes), and long tag detection range (& lifespan), and was thus adopted for the transmit & receive components of the POST/COAST array. The receivers were also lower cost than any of the alternatives (and still are), permitting a more extensive telemetry infrastructure to be built for a given cost. The initial trade-off was that the original V9 acoustic tag was larger and could only be implanted into larger smolts (≥ 14 cm). In 2006, however, the smaller V7 tag (which operates on the same frequency as the V9 tag, 69 kHz) became commercially available. This tag can be implanted into smolts ≥ 12.5 cm, and was implemented by Kintama beginning in 2008.

Since then, JSATS technology has developed, and produced impressively small tags now nearly rivaling PIT tags in size, but with the engineering trade-off of moving to an even higher frequency (417 KHz). McMichael et al (2010) provide a readable comparison of different manufacturer's equipment from a JSATS perspective, and emphasize the importance of using a smaller tag (the comparison uses VEMCO V9 tags used in 2006, not the V7 used since 2008). However, acoustic attenuation decreases higher frequency signals even more rapidly in seawater than freshwater, therefore tag detection ranges are substantially lower than for the POST/COAST design. The shorter ranges inherent to JSATS is partially compensated for by using more expensive high power receivers to boost detection range, but this also reduces operational lifespan of the receivers to 30-60 days, raising operational costs for maintaining receivers year-round (a goal of POST/COAST). Therefore the use of JSATS for estimating survival in the coastal ocean would likely be logistically and economically infeasible for Columbia River smolts.

Thus, although in principle telemetry arrays can be constructed from any tag and receiver combination, the deployment of the POST array using VEMCO equipment provided relatively high detection rates of migrating smolts implanted with V7 and V9 transmitters in both freshwater and coastal ocean waters using a relatively modest number of receivers with a low false positive detection rate² (Table 5). As Table 5 also shows, the use of JSATS receivers in the ocean to construct a telemetry array would likely require both an unfeasibly large number of receivers and result in high operational costs.

² McMichael et al. (2010) report detection ranges for different vendor's equipment, but the technical definition of range has an arbitrary component because a tag which is distant from a receiver may still be logged but at the cost of recording false detections as well. Thus range may be high in theory, but lower in practice because elevating the receiver's gain also amplifies the acoustic noise. In addition, the JSATS signal transmission scheme used by JSATS, which allows transmission of the ID code in a shorter period of time to reduce tag transmission collisions (about 1/5th of VEMCO's, for example), also inherently has a higher false positive recording rate than coding schemes used by the other acoustic tag manufacturers Ehrenberg & Steig (2009). High false positive rates cause complications for telemetry studies, because algorithms used for data exclusion will falsely pass some detections. The POST/COAST array has false positive rates typically <0.25% of all logged detections (see Kintama's annual reports to BPA).

Appendix G. Ocean conditions off the west coast of Vancouver Island and returns of Columbia River salmon to the Bonneville Dam

To assess the effects of ocean conditions on the production of Columbia River salmon, DFO started to explore the relationship between the return of Columbia River salmon and the ocean conditions observed off the west coast of Vancouver Island by DFO during the 2007 fiscal year and have been updated annually since then (Trudel et al. 2011a). Simple linear regression models showed that the return of Columbia River summer and fall Chinook salmon and coho salmon to Bonneville Dam were related to zooplankton community composition: high returns occurred in years when large and lipid-rich northern copepods were abundant and small and lipid-poor copepods were sparse in coastal waters when Columbia River smolts entered the ocean (Figure. G-1).

These analyses suggest that ocean conditions off the west coast of Vancouver Island could be used to predict adult return 1-2 years following ocean entry of Columbia River salmon smolts. However, given the limited predictive power of these simple regression models, the best that can probably be achieved at this time is a qualitative prediction, such as low, medium, and high, or below average, average, and above average. As a result, DFO adopted the “stoplight” system developed by NOAA to characterize the ocean conditions measured as part of the *Canada-USA Salmon Shelf Survival Study* (Table G-1). With the exception of 2004, the ranking of ocean conditions examined by NOAA and DFO are very similar. Preliminary analyses indicate that the mean rank of these conditions out performed single metrics for Columbia River spring Chinook salmon, but not for summer and fall Chinook or coho salmon. A more comprehensive analysis of these data will be completed in FY12.

Table G-1. Stoplight chart illustrating annual variations in the indices of ocean conditions used in to salmon forecasting efforts by the *Canada-USA Salmon Shelf Survival Study*. Red indicates poor ocean conditions; yellow, average; green, good. Note that ocean conditions in 2008 were mostly “good” whereas the years 1998 and 2005 were mostly poor.

RANK SCORES													
Environmental Variables	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Online data													
Mean SST - WCVI (Amphitrite) - Mar-Jun	12	1	6	2	3	8	11	13	8	4	5	7	10
Survey data - Zooplankton													
C:N Zooplankton Ratio (WCYI)	12	5	11	6	4	7	2	13	9	8	1	10	3
Northern (Boreal) Copepods	13	3	6	8	4	9	10	12	11	5	1	2	7
Southern Copepods	13	6	7	5	4	12	9	11	10	3	2	1	8
Survey data - Fish													
Coho Growth	12	1	3	7	2	8	4	13	9	10	6	11	5
WCYI CR CK CPUE - Jun-Jul	4	2	7	10	5	9	11	12	6	13	1	8	3
WCYI sockeye CPUE - Jun-Jul	8	5	4	11	13	2	3	12	9	6	1	7	10
WCYI coho CPUE - Jun-Jul	9	4	2	6	7	12	13	11	3	8	5	1	10
Mean Rank	10.1	3.7	5.7	7.6	5.8	8.4	7.4	12.0	8.1	7.6	2.4	5.7	6.5
Rank of Mean Ranks	12	2	4	8	3	11	7	13	10	8	1	4	6

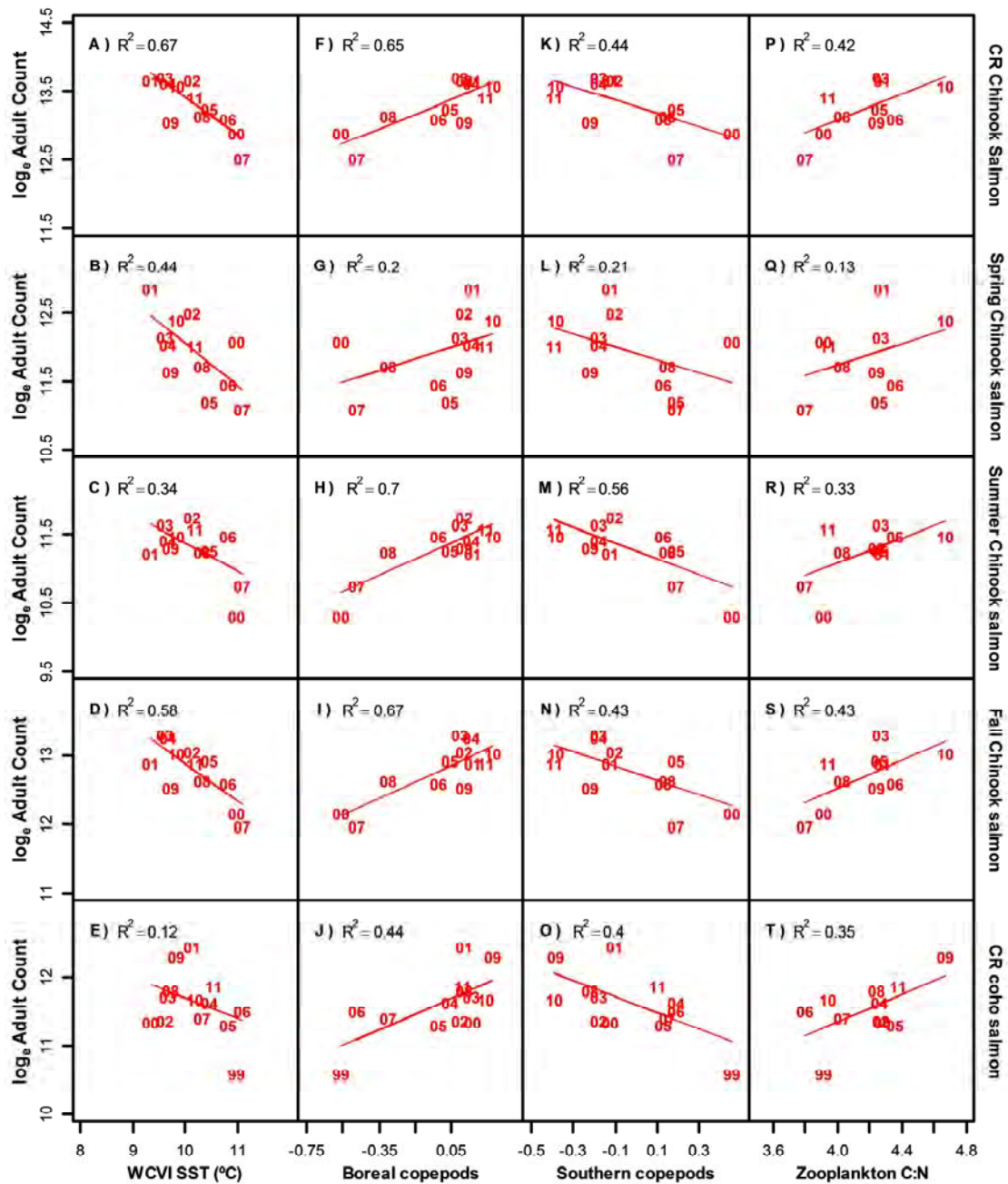


Fig. G-1. Number of adult Chinook and coho salmon returning to the Bonneville Dam in relation to environmental variables observed during their smolt year of the west coast of Vancouver Island (WCVI) in 1998-2011. Environmental variables include: WCVI sea surface temperature (SST in $^{\circ}\text{C}$), Boreal and southern copepod anomalies, and WCVI zooplankton carbon to nitrogen (C/N) ratio in summer. Points are labeled according to their respective return year. Adult counts were offset by two years for Chinook salmon (Columbia River Chinook spend 2-3 years at sea before maturing), and by one year for coho salmon. Adult return data obtained from www.fpc.org website, January 2011. (Updated from Trudel et al., 2011)

Appendix H. NOAA's response to ISRP comments on the *Ocean Survival of Salmonids Study (Project 199801400)* submitted to the Northwest Power and Conservation Council on November 15, 2010

199801400 - Ocean Survival of Salmonids

Proponents: National Oceanic and Atmospheric Administration (NOAA)

Short description: A study to evaluate the role of changing ocean conditions on growth and survival of juvenile salmon from the Columbia River Basin as they enter the Columbia River plume and PNW coastal habitats. Adult returns vary dramatically (over 10 fold) as a result of changing (good or bad) ocean conditions that juveniles experience. Evaluating the benefit of restoration efforts in the Columbia River to restore endangered salmon populations needs to consider ocean conditions as a contributing factor to recovery.

ISRP recommendation: Meets Scientific Review Criteria (Qualified)

Comment:

Qualification: A synthesis of this project, as proposed by the proponents, should be completed and reviewed by the ISRP in 2011.

This is a productive and worthwhile project that has made significant contributions to understanding relationships between Chinook and coho salmon survival and ocean and plume conditions. The ISRP commends the proposed new research on abundance, distribution, timing and migration of smolts through the estuary. Another important new feature of the project is the proposed analysis of factors affecting sockeye, chum, and steelhead. However, the proposal was not clear on the extent to which data on these species were collected in previous years but not analyzed or reported. Rapid gains in knowledge could be accomplished if previous data on these species were collected, although the ISRP recognizes that these species may not be abundant in coastal research trawl samples. An important outcome of the project has been a qualitative method for forecasting salmon runs that appears to be an improvement over past methods. It is refreshing to see a project that directly addresses management concerns. The ISRP strongly concurs with the proponents that a major synthesis of this work should be completed in 2011.

Response to the section of this comment regarding sockeye, chum, and steelhead:
We have been recording and collecting data on steelhead, chum, and sockeye from almost every year we have been doing field sampling. The catches of these salmonids are reported in our cruise reports. We agree that collating our findings would be most useful for these other salmon important to the Columbia River basin. We are presently summarizing data on marine distributions, size, clipping rates, and diets. We also have some limited data on parasite infestation and growth and ocean residence from otolith increment analysis. We have been collecting other biological material from these fish as well but until this round of funding have not

asked for the funds necessary for processing. Additional future analysis will examine genetic composition (once baselines are available), migration rates from CWT recoveries, and detailed comparison with steelhead caught in purse seines in the estuaries. A poster based on the preliminary analysis of the steelhead data was presented at the Salmon Ocean Ecology meeting in Santa Cruz in March 2010. This can be provided if it would be useful. We also have substantial data on pink and chum salmon ocean distributions which was presented by L. Weitkamp at the 2005 and 2008 Pink and Chum Workshops and published in their proceedings (Weitkamp & Emmett, 2006, Weitkamp & Bentley, 2009). These analyses indicate that most pink and chum salmon caught by the Plume Study do not originate from the Columbia River, but instead have immigrated from the Salish Sea (pink salmon) or likely originate from large populations in Willapa Bay and Grays Harbor (chum salmon).

As stated above, we have examined some diets (summarized in Brodeur et al., 2007 for the early years) and hope to continue this in the future, along with examining other aspects of their biology. Sockeye have been rare in most of our surveys but have been increasing since 2007 and we have been collecting data and samples from these fish. A preliminary analysis of 95 sockeye stomachs from 2007 show that they are feeding mainly on fish eggs, which may be important in regulating recruitment of some marine fish should sockeye numbers continue to increase.

Some important issues to be considered during the contracting process and in the synthesis are listed below:

1. Strategic plan. The ISRP recommends the use of synthesis results to develop a strategic plan that prioritizes project hypotheses and management objectives. The current approach is exploratory and observational, including numerous hypotheses and investigations of trails of evidence dealing with limiting factors ranging from lipids to parasites to bird predation. When arguing for an observational rather than experimental approach, the proponents state that each year/sampling season can be considered an “independent observation.” It seems unlikely that the quantitative values of physical and biological variables are independent between years, that is, there is no between-year autocorrelation. The proponents need to justify this assertion or adjust for it in their statistical analyses, as described in the synthesis objective. The strategic plan should explain in greater detail how interaction issues arising from studying four elements (bottom-up, top-down, food-web, and plume structure) at the same time will be addressed.

Response: We agree that with 12 years of data, a more strategic plan could now be made from a synthesis of current observations and findings to help focus the effort on the hypotheses that are testable. We are planning to develop a strategic plan in 2011 to incorporate in the 2012 SOW the findings from the analysis. Current findings support the notion that bottom up control greatly influences the success of juvenile salmon and their eventual return. We suspect that testing this hypothesis more directly will reveal how ocean conditions influence growth capacity and habitat structure in the California Current ecosystem that enable juvenile salmon to

grow and survive and how the plume interacts with the CC to facilitate this outcome. The 2012 SOW should reflect the emphasis on confirming and testing bottom up control as the primary ecological factor through enhanced ocean conditions that foster improved adult returns back to the Columbia River basin.

2. Achievable objectives. Consider whether stated objectives are achievable. For example, can the objective (discussed in proposal's introduction) to determine decadal-scale cycles in ocean productivity be achieved? If so, when will the periodic wave length in cycles be known? If changes are periodic events without a fixed wave length or chaotic events, then how will this objective be achieved?

Response: We agree that a more focused synthesis that can identify what objectives are likely testable. See our response to item #1 above. It turns out that decadal cycles may have been anomalous as we have observed cycles of 3 to 4 years of differing ocean productivity over the past 12 years providing the natural experiments for evaluation. The outcome, as has been reported, is that the ocean conditions can change very quickly to reflect the influence of the large scale forcing on the productivity of the local ocean environment that affect the growth and survival of juvenile salmon leaving the Columbia River basin during their first spring and summer in the ocean landscape.

3. Fishing operation effects. Consider important sources of variation in research trawl and other fishing operations and fishing efficiency with respect to what is known about diel, horizontal, vertical, and seasonal distribution of juvenile salmon that might affect time-series observational data on species composition, abundance, distribution, growth, etc., of juvenile salmon in the survey area.

Response: This is a good comment and one that we have made some progress in but perhaps need to focus a bit more on. We did an extensive study of diel vertical distribution using two research vessels that has been published (Emmett et al., 2004). Our cruises have consistently sampled May, June and September of each year which is as much as our funding levels permit but we have been able to use ships of opportunity to add broad-scale cruises in August and November. For this coming February, we have been planning to collaborate with DFO and use their Research Vessel W.E. Ricker to sample off of Washington and Oregon for up to two weeks. This will be the first attempt ever to examine overwintering juveniles in terms of their habitat, growth and ecology. We acknowledge that the distribution of juvenile salmon can be quite patchy in the ocean and we have been examining this through retrospective analysis of our catch data (Peterson et al., 2010) and special cruises. In June of 2010, we had some additional shiptime on the NOAA ship Miller Freeman where we were able to occupy a fine-scale grid of 16 stations about 1 km apart to examine finer patterns of salmon patchiness in relation to their prey organisms. The salmon from these surveys have been processed and analysis of the data is proceeding.

4. Cruise planning and coordination. The ISRP recommends that the proponents provide annual cruise plans to other related projects. The plans should include sufficient detail on how cruises in the plume, estuary, and ocean will be organized and coordinated with these other projects. For example, the current proposal lacks details on how far upstream the estuary sampling will occur. It seems the sampling will occur only in the lower reaches, and this may not be sufficient to tie in with other work, e.g., POST tagging at Sand Island, LCREP work in the marshes, etc.

Response: We have an established ‘cruise protocol’ that we can make available to any interested group. Cruises have been ongoing for 12 years and cruise planning currently is focused on process studies rather than on the monitoring which is the same year to year. These items are added to the cruise protocols as appropriate. The cruise SOPs can be ascertained from the Cruise Reports which are accessible from BPA.

With respect to the estuary comment, there appears to be some confusion as to its role in this project as we infer from the ISPR comments. The estuary sampling is directed at comparing the type and condition of salmonids leaving the CR estuary to the juveniles we observe in the ocean; it is not directed at identifying relationships to juveniles in other parts of the estuary. Although the findings from this study can be used by other investigators who are working on estuarine habitat issues and the role of the estuary in the salmon landscape to their success, it is not our intent to make these evaluations. We can easily make our findings available to any of the investigators working directly on estuarine studies. We are not planning on changing the estuary purse seine sampling stations or extend the seining further upstream as suggested in the ISPR comments. By sampling at our two current stations, we know [based on genetics (Chinook salmon), CWTs (all species), and PIT tags (all species)] we are catching juvenile salmon from all parts of the Columbia River basin: lower, middle and upper Columbia, and Snake and Willamette tributaries. Because being able to catch this diversity of salmon is one of our primary objectives to compare the stock composition and condition at the location in the estuary just prior to ocean entry to what we actually observe in the ocean, moving our stations further upstream isn’t warranted at this time.

5. Monitoring ocean conditions. Consider greater use of ocean monitoring data collected by other (non-BPA funded) projects for developing indices of ocean conditions, such as hydroacoustics, remote sensing, oceanographic buoys and floats, and robotic vehicles. The ISRP recommends improved coordination and collaboration with other projects and programs collecting these data.

Response: We agree and have been evaluating our findings on this project in relation to other indices from the ocean monitoring data collected by others. In reviewing many of the indices on our ocean indicators hosted on the NWFSC website, a number of the indices included in the ocean indicators page include these other ocean monitoring data which compliments data accumulated from this project.

6. Hatchery vs. wild salmon. Consider a detailed comparison of differences in condition, growth, and survival between hatchery and wild salmon of each species. The Endangered Species Act protects many salmon and steelhead ESUs in the Columbia Basin, yet this study does not address hatchery versus wild salmon issues. Hatchery salmon are released at a large size and have high lipid content, therefore hatchery fish may respond differently to environmental factors compared with wild salmon. In earlier years, many hatchery salmon were not marked and could not be readily identified. However, in recent years, including 2010, nearly all hatchery Chinook and coho salmon and steelhead, with the exception of some tribal and conservation hatchery fish, will receive an adipose fin clip. Relatively small numbers of hatchery Chinook raised in conservation hatcheries will not be marked. The ISRP recommends a detailed comparison of hatchery versus wild salmon of each species.

Response: We agree with the comment and already have made progress in this regard to comparing hatchery to wild fish; we just did not highlight this sufficiently in the proposal. For example, we published a paper in 2008 that highlighted the differences in infection levels of the parasite *Nanophyetus salmincola*, with respect to parasite-associated mortality, in marked vs. unmarked juvenile coho salmon (Jacobson et al., 2008). In addition, we have made a detailed comparison of differences in marine spatial overlap, physical characteristics, diet overlap and growth (2006-2009 only) between hatchery and unmarked (presumed wild) spring Chinook salmon from the Columbia River Basin (1999-2009). We have presented the findings at the State of the Salmon Wild and Hatchery Ecological Interactions Symposium (see presentation by Daly et al. at conference web site <http://www.stateofthesalmon.org/conference2010/presentations.html>) and have submitted a manuscript to Environmental Biology of Fishes which is presently in review. A summary of some important findings are as follows: 1) spatial overlap was high between unmarked and hatchery fish, although catches of unmarked fish were minor compared to those of marked hatchery salmon, 2) peak catches of hatchery fish occurred in May, while a prolonged migration of small unmarked salmon entered our study area toward the end of June, 3) hatchery salmon were characteristically longer and had a greater condition factor by June. Small-scale (by station) diet composition showed significant overlap ($62.8 \pm 13.5\%$) between unmarked and hatchery fish, 4) feeding intensity and growth were not significantly different between unmarked and hatchery fish, and 5) there were synchronous interannual fluctuations in catch, length, body condition, feeding intensity, and growth for unmarked and hatchery fish, indicating that both groups were responding similarly to ocean conditions. With high spatial and trophic overlap, potential competition for food resources during years of low prey abundance may result in density-dependent growth suppression for both natural and hatchery-produced salmon. We also explored analyzing coho salmon but the tagging rates for the years we looked at were too low ($\sim 60\%$) to allow a reasonable criteria to distinguish between hatchery and wild fish caught in the ocean. We hope to follow up this study with other species and stock groups in the future, if clipping rates increase or if we have other methods to reliably distinguish hatchery and wild fish

in our catches. At present (i.e., during years 2007-2010), average clip rates for Columbia River hatchery salmon range from 67.8% (coho) to 91.9% (yearling Chinook), with subyearling Chinook (75.8%) and steelhead (85.4%) at intermediate levels. Although these clip rates are much higher than they have been, it still results in the release of almost 30 million unclipped hatchery fish annually: 16.7 million subyearling Chinook, 7.2 million coho, 2.6 million yearling Chinook, and 2.2 million steelhead.

7. Genetic stock identification. The ISRP recommends standardization of genetic stock identification methods used by BPA-funded estuary and ocean survival projects so that results are directly comparable among projects. Different projects may currently be using different methods, but this was not clearly explained in the proposal.

Response: We agree on standardization. The microsatellite evaluation of genetic origins that is used at the NWFSC is comparable to the approach used by DFO and the methods have been cross validated. We are not sure what method is being used, if any, by David Welch's project. With respect to projects in the estuary, four of the projects that we are aware of use the NWFSC genetics lab for stock identification, thus on balance the majority of projects in the ocean and estuary are using genetic analyses that have been cross validated and have been used to compare across projects already.

8. Otolith microchemistry. The ISRP considers the value of otolith microchemistry research uncertain. The proponents need to consider specifically how this method can provide new information without extensive baseline data collection. The validity of the proposed use of genetic methods to identify stock origin of individual fish sampled for otoliths needs to be demonstrated. Use of daily otolith increments to estimate estuary and plume residence times is also uncertain. For example, project results to date have estimated that yearling Chinook salmon spend several months in the estuary/plume, which is contrary to evidence from trawl survey and tagging research. Hatchery fish are known to have high Sr/Ca ratios because of their feed. Is this another factor that will confound the proposed microchemistry work? Also the Sr/Ca transition cannot distinguish between estuary and plume habitats, an issue that was not clearly described in the proposal. A useful reference is: Elsdon, T.S. and 9 others. 2008. Otolith chemistry to describe movements and life-history parameters of fishes: hypotheses, assumptions, limitations and inferences. *Oceanography and Marine Biology: An Annual Review*, 2008, 46, 297-330.

Response: Space for project description in the proposal was somewhat limited so perhaps some of the lack of clarity is related to the level of detail presented. We reply to each point raised below:

- 1) *'Otolith microchemistry. The ISRP considers the value of otolith microchemistry research uncertain. The proponents need to consider***

specifically how this method can provide new information without extensive baseline data collection.'

a. There are no specifics associated with this statement; therefore it is not clear what baseline information the ISRP deems necessary. However, the potential gain of combining genetic stock identification (GSI) with otolith structural and chemical analysis is that stock-specific information on migration patterns will be generated at temporal scales unattainable using fish scale analyses (daily vs. 7-10 d resolution for otoliths vs. scales, respectively). Furthermore, this information can be generated for all individuals collected – not solely fish with CWT or PIT tags, which can generate biased estimates due to the dominance of hatchery fish. We have gathered fairly extensive baseline information, including: (1) the completion of otolith chemical and structural analysis on >200 Columbia River juvenile Chinook salmon including pre- and post-release hatchery, CWT- and PIT-tagged, and adipose fin-clipped individuals as well as those with no external or internal marks; (2) the completion of a laboratory validation study quantifying the effects of temperature (7, 9, 12°C), salinity (0 to 15), and water Ba:Ca levels on the otolith incorporation of Sr:Ca and Ba:Ca in juvenile Chinook salmon; and (3) collection of water chemistry data from various locations throughout the Columbia River basin. It is worth noting that our laboratory validation study builds upon a previous study confirming positive relationships between water and otolith Sr:Ca in five species, including Chinook salmon (Zimmerman, 2005). The complete presentation of the laboratory analysis of Chinook salmon otolith elemental incorporation is in preparation but the approach is very similar to those presented in Miller (2009) and DiMaria et al. (2010) and some of the results are presented in Miller et al. (2010a). Details of most aspects of the analytical approach can be found in Miller et al. (2010a). It is not clear what additional, extensive baseline collection the ISRP considers essential to complete the basic interpretation of otolith structure and timing of brackish/ocean entrance.

2) *The validity of the proposed use of genetic methods to identify stock origin of individual fish sampled for otoliths needs to be demonstrated.*

a. Several researchers have formally evaluated the accuracy of individual assignment in Pacific salmonids using highly polymorphic markers (Beacham et al., 2006c, Seeb et al., 2007, Narum et al., 2008, Barnett-Johnson et al., 2010, Miller et al., 2010b). Furthermore, some of these assessments are focused on, or include, the assignment of Chinook salmon using the Genetic Analysis of Pacific Salmonids (GAPs) baseline (Seeb et al., 2007, Miller et al., 2010b). Results of these syntheses were previously summarized by the proponents as follows:

‘Microsatellite datasets also can provide accurate information on the source of an individual fish. Beacham et al. (2006c) reported 84%

assignment accuracy using 13 microsatellite loci in a Pacific Rim Chinook salmon analysis. Narum et al. (2008) tested the GAPS microsatellite dataset and found that individuals from 10 Columbia River Basin populations were assigned to the correct source population (tributary or hatchery) with 79% accuracy. Similar tests of the more comprehensive 45 population Columbia River baseline we are using in this study, show that individuals can be assigned to the correct regional genetic stock group with a mean accuracy of 88% (D.Teel, unpublished data).’

Additionally, Dr. Michael Banks, OSU, is completing a power analysis for individual-based assignment applications using GSI. He reports that ‘Crude individual-based assignment results with no probability stringency were modest: 89.9% and 84.6% correct for c-Bayes and ONCOR [two software programs/statistical approaches used to assign individuals], respectively, for the known origin non-baseline samples and 87.1% and 77.8% correct for c-Bayes and ONCOR respectively for coded wire tags samples. Applying higher probability stringency, however increased correct assignment results to greater than 90% correct (ONCOR) for both and greater than 95% (C-Bayes) for both known sample data sets and assignment methods’.

There is also an extensive collection of Chinook salmon of known origin (based on CWT and PIT tags) that have been assigned to a stock using GSI. These collections can be more formally analyzed to generate regional estimates of accuracy; quantification of the error in stock assignment can be generated and specific probabilities of assignment included in formal presentations. Additional details regarding these types of error analysis could be incorporated into any standardization procedures developed for collaborating partners using GSI on Columbia River stocks. However, the value of completing stock-specific analyses cannot be understated. Given the extensive life history variation in salmon, stock-specific analyses are much more likely than mixed stock analyses to provide the resolution needed to elucidate migratory or behavioral patterns and identify specific mechanisms of mortality.

3) *Use of daily otolith increments to estimate estuary and plume residence times is also uncertain.*

a. It appears that we did not adequately present the details of our methodological approach and would like to clarify an important point - we do not claim to be able to estimate ‘estuary and plume residence times’. We are identifying ‘brackish/ocean’ residence times. Although we qualified our determination as ‘brackish/ocean’ residence within the proposal, we did not provide details regarding why this approach cannot be used to differentiate among salinities greater than approximately 8 PSU. This issue has been in the literature for some time (e.g., Kraus & Secor, 2004) and is further

detailed for Chinook salmon in Zimmerman et al. (2005) and Miller et al. (2010a). However, otolith structural and chemical analysis has been used to identify individual transitions from fresh to marine waters in a variety of diadromous fishes for >15 yr (Limburg, 1995, Secor et al., 1995). Due to the widespread application of these methodologies, there was a recent review manuscript (Elsdon et al., 2008, as noted by the ISRP) that summarized conceptual approaches and considerations for reconstructing migratory history of diadromous fishes using otolith structure and chemistry; an approach that, in many respects, has become a standard methodology. Furthermore, this approach has been applied previously in field studies of Chinook salmon (Miller et al., 2010a, Volk et al., 2010) and specifically for populations within the Columbia River basin (Campbell, 2010).

Two of the primary considerations for reconstructing migratory history in juvenile Columbia River Chinook salmon are: (1) determination that relevant water masses display distinct water chemistry (i.e., fresh vs. brackish/ocean waters); and (2) some knowledge of the lag time between individual movement to chemically distinct habitat and detectable change in otolith composition. We have compiled existing data and collected additional water chemistry from throughout the Columbia River basin to validate the primary assumption that freshwater Sr:Ca levels are significantly different (lower) than marine waters (Fig. 1 and Table 1). In regard to the lag time, we have completed a species-specific laboratory validation of the otolith incorporation of Sr:Ca and Ba:Ca in Chinook salmon and determined that the initial change in otolith composition (i.e., increase in Sr:Ca) occurred within 2-3 d after exposure to saline waters (5 PSU). Equilibration, however, required 7-10 d. Therefore, given that we are identifying the initial increase in otolith Sr:Ca (Fig. 2 and 3), there is an approximate lag time of 2-3 d. Furthermore, we adopt a dual marker approach (Sr:Ca and Ba:Ca) to provide further confidence in our determination of the habitat transition from fresh to brackish/salt waters (see Miller et al., 2010a for additional details). Additionally, in the case of hatchery-reared salmonids, the influence of hatchery feed, which is typically dominated by marine protein, should be examined. We have also examined pre- and post-release hatchery fish and evaluated the effects of hatchery rearing, including analysis of the Sr, Ca, and Ba content of five types of hatchery feed, on the otolith Sr:Ca in spring Chinook salmon within the system. There are complex patterns in the otolith chemistry associated with hatchery rearing, likely due to a combination of feed, growth rate, and temperature, but they do not lead to a misinterpretation of brackish/ocean entry (see Fig. 2 vs. 3 for representative examples). Additional details on this point are presented in below (see '5').

- 4) *For example, project results to date have estimated that yearling Chinook salmon spend several months in the estuary/plume, which is contrary to evidence from trawl survey and tagging research.*

a. We would like to clarify this important point: we did not use the term ‘estuary/plume’ to describe our results and apologize for any confusion on this point. We do not think that our data necessarily indicate that individuals reside for ‘several months in the estuary/plume’. The proposal states, “When we evaluate residence time of juvenile yearling interior basin spring Chinook that are captured on the Columbia River transect (which is typically centered in the plume), residence time is measured in months rather than a few days. Residency is measured as the number of daily growth rings (days) apparent in otoliths after a strontium signal is evident, a measure of saltwater entry. Average residence time for juvenile spring Chinook on the Columbia River transect is 25 days, ranging from 5 to 60 days whereas residence time for juvenile spring Chinook captured at our more northerly transects (Queets and La Push) is 35 days (range of 5 to 75 days).’ Figure 28 in the original proposal, which presumably is the source of the ISRP conclusion, indicates that 2% of the Mid and Upper Columbia River spring Chinook juveniles collected on the Columbia River transect resided in *brackish/ocean waters* for 60 d; it is important to realize that these individuals may have travelled south prior to capture. The mean estimates of brackish/ocean residence times generated for the mid- and upper Columbia River spring Chinook salmon are, in fact, very similar to estimates based on CWT analyses of individuals from the Mid and Upper Columbia region collected along the same Columbia River transect (J. Fisher, unpublished data). Preliminary data indicate a mean ocean residence time of 20 d for individuals from the Mid-Columbia and means of 0 and 30 d for individuals from the Upper Columbia River region (Fig. 4). It is important to remember that many previous estimates are based on CWT individuals, which are not necessarily a representative sample of the entire population. Our mean estimate for the stock group (which combines Mid and Upper Columbia River fish) is 25 d. Our approach samples all individuals, including hatchery and naturally-spawned, and therefore may be more representative of the entire population. This example underscores the need for, and value, of stock-specific analyses to avoid over generalizations of observations based on mixed stock groups.

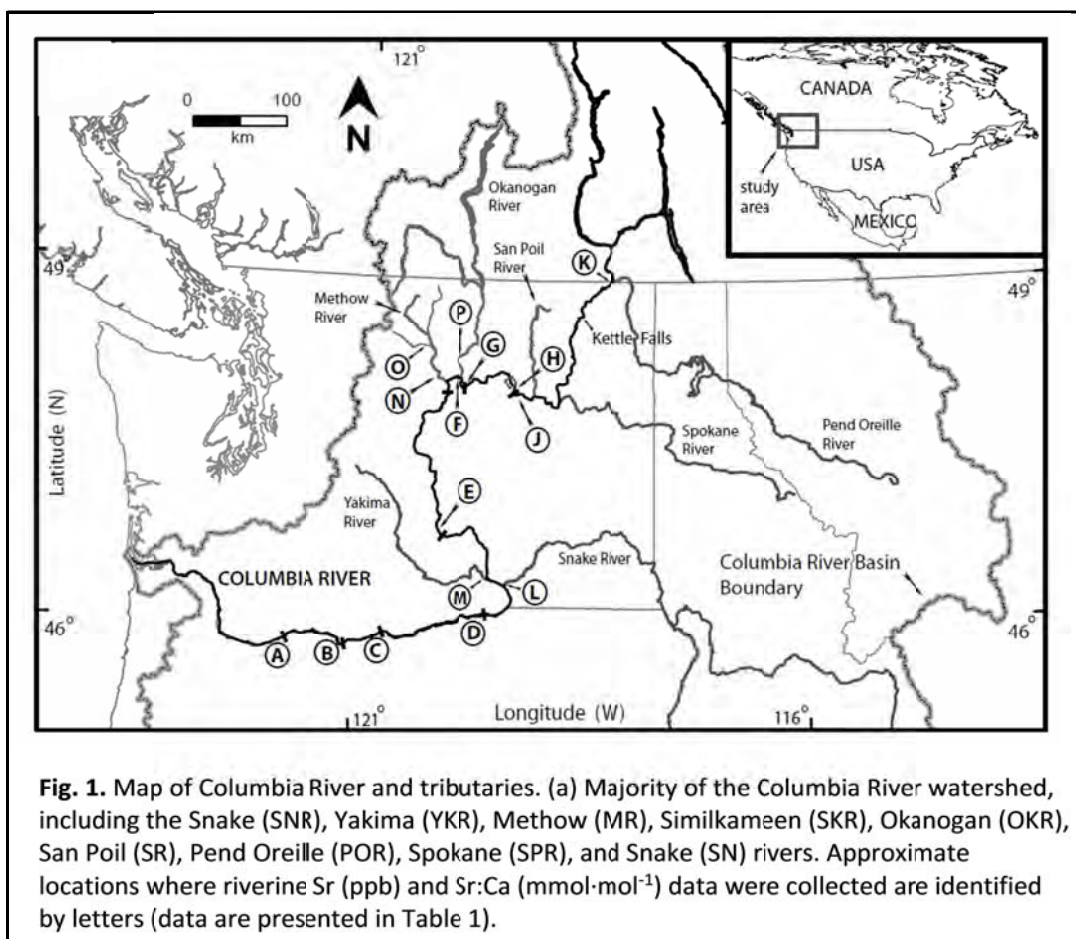
5) *Hatchery fish are known to have high Sr/Ca ratios because of their feed. Is this another factor that will confound the proposed microchemistry work? Also the Sr/Ca transition cannot distinguish between estuary and plume habitats, an issue that was not clearly described in the proposal.*

a. There are good data on the Sr contribution of hatchery feed (Kennedy et al., 2002, Weber, 2002, Miller et al., 2010b); a mean of 32% of the otolith Sr in Chinook salmon during their freshwater residence represents a food contribution. We have also quantified the maternal influence on otolith Sr:Ca patterns in hatchery fish (Miller & Kent, 2009) and examined Central Valley fall and Columbia River spring Chinook hatchery juveniles (Miller et al., 2010a). As noted earlier, there are some interesting patterns within the

Mid and Upper Columbia River yearlings that may actually serve as an indicator of hatchery origin. However, when examining otolith Sr:Ca and Ba:Ca, entrance into brackish/ocean waters is distinct from the period of hatchery residence. We include figures to illustrate this point (Fig. 2 vs. Fig. 3). Finally, the point regarding distinction between estuary and plume habitats was addressed above and is presented in more detail in Kraus and Secor (2004), Zimmerman (2005), and Miller et al. (2010a).

Table 1. Riverine Sr (ppb) and Sr:Ca ($\text{mmol} \cdot \text{mol}^{-1}$) data for various locations in the Columbia River basin. River kilometer = RK. Samples below mainstem dams were collected within 5 km of the dam unless otherwise noted. Samples sites are identified by letters; see Fig. 1 for approximate locations. ‘—’ indicates no data. Note oceanic Sr:Ca is approximately 8.0 to 8.5 $\text{mmol} \cdot \text{mol}^{-1}$.

ID	Location	Sr (ppb)	Sr:Ca ($\text{mmol} \cdot \text{mol}^{-1}$)
A	Columbia River mainstem, below Bonneville Dam	66.0	2.35
B	Columbia River mainstem, below Dalles Dam	62.6	2.32
C	Columbia River mainstem, below John Day Dam	73.0	2.36
D	Columbia River mainstem, below McNary Dam	66.9	2.30
E	Columbia River mainstem, above Priest Rapids Dam	81.5	—
F	Columbia River mainstem, (~12 RK downstream of Chief Joseph Dam)	76.6	2.07
G	Columbia River mainstem, below Chief Joseph Dam	72.4	1.94
H	Columbia River mainstem, below Grand Coulee Dam	73.0	1.95
J	Columbia River mainstem, above Grand Coulee Dam	67.3	1.93
K	Columbia River mainstem, below Pend Oreille River	74.0	1.78
L	Snake River, above confluence with Columbia River	53.3	3.06



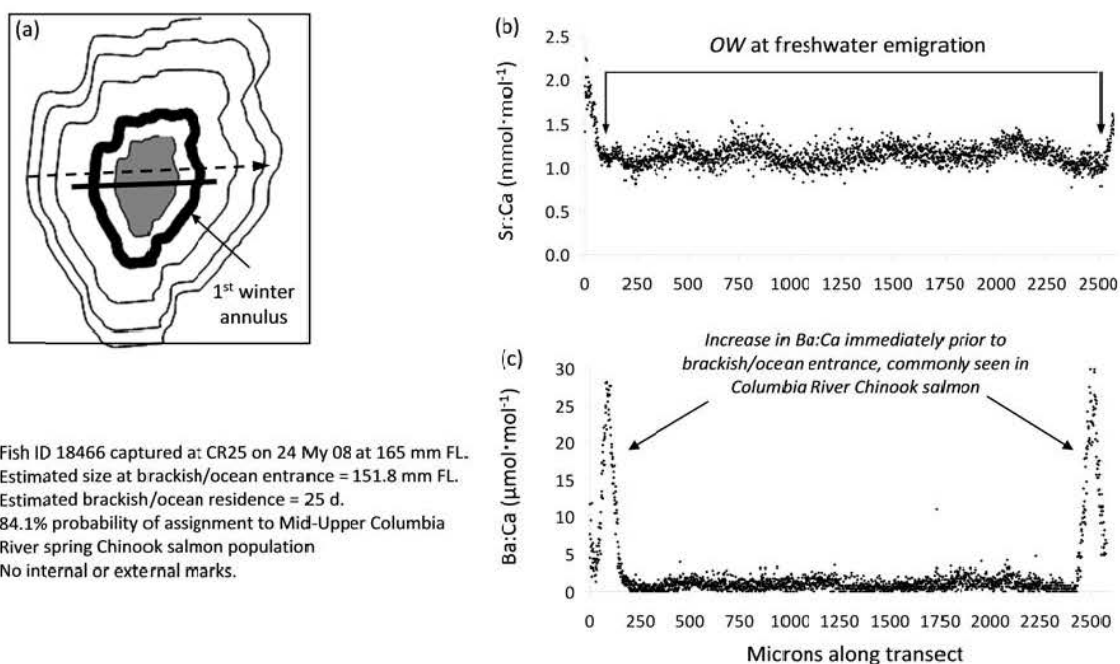


Fig. 2. (a) Schematic (sagittal section) of a sagittal otolith of a juvenile yearling Chinook salmon. Dashed line indicates laser path for elemental analysis and solid line represents otolith width (OW) at freshwater emigration. The core, which represents the egg and early juvenile life history, is shaded and the first winter annulus is labelled. (b) Sr:Ca across an otolith from a yearling Chinook salmon. (c) Ba:Ca across the same otolith. Measurements of otolith width (OW, μm) at freshwater emigration are identified. Note there is no evidence of maternal contribution to core strontium likely due to spring return of mother and length of maternal migration (see Donohoe et al. 2008 & Miller and Kent 2009 for more detail on maternal signatures).

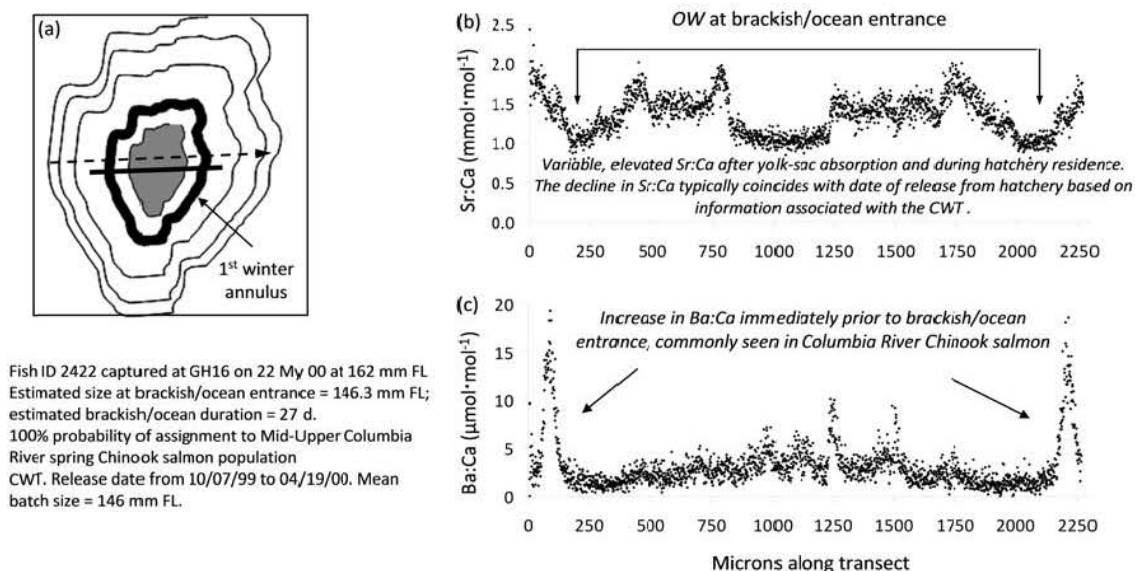


Fig. 3. (a) Schematic (sagittal section) of a sagittal otolith of a juvenile yearling Chinook salmon. Dashed line indicates laser path for elemental analysis and solid line represents otolith width (OW) at freshwater emigration. The core, which represents the egg and early juvenile life history, is shaded and the first winter annulus is labelled. (b) Sr:Ca across an otolith from a yearling Chinook salmon. (c) Ba:Ca across the same otolith. Measurements of otolith width (OW, μm) at freshwater emigration are identified.

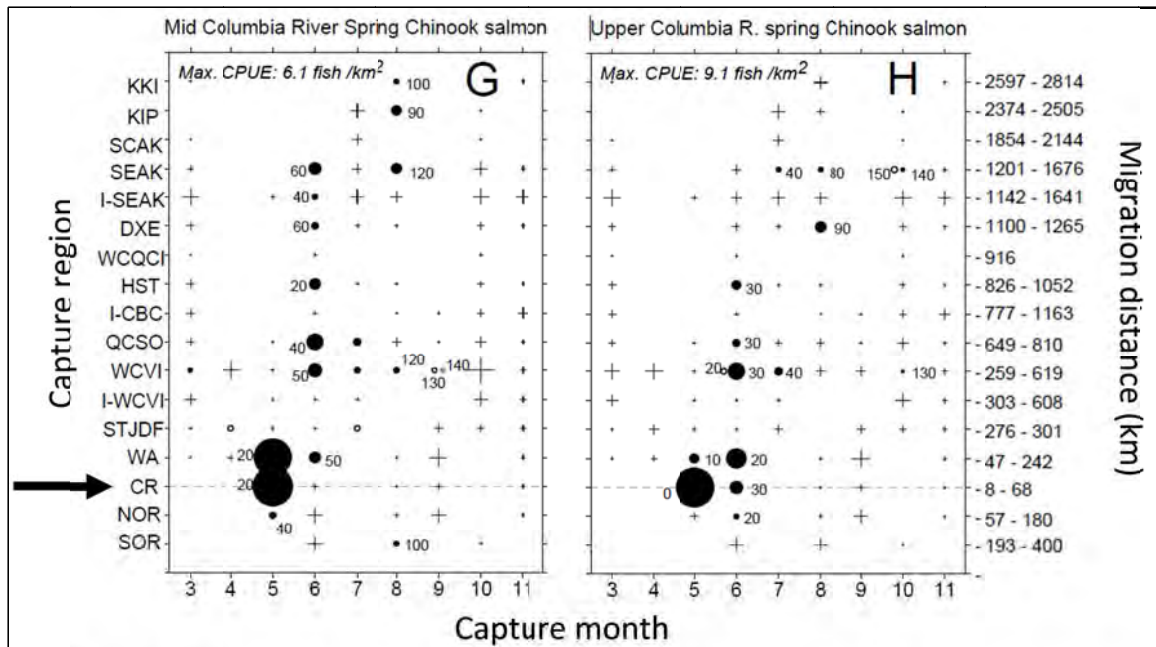


Fig. 4 (from Fisher et al. In revision.) Summary of CWT collections. Catch per effort in surface trawls of age 1.0 fish by stock group, capture region, and month. Within stock groups, areas of circles are directly proportional to CPUE. The maximum CPUE is indicated at the top. The average estimated number of days (to the nearest 10) since ocean entry of fish in each region/month is shown near each circle. Cross size in each region/month indicates total surface trawl effort (only shown when catch = 0). Ranges in distance from the Columbia River mouth of capture locations in each region are also shown. The Columbia River transect is indicated by the filled arrow.

9. Avian predation and alternative prey. The ISRP recommends that the effects of Caspian terns be considered in proposed research on avian predation and alternative prey (anchovy). In the estuary, Caspian tern predation is known to be related to river flows and the Pacific Decadal Oscillation. Proponents need to demonstrate collaboration with other avian predation studies.

Response: Collaboration with existing avian predation studies was required to develop and test the sampling protocols for proposed new work on ocean bird predation. Therefore, we have already established connections with ongoing research on Columbia River estuary avian predation impacts (Oregon State University, Roby et al.; and NOAA Fisheries, Ledgerwood/Sebring) and the availability of forage fishes in the estuary/plume/ocean (NOAA Fisheries; Emmett, Brodeur, Weitkamp and others). If ocean bird diet work is fully funded, then our expectation is to make explicit comparisons between ocean bird diet, estuary bird diet, and forage fish availability. We agree with the reviewers that the proposal narrative should have clearly stated that coordination of new work with existing programs is already in place.

For example, to insure we can make valid comparisons between ocean and estuary bird diet, we shall use methods for collection, processing, and analysis of ocean diet samples which are identical to those used for estuary samples. The same avian diet technician (Reinalda) and salmon geneticists (Teel, Kuligowski) who analyzed tern/cormorant estuary samples worked with us to develop and test protocols for treatment of soft tissue, hard parts, and genetic identification of salmon remains. In some cases, we suggested improvements to existing methods, and those improvements are now being used by not only by our program and the tern predation group, but also by another project investigating murre diet near the Yaquina River, OR.

Additionally, the proposed location of ocean bird predation research at Pt. Adams Research Station provides significant strategic advantages for coordinating sampling efforts. Four of the five existing field programs addressing estuary bird predation or alternative prey availability are currently based out of Pt. Adams, and therefore the PIs has ongoing knowledge of field sampling schedules and preliminary results in these programs. The research program addressing effects on Caspian terns on juvenile salmon survival consists of two primary components: East Sand Island colony monitoring by Oregon State University biologists immediately before and during the nesting season (Roby), and PIT tag recovery after the nesting season by NOAA Fisheries staff at Pt. Adams Research Station in Hammond, OR (Ledgerwood/Sebring). The three research programs addressing variation in alternative prey (i.e. forage fish community composition and abundance) in the estuary and ocean are all led by NOAA Fisheries investigators. All three field programs which directly sample alternative prey (estuary purse seining, daytime trawl surveys in May/June/September, nighttime forage fish sampling) are sponsored by BPA as part of this proposal, and all three are staged out of Pt. Adams Research Station.

The only effort not based at Pt. Adams is the colony-based fieldwork with terns and cormorants on East Sand Island during the breeding season. NOAA has an established correspondence with Roby for coordination between estuary and ocean bird work. NOAA has also developed a communication channel with the program coordinator for East Sand Island fieldwork (Marcella). Maintaining these communications links will facilitate coordination and collaboration among the two programs.

Sampling ocean birds (shearwaters, murres) is necessarily a separate research effort from sampling estuary birds (terns, cormorants). It is not possible to collaborate directly on sample collection because the ocean birds rarely enter the estuary, and neither shearwaters nor murres nest anywhere in the estuary. Conversely, existing estuary fieldwork does not operate outside the river mouth. This is why there is a need for new field programs.

10. Tag recovery. In addition to collection of coded-wire tags (CWT), all salmon and steelhead sampled during fishing and tagging operations should be examined for recovery of PIT tags and acoustic tags, if this is not already being done. The ISRP recommends using a handheld wand detector, V-Detector, or tunnel detector onboard the survey vessels to examine all salmon and steelhead in survey catches for CWTs, as some Columbia River hatcheries release coded-wire tagged fish that do not have an adipose fin clip.

Response: We do check all juvenile salmon for the presence of CWT and PIT tags and also examine them for fin clips (adipose, ventral, caudal), visible implant elastomer (i.e., latex) marks, and internal tags (radio, acoustic, archival, etc.). Because all juvenile salmon caught in the Plume Study are retained (i.e. lethally sampled), we check for non-visual tags (i.e., PIT, CWTs) in the lab with a hand-held CWT wand and Biomark PIT tag reader. By contrast, many juvenile salmon caught by the estuary purse seine study are released after identification and measurement. Nevertheless, we accordingly check them in the field for visual marks and non-visual tags with the appropriate electronic detectors.

11. Tagging effects. New proposed research involves acoustic tagging of juvenile Chinook salmon smolts in the Columbia River estuary with VEMCO and JSATS tags and tracking them as they cross several acoustic listening-lines and with mobile units in the estuary to estimate site-specific survival during outmigration. An evaluation of the effects of tagging stress on fish that are smolting is needed, as stress may be considerable and could affect behavior and survival of tagged fish. Although the proponents think survival will be high because of positive test results in 2010, up-estuary release above the receivers at Astoria and Sand Island may be an added stress to smolts that could be evaluated.

Response: The effects of JSATS tags on survival of yearling Chinook salmon during migration through the basin has been documented (recently by McMichael et al., 2010). We are aware of the effects on tagged fish those will be included in analyses as we examine interactions of fish tagged through other programs with hydrographic conditions in the lower estuary.

Proposed tagging in the estuary with VEMCO tags.

With regard to tag effects, we plan to only tag fish > 130 mm, which will result in a tag/fish mass ratio of < 5%, which is consistent with suggested protocol (e.g., Giorgi et al., 2010). We will use the smallest tags available that are compatible with the POST array. We are hoping that the POST capability will be enhanced in the near future to accommodate smaller tags. We will collect fish from the freshwater lens and release them into freshwater, so the tagging and fish conditions will be quite similar to those at Bonneville Dam, the site of other acoustic tag studies.

Nonetheless, we agree concerns about tagging fish in the estuary environment and transporting them to an upstream release site are valid. Thus, we propose to modify our study design as follows.

First, we will conduct a pilot tag effects study in the first year of our study. During one of the sampling periods in the peak of the run, when we have ample numbers of fish captured, we will collect an additional 40 fish. We will randomly assign 20 fish to treatment and control groups. For the treatment group, we will surgically implant sham tags, which have the same dimensions and mass as the acoustic tags, into each individual. The treatment group will be handled in a similar manner, but will have no surgery. We will hold the fish for two weeks at NOAA's facility in Hammond, Oregon in holding tanks with flow through water. We will conduct a Kaplan-Meier survival analysis and use a log-rank test ($\alpha = 0.05$) to test for significant differences between groups. If we detect significant difference, we will seek funds to conduct a larger scale experiment involving more fish and longer holder periods, likely conducted at the Bonneville Dam facilities.

Second, we will modify our release strategy to have paired releases throughout the season – one near the tagging site and one upstream of the Astoria Bridge array. We will then test whether survival in common segments differs between the two groups. The first common segment is the one between the river mouth and the first array along the coast, at Willapa Bay. We will test for differences by building alternative models of the survival process, one of which has separate survival probabilities (that can vary throughout the season) for each group in the common segments, and one that has equal survival probabilities in these segments. We will determine which model is more consistent with the data using AICc. We believe releasing fish above the Astoria Bridge array is important because it allows us to detect any mortality that occurs shortly after release, which would be lumped with the lower estuary survival estimate when fish are released below this array.

12. Collaboration. This project is collaborating with the CDFO Salmon Shelf Survival Study (#200300900) and the Pacific Ocean Survey Tracking (#200311400, POST, re-named COAST) studies. The ISRP appreciates recent improvements in coordination with these projects. Linkages between these and others studies (e.g., JSATS tagging research) in the estuary, plume, and ocean are established, but the degree of coordination needs further explanation and development. For example, the approaches by NOAA and CDFO are somewhat similar, and integration of data collection and analyses to a greater extent would strengthen results. Likewise, the proponents should consider how data from the NOAA, COAST, and JSATS tagging projects can be integrated to provide a more comprehensive analysis of factors affecting salmon survival.

Response: We have increased our level of collaboration with the DFO group (led by Trudel) in recent years. In addition to many papers that compared results on salmon distribution, growth, community structure, feeding and parasite incidence described in the AFS Volume published in 2007 (Grimes et al., 2007), we have studies ongoing looking at growth comparisons using IGF-1 (led by Beckman), diets (led by Brodeur) and stable isotope analysis (led by Trudel). We also have plans outlined in Comment 3 earlier to collaborate with DFO on a February cruise off Washington and Oregon. We plan to make available space on board our cruises as well this coming summer for their scientists to participate. We have greatly increased our collaborative efforts with the NOAA Santa Cruz Laboratory to extend our normal sampling transects all the way to central California. During a cruise last summer, we provided logistical and manpower support to help in this cruise and are working with this lab to share data and samples. Further, it should be noted that we are directly collaborating in this proposal with COAST and Dr. David Welch as we have a specific task to incorporate VEMCO tags in juveniles collected during our estuary sampling that will be tracked along the receivers placed along the shelf by Dr. Welch's project.

13. Scientific workshop. The ISRP recommends a scientific workshop in 2011 focused on estimation of estuarine and ocean survival, forecasting of adult returns, and adaptive estuary, plume, and ocean environmental assessment for Columbia River Basin salmon and steelhead. Perhaps the proposal should include this workshop. A workshop would help to improve coordination and collaboration, standardization of methods (e.g., genetic stock identification), development of simulation and predictive models, and integration of results among Columbia River Basin estuary and ocean projects. One aspect of all projects that needs work is how to include more detail on sub-stock structure, including hatchery versus wild fish, hatchery release time, area comparisons, in-river migration and associated ocean migration, and more in the models. CDFO and NOAA seem to be taking somewhat different approaches to salmon forecasting, i.e., stoplight charts (red, yellow, and green) with a Bayesian belief network approach by CDFO versus ecosystem indicators by NOAA. Can this be reconciled?

Response: We agree that a workshop would be useful for investigators from the Columbia basin region to become more familiar with the findings from our ocean related research on how ocean and plume conditions affect growth and survival of

juvenile salmon from the CR basin. It should be noted that we have participated in two Science and Policy Exchanges hosted by the NPPC in the past three years and we host an annual Salmon Ocean Ecology workshop, initiated in 1998, for west coast researchers from California to Alaska, which is now including salmon researchers from the east coast. This workshop is open to all interested parties and at the workshop we have conducted an evaluation of forecasting approaches and actually compared forecasts for the past 4 years. In addition, in the past 5 years we have made numerous presentations to the NPPC, on a nearly annual basis, and to the Federal Executive Board and Caucus numerous times. We have also briefed the TAC on using our ocean indicators to improve their forecasts for adult returns to the Columbia River basin, and this is showing promise. Our forecasts are maintained on the NWFSC website and we endeavor to inform the widest audience to view the website, which is updated twice yearly. Further in our 2011 project meeting, we have scheduled a discussion with CDFO investigators to compare and contrast our forecasting approaches to identify areas of synchrony that we can advance in order to minimize confusion. We will continue to work with BPA on the best venues to improve science exchange with other BPA investigators.

14. Adaptive management. Consider how to better implement adaptive management to forecasted changes in ocean survival in the Columbia River system. Consider experiments designed in concert with hatchery, hydrosystem, and harvest managers to test specific hypotheses related to estuarine and early ocean survival. Proponents have indicated that management could respond to release timing and barging vs. in-river releases based on predictions from their 16 indicators and timing of upwelling, but what do managers say about the feasibility? How can managers respond to pathogen problems identified during this project? Or is this strictly an explanatory variable?

Response: We agree that we are at a stage where we could entertain scientific assessments or experiments to consider and implement adaptive management strategies to improve juvenile growth and survival and improve adult return rates under varying ocean conditions. This requires more participants than our scientific research team to initiate. To this end though, we are beginning discussions in 2011 with our NOAA Regional Office to talk with hatchery managers, for instance, to inform them of the role of the ocean in their success of the fish they produce and how they might use the information we provide to test scenarios of altering release amounts and timing to improve overall returns. The tests of scenarios could lead to effective adaptive management options in the future.

With respect to the specific question regarding pathogens, it is currently being evaluated as an explanatory variable but we could envision, if our hypothesis is correct, that eventual altering of release strategies relative to ocean conditions and pathogen loads could be an appropriate management strategy to employ.

15. Sources of variation in forecasts. Consider whether ocean survival forecasts could be improved by integration of additional sources of variation in freshwater and ocean survival (e.g., ocean harvests of immatures, jacks, and adults in Alaska and Canada;

bycatch in commercial groundfish fisheries; and climate and ocean conditions in offshore rearing areas)?

Response: We agree with this recommended approach and will consider additional metrics relating to climate and ocean conditions in offshore rearing areas and ocean harvest. It should be noted that knowledge of offshore rearing areas for all stocks is not clearly known (e.g interior basin spring Chinook salmon) and thus we would recommend efforts to identify stock specific rearing areas in the ocean be a special directed effort in future planning.

16. Quantitative forecasts. Qualitative methods of forecasting are helpful, but difficult for managers to apply and rely upon. That being said, proponents need to exercise caution in promoting the idea that their monitoring data will eventually lead to reliable, quantitative forecasts of ocean survival of salmon. Clearly, it is a goal of their agency to provide scientific forecasting tools to improve fishery management, but to date all quantitative ocean forecasting tools for salmon have failed, and thus expensive, long-term research vessel monitoring surveys are necessary.

Response: We understand the concern. We continue to advocate for improving our quantitative forecasting skills while acknowledging for the time being long term vessel monitoring surveys be supported.

17. Communicating results. Consider developing more effective approaches for communicating project results and forecasts of ocean survival of salmon directly to hatchery, hydrosystem, and harvest managers. The websites, scientific meetings, and peer-reviewed scientific publication are excellent methods for communicating with other scientists, government agencies, educational institutions, and conservation organizations, but are likely not effective tools for communicating directly with hydro, harvest, and hatchery managers.

Response: We agree and will work with BPA and the NPPC to identify venues to inform Columbia River basin researchers and managers of our findings. Also, see response to item #13.

18. Online proposal. Consider improvements to the online proposal form. Descriptions of methods in the online proposal were overly brief for some reviewers. Methods should provide sufficient stand-alone detail in the online form to enable evaluation of scientific and technical merit. The proposal could be improved if methods and metrics were explicitly stated for each objective. This is a complex proposal with six general objectives, both broad and narrow hypotheses, and “Studies” that provide metrics and methods that are intended to address multiple objectives, but the association between each specific objective and the metrics and methods that are intended to address it are unclear. For example, Study One provides methods and metrics that the proponents indicate address objectives one through six, but it is not entirely clear what methods and metrics presented in Study One address which of the six general objectives. The discussion of results in the online form would benefit from an ecosystem diagram

depicting important physical and biological variables and their known or hypothesized interactions (perhaps indicated by arrows between variables). Such a diagram would provide a synopsis of the proponent's current view of the system and how it might work, and would be beneficial in understanding the proposal. More complete details are needed on sampling methodology and analyses, along with a format that reduces the redundancies. Information on the percent of salaries for the PIs and what outside support they have would also help.

Response: We agree that with the new online format detailed methods were not included to the extent that they have been in past submissions and objectives and studies became more complicated. The online proposal process was not entirely clear and easy to follow and did provide a compatible format. Unfortunately, this is largely not an issue that we can solve from the applicant's perspective. We hope that feedback arrived from all who submitted proposals and will give insight to the developers of the online proposal forms on how to improve the process. If not, we will make an even greater effort in the future to best incorporate and clarify our information.

Appendix I. DFO's response to ISRP comments on the Canada-USA *Salmon Shelf Survival Study* (Project 200300900) submitted to the Northwest Power and Conservation Council in November 2010

200300900 - Salmon Shelf Survival Study

Proponents: Canada Department of Fisheries and Oceans

Short description: The Salmon Shelf Survival Study is an ongoing research and monitoring program jointly funded by CDFO and BPA aimed at understand the factors limiting the production of Columbia River salmon in the ocean environment, a key gap identified in the 2009 Fish and Wildlife Program. This research provides baseline data that can assist managers to discern climatic and oceanographic factors from the effects of habitat restoration, hatchery releases, hydrosystem operation, and harvest regulation.

ISRP final recommendation: Meets Scientific Review Criteria (Qualified)

Comment:

This project provides an important link to NOAA project #199801400 (Ocean Survival of Salmonids) for coastwide investigations of survival of northward-migrating Columbia River salmon distributed over the continental shelf off British Columbia and Southeast Alaska. The results benefit Columbia River salmon by potentially enabling managers to understand mechanisms of ocean survival and adaptively manage for changes in ocean conditions. The working hypothesis of this project is that “marine survival of salmon is mediated by the effects of ocean conditions on salmon growth during their first year at sea.” Overall, the project has made good progress on evaluating factors that affect early ocean growth and survival of Columbia River salmon. The ISRP believes it is highly important to keep building on the existing time series of data. The investigators continue to examine new ideas that develop through analyses of existing data. This project examines all species and races of salmon, and it is apparent that hatchery and wild fish are identified when possible. A major accomplishment of ongoing research is the identification of a potential growth/survival bottleneck (in some years) for juvenile Columbia River salmon related to ocean conditions off the west Coast of Vancouver Island. Another import result is the observation that the majority of Columbia River fish caught off British Columbia during summer are of hatchery origin. During the last three to four years the proportion of hatchery fish relative to wild fish has decreased despite fairly stable releases, which may indicate increased production of wild Columbia River salmon. Although the ISRP is not requesting a response to this proposal, we have one major qualification.

Qualification: Address the issues listed below during the contracting process and in the project's 2011 annual report, which will be reviewed by ISRP.

Response: We thank the ISRP committee for providing valuable comments that will help to improve the research and monitoring proposal and plan submitted by

CDFO as part of the *Shelf Salmon Survival Study*, as well as improve the collaboration among BPA-funded ocean survival projects.

Comment #1: Strategic Plan. As noted by the ISRP in previous reviews, the project would benefit from a strategic plan that prioritizes objectives in the event that only partial funding is available for this project.

Response: In the event that only partial funding was available for the *Shelf Salmon Survival Study*, the proposed research and monitoring could be divided into three tiers that represent incremental level of funding:

Bronze package:

The first priority will be to process the remaining archived samples of salmon that have been collected during the last twelve years (with three surveys a year, samples accumulate faster in the freezer than we can process in the laboratory with the current technical support we have for this project). This will allow us to address most of the biological objectives of this project, with the exception of the monitoring of invasive species. This project would be limited to a retrospective analysis of past data, and will thus not be able to track ongoing changes in the oceans. This will require funding to support one technician to process the samples in the laboratory analyses. Funding for genetic analyses, salmon bioenergetics (i.e. food consumption rates), and stable isotopes are considered the highest priorities, as they will provide the baseline data that are understanding of the processes regulating the growth and survival of Columbia River salmon. Due to limited support for data analysis and reporting, publications would be limited to those pertaining to ocean migration and bioenergetics of Columbia River salmon.

Silver package:

In addition to processing the archived samples of salmon described above, processing of the archived zooplankton samples as well as a complete analysis of the data collected to date are considered the second priority of this project. This would require funding to support one research biologist to analyze the data collected as part of this project and communicate the results through primary publications, as well as to cover the identification of the archived samples of zooplankton. As with the previous priority, this project would be limited to a retrospective analysis of past data, and will thus not be able to track ongoing changes in the oceans. However, the added support would allow CDFO to produce a series of publications on the effects of ocean conditions on Columbia River salmon in a timely fashion.

Gold package:

The final priority is to continue the ongoing research and monitoring sampling at sea, so that new field data can be collected and used to track changes in the ocean environment and their effects on Columbia River salmon. This would allow a better integration of the research conducted by NOAA Fisheries and Kintama Research on the ocean survival of Columbia River salmon.

Comment #2a: Linkages between CDFO and NOAA Sampling. The linkages between CDFO sampling off British Columbia and Alaska relative to NOAA sampling off Washington and Oregon need to be clarified. Can one project proceed without the other or are the two sampling programs interlinked so tightly that incomplete understanding would result if one project did not go ahead?

Response: The surveys conducted by CDFO and NOAA Fisheries are highly complementary, and allows a broader coverage of the ocean environment exploited by Columbia River salmon, notably spring Chinook salmon and Redfish Lake sockeye salmon. These ESUs quickly migrate out of the area covered by NOAA Fisheries (Trudel et al., 2009, Tucker et al., 2009, Tucker et al., 2011), and would be missed if sampling was only conducted off Washington and Oregon. Both CDFO and NOAA Fisheries recognize the necessity of coordinating these sampling programs and exchanging data and tissues to provide a comprehensive understanding of the processes regulating the survival of different Columbia River salmon ESUs in the ocean. For instance, NOAA Fisheries have been participating in CDFO surveys since 2007 to collect blood plasma for IGF-I measurements. These analyses will allow CDFO and NOAA Fisheries to map habitat quality (with respect to growth) for juvenile Columbia River salmon over a broad geographic area, and help to understand the limit to their production during their early marine life. CDFO has also performed DNA analyses on the juvenile sockeye salmon collected by NOAA Fisheries off Washington (Tucker et al., 2009), as CDFO has developed the only comprehensive coast-wide DNA baseline that can discriminate all the stocks of sockeye salmon within the Columbia River baseline (Beacham et al., 2005; Beacham, unpublished data) [Note: The SNP baseline developed by Habicht et al (2007) does not discriminate sockeye salmon stocks located between the Columbia River and Southeast Alaska]. The timing of the summer and fall surveys are comparable, and both research programs collect similar data to facilitate comparisons among the regions covered by these projects. Hence, neither project by themselves can fully address the Ocean Strategies of the Columbia River Basin Fish and Wildlife Program. But combined, they increase our ability to predict the response of Columbia River salmon to changing climate and ocean conditions.

Comment #2b: The proponents state, “In addition, CDFO and NOAA Fisheries are planning to extend the CDFO winter survey to the Washington and Oregon coasts to provide additional information on the distribution of Columbia River salmon and to describe the biophysical environment they encounter in these waters during winter. This area has never been sampled for juvenile salmon at that time of the year due to inclement weather.” However, this survey is not described as an objective, and the CDFO work is only to “complement” NOAA work. Presumably similar methods will be used in both CDFO and NOAA surveys, but this needs further explanation. Does NOAA now have a vessel that can handle heavier weather or is there some other reason why the winter survey is now feasible? Have the data from CDFO winter surveys been used to evaluate the winter starvation hypothesis (Beamish & Mahnken, 2001)?

Response: As winter has been hypothesized to be a critical period for juvenile salmon (i.e. Beamish & Mahnken, 2001), conducting field surveys during winter is necessary to evaluate this hypothesis. To date, the data collected by CDFO in the Alaska Coastal Current system are consistent with the starvation hypothesis, but not in Northern California Current (except under extremely poor ocean conditions, such as in 2005). However, this hypothesis remains to be tested on Columbia River salmon.

NOAA Fisheries do not currently have a vessel capable of performing winter surveys. Although no formal plans have been established, CDFO and NOAA Fisheries are currently discussing the possibility of using the *CCGS WE Ricker* in FY11-FY12 to sample the ocean environment from the Oregon coast to the west coast of Vancouver Island during winter. CDFO has been using this vessel to conduct winter surveys off British Columbia and Southeast Alaska since 2001, and hence has the necessary expertise to sample when inclement weather conditions prevail on the continental shelf. As Columbia River fall Chinook appear to remain primarily off coastal Washington and Oregon during their first year at sea (Trudel et al., 2009, Tucker et al., 2011), this joint survey would allow CDFO and NOAA Fisheries to directly test the winter starvation hypothesis on Columbia River salmon.

Comment #2c: NOAA is now proposing to look at sockeye salmon (assuming they have a few fish in their samples). Sockeye is a specific species that the two projects need to collaborate on since Columbia sockeye increased during a period when Fraser River sockeye collapsed (the 2005 & 2007 Fraser smolt years produced very low adult returns compared to what was expected from the long-term Ricker relationships).

Response: CDFO and NOAA Fisheries have collaborated to develop a microsatellite DNA baseline that can be used to discriminate all the sockeye stocks within the Columbia and Snake River basins and to describe the migration routes and behavior of sockeye salmon (Tucker et al., 2009). Both agencies anticipate pursuing their collaboration to understand the processes affecting juvenile sockeye in the marine environment. This will not only help to explain the recent increase in the returns of adult sockeye salmon to the Columbia River, as well as the decline of Fraser River sockeye during the last two decades, as well as the exceptionally high returns observed in 2010.

Comment #3: Interannual Variations in Salmon Distribution. The proponents state, “This project will be successful if interannual variations in the marine distribution of Columbia River salmon are detected.” Proponents should keep in mind that even if interannual variations are detected and significant, we need to know about the mechanisms that determine the variations and how much they vary in time and space. How many years will it take before success can be determined or will this go on forever? The proponents need to consider important sources of variation in research trawl fishing operations and

fishing efficiency with respect to what is known about diel, horizontal, vertical, and seasonal distributions of juvenile salmon. How might these sources of variation affect time-series observational data on species composition, abundance, distribution, growth, etc., of juvenile salmon in the survey area?

Response: The purpose of that project is actually to determine the factors and mechanisms that affect the variability in the ocean distribution of juvenile Columbia River salmon. The statement quoted by the ISRP should have read instead: “This project will be successful if interannual variations in the marine distribution of Columbia River salmon can be modeled as a function of the physical, chemical, and biological condition encountered by these fish”. In addition to temperature, salinity, phytoplankton, and zooplankton biomass, this analysis will consider the time of year (i.e. season) and fish community structure (i.e. species composition and abundance). Growth may be also incorporated in the analyses using either the IGF-I measurements that have been performed by Dr. Beckman on our surveys or otolith microstructure, though it is important to note that IGF-I measurements were only initiated in 2007. Sampling is generally restricted during daylight hours. Hence, it will not be possible to consider diel changes in horizontal and vertical distribution in this study.

The ability of these models to predict changes in salmon distribution over time will depend on the range of variation observed for each of the explanatory variables (e.g. temperature, phytoplankton biomass, smolt production, etc ...). The abiotic and biotic conditions monitored by CDFO during the last decade have varied considerably. Hence the habitat models that will develop by CDFO as part of the *Shelf Salmon Survival Study* are expected to be valid over a broad range of climate and ocean conditions experienced by Columbia River salmon.

Comment #4a: Invasive Species (Objective 3). No details were provided in Objective 3 of the proposal, although section 3.4 of the Major Accomplishments section mentions Humboldt squid. What invasive species will be investigated? How will this information be used?

Response: It is difficult to predict which species will invade the area currently sampled by the *Shelf Salmon Survival Study*, though Humboldt squid is an obvious candidate. However, as all the species collected in the trawl net and bongo nets are identified at the species level, the occurrence of unusual species and range expansion of non-native species will be documented and reported. We will continue to work with other groups at CDFO to document the distribution and abundance of unusual and invasive species.

Their impacts on salmon and marine ecosystems are more difficult to assess: a concomitant change in salmon survival with the appearance of these unusual species may be indicative that they have a significant effect on salmon; though these results will have to be interpreted carefully. For instance, some have argued that the low

return of Fraser River sockeye salmon in 2009 may be linked to the high abundance of Humboldt squid on the continental shelf, despite the lack of direct evidence of predation on Humboldt squid on sockeye salmon. This hypothesis is interesting in itself, but fails to explain why Chinook jack reached a historical high level in the Columbia River for the fall runs in 2009. Predation by Humboldt squid on these fish is expected to be higher, as Columbia River fall Chinook most likely remain on the continental shelf for most of the marine life (Trudel et al., 2009, Tucker et al., 2011), and are therefore expected to interact with Humboldt squid for an extended period of time. They are also smaller than Fraser River sockeye, and potentially more vulnerable to predators (i.e. slower swimming speed).

Comment #4b: Pacific whiting migrations and potential predation could be integrated with estimates to the south. Nothing is mentioned in the proposal about forage fish as a buffer to smolt predation, although the proponents note that a subset of the pelagic forage fish caught in the trawl is sampled. The ISRP encourages proponents to assess the availability, size, and abundances of forage and predatory fishes and squids in their trawl survey catches.

Response: Although not explicitly stated in the proposal, we are planning to examine how adult returns and marine survival of Columbia River salmon are affected by the abundance of forage fish (i.e. predation buffer or competition) and predator using correlations, path analyses, and Bayesian Beliefs Network. We will not only use the catch data from our surveys for these analyses (counts and biomass estimates have been systematically recorded for all species since 2005, and size is available for a subsample of the catch at each station), but also biomass data available from stock assessment surveys and publications.

Comment #5: Coordination with Other Projects. This project benefits greatly from in-kind match support from CDFO, which funds two of the three project surveys each year. The effort includes analysis of stocks from other regions, and this provides for interesting comparisons with Columbia River salmon. The project also has shared information with NOAA's Ocean Survival of Salmonids Project. Still, it would be good for the BPA-funded CDFO, NOAA, and Kintama investigators to coordinate and integrate their efforts and their findings to a greater extent than shown in the proposals. Also, consider greater use of ocean monitoring data collected by other (non-BPA funded) projects for developing indices of ocean conditions, such as hydroacoustics, remote sensing, oceanographic buoys and floats, and robotic vehicles. The ISRP recommends improved coordination and collaboration with other projects and programs collecting these data.

Response: Although significant progress has been achieved during the last five years with respect to collaboration among BPA-funded ocean survival research through joint publications and workshops, sample and data exchange, further effort is certainly required to increase the coordination and integration of these projects. As a first step, NOAA Fisheries, CDFO, and Kintama Research are convening a

meeting in February 2011 to discuss recent findings and upcoming field work in order to improve the collaboration among these projects. All these projects also plan to use monitoring data obtained via remote sensing and buoys, and test fisheries for groundfish and pelagic fish as additional source of ocean and climate data. Although floats are primarily restricted to the open waters of the Pacific Ocean (i.e. Argo floats), they may help to better characterize the boundaries of coastal domains and sources of plankton to the shelf (Batten & Freeland, 2007) where Columbia River salmon spend the first few months of their lives.

Comment #6. Genetic stock identification. The ISRP recommends standardization of genetic stock identification methods used by BPA-funded ocean survival projects so that results are directly comparable among projects. Different projects may currently be using different methods but this was not clearly explained in the proposal.

Response: All the BPA-funded ocean survival projects currently use microsatellite DNA to determine the origin of the fish caught in their study, as microsatellites have consistently been showed to provide a considerably higher degree of accuracy in GSI analyses than Single Nucleotide Polymorphism (SNPs) in Chinook salmon (Narum et al., 2008, Beacham et al., In review), sockeye salmon (Beacham et al., 2010), and chum salmon (Beacham et al., 2008), at least with the SNPs that are currently available for these species.

Chinook salmon: CDFO uses the CDFO microsatellite baseline (Beacham et al., 2006a), whereas NOAA Fisheries and Kintama use the GAPS microsatellite baseline (Seeb et al., 2007, Narum et al., 2008, 2010). Although these baselines rely on different microsatellite loci, both baselines provide comparable assignments at the basin level (Hanson et al., 2010, Beacham et al., In review). Hence, the GSI results obtained by CDFO, NOAA Fisheries, and Kintama on Chinook salmon can be directly compared at the ESU level (i.e. Lower Columbia River, Willamette, Upper Columbia River spring, Upper Columbia River summer/fall, Snake River spring/summer, and Snake River fall). There is insufficient coverage with both baselines to adequately assign individual Chinook salmon at the stock level.

Coho salmon: NOAA Fisheries uses a microsatellite baseline that include populations ranging from Northern California to southern British Columbia (Van Doornik et al., 2007). This baseline is suitable for the “Ocean Survival of Salmonids Study”, as it contains the ESUs that are likely to occur off Washington and Oregon. This baseline is not appropriate for the “Shelf Salmon Survival Study”, as it lacks stocks originating from the regions sampled by CDFO such as the central and north coasts of British Columbia and Southeast Alaska. We are currently expanding and testing the performance of the coho salmon baseline developed at CDFO with fish of known origins.

Sockeye salmon: CDFO uses the microsatellite baseline developed at CDFO (Beacham et al., 2005). Redfish Lake sockeye salmon were added to the CDFO

baseline in 2010. As a result, we can now accurately discriminate individual sockeye salmon originating from Redfish Lake, Lake Wenatchee, and Lake Okanagan. Juvenile sockeye salmon samples collected by NOAA Fisheries as part of the “Ocean Survival of Salmonids Study” have been analyzed by CDFO (Tucker et al., 2009). Hence, in this case, the same baseline and laboratory has been used to determine the origin of juvenile sockeye salmon.

Chum salmon: None of the BPA-funded ocean survival projects are planning to conduct GSI analyses on chum salmon. The “coast-wide” microsatellite baseline developed by CDFO does not currently include any chum salmon from the Columbia River (Beacham et al., 2009), but can easily be updated if DNA analyses are required for juvenile chum salmon caught at sea.

Comment #7: Tag recovery and reporting. In addition to collection of coded-wire tags and PIT tags, all salmon and steelhead sampled during fishing operations should be examined for recovery of acoustic tags, if this is not already being done (no mention of this in the proposal). The ISRP recommends using a handheld wand detector, V-Detector, or tunnel detector onboard the survey vessels to examine all salmon and steelhead in survey catches for coded-wire tags (CWTs), as some Columbia River hatcheries release CWT fish that do not have an adipose fin clip. Apparently, data on CWT recoveries collected by this project have not been reported to the Pacific States Marine Fisheries Commission’s (PSMFC) RMIS database since 2005. Are PIT tag recovery data reported in the PSMFC’s PTAGIS database? The ISRP strongly recommends that reporting of recovered CWTs and PIT tags to the PSMFC’s RMIS and PTAGIS databases should be done on an annual basis.

Response: All the Chinook, coho, sockeye, and steelhead salmon are systematically scanned on board the ship with a handheld wand detector to determine the presence of coded-wire tags (CWT), irrespective if their adipose fins have been clipped or not (Morris et al., 2004). In addition, all the Chinook salmon are scanned onboard the ship for the presence of PIT tags. The ISRP accurately pointed out that the CWT and PIT tag data collected during the Shelf Salmon Survival Study has not been submitted to RMIS and PSMFC's PTAGIS databases since 2005. We have experienced some difficulties in the past within CDFO to submit our CWT to RMIS. We plan to submit all our remaining CWT and PIT tag recoveries to these databases within the next year. As we experienced some difficulties in the past within CDFO to submit these data to external databases, we will be seeking advice from Dr. K. Myers who was instrumental in submitting our CWT recoveries to RMIS in the past (Note: The 2005-2009 CWT recovery data were recently sent to Dr. Myers so that they can be incorporated in the RMIS database).

Comment #8a: Forecast models. The proponents state, “With more than a decade of observations on the ocean conditions experienced by juvenile salmon on the west coast of BC, this CDFO-BPA study has started to develop simple forecasting models for the marine survival of Columbia River salmon 1-2 years prior to the return of adult salmon to

their natal river.” However no elaborations of these models are provided - can this be done? Can confidence intervals be placed on the qualitative information in the red-yellow-green traffic-light charts or some kind of probabilistic statistic?

Response: Yes this can be done, and we apologize for not explicitly stating how we were planning to achieve this. In this project, we propose to assess the effects of ocean conditions on the marine survival and adult returns of Columbia River salmon using linear correlations and regressions with a series of biotic and abiotic variables thought to regulate juvenile salmon growth and using Bayesian Beliefs Networks. These models use ocean conditions experienced by juvenile salmon, and hence, can be used as leading indicators for salmon returns.

Linear regression models can be used to quantitatively predict marine survival and adult returns, and confidence limits around these predictions can be derived using standard statistical textbooks (e.g., Sokal & Rohlf, 1995). However, as pointed by the ISRP, confidence limits around regression models can at times be large. Instead of focusing on quantitative predictions, Prairie (1996) argued that confidence limits around regression models may help to identify the number of distinct classes that a model can truly predict. He further derived a simple function based on the coefficient of determination (R^2) that can be used to determine the number of classes regression models can distinguish. With R^2 ranging from 65% to 85%, regression models can truly distinguish 2-3 classes, such as below average, average, and above average. We propose to use the mean plus or minus half a standard deviation (mean ± 0.5 s.d.) of marine survival and adult return to identify the limits for below average (survival $< \text{mean} - 0.5$ s.d.), above average (mean $+ 0.5$ s.d.), and average (anything within 0.5 s.d. of the mean). In a normal distribution, approximately 34% of the observations are within half a standard deviation of the mean. Hence, these limits generate three classes of roughly the same size. This approach can therefore be easily transposed into red-yellow-green traffic-light charts (i.e. below average, average, and above average).

The Bayesian Beliefs Network (BBN) is an extension of the multiplied regression model applied to qualitative and quantitative relationships, and can be used to directly determine the probability that marine survival and adult return will be below average, average, and above average, and hence provide a direct probabilistic statistics for the red-yellow-green traffic-light charts. The advantage of the BBNs over linear regression models and principal component analyses is that BBNs can simultaneously take into account the relationships that are expected to occur among predictors (such as those depicted in Figure 1 of the proposed research), and examine how marine ecosystems respond to climate forcing.

Comment #8b: Forecast models. The proponents state, “Given that the C:N ratio is an indicator of lipids, and that prey size and lipid contents generally increase with trophic position in aquatic food webs (Rasmussen et al., 1990), salmon growth should also be

positively correlated to the C:N ratio in plankton, their trophic position, and plankton biomass.” Has this hypothesis been tested before?

Response: Relationships between the C:N ratio and lipids have been derived for fish and aquatic invertebrates for two decades (McConnaughey & McRoy, 1979), and has been confirmed by several studies (e.g., Post et al., 2007, Mintenbeck et al., 2008, Hoffman & Sutton, 2010; and several others, Tarroux et al., 2010). Prey size and lipid concentration have been showed to increase with trophic levels in aquatic food webs (Rasmussen et al., 1990, Fisk et al., 2001, Post et al., 2007). Model simulations suggest that prey quality can have strong effects on juvenile salmon growth (Trudel et al., 2002). Effects of prey quality on juvenile salmon growth have also been inferred for pink salmon in Prince William Sound based on their diet (Armstrong et al., 2005, 2008) as well for Oregon coho salmon based on copepod communities (Peterson & Schwing, 2003, Peterson, 2009). However, we are not aware of any studies that have attempted to empirically assess the effects of prey size and prey quality on juvenile salmon growth and survival in the same analysis, and to examine how changes in prey size and prey quality are linked to climate and ocean circulation affect.

Comment #8c: Forecast models. Why not correlate growth, boreal copepods, C/N of plankton with SARs of Chinook (as with Oregon Production Index Hatchery survival) rather than numbers returning? Consider whether ocean survival forecasts could be improved by integration of additional sources of variation in freshwater and ocean survival (e.g., ocean harvests of immatures, jacks, and adults in Alaska and Canada, bycatch in commercial groundfish fisheries, climate and ocean conditions in offshore rearing areas)?

Response: Harvest managers are generally interested in knowing how many fish will come back rather than the marine survival. A high marine survival during years of low smolt production may still lead to few adults returning to spawn, and hence, may still result in fishery closure. Conversely, a low marine survival in years of excessively high smolt production may lead to a good return (but see the low return of adult Fraser River sockeye salmon in 2009 despite one of the highest smolt production year on record). This is the primary reason we are attempting to focus on adult returns rather than marine survival; though this approach requires knowing how many smolts are produced in different systems. Nevertheless, for completeness of our analyses, we will attempt to examine how Chinook SARs vary in relation to ocean conditions.

Most of the mortality is expected to occur in coastal waters during their first year at sea (Pearcy, 1992). The strong correlations observed thus far between adult returns, marine survival, and the ocean conditions observed off the west coast of Vancouver Island strongly suggest that recruitment variability is determined early during their marine life. Hence, we are focusing most of our research on the marine ecology of juvenile salmon when they are on the continental shelf. Nevertheless,

significant mortality may be occurring elsewhere during their marine life. Hence, additional factors such as those listed by ISRP may be explored to provide more robust forecast to fishery managers.

Comment #8d: Forecast models. Are anoxic conditions considered in forecast models?

Response: Oxygen concentration in BC and Southeast Alaska waters have only been measured during the last 3-4 years. This time series is not sufficiently long at the moment to be of any use in predictive models of salmon survival, but may be considered in future iterations of the model. However, oxygen concentration is generally well above hypoxia or anoxia at the depth strata occupied by juvenile salmon, and hence is not expected to affect their survival. Nevertheless, continued monitoring of oxygen concentration is warranted given that anoxic waters have been observed off the Oregon coast (i.e. Dead Zones).

Comment #9: In-river versus ocean survival. In the proposal, the proponents state, “Finally, the in-river survival of salmon smolts is similar in large rivers with and without dams (Welch et al. 2008).” Is this a defensible generalization? For example, several organizations have said there were too few years in the Welch et al. study to reach this conclusion. This leads to the larger issue of whether proponents can deliver accurate quantitative forecasts of Columbia River salmon survival and adult returns without also considering in-river effects.

Response: We agree with the ISRP that the observations obtained by Welch et al. (2008) cannot be generalized beyond the years they studied. The extent to which in-river conditions will affect the ability of the Shelf Salmon Survival Study to accurately forecast Columbia River survival and adult returns is currently unknown. However, given that salmon stocks from the Columbia River and the west coast of Vancouver Island respond similarly to ocean conditions in the Northern California Current System (Fig. 38, 39, 40, and 42 from the annual report submitted to BPA by Trudel et al., 2011), it would appear that the returns of Columbia River salmon are driven to a large extent by changes in the ocean environment. However, continued monitoring of both the river and ocean conditions are necessary to tease apart their effects on Columbia River salmon.

Comment #10: Scientific workshop. ISRP recommends a scientific workshop in 2011 focused on estimation of estuarine and ocean survival, forecasting of adult returns, and adaptive estuary, plume, and ocean environmental assessment for Columbia River Basin salmon and steelhead. Perhaps the proposal should include this workshop. A workshop would help to improve coordination and collaboration, standardization of methods (e.g., genetic stock identification), development of simulation and predictive models, and integration of results among Columbia River Basin estuary/ocean projects. One aspect of all projects that needs work is how to include more detail on sub-stock structure,

including hatchery versus wild fish, hatchery release time, area comparisons, in-river migration and associated ocean migration, and more in the models.

Response: A coordination meeting between BPA-funded ocean survival projects will be hosted by NOAA Fisheries in Newport in February 2011. The purpose of this meeting is to improve on coordination and collaboration, and standardization of methods among BPA-funded projects, and to integrate the results of these projects. It is expected that the field surveys of ocean conditions conducted by CDFO and NOAA Fisheries combined with the region-specific survival estimates derived by the *Coastal Ocean and Salmon Tracking* project will improve our ability to assess how the estuary, plume, and ocean provide the necessary data affect Columbia River salmon and steelhead.

A workshop focusing on the marine ecology of juvenile salmon and forecasting models will be hosted by NOAA Fisheries in Seattle on March 23-24 2011. Forecasting and simulation models structure and performance will be evaluated and compared at the workshop.

As with any scientific research, progress is achieved incrementally. Early attempts focused on large aggregation of stocks, without any discrimination of wild and hatchery fish. Now that we can identify wild and hatchery fish, and that tools are available to delineate major ESUs and track in-river migration, future efforts to relate Columbia River salmon to ocean conditions by CDFO and NOAA Fisheries will focus on ESUs and incorporate river conditions expected to affect the timing of ocean entry of these fish. Though, it is important to note that the ability to go beyond ESUs is limited by DNA baselines as well as by the number of fish that are and can be caught at sea, given sampling permit restrictions on ESA-listed stocks.

Comment #10b: CDFO and NOAA seem to be taking somewhat different approaches to salmon forecasting, i.e., stoplight charts (red, yellow, and green) with a Bayesian belief network approach by CDFO versus ecosystem indicators by NOAA. Can this be reconciled?

Response: The approaches proposed by CDFO and NOAA have their strengths and weaknesses. For instance, the Bayesian Beliefs Network directly provides a probability estimate that returns or survival will be low, medium, or high (or red, yellow, green), is well suited for quantitative and qualitative data, takes into account the relationships that are expected to occur among explanatory variables (such as sea surface temperature, mixed-layer depth, current direction, ...), but is computationally more complex. The approach used by NOAA simply ranks the observations from lowest to highest with respect to their expected effects on salmon returns. However, some variables that are included are potentially redundant (for instance, sea surface temperature and PDO). Averaging the ranks will give this give more weights to redundant variables, which bias their forecast. Despite these differences, the results of both approaches can and will be compared directly.

Comment #11: Adaptive management. Project proponents might be overselling their ability to provide quantitative estimates of ocean conditions to help forecast runs. A case in point seems to be CDFO's recent failure to forecast near record returns of Fraser River sockeye salmon in 2010. A project focus directed toward use of information on ocean conditions for adaptive management of Columbia River hatchery operations, hydrosystem operations, and habitat restoration might be more appropriate.

Response: We agree with the ISRP that the proposed research is best suited to provide *qualitative* indicators on the state of ocean conditions with respect to salmon (favorable, unfavorable, or neutral) “for adaptive management of Columbia River hatchery operations, hydrosystem operations, and habitat restoration” due to the uncertainties in the correlational models derived in this project. Nevertheless, these models can still be used to provide *quantitative* predictions on salmon returns that help managers to make informed decisions on harvest rates. Notably, the growth indicators developed as part of this project have been incorporated into the CDFO stock assessment for west coast of Vancouver Island (WCVI) coho salmon in 2009. A comparison of the various methods used by CDFO to forecast the marine survival of WCVI coho salmon (e.g. coho jacks, euphausiid biomass, stock-recruitment models) have showed that the growth indicators derived in this project provided the most accurate estimates of marine survival for these fish. Preliminary data for the 2010 returns appear to be consistent with the predictions obtained from these growth indicators. Thus, these correlational models have the potential to inform managers on future returns of salmon, and guide harvest management decisions.

Notes concerning Fraser River sockeye: The methods currently used by CDFO to forecast the return of Fraser River sockeye are based on Ricker stock-recruitment curves and do not include any information on the ocean conditions experienced by these fish. This may explain, at least in part, why CDFO has been unable to forecast the unusually low and high returns of sockeye salmon to the Fraser River in 2009 and 2010, respectively.

Comment #12: Communicating results. Consider developing more effective approaches for communicating project results and forecasts of ocean survival of salmon directly to Columbia River Basin hatchery, hydrosystem, and harvest managers. The websites, scientific meetings, and peer-reviewed scientific publication are excellent methods for communicating with other scientists, government agencies, educational institutions, and conservation organizations, but are likely not effective tools for communicating directly with hydro, harvest, and hatchery managers.

Response: CDFO will work with their BPA COTR in FY11 and beyond to develop a more effective approach to effectively communicate the results of the *Shelf Salmon Survival Study* directly to Columbia River Basin hatchery, hydrosystem, and harvest managers.

Comment #13: Update Online Proposal Format. The format of this proposal was confusing and difficult to follow. Proponents should reformat their online proposal to better conform to the specific information requested in each section of the online form. The repetition of the same deliverables under several objectives seems unnecessarily repetitive. Objectives providing the same deliverables could be combined into one objective. Specific objectives need to be clearly stated as desired outcomes in the proponent's section 2.0 of the problem statement, instead of describing the methodological approaches. These should correspond to objectives in the objectives and deliverables part of the proposal form. At present, objectives are not stated as desired outcomes, for example, Objective 1 is "Ocean Conditions," and this might be better stated as, "Assess effects of ocean conditions on Columbia River salmon survival." The problem statement section is unnecessarily long, and describes the entire proposal including methods, timelines for deliverables, etc. This section could be shortened by moving methods, etc., to other more appropriate sections of the proposal. This proposal needs to address the online tailored questions for tagging as it involves recovery of CWTs and genetic stock identification.

Response: We attempted as much as possible to adhere to the online forms to develop this research proposal. Like the ISRP, we feel that there was some repetition among some sections, which made the proposal unnecessarily long. Given that this comment was raised by ISRP on several of the proposals submitted to BPA, we would be tempted to conclude that this occurred as a result of a lack of clarity on the online forms. For instance, in the Problem Statement section, the instruction indicates the following:

"In this section describe the specific problem or need your proposal addresses. Describe the background, history, and location of the problem. For projects doing research or monitoring, identify the management questions the work intends to address and include a short scientific literature review covering the most significant previous work related to the project. Also include the work of [key project personnel](#) on any past or current work similar to the proposal."

As this project is an ongoing Research, Evaluation, and Monitoring project, part of the scientific background requires that we discuss the issue that we are trying to address, which by necessity should also include a summary of the research conducted by the proponents (i.e. what have the proponents found to date, and what is currently missing), as well as a description of the management objectives pertaining to BPA. We opted to only provide a limited summary of the key findings of our past research on this topic in this section, as there was a much more detailed section where we were asked to present the major accomplishments of our project. Nevertheless, to reduce the length of the proposal, we eliminated the Methods and Timeline components of this section, as the methods section was described elsewhere in details.

We agree with the ISRP that two of the objectives were fairly similar (Ocean Conditions and Climate Change) and grouped them together. Also, as requested by the ISRP, we changed the rephrased the title of each objectives to reflect a desired outcome.

Finally, the intent of the BiOp RPAs that focus on recovery of CWTs and genetic stock identification RPA 62 appeared to be targeting adult fish more than juvenile salmon, which is why we did not include any specific information for these RPAs in the proposals.

Appendix J. Kintama's response to ISRP comments on the *Coastal Ocean And Salmon Tracking Study (Project 200311400)* submitted to the Northwest Power and Conservation Council on December 2010

200311400 - Coastal Ocean Acoustic Salmon Tracking (COAST)

Proponents: Kintama Research

Short description: By providing direct data on smolt movements and survival in the early ocean period, this proposal addresses a number of BiOp requirements and objectives in both the Fish and Wildlife Program and the MERR Plan. It also extends Kintama's 2006-2010 work and results. The intent is to inform FCRPS management with detailed data about listed Chinook stocks, including patterns of migration; seasonal changes in ocean survival relative to the hydrosystem and estuary; and survival correlations with ocean indicators.

ISRP recommendation: Meets Scientific Review Criteria (Qualified)

Comment:

This is one of three BPA-funded projects that address the critical uncertainty of ocean effects on survival of Columbia River salmon. The ISRP appreciates that project proponents have followed some of ISRP's past recommendations to develop approaches tailored specifically to Columbia River salmon in the estuary, plume, and ocean. Coordination with other ocean and estuary projects has improved. However, a number of past issues raised by ISRP and ISAB have not been addressed. In addition, there are new issues resulting from proposed changes in project design and methods that need to be addressed. Although the ISRP is not requesting a response at this time, we do have one major qualification.

Qualification 1: Address the issues listed below during the contracting process and in the project's 2011 annual report, which will be reviewed by the ISRP:

1. Feasibility of COAST Approach. How can the proposed objectives be achieved if the open-coast acoustic array is still being developed? Are there other approaches that would be more cost-effective for estimating life-stage specific open ocean distribution and survival of salmonids?

The proposed work could yield important new data on coastal and estuarine distribution of Columbia River Basin salmonids and endangered ESUs. However further information is requested on how the proponents view the strategic balance of this project between assessing broad "offshore" distributions (where it appears more development work is needed as mentioned below) versus detailed monitoring to estimate survival between closely spaced reaches in the estuary.

Response: Most technologies continuously evolve and few ever reach stasis without also becoming obsolete. We expect that we will continue to refine the array technology while also conducting salmon conservation research; the two are inseparable unless funding models change and large amounts of money are granted solely for engineering development work divorced directly from the salmon conservation issues; we view this as extremely unlikely.

When we developed the original pilot-scale design to demonstrate feasibility for Columbia River salmon issues in 2003~04, NOAA's trawl survey work indicated that essentially all Chinook smolts were caught in waters shallower than 200m; we thus set the outer limit to the array to this depth. Since then, based on the acoustic tagging results, we have found that in some years there is an essentially uniform distribution of Chinook smolts out to at least 280m, the current (2010) outer limit of the sub-array at Willapa Bay (however, smolt distribution farther north at Lippy Point is concentrated on the mid and inshore shelf area). Interestingly, NOAA's trawl surveys in the Willapa Bay area since 2007 have consistently captured smolts in 200 m water depths, so it is possible that smolts show wider cross-shelf distribution into deeper waters now than in the early years of the decade. However, the NOAA trawl results (Bi et al., 2007; Figure 3) do show that the probability of capturing juvenile Chinook or coho in the Washington coast trawl survey does go to zero by about 300-600 m bottom depths:

We suspect that our coastal arrays thus come close to covering most of the smolt migration corridor because the estimated detection probability of the Willapa Bay sub-array, as measured from the ratio of detected/not-detected smolts enumerated on the Lippy Point sub-array is quite close to the detection

probability of the sub-arrays within the Salish Sea (Strait of Georgia) once receiver loss to trawlers is taken into account (Melnychuk, 2009, Welch et al., 2009, Melnychuk & Walters, 2010). This suggests that the unbounded outer coast arrays are detecting most migratory smolts; however, as we noted in our proposal, the return of several tagged smolts as adults that were not previously detected as smolts on the ocean array is a cause for concern. We cannot as yet reliably evaluate

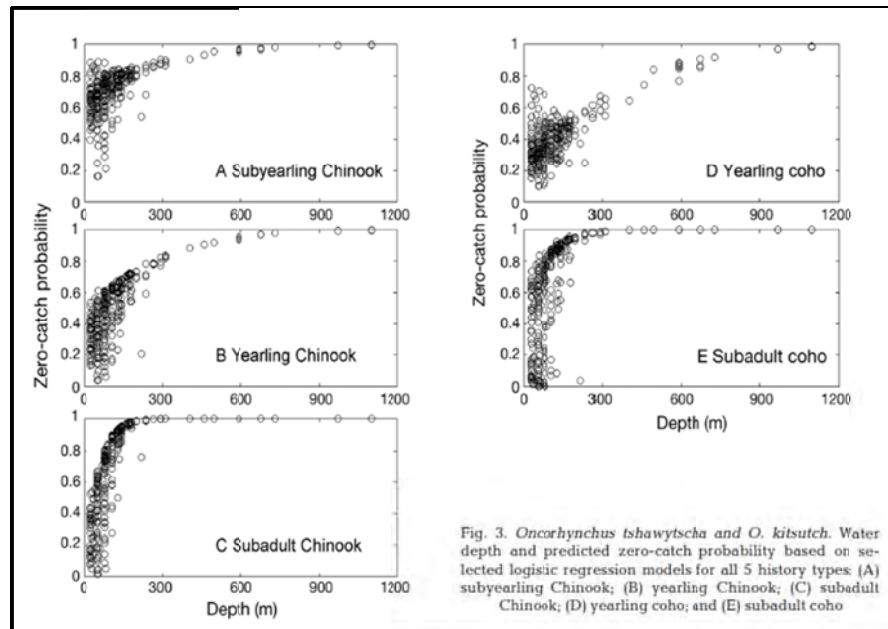


Fig. 3. *Oncorhynchus tshawytscha* and *O. kitsutch*. Water depth and predicted zero-catch probability based on selected logistic regression models for all 5 history types: (A) subyearling Chinook; (B) yearling Chinook; (C) subadult Chinook; (D) yearling coho; and (E) subadult coho

whether the return of adults not detected as smolts represents smolts that (1) permanently migrate off-shelf; (2) take up residence between arrays; or (3) migrated on the shelf but were not detected by the arrays.

We do not currently believe that there are other more cost-effective approaches that we could implement; both the JSATs and HTI technologies use acoustic tags whose frequencies are infeasible for use in the coastal ocean. Furthermore, other than acoustic telemetry, there are no other technologies that can provide direct, and robust determinations of salmon movements and survival in the coastal ocean: acoustic receiver arrays sample 24x7x365 throughout the whole water column across migration corridors.

The project claims that its methodology is the only experimental technique available for addressing these issues, including early marine survival of salmon. While the approach is innovative and more direct, other studies have used incremental scale and otolith growth to examine size- and life-stage dependent mortality during specific periods at sea.

Response: Projects involving scale or otolith growth are focussed solely on the survivors that return as adults; as a result, it is unclear when (& therefore where) in the life history mortality occurs and how it relates to the growth patterns of the survivors seen in the early life history. In particular, if survival variation later in the life history is large, the interpretation of scale or otolith based early growth patterns may be distorted in complicated ways that confound survival effects later in the marine life history with survival in the early coastal phase. These are not separable if both life history periods are important to adult returns.

The low reported survival at sea is not surprising given the history of low survival rates of yearling and subyearling Chinook salmon based on CWT data. Chinook salmon are well-known to have lower ocean survival rates than other salmon species. The declining survival with distance from the Columbia is expected. For fisheries management, the key information is the evaluation of survival of in-river versus transported smolts. It would be of interest to compare results from CWT and PIT tagged salmon with those from this study and evaluate the benefit of the acoustic tag versus CWT and PIT tag for this management question because the acoustic tag approach is much more costly.

Response: We will attempt to do so in future. Because the number of tags needed to measure juvenile survival over the first few months at sea is much smaller than what is needed to estimate SARs (to adult return) using PIT tags, we believe that the cost of our early marine survival estimates may be roughly comparable - while the cost of the tags differs by approximately one-hundred fold, the acoustic tag sample size needed is only about 1/100th the number needed for PIT tag-based studies. Our ability to compare survivals is however, currently somewhat limited because it takes 3 years for all the adults to return from the sea and generate final SAR estimates; this means that the 2006 acoustic tag survival estimate can be compared with the 2009 SAR estimate, and the 2007 acoustic tag survival estimate can be compared with the 2010 SAR estimate. Although we have acoustic tag survival estimates for

2. Strategic Plan for COAST Array Location. Does COAST have a strategic plan for COAST array location, developed in cooperation with other Columbia River projects that use or plan to use BPA-funded arrays for their projects? If not, such a plan needs to be developed.

Response: We agree with the ISRP on the importance of the two southern sub-arrays (particularly for identifying which stocks of spring and fall Chinook move south) and that there are clear statistical benefits to additional tagging, as we

demonstrated in our proposal. However, the 2012-14 proposal request was clearly constrained to current funding levels which forced us to balance several research priorities. Since the ISRP review, we have also responded to an RME workgroup review with the benefit of more recent data, and we are now proposing to move one of our planned northerly sub-arrays to south of the Columbia for 2011 to re-examine southerly migration patterns. More generally, we can readily provide further detailed cost estimates in support of an expanded program including more sub-arrays and more tags if additional funding is available.

“A closer examination of the location of arrays. . . to develop a strategic plan” can certainly be developed. We note, however, that the location of sub-arrays is not dictated solely by purely scientific issues - it has taken many years to put together the coastwide permits required, plus much prior planning of locations that would be relatively effective. Factors that need to be taken into account in choosing locations include:

- good physical locations to prevent gear loss due to natural events
- moderate shelf widths to reduce cost
- proximity to ports to more rapidly access data and reduce vessel time
- reduced impact from commercial fishers to minimize loss and maximize detection rate

We would be pleased to present this material, but are uncertain as to how to organize this—perhaps as part of the suggested regional workshop?

3. Coordination with other projects. What specific process is used by COAST to coordinate with other projects to estimate survival of Columbia River salmon?

Coordination with other projects has improved, but it could be better. The proponents promise to tie in closely with the CDFO Shelf Survival proposal (#200300900) and the NOAA Ocean Survival of Salmonids proposal (#199801400). All three projects promise a key deliverable - survival. However, the coordination appears rather loose and further information on exactly how the three projects will work together is required.

Response: We have collectively discussed the ISRP’s request with the NOAA & DFO groups and are proposing that we will add one specific day of additional coordination and planning to the end of the now annual Salmon Ocean Ecology meeting that all three parties attend. (The 2011 meeting is scheduled for 23-24 March in Seattle). We will use this venue to review our collective results and discuss possible additional collaborative work. Note that under Kintama’s 2011 program of work, time is allocated specifically to develop a coordinated program with NOAA for 2012-14.

The only other formal co-ordination we have had was a collaborative effort to compare the survival rates of JSATs and Kintama-tagged smolts in 2010, which Dr Skalski’s group at the University of Washington is undertaking. We would welcome suggestions from the ISRP as to additional mechanisms to develop further effective collaborative efforts.

The proposal presents a possibly unbalanced review of VEMCO tags relative to JSATS, and no discussion is provided in reference to McMichael et al. (2010) regarding their survival estimates. Nevertheless it is encouraging to see the increased discussions and joint work with USACE contractors and others working on survival estimates in the lower river and estuary. The ISRP recommends increased coordination with JSATs research in the estuary, since all COAST smolts are proposed to be released below Bonneville Dam. A component linking COAST to the nearshore studies and restoration work in the estuary, however, is missing. As well, the inner estuary proposals (e. g., LCREP, #200300700) should be tied in to the propose COAST work.

Response: Having seen close-up the work of our colleagues at PNNL during the 2010 field season, we have high regard for their professional competence. McMichael et al.'s (2010) paper devoted nearly 2 pages to comparing the strengths and weaknesses of the JSATs technology relative to VEMCO technology, with an emphasis on tag programming and size (Welch recused himself from review of the original manuscript owing to the conflict of interest issue). McMichael et al. (2010) cited tag specifications from our 2006 study (Rechisky et al., 2009), however since 2008 we have used a smaller tag than was used in 2006 (3.1g vs 1.6g), and thus the tag size comparison presented in McMichael et al. (2010) is outdated. In addition, we would respectfully suggest that McMichael et al.'s (2010) paper focussed on the strength of the JSAT's technology, which certainly has a tag burden advantage that allows for tagging smolts at the lowest end of the size distribution, and not on the weaknesses of the technology: it is certainly true that the frequency that the JSATs tag operates is significantly more highly attenuated in salt-water than that of the VEMCO tags which severely limits the use of the former in non fresh-water applications.

Because we have proposed to release smolts at or below Bonneville Dam for 2011 and in future years, we do plan to use JSATs acoustic survival estimates and NOAA PIT tag survival estimates to estimate total juvenile survival of yearling Chinook from the Snake and Columbia rivers to the northern end of Vancouver Island.

Multiple years of acoustic tracking data have demonstrated that spring Chinook from Dworshak and Cle Elum hatcheries migrate very rapidly through the estuary (~80km/day from Bonneville Dam to the Astoria Bridge), therefore residence time in the estuary is very short for these populations and estimated survival is high (80-100% - and PNNL results using JSATs have to date been in agreement with Kintama's). However, if the COAST project finds that smolt behavior in the estuary varies for different genetic stocks (genetic sampling being conducted for all tagged fish in 2011), we agree that the estuary may become a more important factor influencing survival and therefore may warrant an investigation into the sources of mortality in the estuary and the restoration work in progress.

5. Deliverable V. Testing the Delayed Mortality Theory. Can the proponents provide stronger justification for continuation of work on this deliverable? If the work continues, are there other more cost-effective methods for achieving the objective?

Response: The work we are proposing simply takes the data generated from our field work and compares the below Bonneville survival of stocks with low SARs against those with high SARs. Apart from the limited additional costs of analyzing the data this way and writing up the results, there are no additional costs beyond the genetic identification of the tagged fish (\$40K)- we specifically laid out the experimental design so that multiple nested hypotheses can be examined simply by changing the animals within each of the groups under comparison.

The Independent Scientific Advisory Board ([ISAB 2007-1](#)) advised against continuing efforts to measure absolute latent mortality, suggesting instead that the focus should be on estimating processes such as in-river versus transport mortality that can be measured directly. Proponents acknowledge the ISAB recommendation but argue for continuation in part by citing Welch et al. (Welch et al., 2008), a comparison of the un-dammed Fraser/Thompson River with the dammed Columbia. The ISAB (2007-1) concluded that determining latent mortality relative to a damless reference is not measurable. The argument in the proposal does not convince the ISRP that this ISAB conclusion warrants reconsideration.

Response: In our view it seems prudent to develop common-sense comparisons of survival for different groups of spring Chinook because this perspective is otherwise lacking and we now have the technology to do so. Our published comparisons to date were for i) Fraser (no dams) versus Snake (8 dams), and ii) Yakima (4 dams) versus Snake (8 dams). It seems unlikely that the climate will continue to favour high (and sometimes record) returns of Chinook to the Snake River for much longer, given the predictions from global warming models, so any sensible comparative survival studies that we can develop by contrasting the survival of different groups of Chinook provide valuable information - in the absence of accurate baseline measurements of Snake River Chinook survival prior to the construction of the hydrosystem, this seems to be the next best choice.

Can acoustic tags provide a more accurate and precise estimate of differential delayed (latent) mortality than a similar study approach that used greater numbers of coded wire tagged fish (at a much lower cost)? The acoustic tags estimate survival after a few months, but CWTs measure survival to adults. Has a comparison of the two approaches been made? If research on this objective continues, it would be important to incorporate survival of hatchery versus wild fish into the analysis. Will Chinook salmon tagged by COAST below Bonneville be identified as hatchery versus wild fish? The proposal notes that wild salmon tend to have higher survival rates; therefore, the ratio may affect the survival findings. What is the expected hatchery/wild tagging ratio? It would be interesting to compare data of tagged and untagged Chinook. Also, the study might compare survival rates with those from CWT salmon. This could tell us the fraction of mortality that occurs during early versus late marine life.

Response: As the ISRP notes, acoustic tags estimate survival within the first several months after tagging. The great advantage over PIT tags or CWTs (which estimate net salmon survival to adult return after 2-3 years at sea) is that because much of the marine mortality occurs within the first months after ocean entry, if differential mortality occurs we would expect to see this difference soon after ocean entry, and acoustic technology provides us with the ability to quantify it. PIT tags or CWTs cannot do this. If Snake River Chinook smolts have lower SARs than non-Snake River fish because of survival differences later in their life history (that may occur for reasons unrelated to anthropogenic influences experienced during hydrosystem migration), then PIT or CWT estimates cannot be used to discriminate this important difference. Therefore, yes, acoustic tags can provide more accurate and precise estimates of differential mortality of juvenile salmonids.

Furthermore, while PIT tags are a fraction of the cost of VEMCO acoustic tags (the cost of which would also be lower if purchased in large volumes), far fewer acoustic tags are required to measure early marine survival. The precise economic trade-off depends on the capital & operational costs for the PIT tag system (mainly operational only at the dams and in tributaries) and the geographically extensive COAST/POST array.

It is our understanding that almost all hatchery Chinook will be adipose-clipped in 2011. We will be tagging a representative sample of run of the river fish and therefore. our sample will be representative of the run at that time greater than 130mm.

6. Detection Efficiencies. The ISRP has a number of questions about tag detection efficiencies that were not addressed in the proposal. What percentages of fish are detected only once, for example, and not again? Are these deemed mortalities or did fish residualize in areas outside of the detection range of arrays? Along the arrays in the ocean, what about fish that migrate close inshore where there are no receivers? And how often are receivers down or lost? On page 22 - the detection range for V7 tags is less than 300m. The detection probability for V7 tags is about 70%. The accuracy and precision of the estimates is questionable. It seems that COAST has given up a lot by going from the V9 to the V7 tag. The depth of a proposed new array at Cape Elizabeth would extend to 500m, but is this depth beyond the detection range of the V7 tags? Are tagged fish easily detected if they are at or near the surface and the cable is in 500m deep water? What is the effect of wave action on detection of tagged fish?

Response: A substantial amount of the requested information is detailed in our annual reports to BPA. We will endeavour to address other points during the development of our 2010 Annual Report. As for some of the specifics, a brief, and partial, response is provided in the interim:

What percentages of fish are detected only once, for example, and not again?

Single detections represent a very small proportion of the total detections. Details of our data screening procedure can be found in our annual reports.

Are these deemed mortalities or did fish residualize in areas outside of the detection range of arrays?

It is not currently possible to distinguish between these two possibilities.

Along the arrays in the ocean, what about fish that migrate close inshore where there are no receivers?

Any missed fish reduce the estimated detection efficiency. This is true whether they move close to the beach, beyond the outer offshore limit of the sub-array, or simply pass through the sub-array without being detected.

How often are receivers down or lost?

This is addressed in detail in each annual report. It is both year and site-specific. For example, in 2006, the Willapa Bay sub-array suffered ~25% gear loss due to fishing activity. In 2009, however, gear loss was only 11%. For the Lippy Point sub-array gear loss or failure is typically 0%.

On page 22 - the detection range for V7 tags is less than 300m. The detection probability for V7 tags is about 70%. The accuracy and precision of the estimates is questionable.

The accuracy and precision of the array *design software* is based on exact equations and is not subject to error (except with respect to predicting the detection efficiency of the sub-arrays, as this is site-specific). If the ISRP is referring to the *results* from prior years, then precision is based on the accepted standard of the CJS methodology. In Kintama's view, "*accuracy*" is a biological issue, not a statistical one - if we reduce survival of tagged animals relative to the untagged fish our results are inaccurate. (This is why we compare the survival of our tagged fish with NOAA's PIT-tagged animals, as it gives us an objective basis for assessing whether the Kintama survival estimates are accurate by comparing the results with a known baseline). In statistical parlance, our results are accurate (unbiased) if our tagged fish have the same survival as their untagged counterparts.

It seems that COAST has given up a lot by going from the V9 to the V7 tag.

We agree, but felt that we had little choice - many in the biological community were dismissing our results (of equal survival of Snake & Yakima smolts, for example) because we only used smolts >14 cm with the V9 tag, and therefore the argument was made that our findings might not apply to smaller fish. The move to the V7 tag was partly intended to address this issue while we developed the array designs for even smaller V5 & V6 tags.

The depth of a proposed new array at Cape Elizabeth would extend to 500m, but is this depth beyond the detection range of the V7 tags?

When acoustic nodes are deployed in deeper water the receivers are positioned near the surface. Our preferred placement depth is 150m below the surface or 3~5m

above the seabed for shallower locations; all of our reported detection efficiency results are based on this design strategy.

Are tagged fish easily detected if they are at or near the surface and the cable is in 500m deep water?

Yes, because in deeper water, only the anchor is at the bottom; the receiver is suspended in the water column such that it is near the surface.

What is the effect of wave action on detection of tagged fish?

Generally, it increases ambient noise levels, and thus decreases detection efficiency. “Weather” related effects are included in the reported detection efficiency results.

7. Genetic stock identification (GSI). How many genetic stocks of juvenile spring Chinook salmon can be identified by the proposed GSI? Procedures for GSI need to be described. Proponents need to demonstrate that current techniques are capable of identifying origins of individual fish that are tagged and released. Ocean studies should advance toward designs that can also evaluate differences/similarities in survival of hatchery vs. wild fish of the same genetic stock. Is there a way to standardize genetic stock identification methods so that results of the three BPA-funded ocean projects are directly comparable (different labs are using different methods)?

Response: Dr. Narum of CRTFC, to whom we are subcontracting this work, recommends that we use his panel of SNP markers to allow initially identifying each fish to an ESU, and then deal with more complex stock assignments within the Columbia Basin. We are advised by Dr. Narum that the inclusion of microsatellite markers is unnecessary and will make the project considerably more expensive if we were to genotype both SNPs and microsatellites. Narum’s panel of SNP markers includes 75 loci that have been standardized among genetics labs, along with additional markers that will allow us to address specific issues in the Columbia Basin.

While there are many benefits of standardizing markers for baselines (which the genetics community has done), GSI applications vary widely and a standardized approach for determining stock proportions in mixtures cannot suit all needs. For example, field studies on ocean-caught smolts may be satisfied with assignment to ESU level, while others (including Kintama's proposal) require finer scale assessment of stocks. Further, fine scale applications in the Columbia Basin have issues of complexity that differ greatly from other areas such as Puget Sound and BC (each regional area has specific problems regarding stock separation). We note that the Pacific Salmon Commission has already held some in-depth workshops regarding GSI with broad participation and the workgroups have developed recommendations available at: http://www.psc.org/info_genetic_stock_id.htm#REPORTS.

8. Definition of the plume. Why is the plume defined as Sand Island to Willapa Bay? The proponents' definition of the plume (Sand Island to Willapa Bay) is very different than accepted terminology, and the proposal would be improved by an explanation as why they chose this definition. The plume is usually described as outside the Columbia River bar, and the plume disperses both to the north along the Washington coastline and to the south along the Oregon coastline.

Response: Our definition is operational, and is defined by regions where we believe we can effectively deploy telemetry sub-arrays. The plume is a major feature within the Astoria/Sand Island to Willapa Bay region. In the future we will define the plume using the accepted terminology, and state that the migration segment from Astoria/Sand Island to Willapa Bay (and any lines to the south) encompasses the plume.

9. Alternatives to Fixed Arrays. Are there other more innovative techniques than fixed acoustic arrays that could be employed in the future to track open coast and ocean distribution, migration patterns, and survival of Columbia River spring Chinook? For example, what about the use of robotic vehicles to measure ocean conditions and track tagged salmon to extend coverage beyond the detection range of fixed listening lines on the continental shelf/slope?

Response: Dr. John Payne of POST began experimenting with gliders in a collaboration with UW/APL researchers this year (See <http://mediaglide.com/view/1479/> or the "November 2010 POST e-Blast" email). The trial picked up one of our tagged smolts over the Washington shelf north of the Columbia (near La Push). However, while we are interested in and support the concept of POST's glider research, we are sceptical that it will become a cost-effective alternative to fixed arrays for detailed survival and tracking studies in the foreseeable future. We assessed the use of gliders back in the 2001~02 period. At present, the approach still remains more expensive, more labor-intensive, and more difficult to both interpret (the position of the glider must be estimated for each fish detection) and analyze (with gliders continuously moving about, the concept of detection efficiency does not really apply). Nevertheless, receiver-borne gliders have some utility in truly deep offshore waters, but we feel that our current array deployment technology is probably effective in waters of up to at least 1,000m.

10. Scientific workshop. The ISRP recommends a scientific workshop in 2011 focused on estimation of estuarine and ocean survival, forecasting of adult returns, and adaptive estuary, plume, and ocean environmental assessment for Columbia River Basin salmon and steelhead. Perhaps the proposal should include this workshop. A workshop would help to improve coordination and collaboration, standardization of methods (e.g., genetic stock identification), development of simulation and predictive models, and integration of results among Columbia River Basin estuary/ocean projects. One aspect of all projects that needs work is how to include more detail on sub-stock structure, including hatchery

versus wild fish, hatchery release time, area comparisons, in-river migration and associated ocean migration, and more in the models.

Response: We will develop a joint coordination meeting between NOAA, DFO, and Kintama that will discuss some of these topics at an additional day added on to the annual Ocean Ecology of Salmon workshop (end of March 2011) at which the participants will be attending.

11. Adaptive management. Is it possible that tagging experiments could be designed in concert with hatchery, hydrosystem, and harvest managers to test specific hypotheses related to estuarine and early ocean survival? Are the proponents overselling their ability to use this approach to improve real-time management of spill and transport? How can adaptive management with respect to estimates of ocean survival be implemented in the Columbia River system?

Response: We believe it is possible to develop these specific tagging experiments and would welcome the opportunity to explore this further with managers. It should be possible to relate both spill levels (=flow rates) and transport effort to salmon conservation, since at times when ocean survival rates are lower than in the hydrosystem, retaining the smolts longer in the river would be beneficial to their conservation. A model to predict periods within years when $S_{FW} < S_{Ocean}$ is necessary and would likely be based on oceanographic variables, and amongst these variables identify triggers of poor salmon survival. The key to our proposed work is that the only technology that is capable of relating these measures directly to early ocean survival of salmonid smolts is acoustic telemetry.

The proposal would be improved by further details on how POST results have influenced on-the-ground management decisions by fishery or hydrosystem agencies. For example, has the Welch et al. (2008) paper (“Survival of migrating salmon smolts in large rivers with and without dams”) resulted in any changes in operations of the Columbia River Basin dams? How do COAST indicators tie in with those being developed by CDFO, NOAA, and other projects in this review?

Response: We are in the early stage of relating our along-shelf measurements of survival with NOAA & DFO’s measurements; at the date of writing, we now have 4 data points on directly measured ocean survival (2006, 2008, 2009, 2010) that we can compare with NOAA & DFO’s ocean surveys. The time series is thus just barely long enough to provide some insight into how well the two approaches can mesh.

In the past several reviews, the ISRP asked, “How would the fully-implemented ocean array and long-term monitoring data on seasonal and interannual variations in survival rates or migration rates among years or stocks actually be used by managers of the Columbia River Basin hydrosystem?” The ISRP agrees with the proponents’ past response that estimates of ocean survival for tagged release groups of hatchery fish can be used to inform policy makers, fishery managers, and researchers. However, the proponents have never answered the ISRP’s question about how hydrosystem managers

would actually use the data. The proponents still do not seem to recognize that ocean variability will make the concept of tracking the geography of ocean mortality and subsequent adjustment of hydropower system very difficult to manage.

Response: Although we do not wish to minimize the complexity of developing models/triggers **that can be used for real-time management, the basic points that are coming out of our research are clear:**

- (1) In years when $S_{\text{Ocean}} < S_{\text{Hydrosystem}}$, transporting the smolts around the hydrosystem would be counterproductive, because barging would result in fewer adults returning than if they were left in-river to migrate of their own volition. (This corresponds to the years when the T:IR SAR ratios are <1 , which currently occurs about half the time). Hydrosystem managers could use this result to determine whether to barge or to spill water to accelerate or retard smolt arrival in the ocean.**
- (2) Testing the survival versus release date/time of ocean entry/size at release of tagged hatchery smolts could inform hatchery management by identifying best practices for release that improves the number of adults that return, thereby improving hatchery economics. Managers could use these results to direct the improvement of hatchery production processes, quickly identifying strategies that improve the adult returns from hatchery releases.**
- (3) Identifying (by daily releases of tagged smolts) ocean survival patterns on a daily basis and relating them to, say, satellite remote sensing data, it may be possible to identify simple measurements (e.g. , ocean color) to indicate when hatchery releases should be timed to occur, or spill ramped up or decreased to accelerate or retard the arrival of the wild smolts in the ocean during windows of favorable survival. Managers could thus use the array to learn what patterns of ocean conditions promote survival in the ocean and what patterns degrade survival in the ocean, and thus manage accordingly.**
- (4) If we can demonstrate to most people's satisfaction that delayed (latent) mortality effects of the hydrosystem do not influence survival in the ocean, then this divorces hydrosystem operations from blame for subsequent poor ocean survival after the smolts leave the river. If this point is accepted, then monitoring survival to some defined point (say, Astoria) and showing that freshwater survival remained high in a smolt migration year that led to a catastrophic failure of the adults to return would then credibly make the case that the hydrosystem operations were not responsible for the failure of the adult run. This would thus allow a clear demonstration that low SARS were not the result of freshwater influences but were the result of factors operating out in the ocean that were beyond the hydrosystem managers control. This would be of importance to Columbia River managers if a collapse were to occur that was similar to Snake River Spring Chinook SARS in the 1990s or the catastrophic collapses of Sacramento R Chinook or Fraser River sockeye returns in several recent years. Without such data, it would likely not be possible to provide a defensible response that the hydrosystem management had in fact achieved its goals and was still in compliance.**

The project is clearly significant to regional programs, but the proposal could be improved by attention to unrealistic objectives and expectations that implementation of acoustic tagging technology would result in improved real-time management of spill and transport. The proponents state that the latter two options could be decided upon by measurement of marine survival with their methods: “For example, if marine survival is exceptionally low, transportation and/or increased spill may not be beneficial, as smolts would reach the ocean sooner thereby exposing them to unfavorable ocean conditions (e.g., increased predation or decreased food supply), leading to lower survival. ” Explain the specific processes that would be used to achieve real-time management. Do managers think this process would work?

Response: As above, the point about “real-time management” depends upon the definition. Satellite remote sensing could provide “real-time” monitoring if the latency in the system is low and the satellites can monitor some process that is tightly coupled with salmon survival. Alternatively, in principle survival data could be up-loaded from the coastal arrays near the Columbia River on a daily basis and fed back into the management system. The technology itself is not unrealistic, the question is whether we can use the COAST array to successfully identify either survival or processes that are tightly linked to survival and turn that data around into an accepted product that managers will use. The two key steps here are to:

- (1) successfully make the scientific link between ocean conditions and smolt survival and
- (2) Gain acceptance from managers for the use of the technology.

The sociological issues surrounding change in the workplace are probably hardest, and making the scientific linkage to reliable indices of survival likely somewhat easier. The technological challenges of producing “real-time” survival results (say, within a day of their occurrence) are relatively straightforward (but could be expensive depending upon the approach adopted).

12. Communicating Results. Can the proponents develop more effective approaches for communicating their results directly to Columbia River Basin hatchery, hydrosystem, and harvest managers? Websites, scientific meetings, and peer-review scientific publication are excellent methods for communicating with scientific peers, other government agencies, educational institutions, and conservation organizations, but are likely not effective tools for communicating directly with hydro, harvest, and hatchery managers.

Response: Since 2006 we have attended the Army Corp of Engineers Anadromous Fish Evaluation Program (AFEP) Annual Review in order to communicate our results more broadly, since this meeting is attended by a wide range of Columbia basin researchers and managers. In the past we have also been invited to present our results to researchers and hatchery managers at the Yakima Basin Aquatic Science and Management Conference. If there are basin-wide joint meetings of

hydro, harvest, and hatchery managers, we would be pleased to present and discuss our results; however we are not always aware of any such gatherings. Can the ISRP advise how better to communicate with such parties?

13. Update Online Proposal Format. The format of this proposal was confusing and difficult to follow. Proponents should reformat their online proposal to better conform to the specific information requested in each section of the online form. The repetition of the same deliverables under several objectives seems unnecessarily repetitive. Objectives providing the same deliverables could be combined into one objective. The important information on study design that was included only as an attachment should be incorporated into the online form. The online form should present the complete proposal as a stand-alone document.

Response: The cut and paste nature of the current web submission interface resulted in severe limitations in proposal design, and we found this frustrating as well. Although the web-based proposal was functional and reasonably bug-free, we found that information requested was also repetitive, it being designed for a range of projects of which perhaps the COAST one is not a best example: thus, while to our eyes we thought we had limited the repetition as best we could given the stated requirements, we accept that we may not have been as succesful as we thought.

In most cases we tried to include all of the details within each section; however, it was necessary to attach an external document containing the power analyses because of the difficulty in pasting mathematical equations in the online form – after several efforts a decision was made that this was the only reasonable solution given that we wanted to provide ISRP the full analyses. (The submission interface only allows cut and paste of individual mathematical symbols and allows no control over typesetting of groups of symbols into equations).

References

- Abdul-Aziz, O.I., Mantua, N.J. and Myers, K.W. (2011) Potential climate change impacts on thermal habitats of Pacific salmon (*Oncorhynchus* spp.) in the North Pacific Ocean and adjacent seas. *Can. J. Fish. Aquat. Sci.*, **68**, 1660-1680.
- Armstrong, J.L., Boldt, J.L., Cross, A.D., Moss, J.H., Davis, N.D., Myers, K.W., Walker, R.V., Beauchamp, D.A. and Haldorson, L.J. (2005) Distribution, size, and interannual, seasonal and diel food habits of northern Gulf of Alaska juvenile pink salmon, *Oncorhynchus gorbuscha*. *Deep-Sea Res, Part II*, **52**, 247-265.
- Armstrong, J.L., Myers, K.W., Beauchamp, D.A., Davis, N.D., Walker, R.V., Boldt, J.L., Piccolo, J.J., Haldorson, L.J. and Moss, J.H. (2008) Interannual and Spatial Feeding Patterns of Hatchery and Wild Juvenile Pink Salmon in the Gulf of Alaska in Years of Low and High Survival. *Trans. Am. Fish. Soc.*, **137**, 1299-1316.
- Barnett-Johnson, R., Teel, D.J. and Casillas, E. (2010) Genetic and otolith isotopic markers identify salmon populations in the Columbia River at broad and fine geographic scales. *Environ. Biol. Fishes*, **89**, 533-546.
- Batten, S.D. and Freeland, H.J. (2007) Plankton populations at the bifurcation of the North Pacific Current. *Fish. Oceanogr.*, **16**, 536-546.
- Beacham, T.D., Candy, J.R., McIntosh, B., MacConnachie, C., Tabata, A., Kaukinen, K., Deng, L.T., Miller, K.M., Withler, R.E. and Varnavskaya, N. (2005) Estimation of stock composition and individual identification of sockeye salmon on a Pacific Rim basis using microsatellite and major histocompatibility complex variation. *Trans. Am. Fish. Soc.*, **134**, 1124-1146.
- Beacham, T.D., Candy, J.R., Jonsen, K.L., Supernault, J., Wetklo, M., Deng, L.T., Miller, K.M., Withler, R.E. and Varnavskaya, N. (2006a) Estimation of stock composition and individual identification of Chinook salmon across the Pacific Rim by use of microsatellite variation. *Trans. Am. Fish. Soc.*, **135**, 861-888.
- Beacham, T.D., Jonsen, K.L., Supernault, J., Wetklo, M., Deng, L.T. and Varnavskaya, N. (2006b) Pacific Rim population structure of Chinook salmon as determined from microsatellite analysis. *Trans. Am. Fish. Soc.*, **135**, 1604-1621.
- Beacham, T.D., McIntosh, B., MacConnachie, C., Miller, K.M. and Withler, R.E. (2006c) Pacific rim population structure of Sockeye salmon as determined from microsatellite analysis. *Trans. Am. Fish. Soc.*, **135**, 174-187.

- Beacham, T.D., Candy, J.R., Wallace, C., Sato, S., Urawa, S., Varnavskaya, N., Le, K.D. and Wetklo, M. (2008) Microsatellite stock identification of chum salmon on a Pacific Rim basis and a comparison with single nucleotide polymorphisms (SNPs). NPAFC Doc. 1105. (Available at <http://www.npafc.org>). 77pp.
- Beacham, T.D., Candy, J.R., Wallace, C., Urawa, S., Sato, S., Varnavskaya, N.V., Le, K.D. and Wetklo, M. (2009) Microsatellite Stock Identification of Chum Salmon on a Pacific Rim Basis. *N. Am. J. Fish. Manage.*, **29**, 1757-1776.
- Beacham, T.D., McIntosh, B. and Wallace, C. (2010) A comparison of stock and individual identification for sockeye salmon (*Oncorhynchus nerka*) in British Columbia provided by microsatellites and single nucleotide polymorphisms. *Can. J. Fish. Aquat. Sci.*, **67**, 1274-1290.
- Beacham, T.D., Candy, J.R., Porszt, E., Sato, S. and Urawa, S. (2011) Microsatellite Identification of Canadian Sockeye Salmon Rearing in the Bering Sea. *Trans. Am. Fish. Soc.*, **140**, 296-306.
- Beacham, T.D., Candy, J.R., Wallace, C., Wetklo, M., Deng, L.T. and MacConnachie, C. (In press) Microsatellite stock identification of coho salmon in British Columbia. *Mar. Coast. Fish.*
- Beacham, T.D., Jonsen, K.L. and Wallace, C. (In review) A comparison of stock and individual identification for Chinook salmon (*Oncorhynchus tshawytscha*) in British Columbia provided by microsatellites (STRs) and single nucleotide polymorphisms (SNPs). *Fish. Bull.*
- Beamish, R.J. and Mahnken, C. (2001) A critical size and period hypothesis to explain natural regulation of salmon abundance and the linkage to climate and climate change. *Prog. Oceanogr.*, **49**, 423-437.
- Bi, H., Ruppel, R.E. and Peterson, W.T. (2007) Modeling the pelagic habitat of salmon off the Pacific Northwest (USA) coast using logistic regression. *Mar. Ecol. Prog. Ser.*, **336**, 249-265.
- Brodeur, R.D., Daly, E.A., Schabetsberger, R.A. and Mier, K.L. (2007) Interannual and interdecadal variability in juvenile coho salmon (*Oncorhynchus kisutch*) diets in relation to environmental changes in the northern California Current. *Fish. Oceanogr.*, **16**, 395-408.
- Campbell, L.A. (2010) Life histories of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Columbia River estuary as inferred from scale and otolith microchemistries. Fisheries and Wildlife. Corvallis, OR, Oregon State University, M.Sc. Thesis.
- DiMaria, R., Miller, J. and Hurst, T. (2010) Temperature and growth effects on otolith elemental chemistry of larval Pacific cod, *Gadus macrocephalus*. *Environ. Biol. Fishes*, **89**, 453-462.

- Donohoe, C.J., Adams, P.B. and Royer, C.F. (2008) Influence of water chemistry and migratory distance on ability to distinguish progeny of sympatric resident and anadromous rainbow trout (*Oncorhynchus mykiss*). *Can. J. Fish. Aquat. Sci.*, **65**, 1060-1075.
- Ehrenberg, J.E. and Steig, T.W. (2009) A study of the relationship between tag-signal characteristics and achievable performances in acoustic fish-tag studies. *ICES J. Mar. Sci.*, **66**, 1278-1283.
- Elsdon, T.S., Wells, B.K., Campana, S.E., Gillanders, B.M., Jones, C.M., Limburg, K.E., Secor, D.H., Thorrold, S.R. and Walther, B.D. (2008) Otolith chemistry to describe movements and life-history parameters of fishes: Hypotheses, assumptions, limitations and inferences. In: *Oceanography and Marine Biology: An Annual Review*, Vol 46. R.N. Gibson, R.J.A. Atkinson and J.D.M. Gordon (eds). p. 297.
- Emmett, R.L., Brodeur, R.D. and Orton, P.M. (2004) The vertical distribution of juvenile salmon (*Oncorhynchus* spp.) and associated fishes in the Columbia River plume. *Fish. Oceanogr.*, **13**, 392-402.
- Faulkner, J.R., Smith, S.G., Muir, W.D., Marsh, D.M. and Williams, J.G. (2010) Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids through Snake and Columbia River Dams and Reservoirs, 2010. Portland, Oregon: Report to the Bonneville Power Administration
<http://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P120402>, 100 (2010).
- Fisk, A.T., Hobson, K.A. and Norstrom, R.J. (2001) Influence of chemical and biological factors on trophic transfer of persistent organic pollutants in the northwater polynya marine food web. *Environ. Sci. Technol.*, **35**, 732-738.
- Giorgi, A., Skalski, J.R., Peven, C., Langeslay, M., Smith, S., Counihan, T., Perry, R. and Bickford, S. (2010) Guidelines for conducting smolt survival studies in the Columbia River. In: *Tagging, Telemetry and Marking Measures for Monitoring Fish Populations—A compendium of new and recent science for use in informing technique and decision modalities*. Pacific Northwest Aquatic Monitoring Partnership (PNAMP) Special Publication 2010-002. K.S. Wolf and J.S. O’Neal (eds). Chapter 3, (<http://www.pnamp.org/node/2867>). pp. 47-48.
- Grimes, C.B., Brodeur, R.D., Haldorson, L.J. and McKinnell, S.M. (2007) *The ecology of juvenile salmon in the northeast Pacific Ocean: regional comparisons*. American Fisheries Society, Symposium 57, Bethesda, MD.
- Habicht, C., Seeb, L.W. and Seeb, J.E. (2007) Genetic and ecological divergence defines population structure of sockeye salmon populations returning to Bristol Bay, Alaska, and provides a tool for admixture analysis. *Trans. Am. Fish. Soc.*, **136**, 82-94.

- Hanson, M.B., Baird, R.W., Ford, J.K.B., Hempelmann-Halos, J., Van Doornik, D.M., Candy, J.R., Emmons, C.K., Schorr, G.S., Gisborne, B., Ayres, K.L., Wasser, S.K., Balcomb, K.C., Balcomb-Bartok, K., Sneva, J.G. and Ford, M.J. (2010) Species and stock identification of prey consumed by endangered southern resident killer whales in their summer range. *Endanger. Spec. Res.*, **11**, 69-82.
- Hoffman, J.C. and Sutton, T.T. (2010) Lipid correction for carbon stable isotope analysis of deep-sea fishes. *Deep-Sea Res, Part I*, **57**, 956-964.
- Iwamoto, E.M., Myers, J.M. and Gustafson, R.G. (In press) Resurrecting an extinct salmon evolutionarily significant unit: archived scales, historical DNA, and implications for restoration. *Mol. Ecol.*
- Jacobson, K.C., Teel, D., Van Doornik, D.M. and Casillas, E. (2008) Parasite-associated mortality of juvenile Pacific salmon caused by the trematode *Nanophyetus salmincola* during early marine residence. *Mar. Ecol. Prog. Ser.*, **354**, 235-244.
- Kennedy, B.P., Klaue, A., Blum, J.D., Folt, C.L. and Nislow, K.H. (2002) Reconstructing the lives of fish using Sr isotopes in otoliths. *Can. J. Fish. Aquat. Sci.*, **59**, 925-929.
- Kraus, R.T. and Secor, D.H. (2004) Incorporation of strontium into otoliths of an estuarine fish. *J. Exp. Mar. Biol. Ecol.*, **302**, 85-106.
- Limburg, K.E. (1995) Otolith strontium traces environmental history of subyearling American shad *Alosa sapidissima*. *Mar. Ecol. Prog. Ser.*, **119**, 25-35.
- Litz, M.N.C., Phillips, A.J., Brodeur, R.D. and Emmett, R.L. (2011) Seasonal occurrences of Humboldt squid (*Dosidicus gigas*) in the northern California Current System. *CALCOFI Rep*, **52**, 97-108.
- McConnaughey, T. and McRoy, C.P. (1979) Food web structure and the fractionation of carbon stable isotopes in the Bering Sea. *Mar. Biol.*, **53**, 257-262.
- McMichael, G.A., Eppard, M.B., Carlson, T.J., Carter, J.A., Ebberts, B.D., Brown, R.S., Weiland, M., Ploskey, G.R., Harnish, R.A. and Deng, Z.D. (2010) The Juvenile Salmon Acoustic Telemetry System: A New Tool. *Fisheries*, **35**, 9-22.
- Melnychuk, M.C. (2009) Estimation of survival and detection probabilities for multiple tagged salmon stocks with nested migration routes, using a large-scale telemetry array. *Marine and Freshwater Research*, **60**, 1231-1243.
- Melnychuk, M.C. and Walters, C.J. (2010) Estimating detection probabilities of tagged fish migrating past fixed receiver stations using only local information. *Can. J. Fish. Aquat. Sci.*, **67**, 641-658.

- Miller, J.A. (2009) The effects of temperature and water concentration on the otolith incorporation of barium and manganese in black rockfish *Sebastes melanops*. *J. Fish Biol.*, **75**, 39-60.
- Miller, J.A. and Kent, A.J.R. (2009) The determination of maternal run time in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) based on Sr/Ca and (87)Sr/(86)Sr within otolith cores. *Fish. Res.*, **95**, 373-378.
- Miller, J.A., Bellinger, M.R., Golden, J.T., Fujishin, L. and Banks, M.A. (2010a) Integration of natural and artificial markers in a mixed stock analysis of Chinook salmon (*Oncorhynchus tshawytscha*). *Fish. Res.*, **102**, 152-159.
- Miller, J.A., Gray, A. and Merz, J. (2010b) Quantifying the contribution of juvenile migratory phenotypes in a population of Chinook salmon *Oncorhynchus tshawytscha*. *Mar. Ecol. Prog. Ser.*, **408**, 227-240.
- Mintenbeck, K., Brey, T., Jacob, U., Knust, R. and Struck, U. (2008) How to account for the lipid effect on carbon stable-isotope ratio ($\delta^{13}\text{C}$): sample treatment effects and model bias. *J. Fish Biol.*, **72**, 815-830.
- Morris, J.F.T., Trudel, M., Welch, D.W., Thiess, M.E. and Zubkowski, T. (2004) Canadian Highseas Salmon surveys: CWT recoveries from juvenile Chinook and coho salmon on the continental shelf of British Columbia and southeast Alaska from 1998 to 2003. *N. Pac. Anadrom. Fish. Comm., Doc.*, **823**.
- Narum, S.R., Banks, M., Beacham, T.D., Bellinger, M.R., Campbell, M.R., Dekoning, J., Elz, A., Guthrie, C.M., Kozfkay, C., Miller, K.M., Moran, P., Phillips, R., Seeb, L.W., Smith, C.T., Warheit, K., Young, S.F. and Garza, J.C. (2008) Differentiating salmon populations at broad and fine geographical scales with microsatellites and single nucleotide polymorphisms. *Mol. Ecol.*, **17**, 3464-3477.
- Narum, S.R., Hess, J.E. and Matala, A.P. (2010) Examining Genetic Lineages of Chinook Salmon in the Columbia River Basin. *Trans. Am. Fish. Soc.*, **139**, 1465-1477.
- Pearcy, W.G. (1992) *Ocean ecology of North Pacific salmonids*. Washington Sea Grant Program, University of Washington Press, Seattle, WA, 179pp.
- Peterson, W.T. and Schwing, F.B. (2003) A new climate regime in northeast pacific ecosystems. *Geophys. Res. Lett.*, **30**.
- Peterson, W.T. (2009) Copepod species richness as an indicator of long term changes in the coastal ecosystem of the northern California Current. *CALCOFI Rep.*, **50**, 73-81.
- Peterson, W.T., Morgan, C.A., Fisher, J.P. and Casillas, E. (2010) Ocean distribution and habitat associations of yearling coho (*Oncorhynchus kisutch*) and Chinook (*O. tshawytscha*) salmon in the northern California Current. *Fish. Oceanogr.*, **19**, 508-525.

- Porter, A.D., Welch, D.W., Rechisky, E.L., Challenger, W.O., Scott, M.C.J., Lydersen, H., Winchell, P.M., Neaga, L., Robb, J.D. and Muirhead, Y.K. (2011) Marine and freshwater measurement of delayed and differential-delayed mortality of Columbia & Snake River yearling Chinook smolts using a continental-scale acoustic-telemetry array, 2010. Portland, Oregon: Report to the Bonneville Power Administration by Kintama Research Services Ltd., Contract No. 46389, Project No. 2003-114-00. p. 492 pp.
- Post, D.M., Layman, C.A., Arrington, D.A., Takimoto, G., Quattrochi, J. and Montana, C.G. (2007) Getting to the fat of the matter: models, methods and assumptions for dealing with lipids in stable isotope analyses. *Oecologia*, **152**, 179-189.
- Prairie, Y.T. (1996) Evaluating the predictive power of regression models. *Can. J. Fish. Aquat. Sci.*, **53**, 490-492.
- Rasmussen, J.B., Rowan, D.J., Lean, D.R.S. and Carey, J.H. (1990) Food chain structure in Ontario lakes determines PCB levels in lake trout (*Salvelinus namaycush*) and other pelagic fish. *Can. J. Fish. Aquat. Sci.*, **47**, 2030-2038.
- Rechisky, E.L., Welch, D.W., Porter, A.D., Jacobs, M.C. and Ladouceur, A. (2009) Experimental measurement of hydrosystem-induced delayed mortality in juvenile Snake River spring Chinook salmon (*Oncorhynchus tshawytscha*) using a large-scale acoustic array. *Can. J. Fish. Aquat. Sci.*, **66**, 1019-1024.
- Rechisky, E.L. and Welch, D.W. (2010) Surgical implantation of acoustic tags: Influence of tag loss and tag-induced mortality on free-ranging and hatchery-held spring Chinook (*O. tshawytscha*) smolts. In: *PNAMP Special Publication: Tagging, Telemetry and Marking Measures for Monitoring Fish Populations. A Compendium of New and Recent Science for Use in Informing Technique and Decision Modalities. The Pacific Northwest Aquatic Monitoring Partnership*. K.S. Wolf and J.S. O'Neal (eds). Special Publication 2010-002, Duvall, WA. pp. 71-96.
- Secor, D.H., Hendersonarzapalo, A. and Piccoli, P.M. (1995) Can otolith microchemistry chart patterns of migration and habitat utilization in anadromous fishes? *J. Exp. Mar. Biol. Ecol.*, **192**, 15-33.
- Seeb, L.W., Antonovich, A., Banks, A.A., Beacham, T.D., Bellinger, A.R., Blankenship, S.M., Campbell, A.R., Decovich, N.A., Garza, J.C., Guthrie, C.M., III, Lundrigan, T.A., Moran, P., Narum, S.R., Stephenson, J.J., Supernault, K.J., Teel, D.J., Templin, W.D., Wenburg, J.K., Young, S.E. and Smith, C.T. (2007) Development of a standardized DNA database for Chinook salmon. *Fisheries*, **32**, 540-552.
- Sokal, R.R. and Rohlf, F.J. (1995) *Biometry. 3rd edition*. W. H. Freeman and Company, New York.

- Tarroux, A., Ehrich, D., Lecomte, N., Jardine, T.D., Bety, J. and Berteaux, D. (2010) Sensitivity of stable isotope mixing models to variation in isotopic ratios: evaluating consequences of lipid extraction. *Methods Ecol. Evol.*, **1**, 231-241.
- Teel, D.J., Van Doornik, D.M., Kuligowski, D.R. and Grant, W.S. (2003) Genetic analysis of juvenile coho salmon (*Oncorhynchus kisutch*) off Oregon and Washington reveals few Columbia River wild fish. *Fish. Bull.*, **101**, 640-652.
- Trudel, M., Tucker, S., Zamon, J.E., Morris, J., Higgs, D.A. and D.W. Welch, D. (2002) Bioenergetic response of coho salmon to climate change. N. Pac. Anadrom. Fish Comm, Tech. Rep. 59-61pp.
- Trudel, M., Fisher, J.P., Orsi, J.A., Morris, J.F.T., Thiess, M.E., Sweeting, R.M., Fergusson, A. and Welch, D.W. (2009) Distribution and migration of juvenile Chinook salmon derived from coded wire tag recoveries along the continental shelf of western North America. *Trans. Am. Fish. Soc.*, **138**, 1369-1391.
- Trudel, M., Thiess, M.E., Morris, J.F.T., Zubkowski, T. and Mackas, D.L. (2011) Canada-USA Salmon Shelf Survival Study. Annual Report submitted to the Bonneville Power Administration. 117pp.
- Tucker, S., Trudel, M., Welch, D.W., Candy, J.R., Morris, J.F.T., Thiess, M.E., Wallace, C., Teel, D.J., Crawford, W., Farley, E.V. and Beacham, T.D. (2009) Seasonal Stock-Specific Migrations of Juvenile Sockeye Salmon along the West Coast of North America: Implications for Growth. *Trans. Am. Fish. Soc.*, **138**, 1458-1480.
- Tucker, S., Trudel, M., Welch, D.W., Morris, J.F.T., Candy, J.R., Wallace, C. and Beacham, T.D. (2011) Life-history and seasonal stock-specific ocean migration of juvenile Chinook salmon. *Trans. Am. Fish. Soc.*, **140**, 1101-1119.
- Van Doornik, D.M., Teel, D.J., Kuligowski, D.R., Morgan, C.A. and Casillas, E. (2007) Genetic analyses provide insight into the early ocean stock distribution and survival of juvenile coho salmon off the coasts of Washington and Oregon. *N. Am. J. Fish. Manage.*, **27**, 220-237.
- Volk, E.C., Bottom, D.L., Jones, K.K. and Simenstad, C.A. (2010) Reconstructing Juvenile Chinook Salmon Life History in the Salmon River Estuary, Oregon, Using Otolith Microchemistry and Microstructure. *Trans. Am. Fish. Soc.*, **139**, 535-549.
- Weber, P.K. (2002) Geochemical markers in the otoliths of Chinook salmon in the Sacramento-San Joaquin River system, California. Geography. Berkeley, CA, University of California, Ph.D. Thesis.
- Weitkamp, L.A. and Emmett, R.L. (2006) Juvenile pink and chum salmon in the northern California Current. In: *Proceedings: The 22nd Northeast Pacific Pink and Chum Workshop*. J. Geiger (ed.) Cape Fox Hotel, Ketchikan, Alaska, February 23-25, 2005. pp. 129-136.

- Weitkamp, L.A. and Bentley, P. (2009) Ocean ecology of juvenile pink and chum salmon in the Northern California Current. Proceedings of the pink & chum workshop. Bellingham, WA, February 2008.
- Welch, D.W., Ward, B.R. and Batten, S.D. (2004) Early ocean survival and marine movements of hatchery and wild steelhead trout (*O. mykiss*) determined by an acoustic array: Queen Charlotte Strait, British Columbia. *Deep-Sea Research*, **51**, 897-909.
- Welch, D.W., Rechisky, E.L., Melnychuk, M.C., Porter, A.D., Walters, C.J., Clements, S., Clemens, B.J., McKinley, R.S. and Schreck, C. (2008) Survival of Migrating Salmon Smolts in Large Rivers With and Without Dams (vol 6, pg 265, 2008). *PLoS Biol.*, **6**, 2940-2940.
- Welch, D.W., Melnychuk, M.C., Rechisky, E.R., Porter, A.D., Jacobs, M.C., Ladouceur, A., McKinley, R.S. and Jackson, G.D. (2009) Freshwater and marine migration and survival of endangered Cultus Lake sockeye salmon (*Oncorhynchus nerka*) smolts using POST, a large-scale acoustic telemetry array. *Can. J. Fish. Aquat. Sci.*, **66**, 736-750.
- Zimmerman, C.E. (2005) Relationship of otolith strontium-to-calcium ratios and salinity: experimental validation for juvenile salmonids. *Can. J. Fish. Aquat. Sci.*, **62**, 88-97.

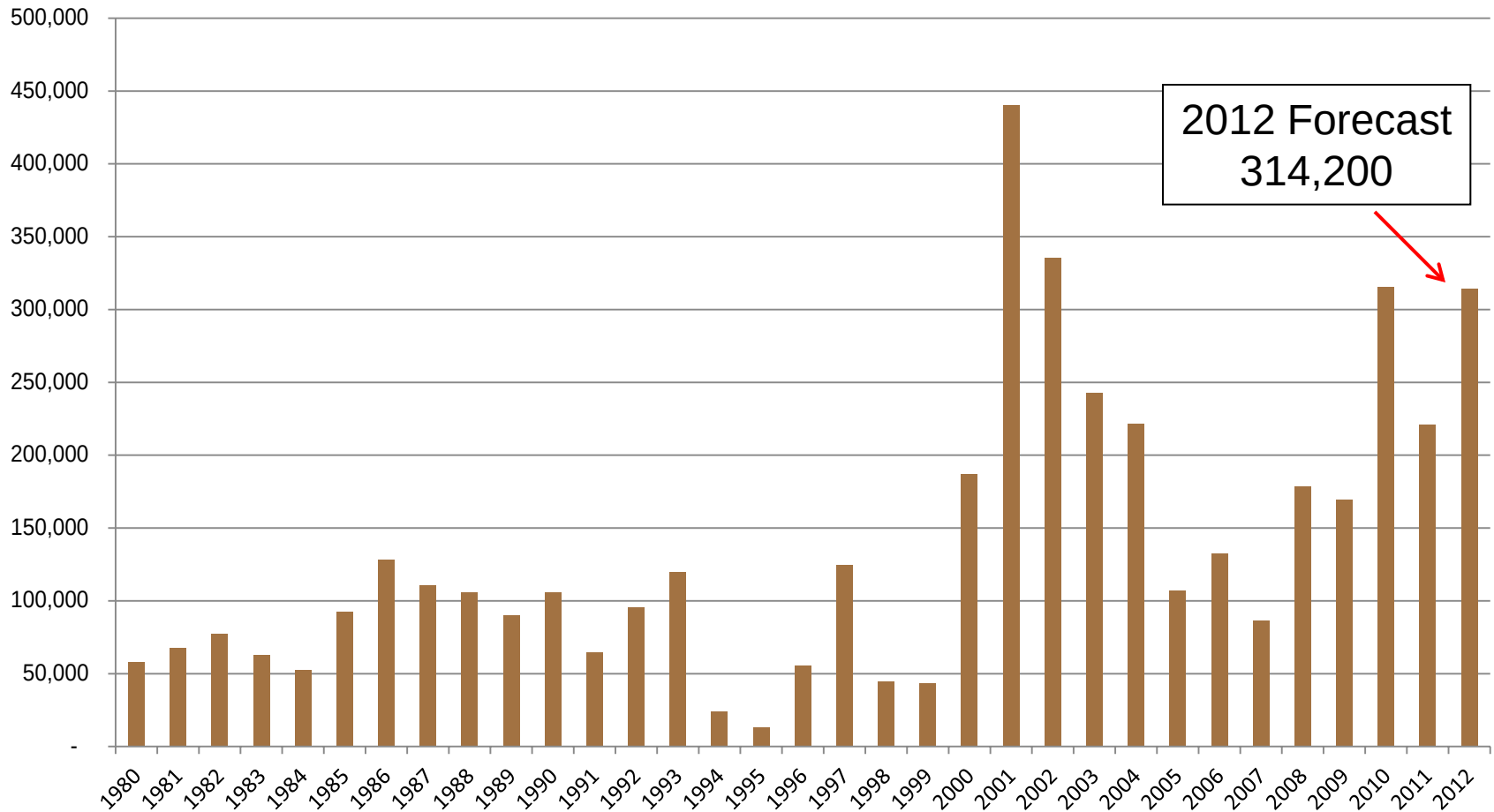
Columbia River Salmon and Steelhead Returns

TMT – March 2012

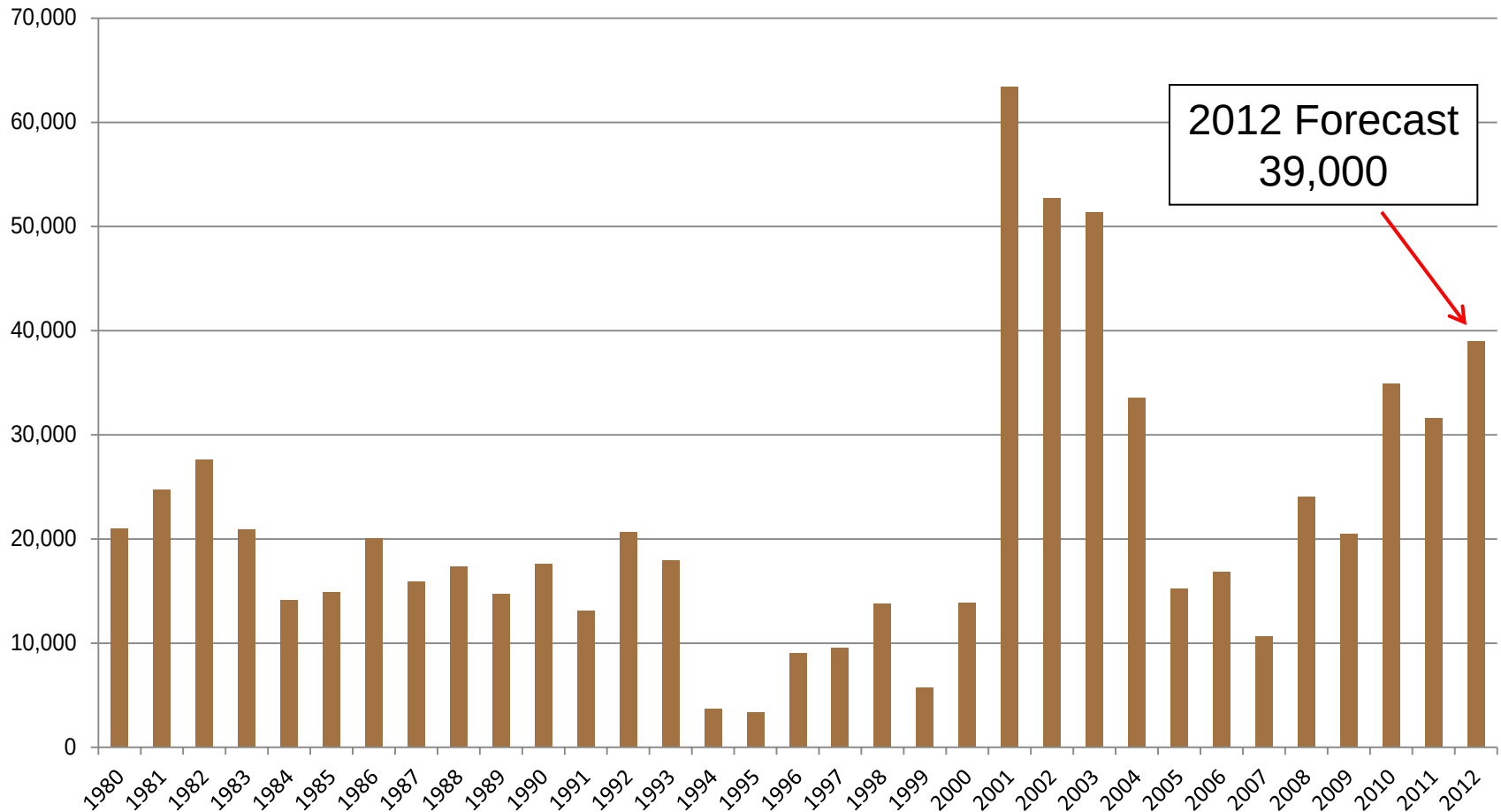
Charles Morrill & Cindy LeFleur

Washington Department of Fish and Wildlife

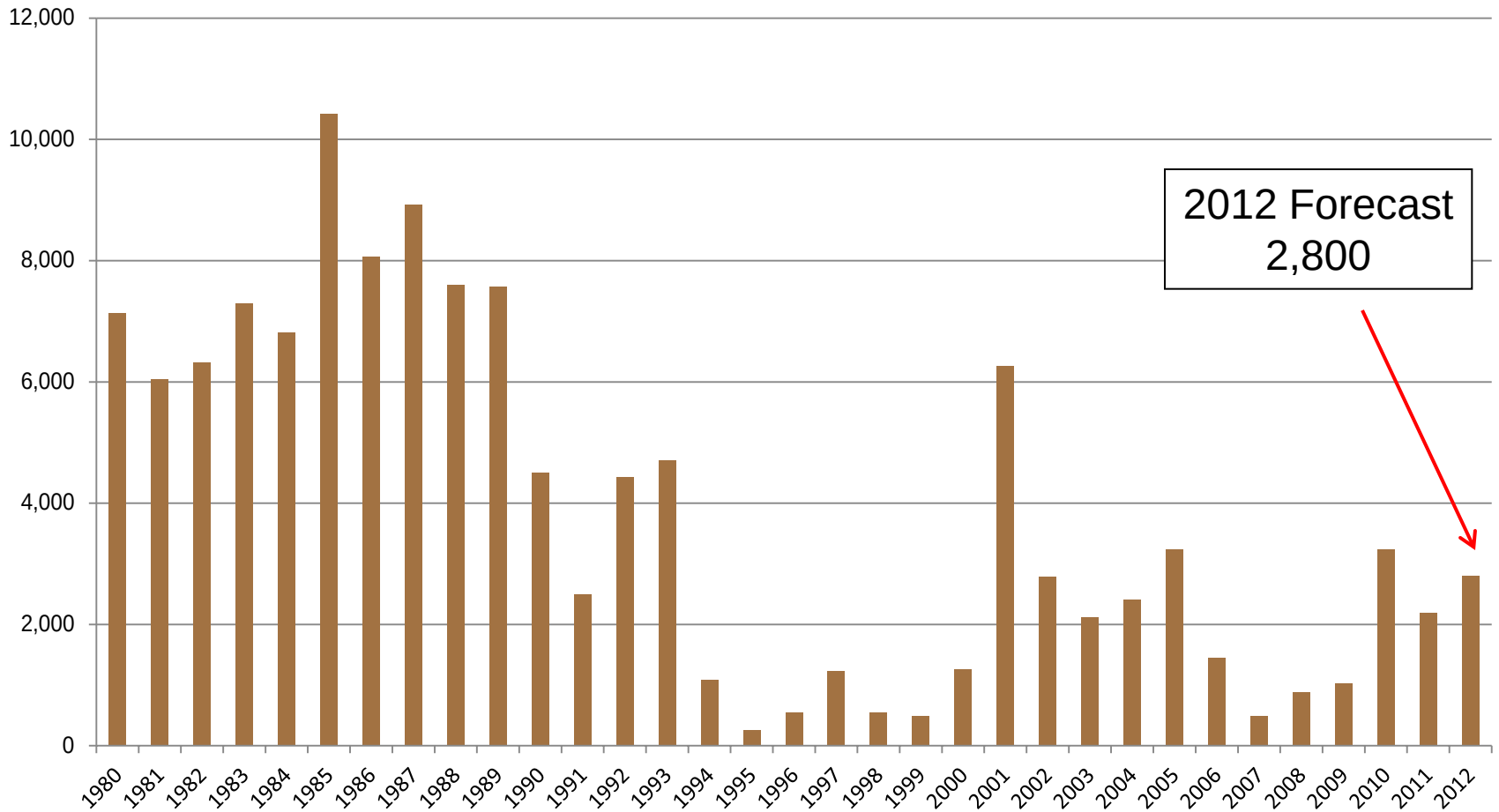
Upriver Spring Chinook



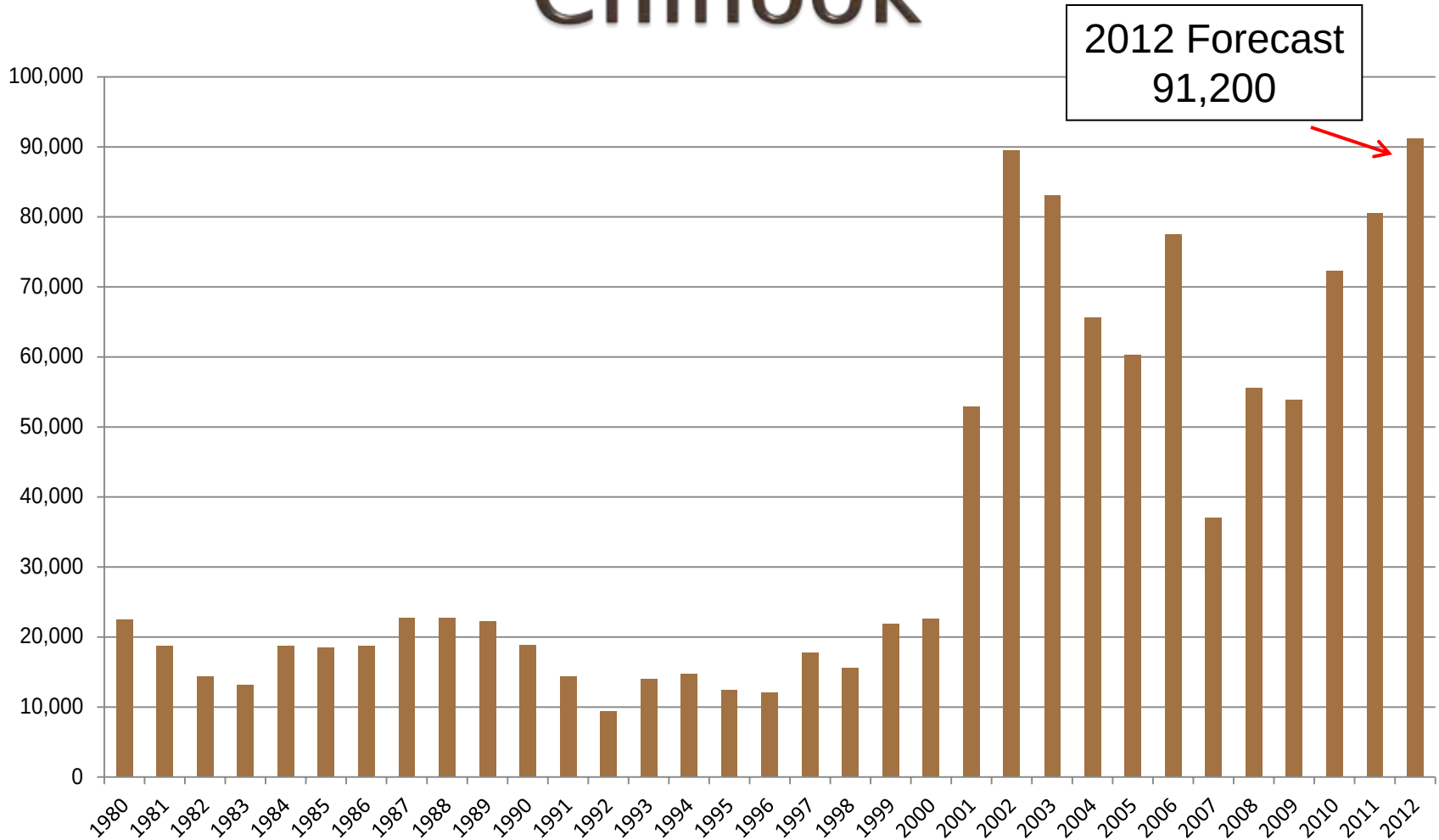
Snake River Wild Spring/Summer Chinook



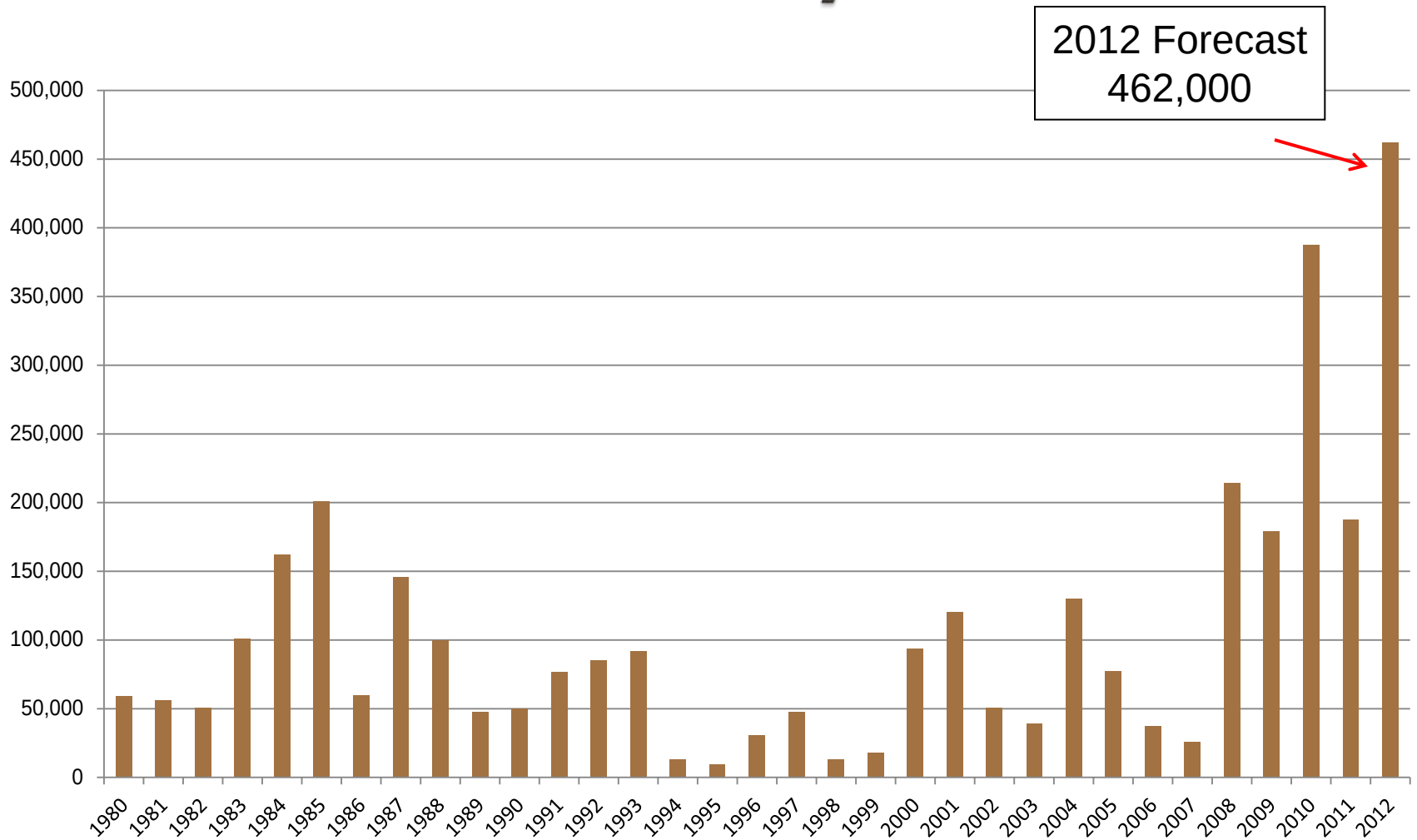
Upper Columbia Wild Spring Chinook



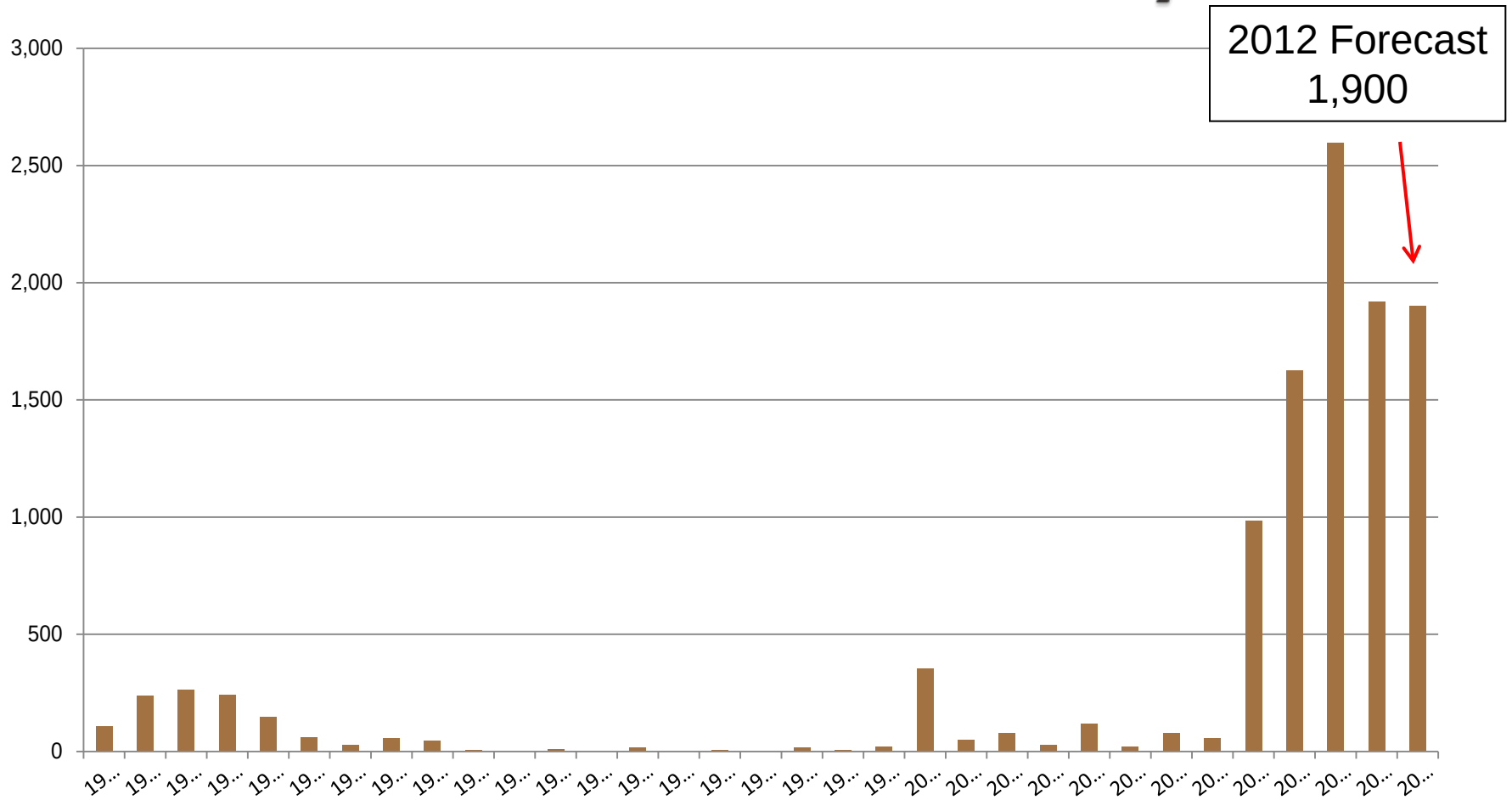
Upper Columbia Summer Chinook



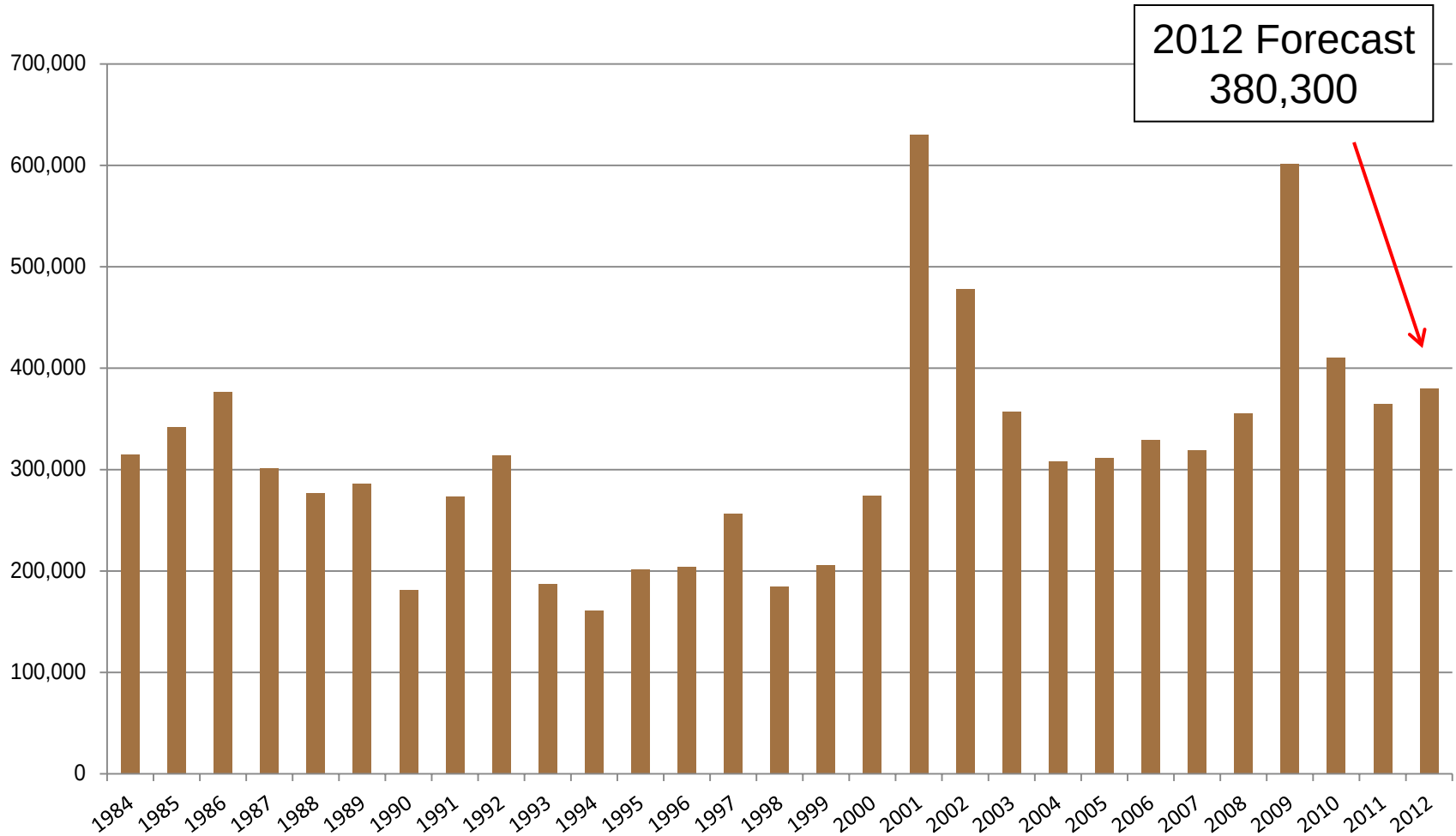
Sockeye



Snake River Sockeye



Upriver Summer Steelhead



2011 Non-Indian Fisheries

- Spring Chinook Sport Fisheries
 - 154,900 angler trips below Bonneville, 11,700 fish kept
 - 2,300 fish kept Bonneville to McNary
 - 1,900 fish kept Snake River
- Summer Season Sport Fisheries
 - 75,800 angler trips below Bonneville - 5,200 summer Chinook kept
 - 1,420 sockeye kept, 12,900 steelhead kept
- Commercial Fisheries
 - Spring Chinook – 4,500 fish
 - Summer Chinook – 5,000 fish

2011 Treaty Indian Fisheries

- } Spring Chinook – 13,200 fish
- } Summer Chinook – 20,600 fish
- } Sockeye – 12,800 fish



2011-2012 Hanford Reach Fall Chinook Protection Program (HRFCPP)

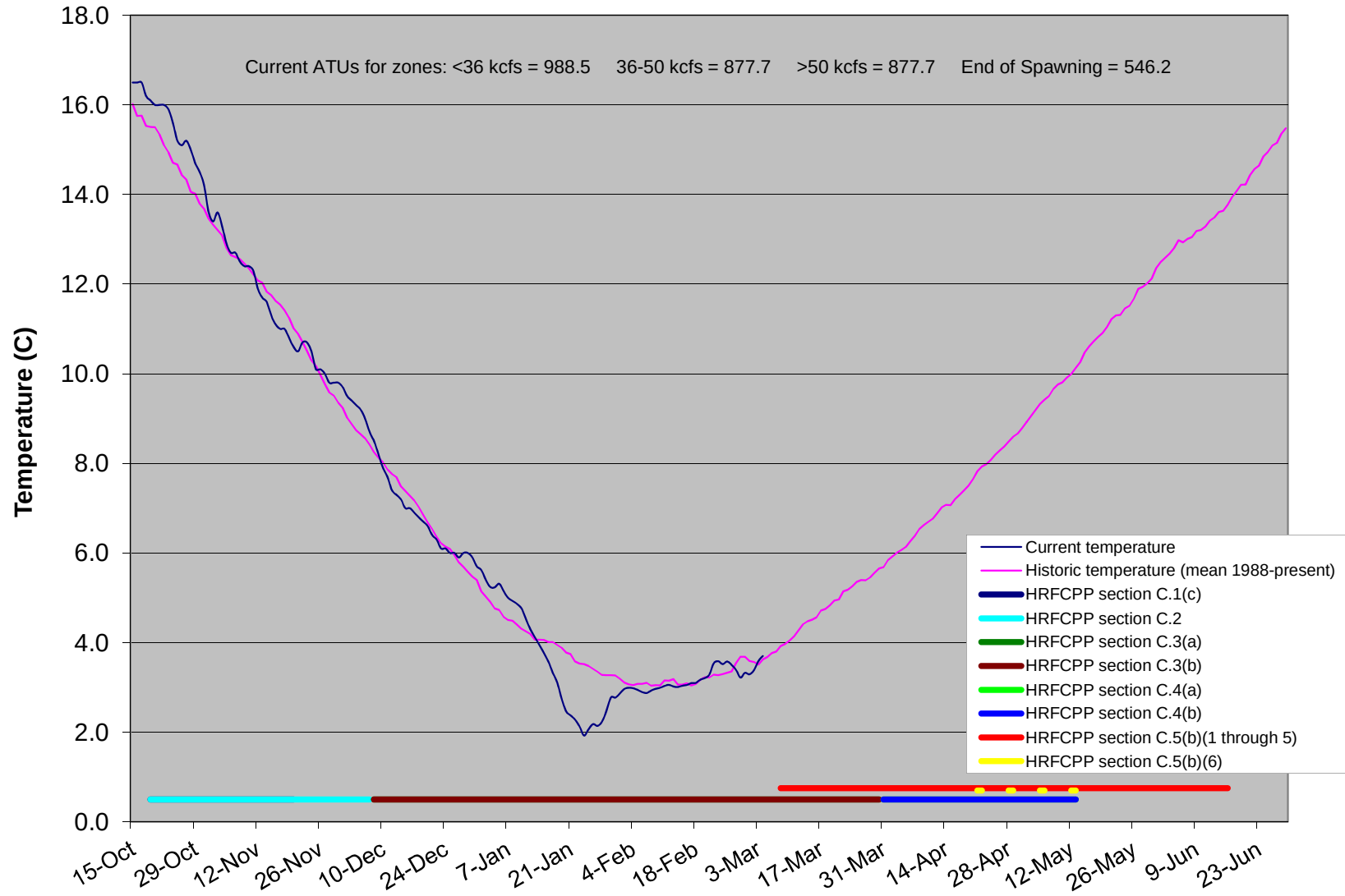
HRFCPP Lifestages			HRFCPP Constraint dates			Current constraint as of 03/04/12
	Begin (000 hrs)	End (2400 hrs)	HRFCPP Section	Begin (000 hrs)	End (2400 hrs)	
Spawning Period	10/19/2011	11/20/2011	C.1(c)	10/19/2011	11/20/2011	
Pre-Hatch Period	10/19/2011	2/20/2012	C.2	10/19/2011	12/7/2011	
Post-Hatch Period	11/26/2011	5/12/2012	C.3(a)	12/8/2011	3/30/2012	Y
Emergence Period	3/8/2012	5/13/2012	C.3(b)	12/8/2011	3/30/2012	Y
Rearing Period	3/8/2012	6/16/2012	C.4(a)	3/31/2012	5/13/2012	
			C.4(b)	3/31/2012	5/13/2012	
			C.5(b)(1-5)	3/8/2012	6/16/2012	
			C.5(b)(6)	4/21/2012	5/13/2012	
	ATUs (celcius)					
	Initiation of spawning	through 03/04/12				
<36 kcfs elevation	10/19/2011	988.5	Current date		Link to TU data	
36-50 kcfs elevation	10/26/2011	877.7	3/6/2012		Link to discharge data	
>50 kcfs elevation	10/26/2011	877.7	Data through:			
End of spawning	11/20/2011	546.2	3/4/2012			
Temperature on 03/04/12		3.7				
Critical Elevation (kcfs)	65		Exceedances:	0		

Cell are highlighted in yellow when ATU criteria are met.

Cell are highlighted in red when these constraints are currently in effect

Dates with red text are predicted based on current conditions and data from 1988 to present

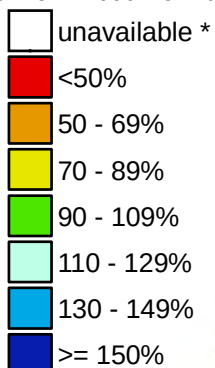
2011-2012 PRD Tailrace Temperatures and HRFCPP constraints



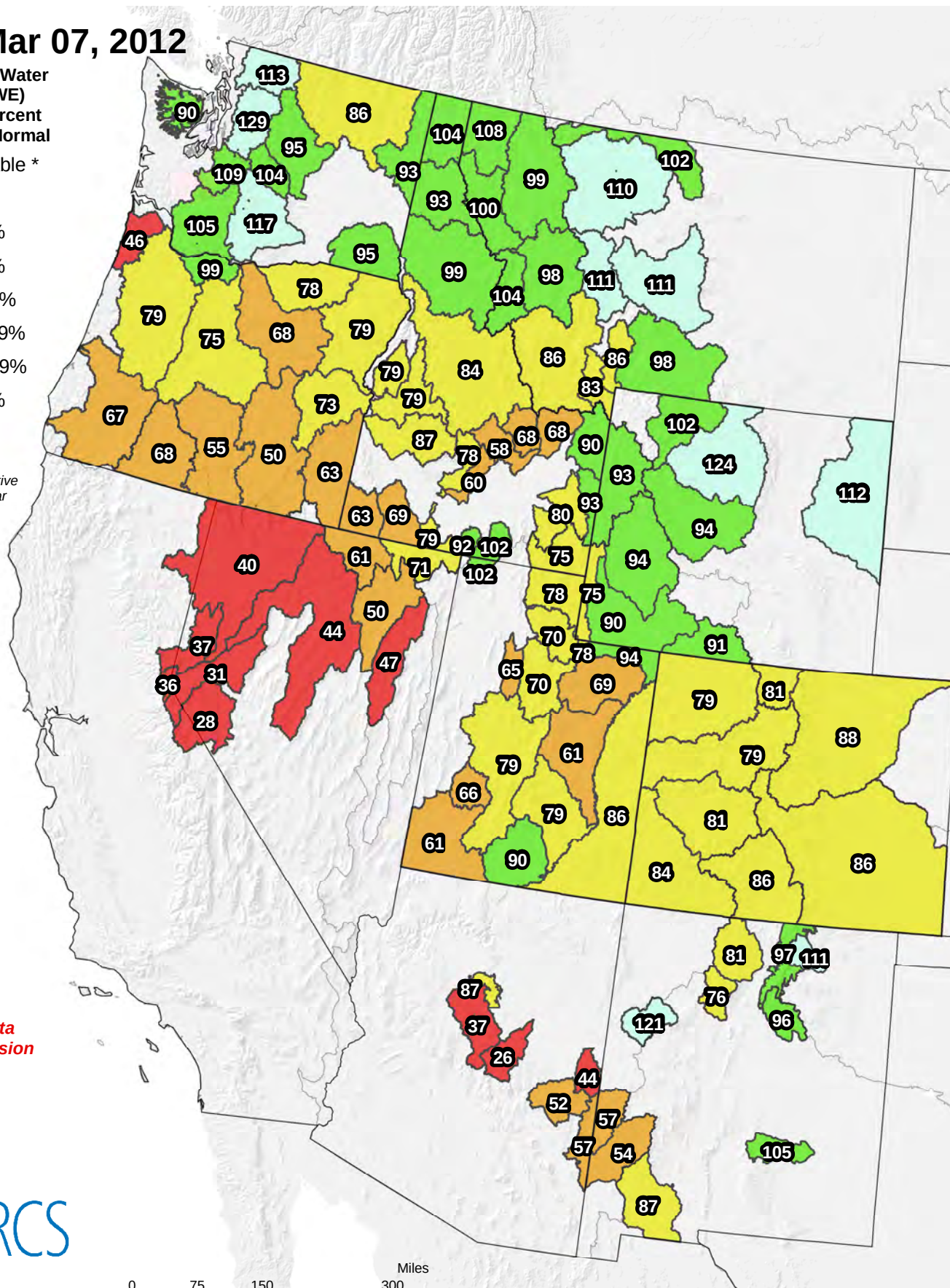
Westwide SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Mar 07, 2012

Current Snow Water Equivalent (SWE)
Basin-wide Percent
of 1971-2000 Normal



* Data unavailable
at time of posting
or measurement
is not representative
at this time of year



Provisional data
subject to revision



The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by the USDA/NRCS National Water and Climate Center
Portland, Oregon <http://www.wcc.nrcs.usda.gov/gis/>
Based on data from <http://www.wcc.nrcs.usda.gov/reports/>
Science contact: Jim.Marron@por.usda.gov 503 414 3047



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND OR 97208-2870

March 2012

2012 Fish Operations Plan

INTRODUCTION

The 2012 Fish Operations Plan (FOP) describes the U.S. Army Corps of Engineers' (Corps) planned operations for fish passage at its mainstem Federal Columbia River Power System (FCRPS) dams during the 2012 fish migration season; generally April through August. The 2012 FOP is consistent with the 2011 Court ordered spring and summer spill operations, and the adaptive management provisions in the 2010 NOAA Fisheries FCRPS Supplemental Biological Opinion (2010 Supplemental BiOp)¹ and the Corps' Record of Consultation and Statement of Decision (ROCASOD) adopting the project operations contained in the 2010 Supplemental BiOp and the Columbia Basin Fish Accords (Accords).

As in 2011, the 2012 FOP incorporates planned project operational adjustments necessary to conduct essential research to evaluate fish passage features during the 2012 migration season. Other FCRPS water management actions and project operations not specifically addressed in this document shall be consistent with the 2010 Supplemental BiOp and other guiding operative documents, including the 2012 Water Management Plan (WMP), seasonal WMP updates, and the 2012 Fish Passage Plan (FPP). Operations described herein are consistent with the 2011 Court Order, including adjustments to address in-season developments through discussion and coordination with the regional sovereigns as provided for in the 2010 Supplemental BiOp.

The following sections describe factors that influence management of fish operations during various runoff conditions, including: management of spill for fish passage, spillway operations, minimum generation requirements, operations under low flow conditions, navigation safety, juvenile fish transportation operations, specified spring operations for fish at each mainstem project, protocols for fish protection measures related to operational emergencies, coordination with regional entities, and monthly reporting.

GENERAL CONSIDERATIONS FOR FISH OPERATIONS

For planning purposes, the Corps' 2012 FOP assumes average runoff conditions. As actual runoff conditions vary in timing and shape and may be higher or lower than average in any given year, adjustments in fish transportation and/or spill operations (spill levels, spill percentages, or spill caps) will be adaptively managed in-season. These in-season changes will be coordinated through the Technical Management Team (TMT) and

¹ The 2010 Supplemental BiOp incorporates the 2008 NOAA BiOp.

other appropriate regional forums, to avoid or minimize adverse impacts to juvenile and/or adult fish passage conditions, navigation safety concerns, or to accommodate powerhouse and/or transmission system constraints. Actual spill levels may be adaptively managed to accommodate fish research or other conditions and will be coordinated through the TMT and other appropriate regional forums.

Management of Spill for Fish Passage

The Corps will manage spill levels for fish passage to avoid exceeding 120% total dissolved gas (TDG) in project tailraces, and 115% TDG in the forebay of the next project downstream consistent with the current State of Washington percent TDG limits.² These limits are referred to as gas caps. The maximum project spill level that meets, but does not exceed, the gas cap is referred to as the spill cap. Gas caps are constant, whereas spill caps may vary daily depending on flow, spill operation, spill pattern, temperature, and other environmental conditions.

As noted above, the spill levels presented below in Tables 2 and 3 are planned spill operations and assume average runoff conditions; however, adjustments to these spill rates may be necessary. Reasons for these adjustments may include:

1. Low runoff conditions that may require adjustments in spill level while still meeting project minimum generation requirements.
2. High runoff conditions where flows exceed the powerhouse hydraulic capacity with the specified spill rates.
3. Navigation safety concerns.
4. Generation unit outages that reduce the powerhouse hydraulic capacity.
5. Power system or other emergencies that reduces powerhouse outflow.
6. Lack of power demand resulting in an increase in spill levels.

The Corps' Reservoir Control Center (RCC) is responsible for daily management of spill operations responsive to changing TDG conditions. In order to manage gas cap spill levels consistent with the states' TDG saturation limits, the RCC establishes the TDG spill caps for the lower Columbia and Snake River projects on a daily basis throughout the fish passage season. The resultant TDG spill caps are set to provide percent TDG saturation levels that are not expected to exceed the 120%/115% TDG limits, which are measured as the average of the highest 12 hourly readings for each day.

Within any given day, some hours of measured TDG levels may be higher or lower than the gas caps due to changing environmental conditions (wind, air temperature, etc.). The process of establishing daily spill caps entails reviewing existing hourly data at each dam

² The 2010 Supplemental BiOp provides: "Specific spill levels will be provided for juvenile fish passage at each project, not to exceed established TDG levels (either 110 percent TDG standard, or as modified by State water quality waivers, currently up to 115 percent TDG in the dam forebay and up to 120 percent TDG in the project tailwater...). In February 2009, the State of Oregon modified its 5-year waiver to remove the 115% forebay TDG limit. However, the Corps will continue to manage to 120% and 115% (the Washington TDG standard) consistent with the 2011 Court Order in 2012.

(including flow, spill, temperature, and TDG levels) and taking into consideration a number of forecast conditions (including total river flow, powerhouse flow, wind and temperature forecast, etc.). These data are used as input variables into the System TDG (SYSTDG) model. The SYSTDG model estimates TDG levels expected several days into the future and is a tool integral to daily decision-making when establishing spill caps at individual dams. Spill caps set by RCC and contained in the daily spill priority list will be met at the projects using the individual project spill pattern(s) contained in the FPP Sections 2 through 9, that most closely corresponds to the specified spill level (i.e. may be slightly over or under the specified spill level or percent value). During the spring freshet, when river flow may be greater than project powerhouse hydraulic capacity given the specified FOP spill level, or a lack of power load results in an increase in the spill level, the Corps will attempt to minimize TDG on a system-wide basis. In this case, spill caps are also developed for 122%, 125%, 127%, 130%, or 135% TDG as a means of minimizing TDG throughout the system.

The Corps will initiate spill at 0001 hours, or shortly after midnight, at each of the projects on the start dates specified in the project sections below. Spill caps will be established at the specified FOP levels and will continue unless conditions require changing to maintain TDG within the upper limits of 120% in the tailwater of a dam and 115% in the forebay of the next project downstream (and at Camas/Washougal³ - except during summer testing). Unless otherwise specified, spill will transition to summer levels at 0001 hours, or shortly after midnight, at each project on the day after spring spill ends, (specified in the project sections below). Operations to manage TDG will continue to be coordinated through the TMT.

Spillway Operations

The Action Agencies will meet the specified spill levels to the extent feasible; however, actual hourly spill levels at each dam may be slightly more or less than those specified in Tables 2 and 3 below. Actual spill levels vary depending on the precision of spill gate settings, flow variations in real time, varying project head (the elevation difference between a project's forebay and tailwater), automatic load following, and other factors.

Operational Considerations:

- **Spill levels:** Project spill levels listed in Tables 2 and 3 coincide with specific gate settings in the FPP project spill pattern tables. Due to limits in the precision of spill gates and control devices, short term flow variations, and head changes, it is not always possible to meet the exact spill levels identified in Tables 2 and 3 or in RCC spill requests (teletypes) to specific projects. Therefore, spillway gates are opened to the gate settings identified in the FPP project spill pattern tables to provide spill levels that are the closest to the prescribed FOP spill levels.

³ The Camas/Washougal TDG fixed monitoring site is located approximately 24 miles downstream of Bonneville Dam and is used to simulate a forebay gauge for Bonneville Dam.

- Spill percentages: Spill percentages are considered target spill levels. The project control room operator and BPA duty scheduler calculate spill levels to attempt to be within $\pm 1\%$ of the target percentage for the following hour (or more than $\pm 1\%$ at The Dalles and Little Goose dams as specified in FPP Sections 3 and 8 spill pattern tables). Prescribed or specified spill percentages in Tables 2 and 3 may not always be attained due to low flow conditions and minimum generation requirements (Table 1), TDG gas cap limitations, temporary spill curtailment for navigation safety, and other unavoidable circumstances. Operators and schedulers review the percentages achieved during the day and adjust spill levels in later hours, with the objective of ending the day with a daily average spill percentage that achieves the specified spill percentage.

Minimum Generation

Both Snake and Columbia River dams have a minimum generation requirement that has been established to maintain power system stability and reliability. The Corps has identified minimum generation powerhouse outflow values derived from actual generation records when turbines were operating within $\pm 1\%$ of best efficiency (Table 1). Values stated in Table 1 are approximations that account for varying head or other small adjustments in turbine unit operation that may result in variations from the reported minimum generation flow and spill amount. Conditions that may result in minor variations include:

1. Varying pool elevation: as reservoirs fluctuate within the operating range, flow rates through the generating unit change.
2. Generating unit governor "dead band": the governor controls the number of megawatts the unit should generate, but cannot precisely control a unit flow; variations may be 1-2% of unit flow.
3. System disturbances: once a generator is online and connected to the grid, it responds to changes in system voltage and frequency. These changes may cause the unit to increase or decrease flow and generation slightly within an hour. Individual units operate differently from each other and often have unit specific constraints.
4. Generation control systems regulate megawatt (MW) generation only; not flow through individual turbine units.

All of the lower Snake River powerhouses may be required to keep one generating unit on line at all times for power system reliability under low river flow conditions, which may result in a reduction of spill at that project. These projects have two "families" of turbines with slightly different capacities – small and large. In most cases during low flow conditions, one of the smaller turbine units (with reduced generation and flow capabilities) will be online. The smaller turbine units are generally numbered 1–3 and are the first priority for operation during the fish passage season. If smaller turbine units are unavailable, larger units may be used.

During low river flow events, the operating unit generally runs at the lower end of the $\pm 1\%$ of best efficiency range. At Lower Monumental Dam, however, turbine unit 1 (the first priority unit during fish passage) cannot operate at the low end of the design range because it has welded blades. Ice Harbor turbine units cannot be operated at the lower end of the $\pm 1\%$ of best efficiency range because these units experience cavitation, which damages the turbine runner and can be detrimental to fish. Therefore, Ice Harbor turbine units will operate at their lower cavitation limits. Minimum generation flow ranges at McNary, John Day, and The Dalles dams are 50-60 kcfs and 30-40 kcfs at Bonneville, as shown in Table 1.

Table 1.— Minimum generation ranges for turbine units at the four lower Snake and four lower Columbia River dams.

Project	Turbine Units	Minimum Generation (kcfs)
Lower Granite	1-3	11.3-13.1
	4-6	13.5-14.5
Little Goose	1-3	11.3-13.1
	4-6	13.5-14.5
Lower Monumental	1	16.5-19.5
	2-3	11.3-13.1
	4-6	13.5-14.5
Ice Harbor	1, 3-6	8.5-10.3
	2	11.3-13.1
McNary	N/A	50-60
John Day	N/A	50-60
The Dalles	N/A	50-60
Bonneville	N/A	30-40

Low Flow Operations

Low flow operations at lower Snake and Columbia River projects are triggered when inflow is not sufficient to meet both minimum generation requirements and planned FOP spill levels listed in Tables 2 and 3. In these situations, Snake River projects will operate one turbine unit at the minimum generation outflow and spill the remainder of inflow at the project. Columbia River projects will also operate at minimum generation and pass the remaining inflow as spill down to minimum spill levels. As river flow transitions from higher flow to low flow, there may be situations when maintaining minimum generation and the target spill identified in Tables 2 and 3 may not be possible every hour, since these projects have limited flexibility. During the transition phase, flow may recede at a higher rate than forecasted and inflow provided by non-Federal projects upstream is often variable and uncertain. The combination of these factors may result in instances where unanticipated changes to inflow cause forebay elevations to go outside of the normal minimum operating pool (MOP) ranges for Snake River projects as provided for in the 2010 Supplemental BiOp.

During low flow conditions when the navigation lock is being emptied at some projects, the total spill volume remains constant, but the spill reported as a percent of total flow may be temporarily reduced below the target spill percentage. This occurs because the volume of water needed to empty the navigation lock during periods of low flow is a greater percentage of the total flow than when river flow is higher.

At Little Goose Dam, when daily average flow in the lower Snake River is ≤ 32 kcfs, achieving 30% spill would require switching powerhouse operations between operating two units at the low end of the $\pm 1\%$ of best efficiency range to operating one unit at the high end of the $\pm 1\%$ of best efficiency range. This operation, in combination with constant inflow from Lower Granite Dam, often makes it difficult to achieve the FOP prescribed spill level downstream at Lower Monumental Dam and to also maintain MOP operations. In years past, through coordination with TMT during low flow periods, Little Goose spill operations changed from 30% to a constant spill level of approximately 7-11 kcfs to smooth out Little Goose outflow, meet Lower Monumental FOP specified spill levels, and maintain the MOP elevation at Little Goose. A similar operation will be implemented in 2012, if necessary, depending on river flow.

Operations during Rapid Load Changes

Project operations during hours when power system load and/or intermittent generation changes rapidly, may result in not meeting FOP specified hourly spill levels because projects must be available to respond to within-hour load variability to satisfy North American Electric Reliability Council (NERC) reserve requirements (“on response”). This usually occurs at McNary, John Day, and The Dalles dams. In addition to within-hour load variability, projects on response must be able to respond to within hour changes that result from intermittent generation (such as wind generation). During periods of rapidly changing loads and intermittent generation, projects on response may have significant changes in turbine flow within the hour, while the spill quantity remains the same within the hour. Under normal conditions, within-hour load changes occur mostly on hours immediately preceding and after the peak load hours; however, within-hour changes in intermittent generation can occur at any hour of the day. Due to the high variability of within-hour load and intermittent generation, these load swing hours may have a greater instance of reporting actual spill percentages that vary more than the $\pm 1\%$ requirement in other hours.

Turbine Unit Testing around Maintenance Outages

Turbine units may be operationally tested for up to 30 minutes by running the unit at speed no load and various loads within the 1% of best efficiency range to allow for pre-maintenance measurements and testing, and to allow all fish to move through the unit. Units may be operationally tested after maintenance or repair, but before a unit comes out of a maintenance or forced outage status. This testing may consist of running the unit for up to 30 minutes before it is returned to operational status. Testing of a unit under maintenance is in addition to a unit operating at minimum generation required for power system reliability. Testing may deviate from unit operating priorities specified in FPP sections 2-9 and may use water that would otherwise be used for spill if the running unit

for reliability is at the bottom of the $\pm 1\%$ of best efficiency range. Water will be used from the powerhouse outflow allocation if possible, and water diverted from spill for operational testing will be minimized. Consistent with the 2011 Court Order and previous years, the Corps will coordinate this testing with the region through the Fish Passage Operations and Maintenance (FPOM) group.

Navigation Safety

Short-term adjustments in spill may be required for navigation safety, primarily at the lower Snake projects, but may also be necessary at the lower Columbia projects. This may include changes in spill patterns, reductions in spill, or short-term spill curtailment. In addition, unsteady flow at Little Goose and Ice Harbor dams during low flow conditions may impact reservoir elevations at those projects and cause inadequate navigation depths at the downstream entrances to the Lower Granite and Lower Monumental navigation locks. Therefore, adjustments to pool elevation in the Little Goose pool and Ice Harbor pool, of up to 1.0 ft. above the MOP operating range may be necessary to accommodate safe entrance to the navigation locks at Lower Granite and Lower Monumental dams during periods of low flow (approximately 50 kcfs or less) and will be coordinated in TMT. These adjustments may be necessary for both commercial tows and fish barges. Additionally, to accommodate safe navigation, the Lower Granite pool will be operated up to MOP+2 ft. depending on river flow, consistent with operations coordinated in 2011⁴.

JUVENILE FISH TRANSPORTATION PROGRAM OPERATIONS

As noted above, the Corps' planned spill operations assume average runoff conditions. In previous years, the FOP provided that spill for fish passage would occur under all flow conditions.⁵ To improve survival of juvenile migrants, the 2010 Supplemental BiOp calls for an annual review of the previous year's fish survival information and discussion with the Regional Implementation Oversight Group (RIOG) to inform transport/spill operations for the subsequent year. After considering the best available information and taking into account input from regional sovereigns, the Corps will continue implementation of the 2011 juvenile fish transportation program operations at the Snake River collector projects in 2012. These operations will continue spill levels specified in Tables 2 and 3 independent of flow conditions. River flow and fish condition will be monitored, and if regional sovereigns recommend adjustments in spill and/or transportation operations that differ from those stated herein, the Corps will use the regional coordination process to make a determination on recommended operational changes.

⁴ Flow specific criteria under the variable-MOP operation are as follows: If inflow is ≥ 120 kcfs, then operate at 733.0-734.0 ft. (MOP); if inflow is 80-119 kcfs, then operate at 734.0-735.0 ft. (MOP+1); if inflow 50-79 kcfs, then operate at 734.5-735.5 ft. (MOP+1.5); if inflow is ≤ 49 kcfs, then operate at 735.0-736.0 ft. (MOP+2).

⁵ The 2009 FOP provided: "In exceptionally low water years, when the projected seasonal average flow is less than 70 kcfs, the Corps will begin transportation on April 20 at all three Snake collector projects. Spill for fish passage will occur under all flow conditions."

The following describes the proposed transportation operations for the lower Snake River projects. Detailed descriptions of project and transport facility operations to implement the juvenile fish transportation program are contained in the FPP Appendix B.

Lower Snake River Dams - Operation and Timing

Transportation will be initiated at Lower Granite Dam no earlier than April 20 and no later than May 1. Transportation will start up to 4 days and up to 7 days after the Lower Granite Dam start date at Little Goose and Lower Monumental dams, respectively. The actual start date for Lower Granite, Little Goose, and Lower Monumental dams will be determined through coordination with TMT as informed by the in-season river condition (e.g. river flow and temperature) and the status of the juvenile Chinook and steelhead runs (e.g. percentage of runs having passed the project).

The collection of fish at lower Snake River projects for transportation will commence at 0700 hours on the agreed to start dates. Barging of fish will begin the following day and collected juvenile fish will be transported from each facility on a daily or every-other-day basis (depending on the number of fish) throughout the migration season. Transportation operations will be carried out at each project in accordance with all relevant FPP operating criteria.

Transportation and spill operations may be adjusted due to research, conditions at fish collection facilities such as overcrowding or temperature extremes, through the adaptive management process with FPOM and/or TMT to better match juvenile outmigration timing or achieve/maintain performance standards.

McNary Dam - Operation and Timing

Transportation will be initiated at McNary Dam between July 15–30 per the 2010 Supplemental BiOp (RPA 30, Table 4) and in coordination with NOAA Fisheries and the TMT. Fish will be transported from McNary Dam by barge through August 16, then transported by truck every other day. All fish collected will be transported except those marked for in-river studies. Fish are expected to be transported through September 30. The presence of factors such as excess shad, algae or bryozoans that can clog screens and flumes may result in discontinuing transport operations at McNary Dam before September 30. Detailed criteria for McNary transport are contained in the FPP, Appendix B.

Transportation operations may be adjusted for research purposes, due to conditions at the collection facilities, or as a result of the adaptive management process (to better match juvenile outmigration timing and/or to achieve or maintain performance standards). If new information indicates that modifying (or eliminating) transportation operations at McNary Dam is warranted, adaptive management will be used to make appropriate adjustments through coordination with the FPOM/TMT.

SPRING SPILL OPERATIONS

Lower Snake River Projects

Spring spill will begin on April 3 at Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams. Spring spill operations will continue through June 20. However, fish run timing and research schedules may require an earlier transition date to summer operations to assure that research occurs during the bulk of the migration. Such changes will be coordinated through TMT. Spring spill levels for Snake River dams are shown in Table 2.

Lower Columbia River Projects

Spring spill will begin April 10 at McNary, John Day, The Dalles, and Bonneville dams. Spring spill operations will continue through June 30 at John Day, and The Dalles dams, through June 19 at McNary Dam, and through June 15 at Bonneville Dam. However, fish run timing and research schedules may require earlier transition dates to summer spill operations to assure that research occurs during the bulk of the migration. Such changes if necessary will be coordinated through the TMT. Spring spill operations are shown in Table 2.

SUMMER SPILL OPERATIONS

Lower Snake River Projects

Summer spill will begin on June 21 at Lower Granite, Little Goose, Lower Monumental and Ice Harbor dams and continue through August 31 at all four Snake River projects. Summer spill levels are shown in Table 3.

Lower Columbia River Projects

Summer spill will begin June 16 at Bonneville Dam, June 20 at McNary Dam, and July 1 at John Day and The Dalles dams and continue through August 31 at all four Columbia River projects. Summer spill levels are shown in Table 3.

PROJECT BY PROJECT OPERATIONS

The following sections describe 2012 spill operations for each project. Included in the descriptions are planned research activities identified in the 2010 Supplemental BiOp. The Corps, regional fishery agencies, and Tribes are interested in the continuation of project research studies under the Corps' Anadromous Fish Evaluation Program (AFEP). These studies have been evaluated through the annual AFEP review process with the regional fishery agencies and Tribes, with the study designs being finalized prior to initiation in 2012. The studies are intended to provide further information on project survival that will help inform the region in making decisions on future operation and

configuration actions to improve fish passage and survival and meet BiOp performance standards at the lower Snake and Columbia River dams.

Table 2.— Summary of 2012 spring spill levels at lower Snake and Columbia River projects.⁶

Project	Planned 2012 Spring Spill Operations (Day/Night)	Comments
Lower Granite	20 kcfs/20 kcfs	Same as 2011
Little Goose	30%/30%	Same as 2011
Lower Monumental	Gas Cap/Gas Cap (approximate Gas Cap range: 20-29 kcfs)	Same as 2011
Ice Harbor	April 3-April 28: 45 kcfs/Gas Cap April 28-June 20: 30%/30% vs. 45 kcfs/Gas Cap (approximate Gas Cap range: 75-95 kcfs)	Same as 2011
McNary	40%/40%	Same as 2011
John Day	Pre-test: 30%/30% Testing: 30%/30% and 40%/40%	Same as 2011
The Dalles	40%/40%	Same as 2011
Bonneville	100 kcfs/100 kcfs	Same as 2011

⁶ Table 2 summarizes the planned spring spill operations. More specific detail governing project operations is included in project specific sections.

Table 3.— Summary of 2012 summer spill levels at lower Snake and Columbia River projects.⁷

Project	Planned 2012 Summer Spill Operations (Day/Night)	Comments
Lower Granite	18 kcfs/18 kcfs	Same as 2011
Little Goose	30%/30%	Same as 2011
Lower Monumental	17 kcfs/17 kcfs	Same as 2011
Ice Harbor	June 21-July 13: 30%/30% vs. 45 kcfs/Gas Cap July 13-August 31: 45 kcfs/Gas Cap (approximate Gas Cap range: 75-95 kcfs)	Same as 2011
McNary	50%/50%	Same as 2011
John Day	July 1-July 20: 30%/30% and 40%/40% July 20-August 31: 30%/30%	Same as 2011
The Dalles	40%/40%	Same as 2011
Bonneville	June 16-July 20: 85 kcfs/121 kcfs and 95 kcfs/95 kcfs July 21-August 31: 75 kcfs/Gas Cap	Same as 2011

Lower Granite

Spring Spill Operations April 3 through June 20: 20 kcfs 24 hours per day.

Summer Spill Operations June 21 through August 31: 18 kcfs 24 hours per day.

Changes in Operations for Research Purposes:

- Research operations: There are no special spill operations for research planned in 2012. Established spill patterns as described in FPP Section 9 will be used.

Operational Considerations:

- Lack of power load or unexpected unit outages could cause involuntary spill at higher total river flow that could result in exceeding the gas cap limits.
- During periods of high spring runoff when involuntary spill occurs, there may be periods where spill levels create unsafe hydraulic conditions for commercial, non-commercial, and fish transportation barges entering and exiting the tailrace and/or while moored at the fish loading facility. If such runoff conditions occur, spill may be reduced temporarily when fish transport barges approach or leave the barge

⁷ Table 3 summarizes the planned summer spill operations. More specific detail governing project operations is included in project specific sections.

docking area or are moored at loading facilities. If conditions warrant a spill reduction for any navigational passage, Lower Granite pool MOP elevation restrictions may be temporarily exceeded until the barge/vessel exits the tailrace safely and spill resumes.

- Unit outages may occur for required or emergency unscheduled maintenance activities described in FPP Appendix A. Maintenance dates are subject to change.

Little Goose

Spring Spill Operations April 3 through June 20: 30% spill 24 hours per day. The spillway weir closure gate will be raised as soon after 0630 hours on April 3 as weather permits.

Summer Spill Operations June 21 through August 31: 30% spill 24 hours per day.

Changes in Operations for Research Purposes:

- Research operations: Performance standard testing at 30% spill will occur in spring and summer 2012 at Little Goose Dam. Testing will begin in late April and continue through mid-July. The dates of testing will be dependent on the size and availability of fish for tagging. Final dates for testing will be coordinated through the Studies Review Workgroup (SRWG). Established spill patterns as described in FPP Section 8 will be used.
- Objectives of the biological test: The objectives of the test are to assess passage distribution and efficiency metrics, forebay retention and tailrace egress times, and dam survival for yearling Chinook, juvenile steelhead, and subyearling Chinook to determine if juvenile dam survival at 30% spill under the current project configuration meets or exceeds the juvenile dam survival performance standard for spring (96%) and summer (93%) migrants specified in the 2010 Supplemental BiOp.

Operational Considerations:

- Daily average flows in the lower Snake River of ≤ 32 kcfs can result in incompatible operations with Lower Monumental Dam and cause spill quantity fluctuations. Alternative Little Goose operations to resolve this issue are described in the Low Flow Operations section above and will be coordinated through the FPOM/TMT.
- Unit outages may occur for required or emergency unscheduled maintenance activities described in FPP Appendix A. Maintenance dates are subject to change.
- Turbine Unit 1 Operation: Operating range will be set within the GDACS program for Little Goose Dam to restrict Turbine Unit 1 operation to approximately the upper 25% of the 1% of best efficiency range (about 16-17.5 kcfs). This will ensure a strong current along the south shore to counter the strong eddy that forms in the tailrace during certain spill conditions. A strong south shore current in the tailrace is important for both adult fish passage and juvenile fish egress. If low flow conditions occur in the spring, the full $\pm 1\%$ of best efficiency range will be restored to minimize impacts on spill levels.

Lower Monumental

Spring Spill Operations April 3 through approximately June 20: Spill to the 115/120% TDG gas cap 24 hours per day.

Summer Spill Operations Approximately June 21 through August 31: 17 kcfs 24 hours per day.

Changes in Operations for Research Purposes:

- Research operations: Performance standard testing at the TDG Gas Cap (spring) and at 17 kcfs (summer) spill will occur in 2012 at Lower Monumental Dam. Testing will begin in late April and continue through mid-July. The dates of testing will be dependent on the size and availability of fish for tagging. Final dates for testing will be coordinated through the SRWG. The “bulk” spill pattern as described in FPP Section 7 will be used. Based on a previous year’s study results, dam survival is higher using the “bulk” spill pattern compared to the “uniform” spill pattern.
- Objectives of the biological test: The objectives of the test are to assess passage distribution and efficiency metrics, forebay retention and tailrace egress times, and dam survival for yearling Chinook, juvenile steelhead, and subyearling Chinook to determine if juvenile dam survival at Gas Cap (spring) and 17 kcfs (summer) spill under the current project configuration meets or exceeds the juvenile dam survival performance standard for spring (96%) and summer (93%) migrants specified in the 2010 Supplemental BiOp.

Operational Considerations:

- Consistent with adjustments made in 2011 spring operations through regional coordination, when total river flow is likely to exceed turbine capacity and spill over the 120% TDG gas cap (occurs at a total river flow of ~140 kcfs) for three or more days, the project will use the uniform spill pattern. This may also occur if spill over the 120% TDG gas cap is required due to “lack of demand” spill at any river flow level.
- Daily average flows of ≤ 32 kcfs can result in incompatible operations with Little Goose Dam and may cause spill quantity fluctuations.
- Transit of the juvenile fish barge across the Lower Monumental tailrace, then docking at and departing from the fish collection facility, may require spill level to be reduced due to safety concerns. The towboat captain may request that spill level be reduced or eliminated during transit. During juvenile fish loading operations, spill is typically reduced to 15 kcfs, but can be reduced further if necessary for safety reasons. Barge loading duration can be up to 3.5 hours. Because of the time needed to complete loading at Lower Monumental, the Little Goose Project personnel will notify the Lower Monumental personnel when the fish barge departs from Little Goose. This ensures that BPA scheduling is provided advance notice for spill control at Lower Monumental Dam. Reducing spill may cause the Lower Monumental pool to briefly operate outside of MOP elevations.

- Operating units within the 1% of best efficiency range translates to as much as 19 kcfs discharge for each of the 6 turbine units, for a maximum hydraulic capacity of approximately 114 kcfs. The expected spill cap is roughly 27 kcfs (but varies depending on total river flow). Therefore, if total river flow is greater than 141 kcfs the gas cap will be exceeded. Either lack of power load or unit outages can also cause forced spill above spill cap limits at higher total river flow.
- Unit outages may occur for required or emergency unscheduled maintenance activities described in FPP Appendix A. Maintenance dates are subject to change.

Ice Harbor

Spring Spill Operations April 3 through June 20: Spill will begin at 45 kcfs day/spill cap night on April 3 and continue until April 28. On April 28, spill will alternate between 45 kcfs day/spill cap night and 30% /30% with the SW operating and continue through the spring season. Nighttime spill hours are 1800–0500.

Summer Spill Operations June 21 through August 31: Spill operations will continue from spring at 30% 24 hours per day vs. 45 kcfs day/Gas Cap night until July 13 at 0500 hours, then 45 kcfs day/Gas Cap night through August 31.

Changes in Operations for Research Purposes:

- Research operations: There are no special spill operations for research planned in 2012. Spill patterns as described in FPP Section 6 will be used.

Operational Considerations:

- Spill operation treatments may be rearranged within a week throughout the season. If rearrangement of treatments occurs, the total number of each spill level treatment for the spring season will not change. The flexibility to rearrange treatments during periods of higher power demand may alleviate the need to declare a power emergency.
- Powerhouse capacity at Ice Harbor is approximately 94 kcfs with all 6 units operating within the 1% of best efficiency range, while spill cap rates are about 100 kcfs. If total river flow exceeds about 194 kcfs, TDG levels may exceed the water quality standards set by the States of Oregon and Washington.
- Unit outages may occur for required or emergency unscheduled maintenance activities described in FPP Appendix A. Dates are subject to change.
- Submersible Traveling Screens (STSs) will be installed by April 1. The normal juvenile bypass operation will be to route fish through the full flow bypass pipe, which has interrogation capability to monitor for PIT tags. From April 1 through July 31, juvenile fish will be sampled every 3 to 5 days to monitor fish condition and then bypassed to the river. Sampling activity may be terminated early should juvenile bypass fish numbers drop to the point where valid sampling is no longer feasible (100 fish of the most dominant species present are needed to properly assess fish

condition). Sampling may also cease if the cumulative number of fish sampled for the season reach the permitted maximum.

McNary

Spring Spill Operations April 10 through approximately June 19: 40% spill 24 hours per day with the two spillway weirs operating. A spillway weir will be operated in both spillbay 19 and spillbay 20 for the period April 10 through June 6. As in past years, both spillbay weirs will be removed from service by June 8 (or next business day as coordinated through the FPOM) for the benefit of subyearling Chinook. This operational change will be coordinated through the Fish Facility Design Review Workgroup (FFDRWG), FPOM, the Tribes, and NOAA. Temporary spill pattern changes to allow removal of the spillway weirs will occur, however spill will continue at 40% during the spillway weir removal process. Following removal of the spillway weirs, the spill pattern contained in Table MCN-10 in FPP section 5 will be used for the remainder of the spring.

Summer Spill Operations June 20 through August 31: 50% spill 24 hours per day without spillway weirs.

Changes in Operations for Research Purposes:

- Research operations: Performance standard testing at 40% spill the spring and 50% during the summer will occur in 2012 at McNary Dam. Testing will begin in late April and continue through mid-July. The dates of testing will be dependent on the size and availability of fish for tagging. Final dates for testing will be coordinated through the SRWG. Spill patterns as described in FPP Section 5 will be used.
- Objectives of the biological test: The objectives of the test are to assess passage distribution and efficiency metrics, forebay retention and tailrace egress times, and dam survival for yearling Chinook, juvenile steelhead, and subyearling Chinook to determine if juvenile dam survival at 40% (spring) and 50% (summer) spill under the current project configuration meets or exceeds the juvenile dam survival performance standard for spring (96%) and summer (93%) migrants specified in the 2010 Supplemental BiOp.

Operational Considerations:

- Juvenile fish collected at McNary during the spring FOP implementation period will be bypassed to the river. The normal operation will be to bypass fish through the full flow bypass pipe, which has interrogation capability to monitor for PIT tags. Every other day, however, in order to sample fish for the Smolt Monitoring Program, fish will be routed through the separator, interrogated for PIT tags, and then bypassed to the river.
- All extended-length submersible bar screens (ESBSs) at McNary will be installed by April 15 as agreed to in consultation with FPOM, the Tribes, and NOAA. This is part of the Corps' consideration of lifting (or waiting to install) some turbine intake screens during periods of significant juvenile lamprey passage. Effects to both

salmon and lamprey have been considered. Although there are some adverse impacts to migrating salmon from this delay in screen installation, regional sovereigns have considered this acceptable in balancing the needs of multiple species.

- Spill will be curtailed as needed to allow safe operation of fish transportation barges near collection facilities downstream of the project.
- During the periods when total river flow exceeds approximately 320 kcfs, involuntary spill in excess of the States' TDG limits for fish passage may occur.
- In addition, low power demand may also necessitate involuntary spill at total river flow of less than 320 kcfs.
- Unit outages may occur for required or emergency unscheduled maintenance activities described in FPP Appendix A. Dates are subject to change.

John Day

Spring Spill Operations April 10 through June 30: 30% spill 24 hours per day will begin on April 10 and continue until testing begins on approximately April 27. During the test, spill 30% and 40% 24 hours per day for the remainder of spring. Spill levels will alternate between 30% and 40% spill in 4-day blocks with two-day treatments. Spill level changes will occur at 0600 hours.

Summer Spill Operations July 1 through August 31: Spill operations will continue from spring at 30% and 40% spill 24 hours per day and continue through approximately July 20. Spill levels will alternate in a four-day block with two-day treatments (30% or 40% spill). Spill treatment changes will occur at 0600 hours. Once performance standard testing concludes, 30% spill 24 hours per day will begin approximately July 20 and continue through August 31.

Changes in Operations for Research Purposes:

- Research operations: Performance standard testing at 30% and 40% spill will occur in spring and summer 2012 at John Day Dam. Testing will begin in late April and continue through mid-July. The dates of testing will be dependent on the size of fish, fish availability, and the number of treatments needed for testing. Final dates for testing will be coordinated through the SRWG. Spill patterns contained in FPP section 4 will be used.
Objectives of the biological test: The objectives of the test are to assess passage distribution and efficiency metrics, forebay retention and tailrace egress times, and dam survival for yearling Chinook, juvenile steelhead, and subyearling Chinook to determine if juvenile dam survival at 30% and/or 40% spill under the current project configuration meets or exceeds the juvenile dam survival performance standard for spring (96%) and summer (93%) migrants specified in the 2010 Supplemental BiOp.

Operational Considerations:

- Spill operation treatments may be rearranged within a week throughout the season. If rearrangement of treatment occurs, the total number of each spill level treatment for

the spring season will not change. The flexibility to rearrange treatments during periods of higher power demand may alleviate the need to declare a power emergency.

- Unit outages may occur for required or emergency unscheduled maintenance activities described in FPP Appendix A. Maintenance dates are subject to change.
- Unit outages and spillway outages may also be required to repair hydrophones and other research equipment. These will be coordinated through FPOM and TMT as needed.

The Dalles

Spring Spill Operations April 10 through June 30: 40% spill 24 hours per day.

Summer Spill Operations July 1 through August 31: 40% spill 24 hours per day.

Changes in Operations for Research Purposes:

- Research operations: Performance standard testing at 40% spill will occur in summer 2012 at The Dalles Dam. Testing will begin in June and continue through mid-July. The dates of testing will be dependent on the size and availability of fish for tagging. Final dates for testing will be coordinated through the SRWG. Spill patterns developed for use with the spillwall and included in FPP section 3 will be used.
- Objectives of the biological test: The objectives of the test are to assess passage distribution and efficiency metrics, forebay retention and tailrace egress times, and dam survival for subyearling Chinook to determine if juvenile dam survival at 40% spill under the current project configuration meets the juvenile dam survival performance standard for summer migrants (93%) specified in the 2010 Supplemental BiOp.

Operational Considerations:

- If total river flow is between 90 and 150 kcfs, the spill percentage could range from 38.6 to 41.4 percent; if the total river flow is between 150 and 300 kcfs, the spill percentage could range from 38.9 to 41.2 percent; if the total river flow is between 300 and 420 kcfs, the spill percentage could range from 38.4 to 41.0 percent.
- At no time is spill recommended on the south side of the spillway (Bays 9-23) as this creates a poor tailrace egress condition for spillway-passed fish.
- Spill bays 10, 11, 13, 16, 18, 19, and 23 are not operational due to wire rope, structural, and concrete erosion concerns.
- The spill pattern in the FPP is based on a nominal Bonneville forebay elevation of 74 feet.
- Unit outages may occur for required or emergency unscheduled maintenance activities described in FPP Appendix A. Maintenance dates are subject to change.

Bonneville

Spring Spill Operations April 10 through June 15: 100 kcfs spill 24 hours per day.

Summer Spill Operations June 16 through August 31: Summer spill operations will alternate every two days between 85 kcfs/121 kcfs and 95 kcfs 24 hours per day. The alternating operation will begin at 0430 hours approximately June 16 and continue through July 20. Spill changes will occur according the daytime spill schedule contained in Table BON-5 in FPP section 2. Spill at 85 kcfs/121 kcfs and/or 95kcfs/95 kcfs will be unconstrained by the Camas/Washougal fixed monitoring TDG station. Following the alternating spill operation, a 75 kcfs/Gas Cap operation (managed using the Camas/Washougal fixed monitoring TDG station) will begin on July 21 and continue through August 31.

Changes in Operations for Research Purposes:

- Research operations: Performance standard testing at 85 kcfs/121 kcfs and 95 kcfs spill 24 hours per day will occur in summer 2012 at Bonneville Dam. Testing will begin in June and continue through mid-July. The dates of testing will be dependent on the size and availability of fish for tagging. Final dates for testing will be coordinated through the SRWG. Spill patterns as described in FPP section 2 will be used.
- Objectives of the biological test: The objectives of the test are to assess passage distribution and efficiency metrics, forebay retention and tailrace egress times, and dam survival for subyearling Chinook to determine if juvenile dam survival at either 85 kcfs/121 kcfs and/or 95 kcfs 24 hours per day spill under the current project configuration meets the juvenile dam survival performance standard for summer migrants (93%) specified in the 2010 Supplemental BiOp.

Operational Considerations:

- High flow conditions in 2011 moved rock and large boulders into the Bonneville spillway stilling basin. If left in place, the rock and boulders would cause significant erosion and damage to the stilling basin due to ball milling during spill. For dam safety, before spill for juvenile fish passage occurs in April 2012, this material will be removed from the stilling basin. The schedule is to complete removal of material from the stilling basin by April 1, 2012. This has been coordinated through FPOM and any schedule delays impacting the initiation of spill will be coordinated through the FPOM and TMT.
- Minimum spill level is 50 kcfs; however, as in past years, under extreme low flow conditions lower spill levels may be considered and coordinated through the TMT. This is to provide acceptable juvenile fish egress conditions in the tailrace.
- During spring, at a total river flow of less than about 135 kcfs, spill will be less than 100 kcfs to maintain minimum powerhouse generation of 30 kcfs plus fish ladder and facility spill (e.g. second powerhouse corner collector, first powerhouse sluiceway).

- The TMT will consider the possible effects of TDG on emerging chum salmon downstream of Bonneville Dam. The TMT may request special operations such as flow increases or spill reductions to protect ESA-listed fish.
- Unit outages may occur for required or emergency unscheduled maintenance activities described in FPP Appendix A. Maintenance dates are subject to change.
- Actual spill levels at Bonneville Dam may range from up to 3 kcfs lower or higher than specified in Table 2. A number of factors influence this including hydraulic efficiency, exact gate opening calibration, spillway gate hoist cable stretch due to temperature changes, and forebay elevation (a higher forebay results in a greater volume of spill since more water can pass under the spill gate).
- The second powerhouse Corner Collector (5 kcfs flow) will operate from the morning of April 10 through the remainder of the spill season as coordinated through the FPOM.
- High river flow and excessive debris load at the second powerhouse may require removal of submersible traveling screens (STSS) and vertical barrier screens (VBSs) according to criteria described in FPP Section 2 in coordination with the FPOM.

TRANSPORT AND LATENT MORTALITY RESEARCH

Seasonal Effects of Transport

A study will be conducted to determine seasonal effects of transporting fish from the Snake River to optimize a transportation strategy. At Lower Granite, fish will be collected for this study starting on April 4, with marking beginning on April 5. Depending on the number of fish available, fish will be collected 1-2 days with tagging occurring on the day following collection. A barge will leave each Thursday morning with all fish collected during the previous 1-3 days. By barging all fish (minus the in-river group) during 1 to 3 days of collection, barge densities will be maintained at a level similar to what would occur under normal transport operations that time of year. This pattern will occur in the weeks preceding general transportation and will be incorporated into general transportation once that operation begins. The desired transported sample size is 6,000 wild Chinook and 4,000 - 6,000 wild steelhead weekly for approximately eight weeks.

Latent Mortality

A study will be conducted to evaluate latent mortality associated with passage through Snake River dams. The goal of this study is to determine whether migration through Snake River dams and reservoirs causes extra mortality in Snake River yearling (spring/summer) Chinook salmon smolts. Specifically, the study will determine if life-cycle survival downstream from McNary Dam is significantly higher for yearling hatchery Chinook salmon released into the Ice Harbor Dam tailrace than for counterparts which must pass three additional dams and reservoirs after release into the Lower Granite Dam tailrace. Fish will be collected at Lower Granite Dam beginning approximately April 20, with the goal of tagging approximately 74,000 smolts of which 45,000 will be

released into the tailrace of Lower Granite Dam, and 29,000 transported by truck and released in the tailrace of Ice Harbor Dam.

EMERGENCY PROTOCOLS

The Corps and the Bureau of Reclamation will operate the projects in emergency situations in accordance with the WMP Emergency Protocol (WMP Appendix 1). This protocol identifies the process the Action Agencies will use in the event of an emergency concerning the operation of FCRPS that impacts planned fish protection measures. The most recent version of the Emergency Protocols is located at:

<http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2010/final/emergencyproto>

COORDINATION

To make adjustments in response to changes in conditions, the Corps will utilize the existing regional coordination committees. Changes in spill levels when flow conditions are higher or lower than anticipated will be coordinated through the TMT. This could include potential issues and adjustments to the juvenile fish transportation program. Spill patterns and biological testing protocols that have not been coordinated to date will be finalized through the Corps' AFEP subcommittees, which include the SRWG, FFDRWG, and FPOM.

REPORTING

The Corps will provide periodic in-season updates to TMT members on the implementation of 2012 fish passage operations. The updates will include the following information:

- the hourly flow through the powerhouse;
- the hourly flow over the spillway compared to the spill target for that hour; and,
- the resultant 12-hour average TDG for the tailwater at each project and for the next project's forebay downstream.

The updates will also provide information on substantial issues that arise as a result of the spill program (e.g. Little Goose adult passage issues in 2005 and 2007), and will address any emergency situations that arise.

The Corps will continue to provide the following data to the public regarding project flow, spill rate, TDG level, and water temperature.

- Flow and spill quantity data for the lower Snake and Columbia River dams are posted to the following website every hour: <http://www.nwd-wc.usace.army.mil/report/projdata.htm>
- Water Quality: TDG and water temperature data are posted to the following website every hour: <http://www.nwd-wc.usace.army.mil/report/total.html>. These data are received via satellite from fixed monitoring sites in the Columbia and Snake rivers

every hour, and placed on a Corps public website upon receipt. Using the hourly TDG readings for each station in the lower Snake and Columbia rivers, the Corps will calculate both the highest and highest consecutive 12-hour average TDG levels daily for each station. These averages are reported at:

http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/wa/

PROPOSED DRAFT MARCH 15, 2012

	LACK OF LOAD SPILL CAPS								FISH PASSAGE SPILL CAPS
PROJECT	110%	115%	120%	122%	125%	127%	130%	135%	115/120%
LWG	20	30	45	52	63	85	90	200	41
IHR	25	35	75	85	110	124	145	240	90
TDA	45	60	135	160	269	294	360	400	140
BON	65	75	100	120	215	234	250	240	100
LGS	18	23	52	59	70	95	125	177	40
LMN	18	23	44	60	80	120	180	250	28
MCN	48	80	140	152	230	280	321	375	150
JDA	20	80	144	177	190	206	250	300	146
DWR	GC	GC	GC	GC	GC	GC	GC	GC	GC
CHJ	25	61	100	150	190	200	250	300	
GCL(a)	0	5	19	21	25	32	42	57	---
GCL(b)	5	10	15	50	75	93	120	130	---

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger / Ron Boyce	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday March 21, 2012 9:00am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 8437

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review March 7 Meeting Minutes [\[Meeting Minutes\]](#)
3. Forecast Update - Tony Norris, BPA
4. Spill Priority List - Doug Baus, Corps
 - a. [TDG Production Estimates](#)
5. Other
 - a. Set agenda and date for next meeting - **March 28, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger / Ron Boyce	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday March 21, 2012 9:00am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 8437

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review March 7 Meeting Minutes [\[Meeting Minutes\]](#)
3. Forecast Update - Tony Norris, BPA
4. Spill Priority List - Doug Baus, Corps
 - a. [TDG Production Estimates](#)
5. Other
 - a. Set agenda and date for next meeting - **March 28, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

DRAFT INITIAL 2012 SPILL PRIORITY LIST

* DENOTES CHANGE

LEVEL 1 SPILL (115% FOREBAY OR 120% TAILWATER WHICH EVER IS MORE RESTRICTIVE) IF NOT ALL READY SPILLING TO THESE LEVELS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
1) LWG UP TO FISH PASSAGE SPILL CAP	41
2) IHR UP TO FISH PASSAGE SPILL CAP *	90
3) TDA UP TO FISH PASSAGE SPILL CAP *	140
4) BON UP TO FISH PASSAGE SPILL CAP *	100
5) LGS UP TO FISH PASSAGE SPILL CAP *	40
6) LMN UP TO FISH PASSAGE SPILL CAP *	28
7) MCN UP TO FISH PASSAGE SPILL CAP *	150
8) JDA UP TO FISH PASSAGE SPILL CAP *	146
9) CHJ UP TO 110% *	25

LEVEL 2 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
10) LWG UP TO 120% TDG SPILL CAP *	45
11) IHR UP TO 120% TDG SPILL CAP *	75
12) TDA UP TO 120% TDG SPILL CAP *	135
13) BON UP TO 120% TDG SPILL CAP *	100
14) LGS UP TO 120% TDG SPILL CAP *	52
15) LMN UP TO 120% TDG SPILL CAP *	44
16) MCN UP TO 120% TDG SPILL CAP *	140
17) JDA UP TO 120% TDG SPILL CAP *	146
18) DWR UP TO 110% TDG SPILL CAP	32%
19) CHJ UP TO 120% SPILL CAP* (SHAPED 115% AT WEL, UP TO THE 120% IN THE CHJ TAILRACE, DEPENDING ON EXPECTED DURATION)	60

LEVEL 3 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
20) LWG UP TO 122% TDG SPILL CAP *	52
21) IHR UP TO 122% TDG SPILL CAP *	85
22) TDA UP TO 122% TDG SPILL CAP *	160
23) BON UP TO 122% TDG SPILL CAP	120
24) LGS UP TO 122% TDG SPILL CAP *	59
25) LMN UP TO 122% TDG SPILL CAP *	60
26) MCN UP TO 122% TDG SPILL CAP *	152
27) JDA UP TO 122% TDG SPILL CAP *	177
28) CHJ UP TO 120% TDG SPILL CAP *	100
29) GCL UP TO 110% TDG SPILL CAP *	(DRUMGATES)5

LEVEL 4 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
30) LWG UP TO 125% TDG SPILL CAP *	63
31) IHR UP TO 125% TDG SPILL CAP *	110
32) TDA UP TO 125% TDG SPILL CAP *	269
33) BON UP TO 125% TDG SPILL CAP	215
34) LGS UP TO 125% TDG SPILL CAP *	70
35) LMN UP TO 125% TDG SPILL CAP *	80
36) MCN UP TO 125% TDG SPILL CAP *	230
37) JDA UP TO 125% TDG SPILL CAP *	190
38) GCL UP TO 120% TDG SPILL CAP *	(DRUMGATE) 15
39) CHJ NOT TO EXCEED 190 KCFS (CHJ IS EXPECTED TO BE DEGASSING, LIMIT FOR DAM SAFETY CONCERNS)	190
40) GCL UP TO 125% SPILL CAP	(DRUMGATE) 75

LEVEL 5 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
41) LWG UP TO 127% TDG SPILL CAP *	85
42) IHR UP TO 127% TDG SPILL CAP *	124
43) TDA UP TO 127% TDG SPILL CAP *	294
44) BON UP TO 127% TDG SPILL CAP*	234
45) LGS UP TO 127% TDG SPILL CAP *	95
46) LMN UP TO 127% TDG SPILL CAP *	120
47) MCN UP TO 127% TDG SPILL CAP *	280
48) JDA UP TO 127% TDG SPILL CAP *	206
49) GCL UP TO 127% TDG SPILL CAP *	93

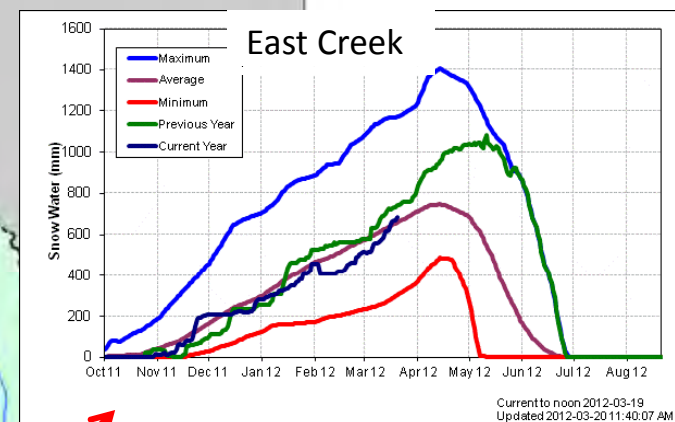
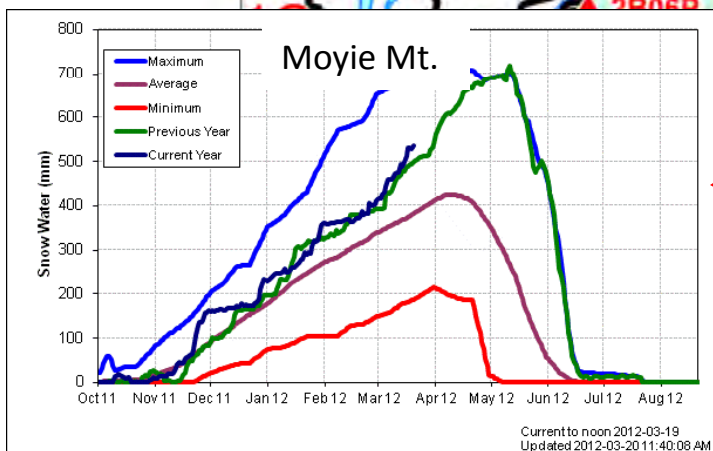
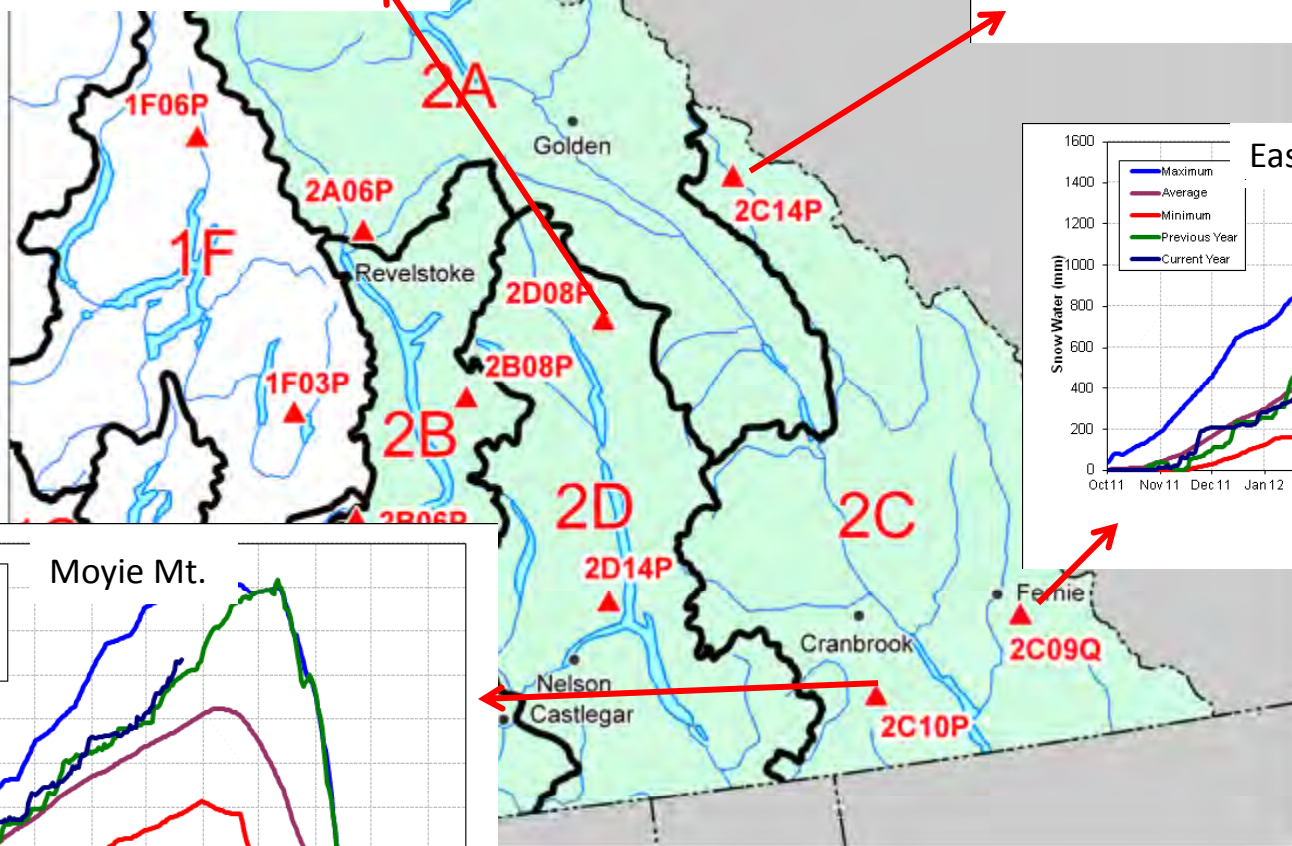
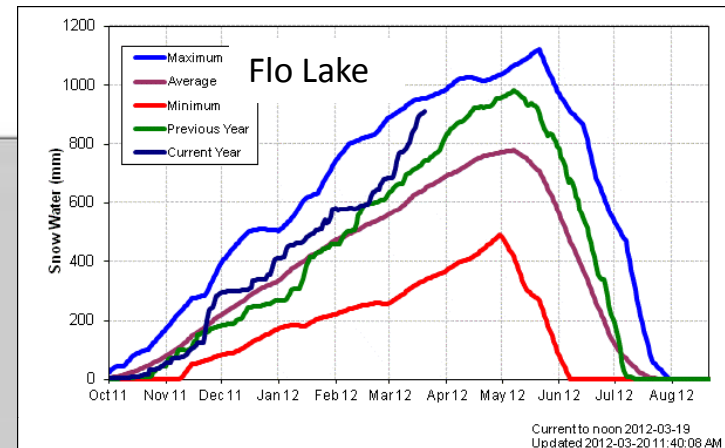
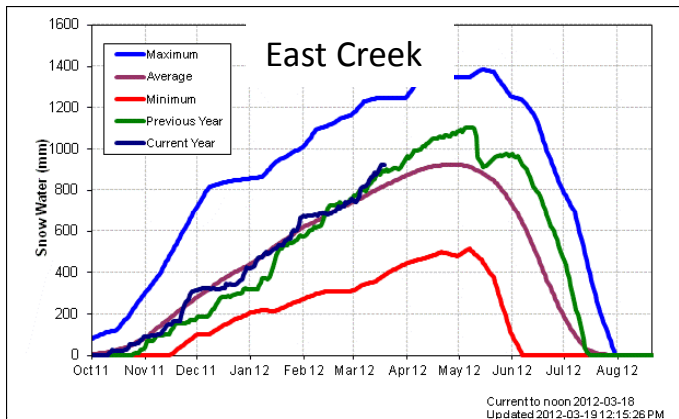
LEVEL 6 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
50) LWG UP TO 130% TDG SPILL CAP *	90
51) IHR UP TO 130% TDG SPILL CAP *	145
52) TDA UP TO 130% TDG SPILL CAP *	360
53) BON UP TO 130% TDG SPILL CAP*	250
54) LGS UP TO 130% TDG SPILL CAP *	125
55) LMN UP TO 130% TDG SPILL CAP *	180
56) MCN UP TO 130% TDG SPILL CAP *	321
57) JDA UP TO 130% TDG SPILL CAP *	250
58) GCL UP TO 130% TDG SPILL CAP *	(DRUMGATE) 120

LEVEL 7 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
59) LWG UP TO 135% TDG SPILL CAP *	200
60) IHR UP TO 135% TDG SPILL CAP *	240
61) TDA UP TO 135% TDG SPILL CAP *	400
62) BON UP TO 135% TDG SPILL CAP*	240
63) LGS UP TO 135% TDG SPILL CAP *	177

64) LMN UP TO 135% TDG SPILL CAP *	250
65) MCN UP TO 135% TDG SPILL CAP *	375
66) JDA UP TO 135% TDG SPILL CAP *	300
67) GCL UP TO 135% TDG SPILL CAP *	(DRUMGATE) 130

DRAFT

Kootenai Basin Snotel British Columbia

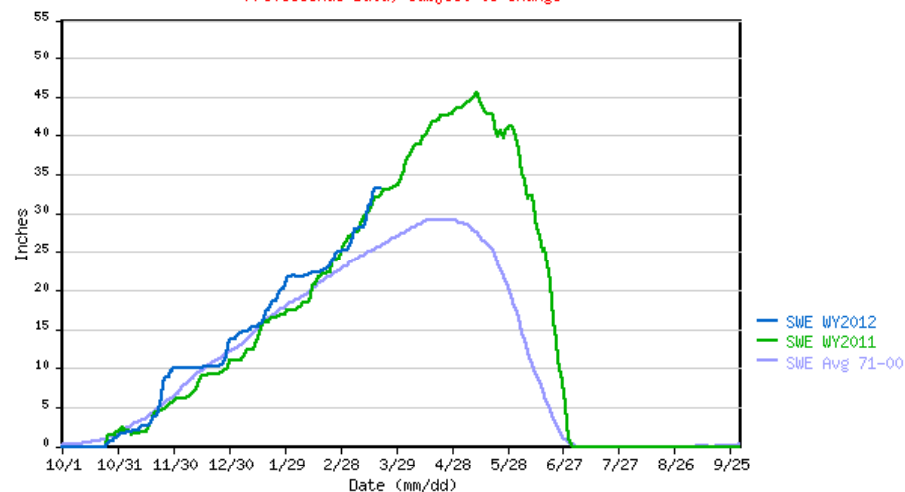


Kootenai Basin United States

Hawkins Lake

15A03S SNOTEL as of 03/20/2012

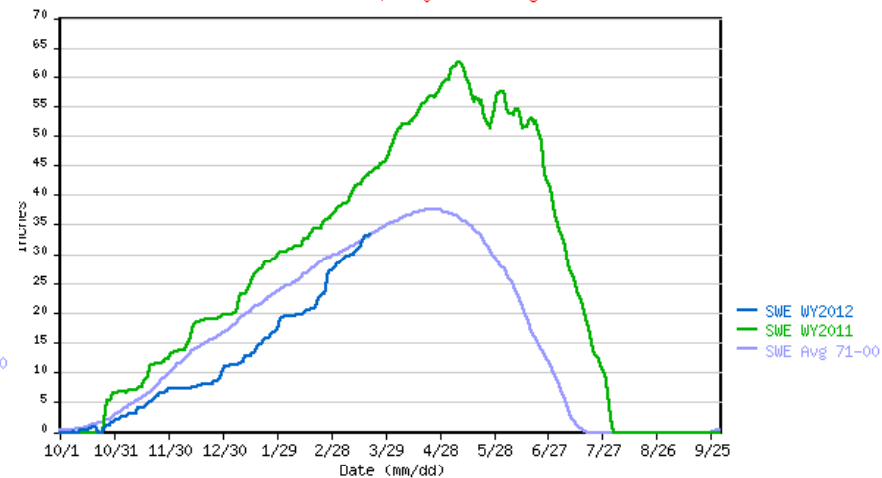
*** Provisional Data, Subject to Change ***



Stahl Peak

14A12S SNOTEL as of 03/20/2012

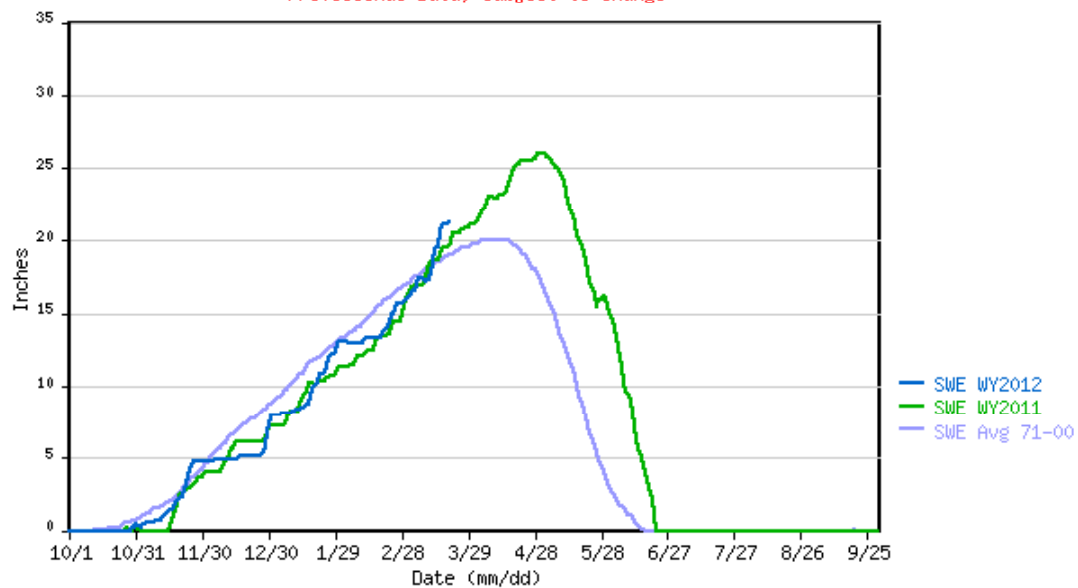
*** Provisional Data, Subject to Change ***



Banfield Mountain

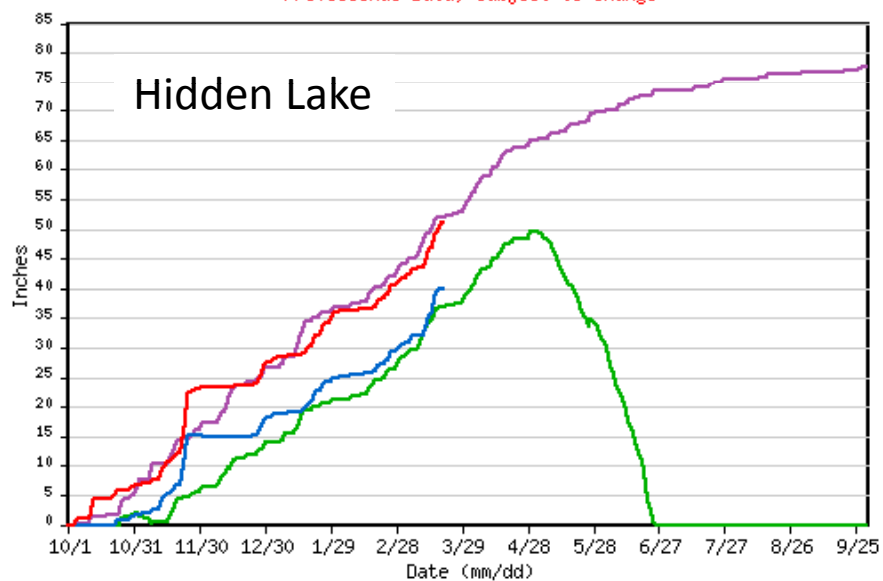
15A08S SNOTEL as of 03/20/2012

*** Provisional Data, Subject to Change ***



16A12S SNOTEL as of 03/20/2012

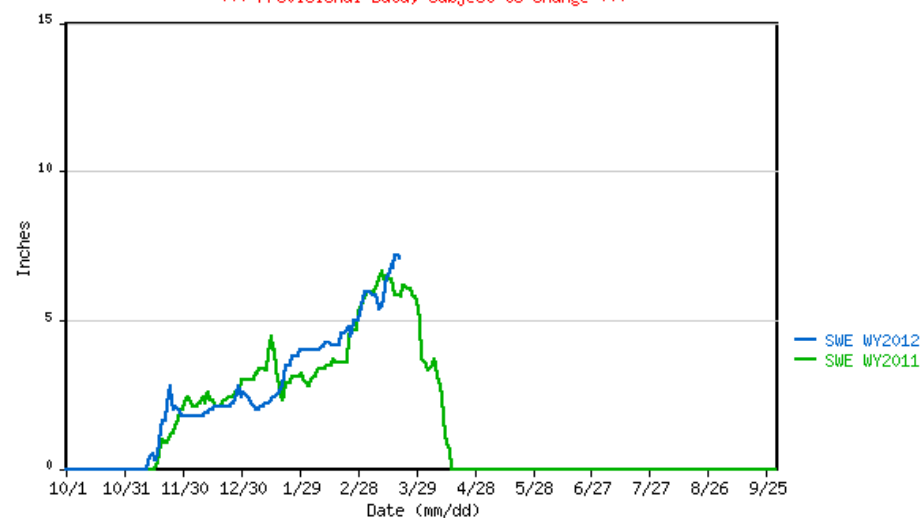
*** Provisional Data, Subject to Change ***



Myrtle Creek

16A14S SNOTEL as of 03/20/2012

*** Provisional Data, Subject to Change ***



COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

March 21, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the “record” of the meeting, only a reminder for TMT members.

Meeting Minutes

The notes from 3/7 and today's meeting will be posted for review and finalized at the next, 3/28 TMT meeting.

Forecast Update

John Roache, Reclamation, reported that the March 6 official final water supply forecast had shown The Dalles at 97% of average, which would translate to a 1237 foot flood control target for Grand Coulee at the end of April. Since then, forecasts have changed considerably and The Dalles is now showing a 103% of average water supply forecast, which impacts the flood control target at Grand Coulee. To meet the flood control elevation need, John said the action agencies would need to begin drafting Grand Coulee now by about a foot per day to minimize or avoid spill later in the season. Tony Norris, BPA, added that conditions this year are even more extreme than were seen last year at this time. Paul Wagner, NOAA, said drafting Grand Coulee lower than the April 10 elevation (based on The Dalles March final forecast) due to a rising March water supply forecast is consistent with the BiOp as long as these details are coordinated with TMT. Additional graphs were linked to the agenda including SNOTEL and RFC snow, showing additional data being used to determine flood control elevation targets. TMT will receive updates at each upcoming meeting as the region continues to closely monitor changing water supply conditions.

Libby Operations

Joel Fenolio, COE-Seattle District, described the conditions at Libby as ‘similar to Grand Coulee’: With an April-August forecasted water supply of about 6.2 MAF (107% of average) and a lot of snow pack above and below the dam, Libby was beginning to draft to stay ahead of the likely increase in water supply (anticipated to go up to 6.5 MAF. The plan is to draft Libby to 2396 feet by the end of April which is 10 feet below the current elevation. The COE was proceeding while acknowledging they still had the flexibility to scale this draft back later, if the April final forecast is below this projection.

John Roache, Reclamation, and Steve Hall, COE-Walla Walla District, added that these rising water supply conditions were also impacting operations at Hungry Horse and Dworshak.

Chief Joseph Spill Test

Joel Fenolio, COE-Seattle District, reported that a spill test was being planned at Chief Joseph for next week – 60 kcfs (30 kcfs through two spill bays) – to test uplift pressures and how well the dam would hold up during this “1% event” scenario. The test will run for 24-48 hours and if the criteria are met, a second test at 40-50 kcfs (20-25 through two spill bays) will be conducted. The actual duration of the test is subject to change based on real time conditions. The test will be extended if the test data suggests a need to extend the duration of the test. The results of the test (with visual representations as requested from a TMT member) will be shared at a TMT meeting in April.

Spill Priority List

A draft spill priority list was linked to today’s agenda and presented by Scott English, COE. TMT members provided initial feedback:

- Paul Wagner, on behalf of the salmon managers, said they had discussed the list and thought it looked like a good strategy at this point in terms of starting with projects on the Snake River, and the placement of Chief Joseph on the list. He said they might offer recommended changes to the list later in the season.
- Question – why is the spill cap for Ice Harbor 90 kcfs at Level 1 and only 75 kcfs at Level 2? Response: The spill caps for all projects are based on current expected capacity based on outages, system flows, etc. If system flows are such that require a move up to Level 2, spill capacity goes down due to elevated TDG in the river.
- The current spill list assumes one outage at each project – the spill cap amounts will adjust according to actual outages/capacity at the projects, but the spill priority order will not change.

Next steps: The spill priority list will be revisited at next week’s TMT meeting, and if no changes are recommended, will go in to effect in time for the start of the spill season.

Next Meeting, 3/28: Face to Face, 9:00 am

Agenda items include:

- Updated Water Supply Forecasts
- Hanford Reach Update
- Bonneville Turbine Operations/Spring Creek Hatchery Release
- Operations Review
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

March 21, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of BPA, COE, USFWS, NOAA, BOR, CRITFC/Umatilla Tribe, Colville Tribe, Oregon, Washington, Idaho and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Update on Water Supply Forecast

John Roache, BOR, reported that the April-August forecast for The Dalles, which is used to calculate Grand Coulee's flood control requirement, has increased significantly. Based on the March 6 forecast of 90.6 MAF (97% of average), the end of April flood control elevation at Grand Coulee was 1237 feet, with an April 10 BiOp elevation objective of 1257.7 feet. However, based on the latest available ESP forecast from the Northwest River Forecast Center (NWRFC) of 95.5 MAF (103% of average), the end of April flood control target is likely to be in the range of 1220-1230 feet. (The official forecast used to determine the end of April target will be available on April 5.) If Grand Coulee were on track to meet this target, the reservoir should be at 1260 feet now instead of its current elevation of 1268 feet. This calls for a significant draft beginning immediately. The situation is similar to last year, except the current Grand Coulee elevation is about 15 feet higher than last year, Tony Norris, BPA, added.

The current April 10 objective of 1257.7 feet is based on the March forecast and will probably be attained before April 10 as the reservoir drafts toward a lowered flood control target, Roache said. Because April is probably too late to start drafting to such a low elevation, the draft needs to begin in March. The actual date on which 1257.7 feet is attained won't be known until early April. Paul Wagner, NOAA clarified that drafting Grand Coulee lower than the April 10 elevation (based on The Dalles March final forecast) due to a rising March water supply forecast is consistent with the BiOp as long as these details are coordinated with TMT. Roache said the BOR will monitor the situation closely. TMT will revisit this topic throughout spill season.

3. Libby Operations

Joel Fenolio, COE, reported a similarly increasing forecast at Libby Dam. The Corps March 1 forecast of 5635 kaf was 96% of average (based on 1975 – 2009); the projected April 1 forecast is going to be around 6.0 MAF. While precipitation so far has been below average, snowpack is about the same as last

year. Fenolio showed TMT the latest ESP traces and SNOTEL site information for Libby, linked to today's agenda. The SNOTEL data indicates less snowpack than last year in southeast portion of the watershed above the dam, but snowpack throughout the rest of the Kootenai basin is similar or above last years snowpack. Areas below the dam have higher than average snowpack, like last year which was 108% of average.

Given the rising forecast due to accumulating snowpack in the Libby Basin, Seattle District is assuming that this will be a 6.5 MAF year at Libby, the COE Seattle District will begin drafting soon, Fenolio said. ESP traces and the NRCS March 1 forecast indicate that the COE forecast for Libby is probably low, which increases the need to draft. So the plan is to draft Libby to 2396 feet by around the middle of April, 10 feet below the current elevation. An April forecast of 6 MAF (an average year) would put the end of April flood control target at 2411 feet. For comparison sake, last year's March forecast for Libby was 7.1 MAF and its April forecast was 7.2 MAF.

In light of the available information, the COE will operate Libby to a 6.5 MAF assumption for the Apr-Aug Inflow volume and draft another 10 feet during the first part of April. John Roache added that Hungry Horse is following the same pattern of an increasing forecast and said he will give an update on Hungry Horse operations at the March 28 TMT meeting. Steve Hall noted that the Dworshak forecast has also increased.

4. Chief Joseph Spill Test

To test uplift pressures on monoliths in the Chief Joseph spillway, the COE plans next week to spill 30 kcfs through bays 12 and 13 for a continuous period of 24-48 hours (potentially longer if needed), beginning at 6 am on March 27, Fenolio reported. The spill test is needed because many of the surface seals between monoliths in the spillway were damaged by last year's high flows, allowing water to get in and potentially move the monoliths. The 48-hour test period will be extended if necessary so uplift pressures have time to stabilize. There is also a possibility of testing at 20 and 25 kcfs spill per bay, depending on the results at 30 kcfs.

If uplift pressures become critical, the COE will begin engineering design for repairs of the surface seals between monoliths, Fenolio said. Bays 12 and 13 were chosen for the test because there is already existing instrumentation there. An important goal of the test will be operation of the Chief Joseph powerhouse to try and mitigate TDG levels downstream caused by releasing water over the spillway. The test will provide TDG data at Chief Joseph, which will probably be available in April. Fenolio will report back to TMT after the test is completed.

5. Spill Priority List

Scott English, COE, outlined the provisions of the draft spill priority list attached to today's agenda. Level 1 spill is within the TDG waivers of 115% in the forebay or 120% in the tailrace, while Level 2 includes short durations of higher spill, and the volumes increase with Levels 3 and 4. The spill priority list contains estimated spill caps for each project at each level of spill. These are subject to change as conditions develop.

Wagner said the spill priority list is acceptable at present, although it may need adjustments as spill season unfolds. The COE's plan is for TMT to discuss and finalize this list at the March 28 meeting.

Russ Kiefer, Idaho, asked why increasing levels of spill on the list contain lower spill caps for the same project. That is because the level 2 spill caps must generally be lower to accommodate elevated TDG levels entering the forebay from the next dam upstream, Laura Hamilton, COE, explained. That is true at both Ice Harbor and The Dalles.

Charles Morrill, Washington, asked whether the spill caps on the list reflect full powerhouse operations. No, Hamilton said, they are based on an assumption of at least one unit outage. Outages are an important factor especially on the Snake River, where having two units out at the same project can cause water quality problems.

6. Next TMT Meeting

TMT will meet next in person March 28. Water supply forecasts and flood control operations, Libby operations, Hungry Horse operations, the spill priority list, Bonneville turbine operations for the Spring Creek Hatchery release, a Hanford Reach update, and the usual operations review will be on the agenda.

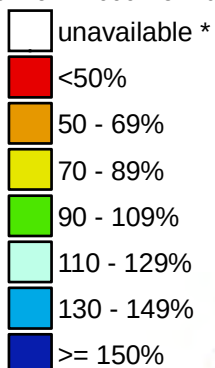
<i>Name</i>	<i>Affiliation</i>
Rick Kruger	Oregon
Tony Norris	BPA
Doug Baus	COE
Scott Bettin	BPA
David Wills	USFWS
Paul Wagner	NOAA
Tom Lorz	CRITFC/Umatilla
John Roache	BOR
Glen Trager	Iberdrola
Steve Hall	COE Walla Walla
Joel Fenolio	COE
Heather Dohan	Puget Sound Energy
Margaret Filardo	FPC

Lisa Wright	COE
Scott English	COE
Bill Proctor	COE
Rob Allerman	Deutsch Bank
Stu Leavitt	Salish-Kootenai
Richelle Beck	Grant PUD
Barry Espenson	CBB
Don Tinker	SCL
Bruce McKay	hydropower consultant
Sheri Sears	Colville Tribe
Greg Otting	Merrill
Charles Morrill	Washington
Russ Kiefer	Idaho
Laura Hamilton	COE

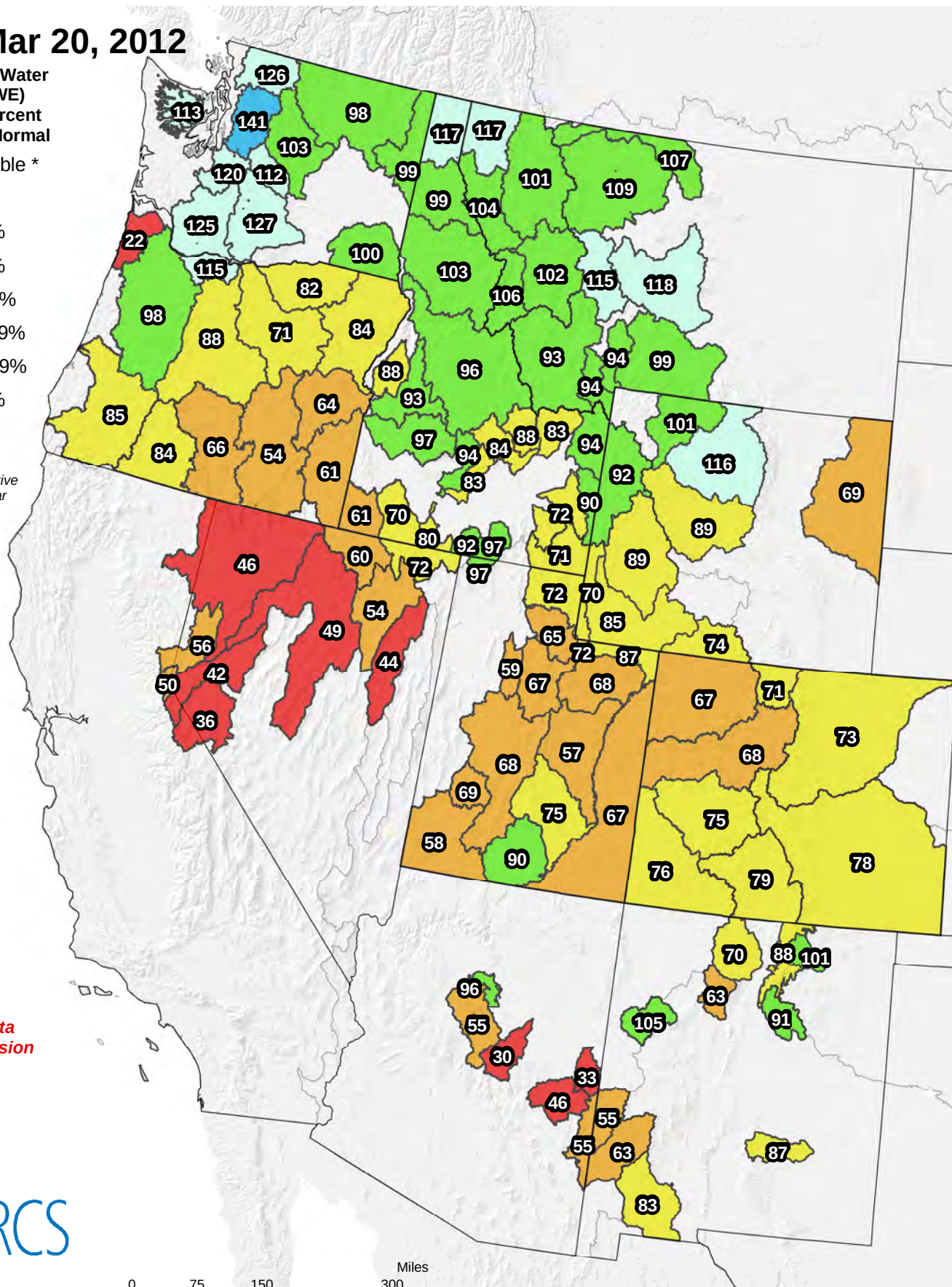
Westwide SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Mar 20, 2012

Current Snow Water Equivalent (SWE)
Basin-wide Percent
of 1971-2000 Normal



* Data unavailable
at time of posting
or measurement
is not representative
at this time of year



*Provisional data
subject to revision*



The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by the USDA/NRCS National Water and Climate Center
Portland, Oregon <http://www.wcc.nrcs.usda.gov/gis/>
Based on data from <http://www.wcc.nrcs.usda.gov/reports/>
Science contact: Jim.Marron@por.usda.gov 503 414 3047

SYSTEM OPERATIONAL REQUEST: 2012-01

TO:	BG John R. McMahon	COE-NWD
	Jim Barton	COE-Water Management
	Doug Baus	COE-RCC
	David Ponganis	COE-PDD
	Colonel Bruce A. Estok	COE-Seattle District
	J. William McDonald	USBR-Boise Regional Director
	Steven Wright	BPA-Administrator
	Steve Oliver	BPA-PG-5

FROM: Kootenai Tribe of Idaho; Sue Ireland, Fish and Wildlife Department Director

DATE: March 28, 2012

SUBJECT: September / October 2012 Libby Dam Outflow for Kootenai River Habitat Restoration Project, Phase 2, Braided Reach

SPECIFICATIONS:

Release minimal outflow from Libby Dam during September (6,000 cfs) and October (4,000 cfs minimum), 2012.

JUSTIFICATION:

Minimum flows in the Kootenai River in September and October are requested to allow the Kootenai Tribe of Idaho’s contractor to de-water two areas (channels) located in the Kootenai River Habitat Restoration Project, Phase 2, Braided Reach 2 project area. The restoration strategy for this portion of the project is to stabilize eroding banks, trap sediment and promote floodplain development, increase riparian vegetation, and increase channel margin and side channel complexity. The Upper Meander project will result in restoration of approximately 2,000 feet of river bank and will substantially reduce sediment loading that is contributing to degraded habitat conditions downstream. The North Side Channels project will address degraded habitat conditions in 7,500 feet of side channels.

Provide gradually declining discharge to the target flow following ramping rates and minimum flow guidelines in the 2006 BiOp for bull trout and white sturgeon.

The proposed operation is requested in order to implement the Tribe’s Phase 2, Braided Reach 2 portion of the Kootenai River Habitat Restoration Project. The proposed operation will also ensure Action Agency compliance with the USFWS Biological Opinion regarding the Effects of Libby Dam Operations on the Kootenai River White Sturgeon, Bull Trout, and Kootenai Sturgeon Critical Habitat (1901F0279R) as clarified (2008). Action 2.1 under RPA Component 2 (Management of Sturgeon Habitat) calls for Action Agency cooperation in implementing the Kootenai Tribe of Idaho’s Kootenai River Restoration Project Master Plan.

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday March 28, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 5497

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review March 7 and 21 Meeting Minutes
 - a. [March 7 Minutes](#)
 - b. [March 21 Minutes](#)
3. NWRFC Water Supply Forecast Update - Doug Baus, COE-NWD
 - a. [Forecast](#)
 - b. [Westwide SNOTEL](#)
4. Vernita Bar Update - Russell Langshaw, Grant County PUD

- a. [Program Update](#)
- 5. Kootenai SOR - *Doug Baus, COE NWD, and; Sue Ireland, Kootenai Tribe*
 - a. [2012-01](#)
- 6. Spring Creek Hatchery Release - *Dave Wills, USFWS*
 - a. [BON operations for Spring Creek Hatchery Release](#)
- 7. Spill Priority List - *Doug Baus, COE-NWD*
 - a. [March 21 Draft Spill Priority List](#)
 - b. [March 28 Draft Spill Priority List](#)
- 8. Operations Review
 - a. Reservoirs
 - b. Fish
 - c. Water Quality
 - d. Power System
- 9. Other
 - a. Set agenda and date for next meeting - **April 4, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

2012 Bonneville Dam Operations for the Spring Creek Hatchery Release

Approximately 8 million juvenile tule fall Chinook salmon will be released from Spring Creek and Little White Salmon National Fish Hatcheries on the morning of Wed, April 11. The Corps will implement the operation as requested by Dave Wills, USFWS, to improve passage conditions through the powerhouse 2 gatewells. Thus, as coordinated with TMT at the March 28, 2012, meeting, the Corps will operate as follows:

- Beginning at 06:00 on Thursday, April 12, BON will operate as described below as a hard constraint through 17:00 Monday, April 16, then as a soft constraint through 17:00 Friday, April 20 (dates may be adjusted based on real-time passage data collected at the Bonneville Dam Smolt Monitoring Facility). All turbine unit operating ranges are within 1% of best efficiency and all units will be operated in the priority order as defined in the 2012 Fish Passage Plan.
 1. Operate PH2 Units up to 25% of the operating range.
 2. Then, operate PH1 Units up to 100% of operating range (full capacity).
 3. Then if necessary due to high flows, incrementally increase PH2 units one at a time within 25-50% of the operating range, then one at a time within 50-100% of the operating range.
 4. Then if flows exceed powerhouse capacity (all available units at both powerhouses are at full capacity), increase spill as necessary above the spring spill rate of 100 kcfs¹.

¹ The 2012 Fish Operations Plan (FOP) defines the spring spill rate at Bonneville as 100 kcfs 24 hours/day from April 10 through June 15. The FOP is included in the Fish Passage Plan as Appendix E, available online at: <http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/>

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

March 28, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Meeting Minutes

The notes from the 3/7 Official Meeting Minutes and Facilitator's Notes were reviewed and, with no suggested edits, finalized at today's meeting. The summaries from 3/21 and today's meeting will be reviewed at the next face to face meeting, scheduled for 4/11.

Water Supply Forecast Update

Doug Baus, COE, shared a water supply forecast update, saying conditions were similar to what was reported last week, with upward trends in water supply seen throughout the basin. The Dalles April-August water supply forecast was 109%. Also, the SNOTEL information showed above normal snow water equivalents throughout most of the basin.

Spring Creek Hatchery Release

Dave Wills, USFWS, reported that, per the Water Management Plan, USFWS was coordinating with the action agencies on Bonneville turbine operations to meet the needs of the Spring Creek hatchery release scheduled to begin on 4/11 assuming spring spill begins on 4/10. The specific operation is similar to that provided last year, operating the Bonneville turbine to the lower portion of the 1% range, fully loading PH1, and stepping up accordingly to meet flow and TDG requirements. In response to a question, Dave responded that it is anticipated the fish will pass quickly again as they did last year, given the high flows in the system. However, for planning purposes, USFWS would like to take the approach outlined while monitoring and making real time adjustments as needed.

Next Steps/Operation – The COE will coordinate with USFWS to develop a teletype and plan to implement the operation as proposed. The COE will post a summary of the operation as an attachment to today's agenda item linked to the TMT web page.

Other: As an informational item regarding the Dworshak Hatchery release, Dave Wills also shared that there will not be a minimum Spring Chinook release and no additional coordination for extra flows will be needed this year. The release is scheduled to occur tonight (March 28). Smolts are released at night to minimize the risk of predation during their migration to the mainstem.

Spill Priority List

The draft spill priority list posted and discussed during last week's TMT meeting was re-posted to today's agenda. Following up from last week, Paul Wagner, NOAA/FPAC Chair, reported that the salmon managers had discussed and developed a recommendation for a revised list given that performance testing at Lower Monumental, Little Goose,

McNary and John Day are not scheduled until later in April. The new proposed list for Level 1 was described as follows:

- Lower Granite (facilitate juvenile passage)
- Little Goose (facilitate juvenile passage)
- Lower Monumental (facilitate juvenile passage)
- Bonneville (to support kelt and juvenile passage)
- John Day
- Ice Harbor
- McNary
- The Dalles
- Chief Joseph up to 110% (through March 31; Remove April 1-23)

Doug Baus, COE, responded that the COE could implement the proposed list beginning April 1 (not before due to TDG waiver requirements) and suggested setting an 'end date' of 4/23 to make changes to the list to accommodate the performance testing scheduled on 4/26 and 4/27. Russ Kiefer, Idaho, offered his preference not to spill right now but, if necessary to meet flow demands in the system, use the salmon managers preferred order listed above, adding Chief Joseph back in to the end of the 110% list.

Action/Next Steps: With all TMT members amenable to this plan, the COE said they would initiate implementation of the lists (the winter list using the above order between now and April 1, and the spring spill priority list also using the above recommended order) until 4/23. On 4/23, the list will revert back to the original draft posted by the COE last week. TMT members will revisit the spill priority list to touch base on whether and how it has been used to date at their next TMT meeting on 4/11.

Kootenai SOR 2012-01

Sue Ireland, Kootenai Tribe, presented an SOR describing a request to provide Libby operations to meet the tribe's needs for the second phase of restoration work planned for this Fall. The specifics of the request were the same as provided last year, including operating Libby at a 6 kcfs minimum in September and at 4 kcfs minimum in October, using a gradual ramp down approach to get to these flow levels.

Bill Proctor, COE RCC Chief, said to do this, the action agency would target an end of August elevation of 2449' and then operate the project to minimum bull trout flows in September (6 kcfs) and October (4 kcfs). Some TMT members responded that while they understand the validity of this approach for planning purposes, they don't want a hard elevation constraint in August to compromise the greater interest in minimizing fluctuations in support of providing biological benefits to resident fish. Brian Marotz, Montana, stressed that data clearly shows the biological impacts of varying the flow levels. Other TMT members including Paul Wagner, NOAA, agreed that they would like to maintain flexibility for in-season management around this operation to meet the multiple needs of the river and lake. Joel Fenolio, COE Seattle, confirmed that the target elevation for August 31 would be managed through in-season coordination with TMT as forecasts and observed conditions develop.

TMT members were polled on their support for the SOR:

- Washington – Supports the operation so long as it protect the river’s ecology
- Oregon – No objection
- Montana – Supports the operation
- Idaho – Supports the operation
- NOAA – Supports the operation with the ability to do in-season management to get to the desired flows
- USFWS – Supports the operation
- CTUIR – Support the request for now and will need to monitor the operation as it progresses in-season
- Nez Perce: No Objection. (Not available for the March 28 meeting but provided the Corps with this response via phone on April 3.)
- Colville Tribes – Supports the operation
- Reclamation – Supports the operation, agrees with the desire to manage the operation in-season
- BPA – Supports the operation
- COE – Supports the operation

Sue Ireland thanked TMT for their time and for agreeing to the request, saying this was a very important project to the Tribe. She offered to provide a slide show of last year’s restoration work at an upcoming TMT meeting.

Vernita Bar Update

Russell Langshaw, Grant County PUD, used an Excel spreadsheet to show data and the process for setting protection levels and dates to protect fish in the Hanford Reach. Protection flows began on 3/8 and are expected to end on 6/19 (this date might change). The specific operation at Priest Rapids was 107.1 kcfs discharge, with a 41.3 kcfs daily delta and 54.3 kcfs daily delta constraint. There have been no exceedances to date. Russell noted in response to a question that comparisons to previous years can be done by linking to those data sets – which were available via the spreadsheet that is continuously updated and can be found on the PUD’s website.

Russell will provide another Vernita Bar update along with stranding entrapment results at the 4/11 TMT meeting.

Operations Review

Reservoirs – John Roache, Reclamation, reported on projects. Hungry Horse was at elevation 3529.58 feet, with 5.5 kcfs out and plans to ramp up outflows again in early April to manage the increasing water supply forecast and expected lower flood control elevations. Grand Coulee was at elevation 1261.3 feet and drafting about a foot per day – to target a flood control elevation of 1220-1225 feet end of April. Drum gate maintenance is being planned at Grand Coulee. Lisa Wright, COE, reported on projects. Libby was at elevation 2404.6 feet, with 4.1 kcfs in and 16.4 kcfs out. Drafts were expected to increase out of Libby, Dworshak and Brownlee with the upward trend in water supply forecasts. Albeni Falls was at elevation 2054.5 feet with 25 kcfs in and 29.6 kcfs out. Priest Rapids

inflows were 154.1 kcfs. Dworshak elevation was 1523.1 feet with 10.2 kcfs in and 10.6 kcfs out. Lower Granite inflows were 91.7 kcfs; McNary inflows were 279.9 kcfs; and Bonneville inflows were 249.4 kcfs.

Fish – Paul Wagner, NOAA, reported that the traps were in on the Salmon River and so far, about 1,000-2,000 yearling Chinook have passed – as many as 1/3 of those natural/wild. Lower Granite saw about 6,000 pass and Bonneville saw about 600 pass – some of the latter were thought to be over-wintering yearling Fall Chinook. Charles Morrill, Washington, added that many of the yearling Chinook passing Lower Granite were unclipped fish. Steelhead counts were 2,000/day at Lower Granite. Juvenile lamprey counts at Bonneville were about 300/day. With respect to adults, 33 spring Chinook and 79 steelhead had been observed passing Bonneville; about 200 steelhead passed Lower Granite; and five kelt observed passing through the juvenile facility at Bonneville.

Water quality – Laura Hamilton, COE, reported that the gauges are in place and are tracking TDG. Some spill has already occurred in the Lower Snake and Columbia projects due to the high flows. Format changes were made to the reporting screen as requested by TMT members. Also, the Chief Joseph spill test had begun. Joel Fenolio, Seattle District COE, reported that TDG levels so far were lower than expected. Joel will provide a full report from the test at the next TMT meeting.

Power system – Tony Norris, BPA, reported that BPA is trying to manage over-generation given the high flows and offered a proposal for TMT consideration. The recommendation was to delay drafting the Snake projects to MOP. Typically, all 4 Lower Snake projects are drafted to MOP no later than 0001 hours on April 3. BPA's proposal is to stagger drafting the projects to MOP one project per day beginning on April 3. Lower Granite would be drafted for flood control so would be at MOP by 0001 hours on April 3, then each subsequent downstream project would be drafted to MOP, one per day over the next 3 days – Little Goose by 2400 hours on April 3, Lower Monumental by 2400 hours on April 4, and Ice Harbor by 2400 hours on April 5. This would allow BPA to alleviate over-generation conditions in March and allow them to manage it in April when they are better prepared to do so. Tony said this shift would move alleviate up to 500 megawatts of over-generation from March to April.

Next steps/Action: The salmon managers said they needed to caucus on this issue before they could respond to the request, and BPA needed to follow up with the Nez Perce Tribe who was not represented at the meeting. TMT agreed to revisit this issue at 9:00 AM on 3/29, which would allow time for coordination and still have the opportunity to implement the operation. (*See Facilitator's Notes for 3/29 TMT meeting for more information.)

Next Meeting, 4/11: Face to Face, 9:00 am

Agenda items include:

- Updated Water Supply Forecasts
- Hanford Reach Update
- Spill Priority List Check In

- Chief Joseph Spill Test Report
- Operations Review
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

March 28, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of the COE, Montana, NOAA, BPA, BOR, Idaho, Oregon, USFWS, Montana, the Kootenai and Colville tribes, CRITFC/Umatilla Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review March 7 Meeting Minutes

There were no suggested changes today, so the facilitator's notes and official minutes for March 7 were deemed final. Review of the March 21 notes and minutes was postponed until the next TMT meeting on April 11.

3. NWRFC Water Supply Forecast Update

Conditions are similar to last year, Baus reported. Water supplies are above average throughout most of the region, with the exception of southeastern Idaho. Today's forecast for the Columbia River at The Dalles is 109% of average. Information from the westwide SNOTEL sites is consistent with the RFC water supply forecast, which is forecasting above normal water supplies throughout most of the basin. In comparing forecasts over time, it's important to focus on actual volumes rather than percentages of normal because the percentages change whenever the 30-year normals are updated, Tony Norris, BPA, said.

4. Vernita Bar Update

Russell Langshaw, Grant PUD, presented the latest temperature and flow data for the Hanford Reach chinook protection program. This information is linked to the TMT agenda and is updated daily.

Protection flows began on March 8 and are projected to end June 19 this year. Temperatures so far have been following the historical mean closely after a big drop in January. Current temperatures are a few degrees F below average. Last year was warmer for most of fall and early winter, so temperature units added up quickly. However, by mid-winter 2011-12, the tally dropped below average, resulting in a long protection period. This year, the protection period will probably be closer to average length. Mean daily discharges for the past 7 days are 150 kcfs, with a daily delta of 41.3 kcfs.

Langshaw will give another update at the next TMT meeting April 11. He will also report on the results of the 2011 stranding and entrapment study.

5. Kootenai SOR re: Libby Operations

Sue Ireland, Kootenai Tribe, presented this SOR, which calls for operating Libby at minimum flows in September (6 kcfs) and October (4 kcfs) to implement phase 2 of the Kootenai River Habitat Restoration Project. Phase 1 went well last year, thanks to regional support.

Joel Fenolio, COE Seattle district, added that an elevation of 2449 ft at the end of August would be targeted to the extent possible, without focusing on exact volumes or flows to be released between the end of the sturgeon pulse and August 31. Seattle District will coordinate, as needed, with TMT on the operation to reach 2449 ft end of August. Bill Proctor, COE, specified that the action agency commitment is to a target elevation of 2449 ft by end of August and then minimum flows in September and October, not elevation targets, at the end of September and October. In order to achieve minimum flows in September of 6 kcfs the COE will ramp down flows as gradually as possible given the forecasted and observed weather conditions, and will coordinate operations in July and August through TMT as necessary.

TMT members gave their views of the Kootenai SOR:

- **Idaho** – Supports the SOR.
- **Montana** – Support the operation if the rampdown is gradual.
- **NOAA** – Supports the operation. Agrees that river operations shouldn't be driven by an elevation target.
- **Washington** – Supports the operation.
- **Oregon** – No objections at this time.
- **CRITFC/Umatilla** – Supports the operation.
- **Colville Tribe** – Supports the operation if the rampdown is gradual.
- **USFWS** – No objections.
- **BOR** – Supports the operation.
- **BPA** – Supports the operation.
- **COE** – Supports the operation.

There was consensus today on targeting elevation 2449 ft at the end August and holding minimum flows of 6 kcfs in September and 4 kcfs in October for planning purposes. While this is the coordinated operation some TMT members voiced concerns regarding the consequences of focusing on elevations at times that may have adverse impacts on river biology. Meeting the specifics of this request needs to be balanced with concerns for river biology. The action agencies will coordinate the specifics of this operation through TMT as necessary.

6. Spring Creek Hatchery Release

Dave Wills, USFWS, made a request today for specific turbine operations at Bonneville Dam to facilitate the release of approximately 8 million juvenile tule fall Chinook salmon on the morning of April 11 from the Spring Creek Hatchery. The USFWS request called for beginning the Spring Creek Hatchery Release Bonneville Powerhouse operation on the morning of April 12 with the following specific operational requests, to be implemented in order to provide increased levels of generation as necessary:

1. Operate PH2 Units up to 25% of the operating range.
2. Then, operate PH1 Units up to 100% of the operating range (full capacity).
3. Then if necessary due to high flows, incrementally increase PH2 units one at a time within 25-50% of the operating range, then one at a time within 50-100% of the operating range.
4. Then if flows exceed powerhouse capacity (all available units at both powerhouses are at full capacity), increase spill as necessary above the spring spill rate of 100 kcfs as prescribed in the 2012 FOP.
5. Voluntary spill associated with this operation will be limited by the lower spill rate identified in either: 1) FOP spill rate of 100 kcfs or 2) 120%/115% TDG fish passage spill cap rate.
6. The end date for the operation is currently requested to be on April 20, but this date will be adaptively managed based on real-time smolt passage observations at the Smolt Monitoring Facility.

A process similar to last year's could work well again this year, Wills said. Norris asked whether any adjustments are needed based on lessons learned last year. Wills said nothing different is needed this year, considering that the start and end dates could be adjusted based on real-time smolt passage conditions observed at the Smolt Monitoring Facility to help shape the operation. If flows are high again this year, fish will probably move faster than usual, and the operation could end early. The COE will post details of the operation on the TMT website.

Doug Baus, COE, indicated the COE would implement the USFWS request consistent with the 2011 operation but added a point of clarification associated with ambiguity that occurred during the 2011 operation. Spill rates at

Bonneville Dam identified in the FOP are governed by the 120/115% TDG fish passage spill cap. At times the spill cap may be lower than the BON spill rate identified in the FOP. When there is a difference between the voluntary spill rate identified in the FOP and the 120/115% TDG fish passage spill cap the Action Agencies spill at the lower rate.

Lisa Wright, COE, explained the operation would be increased incrementally, one unit at a time, in powerhouse 2 until full capacity is reached. At that point any additional flow would be involuntary spill that could exceed FOP spill levels. The COE will coordinate with USFWS on the specifics of the teletype to be issued to project staff.

Normally USFWS would coordinate the Dworshak spring chinook release with TMT members if extra flows are needed to push fish into the mainstem. However, this year USFWS will not be doing a minimum release at Dworshak, Wills reported. The hatchery will release spring chinook tonight. The release is done at night to minimize bird predation and give fish an opportunity to take cover in the mainstem. No other coordination is needed for extra flows.

7. Spill Priority List

Paul Wagner reported on yesterday's FPAC discussion of the draft spill priority list presented at last week's TMT meeting, which is posted to today's agenda. The salmon managers recommended the following spill priority order of Lower Snake and Lower Columbia projects: 1) Lower Granite, 2) Little Goose, 3) Lower Monumental, 4) Bonneville, 5) John Day, 6) Ice Harbor, 7) McNary, 8) The Dalles. Chief Joseph would be implemented only after all Lower Snake and Lower Columbia projects have reached 120% TDG. Idaho and USFWS representatives expressed support for these recommended changes.

In response to the salmon managers' request, Baus said the action agencies had come up with a second draft of the spill priority list, which will be posted to today's agenda. The action agencies made an effort to move Snake River projects to the top of the level 1 list. However, Doug Baus, COE, and Laura Hamilton, COE, clarified that prior to April 1, the TDG waiver is not in effect so the wintertime spill priority list that is currently in place through March 31 needs to include Chief Joe at earlier levels (110% and 115%). The order of mainstem projects on the wintertime spill priority list can be re-ordered to reflect the salmon managers' request, but Chief Joseph will be included at Level 1 (up to 110%) and Level 2 (up to 115%) since the TDG waiver is not yet in effect. The list that will go into effect April 1-23 will not include Chief Joe before spilling mainstem projects to 120%, as requested by the salmon managers. Additionally the Action Agencies would be considering the order of the spill priority list due to the forthcoming spring BiOp performance standard testing that will be commencing between approximately April 26-27 at Little Goose, Lower Monumental, McNary, and John Day.

Russ Kiefer, Idaho, recommended following the salmon managers' spill priorities up to TDG saturation rates of 110% until midnight April 1, then following the same order to 115% and 120% TDG spill caps once the waivers go into effect. The action agencies agreed to this and will revise the list to include a 110% TDG category, with Chief Joseph in this category. There were no objections to this course of action. Baus will give a presentation on the spill priority list at the next TMT meeting.

8. Operations Review

a. Reservoirs. Grand Coulee is at elevation 1261.3 feet and drafting because the forecast at The Dalles has increased. An end of April flood control elevation in the 1220-1225 foot range is expected. Hungry Horse is at elevation 3529.58 feet, ramping up from minimum flows and currently releasing 5.5 kcfs, which will probably increase in April in response to the water supply forecast. The April final forecast is expected to rise and the flood control elevation to drop accordingly.

Libby is at elevation 2404.6 feet with inflows of 4.1 kcfs and releases of 16.4 kcfs. Albeni Falls is at elevation 2054.5 feet with inflows of 25 kcfs and releases of 29.6 kcfs. Priest Rapids inflows are 154.1 kcfs. Dworshak is at elevation 1523.1 feet with inflows of 10.2 kcfs and discharges of 10.6 kcfs.

Lower Granite inflows are 91.7 kcfs. McNary inflows are 279.9 kcfs. Bonneville inflows are 249.4 kcfs.

b. Fish. Juveniles: The trap on the Salmon River has caught 1,000-2,000 fish, many of them hatchery fish, Paul Wagner reported. Approximately a third of these fish are naturally produced, Russ Kiefer added. Lower Granite daily counts are 3,000-6,000 fish, a mix of hatchery and wild. The Bonneville daily count was in the thousands due to the Klickitat Hatchery release, but that count has dropped to 400-500 fish per day. Some 3,000-4,000 subyearling chinook from the mid Columbia have been seen passing Bonneville daily. Kiefer commented that many of the yearlings passing Bonneville are overwintering fall chinook.

Charles Morrill, Washington, reported a higher proportion this year of untagged yearling chinook without a coded wire tag than expected which are generally naturally bred fish. Steelhead have been passing Lower Granite at the rate of a couple thousand per day, a mix of hatchery and wild fish, Wagner reported. Lamprey counts at Bonneville are a few hundred per day and around 20 per day at Lower Granite. Morrill and Wagner agreed that counts of lamprey at Lower Granite are not a good indication of what's actually happening since they generally pass through the separator and subsequently are not counted.

Adults: So far, 33 spring chinook adults have passed Bonneville this season at the rate of a couple per day, Wagner reported. The same is true of spring chinook jacks. Summer steelhead have gotten an early start this year.

c. Water Quality. Laura Hamilton, COE, reported that all TDG gages are in place and operating. As of last night, all lower Snake and lower Columbia projects had begun spilling, beginning with McNary on March 14 and Ice Harbor on March 26. Spill is expected to continue until spill season starts in response to high inflow forecasts.

Chief Joseph has been spilling around 60 kcfs for the spill test, producing TDG levels of 124-129%. Joel reported that at 30 kcfs per bay, pressures in the monoliths have stabilized below critical levels. The next step is to increase spill to 40 kcfs per bay at around 2200 hours tonight. The test will be completed within 48 hours, as coordinated previously. The flow-weighted average between the powerhouse and spillway is 122% TDG, and the tailwater (not mixed river) reading is 129% TDG. The current tailwater elevation is 785.2 feet, and the COE plans to keep it around 786 feet.

Richelle Beck, Grant PUD, asked for clarification of the mixed-river TDG saturation levels coming from Chief Joseph. The best way to calculate this would be the flow-weighted average in the forebay and spillway, plus flows going through the spillway and powerhouse 2, Fenolio replied. The COE won't have real time data on this until the flow monitors are pulled. Fenolio will give a report on the spill test at the April 11 TMT meeting.

d. Power System.

Tony Norris, BPA, proposed an operation to help manage overgeneration in the next week and a half. With inflows increasing, BPA proposes to consecutively draft the lower Snake River projects from upstream to downstream starting with Little Goose by midnight on April 3 (Lower Granite is being drafted for flood control and will already be at MOP by April 3). Postponing these MOP releases until the first week of April would help BPA manage overgeneration in March. This could move as much as 500 MW of generation into April, when fish spill takes some generation off the system. The proposal would increase flow and generation at each project in April as the projects draft toward MOP. There would not necessarily be increased spill but a greater likelihood of lack of market spill above FOP levels at these projects.

The Corps of Engineers had indicated that consensus is needed to implement the proposal because it would change planned operations under the FOP. Recognizing that a decision on the proposal must come quickly in order to offer any value, representatives from Washington, USFWS, CRITFC and the Kootenai Tribe agreed to a caucus after today's meeting. TMT will revisit the proposal in a conference call tomorrow morning.

4. Next TMT Meeting

After tomorrow's conference call regarding MOP, the next regular TMT meeting will be on April 11, with a conference call on April 4 if needed.

<i>Name</i>	<i>Affiliation</i>
Doug Baus	COE
Jim Litchfield	Montana
Paul Wagner	NOAA
Lisa Wright	COE
Tony Norris	BPA
John Roache	BOR
Russ Kiefer	Idaho
Locke Christman	BPA
Laura Hamilton	COE
Karl Kanbergs	COE
Bill Proctor	COE
 <i>Phone:</i>	
Rick Kruger	Oregon
David Wills	USFWS
Tim Lenahan	Lenahan Co.
Brian Marotz	Montana
Greg Hoffman	COE Libby Dam
Jason Flory	USFWS Idaho
Shane Scott	PPC
Dave Benner	FPC
Joel Fenolio	COE
Barry Espenson	CBB
Don Tinker	SCL
Heather Dohan	Puget
Bruce MCKay	consultant
XX	Grant PUD
Josh McCall	Puget
Mike Shapley	Snohomish
Tara Kelly	JP Morgan
Richelle Beck	Grant PUD
Sue Ireland	Kootenai Tribe
Sheri Sears	Colville Tribe
Charles Morrill	Washington
Tom Lorz	CRITFC/Umatilla
Steve Hall	COE
Joel Fenolio	COE

DRAFT 2012 SPILL PRIORITY LIST (NOW – APRIL 23)**3/28/12**

All spill flows are provided in kcfs or percent of total river flow.

LEVEL 1 SPILL (110% TAILWATER WHICH EVER IS MORE RESTRICTIVE) IF NOT ALREADY SPILLING TO THESE LEVELS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
1) LWG UP TO FISH PASSAGE SPILL CAP	41
2) LGS UP TO FISH PASSAGE SPILL CAP	40
3) LMN UP TO FISH PASSAGE SPILL CAP	28
4) BON UP TO FISH PASSAGE SPILL CAP	100
5) JDA UP TO FISH PASSAGE SPILL CAP	146
6) IHR UP TO FISH PASSAGE SPILL CAP	90
7) MCN UP TO FISH PASSAGE SPILL CAP	150
8) TDA UP TO FISH PASSAGE SPILL CAP	140
9) CHJ UP TO 110% (THROUGH MARCH 31; REMOVE APRIL 1-23)	25

LEVEL 2 SPILL (115% FOREBAY OR 120% TAILWATER WHICH EVER IS MORE RESTRICTIVE) IF NOT ALREADY SPILLING TO THESE LEVELS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
1) LWG UP TO FISH PASSAGE SPILL CAP	41
2) LGS UP TO FISH PASSAGE SPILL CAP	40
3) LMN UP TO FISH PASSAGE SPILL CAP	28
4) BON UP TO FISH PASSAGE SPILL CAP	100
5) JDA UP TO FISH PASSAGE SPILL CAP	146
6) IHR UP TO FISH PASSAGE SPILL CAP	90
7) MCN UP TO FISH PASSAGE SPILL CAP	150
8) TDA UP TO FISH PASSAGE SPILL CAP	140

LEVEL 2 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
9) LWG UP TO 120% TDG SPILL CAP	45
10) LGS UP TO 120% TDG SPILL CAP	52
11) LMN UP TO 120% TDG SPILL CAP	44
12) BON UP TO 120% TDG SPILL CAP	100
13) JDA UP TO 120% TDG SPILL CAP	146
14) IHR UP TO 120% TDG SPILL CAP	75
15) MCN UP TO 120% TDG SPILL CAP	140
16) TDA UP TO 120% TDG SPILL CAP	135
17) DWR UP TO 110% TDG SPILL CAP	32%
18) CHJ UP TO 120% SPILL CAP (SHAPED 115% AT WEL, UP TO THE 120% IN THE CHJ TAILRACE, DEPENDING ON EXPECTED DURATION)	60

LEVEL 3 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
19) LWG UP TO 122% TDG SPILL CAP	52

20) LGS UP TO 122% TDG SPILL CAP	59
21) LMN UP TO 122% TDG SPILL CAP	60
22) BON UP TO 122% TDG SPILL CAP	120
23) JDA UP TO 122% TDG SPILL CAP	177
24) IHR UP TO 122% TDG SPILL CAP	85
25) MCN UP TO 122% TDG SPILL CAP	152
26) TDA UP TO 122% TDG SPILL CAP	160
27) CHJ UP TO 120% TDG SPILL CAP	100
28) GCL ¹ UP TO 110% TDG SPILL CAP	RO=0; DRUMGATES=5

¹ Transition to GCL drumgates when forebay elevation is between 1267-1270 feet.

LEVEL 4 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
29) LWG UP TO 125% TDG SPILL CAP	63
30) LGS UP TO 125% TDG SPILL CAP	70
31) LMN UP TO 125% TDG SPILL CAP	80
32) BON UP TO 125% TDG SPILL CAP	215
33) JDA UP TO 125% TDG SPILL CAP	190
34) IHR UP TO 125% TDG SPILL CAP	110
35) MCN UP TO 125% TDG SPILL CAP	230
36) TDA UP TO 125% TDG SPILL CAP	269
37) GCL ¹ UP TO 120% TDG SPILL CAP	RO=15; DRUMGATE=19
38) CHJ NOT TO EXCEED 190 KCFS (CHJ IS EXPECTED TO BE DEGASSING, LIMITED FOR DAM SAFETY CONCERNS)	190
39) GCL ¹ UP TO 125% SPILL CAP	RO=25; DRUMGATE=75

LEVEL 5 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
40) LWG UP TO 127% TDG SPILL CAP	85
41) LGS UP TO 127% TDG SPILL CAP	95
42) LMN UP TO 127% TDG SPILL CAP	120
43) BON UP TO 127% TDG SPILL CAP	234
44) JDA UP TO 127% TDG SPILL CAP	206
45) IHR UP TO 127% TDG SPILL CAP	124
46) MCN UP TO 127% TDG SPILL CAP	280
47) TDA UP TO 127% TDG SPILL CAP	294
48) GCL ¹ UP TO 127% TDG SPILL CAP	RO=32; DRUMGATE=93

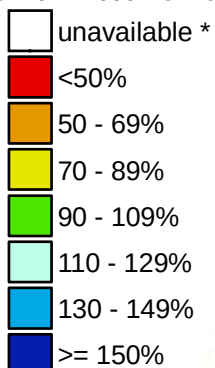
LEVEL 6 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
49) LWG UP TO 130% TDG SPILL CAP	90
50) LGS UP TO 130% TDG SPILL CAP	125
51) LMN UP TO 130% TDG SPILL CAP	180
52) BON UP TO 130% TDG SPILL CAP	250
53) JDA UP TO 130% TDG SPILL CAP	250
54) IHR UP TO 130% TDG SPILL CAP	145
55) MCN UP TO 130% TDG SPILL CAP	321
56) TDA UP TO 130% TDG SPILL CAP	360
57) GCL ¹ UP TO 130% TDG SPILL CAP	RO=42; DRUMGATE=120

LEVEL 7 SPILL IS AS FOLLOWS:	SPILL CAPS (CAN BE CHANGED)
58) LWG UP TO 135% TDG SPILL CAP	200
59) LGS UP TO 135% TDG SPILL CAP	177
60) LMN UP TO 135% TDG SPILL CAP	250
61) BON UP TO 135% TDG SPILL CAP	240
62) JDA UP TO 135% TDG SPILL CAP	300
63) IHR UP TO 135% TDG SPILL CAP	240
64) MCN UP TO 135% TDG SPILL CAP	375
65) TDA UP TO 135% TDG SPILL CAP	400
66) GCL ¹ UP TO 135% TDG SPILL CAP	RO=57; DRUMGATE=130

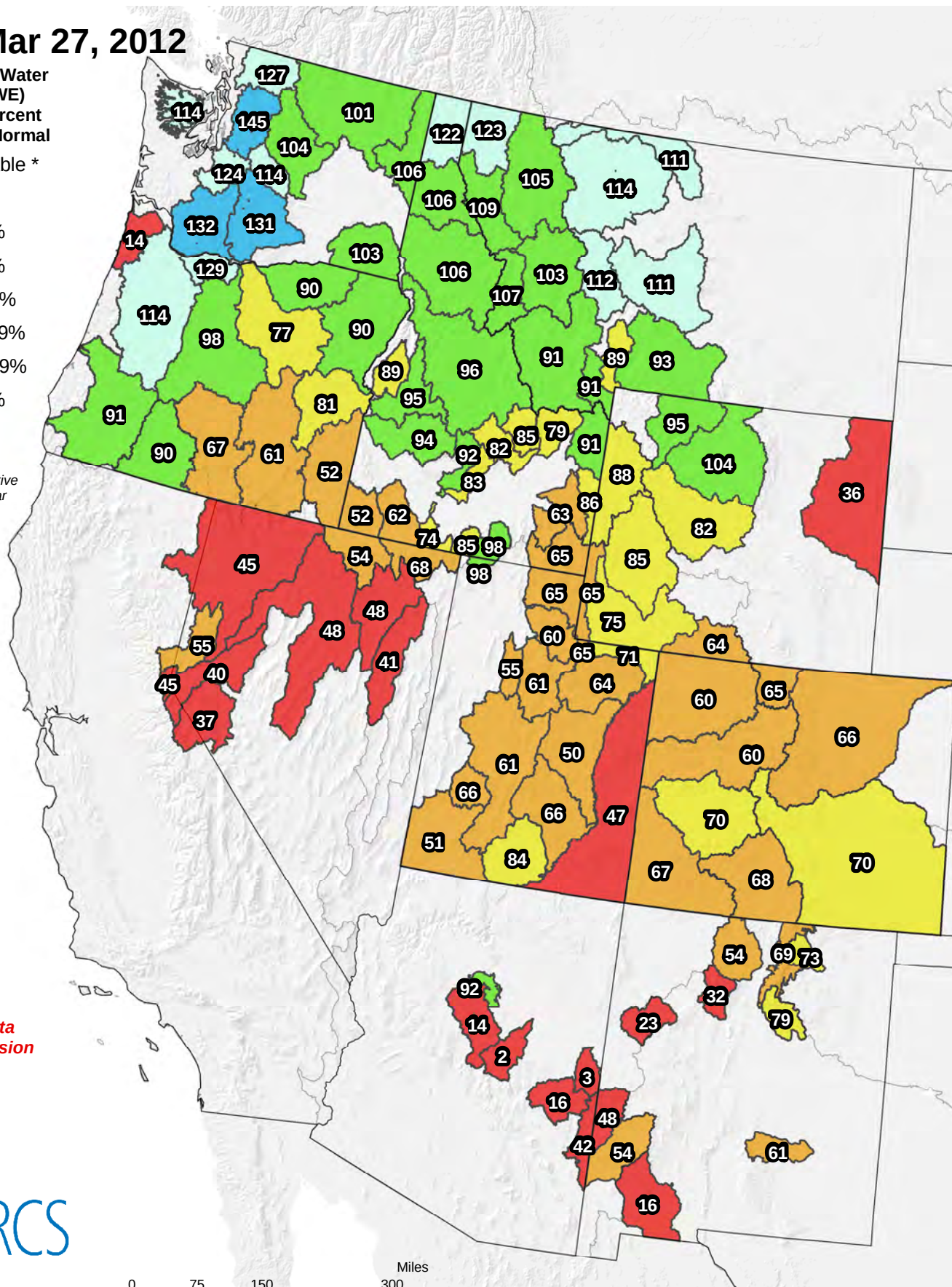
Westwide SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Mar 27, 2012

Current Snow Water Equivalent (SWE)
Basin-wide Percent
of 1971-2000 Normal



* Data unavailable
at time of posting
or measurement
is not representative
at this time of year



*Provisional data
subject to revision*



The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by the USDA/NRCS National Water and Climate Center
Portland, Oregon <http://www.wcc.nrcs.usda.gov/gis/>
Based on data from <http://www.wcc.nrcs.usda.gov/reports/>
Science contact: Jim.Marron@por.usda.gov 503 414 3047

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Thursday March 29, 2012 9:00am - 11:00am

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 8437

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. 2012 MOP Operation - Tony Norris - BPA
 - a. [March 29 Update](#)
3. Other
 - a. Set agenda and date for next meeting - **April 11, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

March 29, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the “record” of the meeting, only a reminder for TMT members.

Spill Priority List

Doug Baus, COE, clarified from yesterday's discussion that the COE will be able to implement the salmon managers' requested list on 4/1 due to TDG waivers that are not in effect until that date. The wintertime spill priority list that is currently in place through March 31 has a Level 1 of up to 110% TDG and a Level 2 of up to 115% TDG to manage within state standards prior to the waiver period.

MOP Operations

Following up from yesterday's meeting, TMT revisited a proposal from BPA to shift MOP operations. The proposal would take a staggered, one project per day approach. Tony Norris, BPA, said Lower Granite will be at MOP for flood control (not later than 0001 hours on 4/3), and the rest of the projects would be drafted to MOP elevations as follows:

Little Goose to MOP no later than 2400 hours on 4/3; Lower Monumental to MOP no later than 2400 hours on 4/4; and Ice Harbor to MOP no later than 2400 hours on 4/5.

Paul Wagner, on behalf of the salmon managers, said they discussed in caucus following yesterday's TMT meeting the concerns and potential benefits/detriments to this operation from a biological perspective. He added that juvenile passage at Lower Granite was about 6,500 as of today, indicating the migration might be a little earlier. That said, the fish will likely respond to changes in turbidity (from flow increases) so he also would expect another change in movement when the MOP operation occurs.

Rick Kruger, Oregon, asked about flow expectations for the projects between now and 4/3. Tony Norris responded that flood control requirements at Brownlee and Dworshak will keep flows on the increase. That said, implementing this proposed operation would shift flows associated with the draft of the Lower Snake projects to their MOP range in to April. Until then, Tony suggested spill will likely occur at night and over the weekend. He also clarified the rationale to do the shift – to better manage for over-generation conditions by moving it from late March in to early April.

TMT members were polled on their support for BPA's proposed MOP operation:

- Idaho: We think there will be more migrating fish in early April, and that increases in flows at that time would be beneficial to more fish. We support this operation.

- Washington – We support this operation, given the specific hydrograph this year.
- Montana – We support this operation.
- Oregon – We are not as convinced there is a positive benefit, but given the increase in flows anticipated between now and 4/3, the benefit to going to MOP now is not as great as it would have been without the flows. We are pleased that the action agencies are willing to make this adaptive management change – we would like to see this adaptive management approach used in future situations during which there would be a significant benefit to fish. We do not object to this operation for this year only.
- USFWS – No objection to the operation.
- NOAA – We see a small benefit to this operation and like the staggered approach to reaching MOP – and see potential benefit to more fish in early April. We support the operation.
- Nez Perce Tribe – As a biologically neutral operation given this year’s water and fish conditions, we do not object to this operation, for this year only.
- Colville Tribes – We support this operation and think it will provide a small biological benefit.
- Umatilla/CRITFC – No objection. (Not in attendance during the March 29 meeting but provided this response during the March 28 meeting.)
- Reclamation – We support this operation.
- COE – We hear consensus to move forward with the operation, and will use the recommendation to inform our legal and policy discussions. We will make a decision as soon as possible.

Action – The COE will follow up via email to TMT with a decision, and post that decision as a link to today’s agenda.

**NOTE:* The COE’s Doug Baus sent an email to TMT following the meeting indicating that “the Action Agencies (AAs) will implement the modified Minimum Operating Pool (MOP) operation proposed by BPA and discussed during today’s TMT conference call.”

Next Meeting, 4/11: Face to Face, 9:00 am

Agenda items include:

- Updated Water Supply Forecasts
- Hanford Reach Update
- Spill Priority List Check In
- Chief Joseph Spill Test Report
- Operations Review
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

March 29, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of NOAA, the Colville Tribe, Oregon, Washington, Nez Perce Tribe, BPA, Montana, Idaho, BOR, the COE and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Spill Priority List Clarification

Baus made a clarification to yesterday's discussion regarding the implementation date of the draft spill priority list attached to yesterday's agenda as item 7b. The COE intends to implement the spill priority list agreed upon yesterday, with the recommended order of projects and excluding Chief Joseph until all mainstem projects have reached 120% TDG. However, the COE will not be able to implement the proposed list until the Oregon waiver goes into effect on April 1. Laura Hamilton, COE, explained that the COE is required to have a different "wintertime" spill priority list during non-fish passage season when the Oregon TDG waiver is not in effect (Sept 1 – March 31), which includes a 115% level in order minimize system-wide TDG outside the waiver period. Due to these waiver requirements, the spill priority list discussed at TMT during the March 28 meeting will be implemented April 1-23. From now through March 31, the wintertime spill priority list will reflect the salmon managers' requested order of Lower Snake and Lower Columbia projects, but will include Chief Joseph at the bottom of Levels 1 and 2 (110% and 115%, respectively).

3. 2012 MOP Operation

Tony Norris, BPA, gave a recap of the proposal he presented to TMT yesterday, which would help manage overgeneration conditions on the hydrosystem in March. Lower Granite can be expected to be within its MOP range no later than 0001 hours on April 3. If the BPA proposal is implemented, Little Goose would then be drafted to MOP no later than 2400 hours on April 3, then Lower Monumental to MOP by no later than 2400 hours on April 4, and then Ice Harbor to MOP by no later than 2400 hours on April 5. The purpose of the operation is to move generation out of March into April, when fish spill reduces generation.

In response to the proposal, the salmon managers caucused yesterday and COE and BOR representatives conferred within their agencies. The main

purpose of today's call was to poll TMT members and make a decision on this proposal soon enough to reap any benefits it could provide.

Speaking on behalf of FPAC, Paul Wagner said yesterday's caucus was a gathering of concerns and views that should be expressed individually. One factor to consider is that fish seem to be arriving earlier this year than usual, with 6500 fish passing Lower Granite both yesterday and today.

Rick Kruger, Oregon, asked how much overgeneration spill is expected between now and April 3. At night the likelihood of spill is extremely high, and the lower Snake projects will probably spill during most hours this coming weekend, Norris replied. This proposal would reduce the likelihood of spill at those projects in March and increase the likelihood of additional lack-of-load spill in April. The action agencies are better positioned manage overgeneration in April than in March.

TMT members stated their views:

- **Idaho** – Supports the proposal. A little more spill in early April is likely to benefit fish because there are more fish in the system in early April than in March.
- **Montana** – Supports the proposal.
- **Washington** – Agrees with Idaho's position.
- **USFWS** – No objection.
- **NOAA** – Supports the operation because a small bump in migration counts can be anticipated from the increased hydrograph.
- **Nez Perce** – Sees the operation as being neutral. No objection, with the caveat that this operation applies to this year only.
- **Colville Tribe** – Supports the operation and foresees a small benefit.
- **Oregon** – Because flows are expected to increase, the benefit from drafting to MOP as proposed won't be as significant as it might have been. However, the operation provides a pulse for fish later when there are more fish in the river, a potential benefit. It's good the action agencies are willing to manage operations adaptively. Oregon has no objections to this proposal – as long as the same willingness applies to operational changes that could provide significant benefits for fish. Agrees with Nez Perce's caveat that the modified MOP operation applies to this year only and does not set a precedent.

- **BOR** – Supports the proposal.
- **Umatilla/CRITFC** – No objection. Umatilla/CRITFC did not participate in the March 29 TMT meeting but provided this response to the proposed operation during the March 28 TMT meeting.

In response to this poll of TMT members, the COE will confer with its legal and policy advisers. TMT will be notified by email later today of the Action Agencies decision regarding this operation.

4. Next TMT Meeting

TMT will meet in person on April 11, with a conference call if needed on April 4.

<i>Name</i>	<i>Affiliation</i>
Paul Wagner	NOAA
Sheri Sears	Colville
Rick Kruger	Oregon
Charles Morrill	Washington
Dave Statler	Nez Perce
Tony Norris	BPA
Jim Litchfield	Montana
Russ Kiefer	Idaho
Rich Lanagan	Grant PUD
Scott English	COE
Karl Kanbergs	COE
Laura Hamilton	COE
Lisa Wright	COE
Margaret Filardo	FPC
Dave Benner	FPC
Brandon Chockley	FPC
Richelle Beck	Grant PUD
John Roache	BOR
Doug Baus	COE

Thu 3/29/2012 3:29 PM

TMT Members, Alternates, and Interested Parties,

The Action Agencies (AAs) will implement the modified Minimum Operating Pool (MOP) operation proposed by BPA and discussed during today's TMT conference call. A brief summary of the operation as discussed during the March 28 and 29 TMT meetings is included below.

- Lower Granite - draft to MOP (for Lewiston-Clarkston flood protection) no later than 0001 hour on April 3, then draft downstream projects sequentially (one project per day)
- Little Goose - draft to MOP no later than 2400 hours on April 3
- Lower Monumental - draft to MOP no later than 2400 hours on April 4
- Ice Harbor - draft to MOP no later than 2400 hours on April 5

Poll Results (see meeting minutes for detailed comments from TMT representatives):

- CRITFC/Umatilla (Lorz) - No objection (this was provided during the March 28 TMT meeting).
- ID (Kiefer) - Support.
- WA (Morrill) - Support.
- MT (Litchfield) - Support.
- OR (Kruger) - No objection.
- USFWS (Wills) - No objection.
- NOAA (Wagner) - Support.
- Nez Perce (Statler) - No objection.
- Colville (Sears) - Support.
- BOR (Roache) - Support.
- Corps (Baus) - The AAs will provide TMT with notification pending legal and policy review of TMT's feedback.

The AA's will provide info to TMT on this operation during the TMT meeting currently scheduled for April 11.

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday April 11, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 5497

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review March 21, 28, 29 Meeting Minutes
3. Water Supply Forecast Update - Doug Baus, COE-NWD
 - a. [NWRFC The Dalles Dam Forecasts](#)
 - b. [NRCS SNOTEL](#)
 - c. [April Final Forecasts](#)
4. Spill Priority List - Scott English, COE-NWD
 - a. [April 11 List](#)

5. Operations Review
 - a. Reservoirs
 - b. Fish
 - c. Water Quality
 - d. Power System
6. Other
 - a. [Update Ice and Trash Log Jam](#)
 - b. Set agenda and date for next meeting - **April 18, 2012**
 - c. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

April 11, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Meeting Minutes

The Official Meeting Minutes and Facilitator's Notes from meetings on 3/21, 3/28 and 3/29 were reviewed. Russ Kiefer, Idaho, said he had some edits to the 3/28 summaries that he will bring up at the 4/18 TMT meeting. The notes will be finalized at that time.

Spring Creek Hatchery Release Update

Doug Baus, COE, reported that a log jam in the ice/trash sluiceway at Bonneville PH 1 was creating operational challenges for the Spring Creek Hatchery release. Prior to notification of the log jam on April 11 the USFWS released 900,000 out of the 5 million juvenile tule fall chinook. Upon notification of the log jam the USFWS postponed the remainder of the release until further notice. Doug provided background on two options for removing the log that the COE was currently exploring:

- 1) Close off the sluiceway and remove the log using a crane and bridle. While this might be efficient, it would also require lowering the Bonneville forebay, and current hydrologic conditions (high flows) did not make this a likely option.
- 2) Use of bulkheads. This would require an approximately 5 day operation – two days to install the bulkheads; approximately a half day to cut up and remove the log; and two days to remove the bulkheads. This was the most likely operation at this time based in current conditions

Doug asked for feedback and any additional information that would help guide the decisions – he noted that the COE needed to make a decision in short order, and would also need to coordinate with the project to determine the best path forward.

Additional information was shared. Given the water quality needs of the fish and conditions at the hatchery, USFWS hatchery managers Spiro Stylos and Mark Aarons said it would be possible to delay the remaining release until Monday, possibly Wednesday. At that point, water quality conditions at the hatchery would start to put the health of the fish at risk. In addition, a representative from the Little White Salmon National Fish Hatchery said they could delay their release for another week.

TMT members provided feedback. Dave Wills, USFWS, said his agency preferred to use the sluiceway to pass the fish given better conditions there than through other passage routes – so long as the delay does not cause a hazard to the fish while they are being held at the facility. Rick Kruger, Oregon, expressed concern for other fish passing the dam and

asked the COE to consider increasing night time spill at Bonneville to support passage at this time. Tom Lorz, CRITFC/CTUIR, echoed this suggestion as a way to lessen the impact of operating the powerhouse at the upper end of 1%.

Action/Next Steps: Doug Baus, COE, said the COE will use the input from TMT to inform a plan forward. They will work with USFWS and the project to coordinate a specific operation, keeping in mind the desire to keep the delay to a minimum (5 days is preferred) and to support additional fish passing through the project at this time. Doug will coordinate with TMT via email notification, and this item will be revisited at the 4/18 TMT meeting.

***NOTE:** Doug sent an email to TMT on 4/12 indicating that: ‘the attempt to remove the log from the ITS this afternoon has failed. The Project will begin installing ITS bulkheads tomorrow.’

Water Supply Forecasts

Doug Baus, COE, reported that the latest April-August water supply forecast for The Dalles was 103.5 MAF (111% of average). He said the water supply forecast was continuing a trend of above average throughout the basin, and added this trend was also true for snow water equivalents as shown at the NRCS SNOTEL sites. April final forecasts were as follows:

- The Dalles April-August (103.7 MAF; 111% of average)
- Lower Granite April-July (22.5 MAF; 104% of average)
- Dworshak April-July (29.66 MAF; 111%)
- Libby April-August (6.872 MAF; 117%)
- Hungry Horse – reported by John Roache, Reclamation April-July (2.075 MAF; 104%)

Spill Priority List

Scott English, COE, shared a draft spill priority list for initiation on 4/23 to set up for performance standard tests – as was discussed at the 3/28 TMT meeting. Oregon’s Rick Kruger suggested that the heading include a note about the performance standard testing as an indicator for why the order was going to change at that time. No additional comments on this list were offered at this time.

With regards to the current spill priority list, Dave Wills, USFWS, brought forth for discussion a request to move Bonneville to the top of the Level 3 list during the Spring Creek Hatchery release operation to potentially provide additional spill at Bonneville Dam. Paul Wagner, NOAA, said that because adult numbers are currently low, he would support the alternative spill priority list for a short duration. When adult numbers increase, there are risks to their passage as well as to adult fallback. TMT discussed the option of using the proposed alternative list now to support the 900,000 Spring Creek hatchery fish already released, and/or to use the list when the rest of the release occurs after the log issue at Bonneville has been resolved. Paul Wagner suggested that he would need to check in again early next week to determine adult passage numbers before agreeing to use the modified list at that time. Russ Kiefer, Idaho, said he was ok with

putting Bonneville at the top of Level 3, would prefer waiting until the bigger release occurs, but would go with the will of the group.

The option of increasing nighttime spill at Bonneville was offered again in the context of the modified spill priority list, as a way to reduce the impact of operating in the upper end of 1%. The COE responded that they would take this recommendation in to consideration.

Action/Next Steps: Hearing no objections, the COE planned to issue a teletype to the projects to place Bonneville at the top of the Level 3 spill priority list, effective immediately and until further notice. If Salmon Managers would like modifications made to this list then they will contact the COE next week. They will also share their decision about nighttime spill at Bonneville).

Operations Review

Reservoirs – John Roache reported on Reclamation projects. Hungry Horse was at elevation 3526.4 feet, with 9 kcfs outflows. The project was targeting a flood control elevation of 3521.7 feet by 4/30. Grand Coulee was at elevation 1246 feet, drafting to reach 1220.2 feet by 4/30. John noted that ferry operations will be suspended while elevations are below 1228 feet, and it was anticipated this would occur around 4/23. Lisa Wright reported on COE projects. Libby was at elevation 2391.5 feet, with 5.4 kcfs inflows and 25 kcfs outflows. Dworshak was at elevation 1516.7 feet, with 9.7 kcfs in and 19.4 kcfs out. Priest Rapids inflows were 193 kcfs; inflows were 92.5 kcfs at Lower Granite; 293.5 kcfs at McNary and 285.9 kcfs at Bonneville.

Fish – Paul Wagner, NOAA, reported on fish. Adult spring Chinook passage counts at Bonneville were about 16/day, and increasing. Steelhead numbers were about 30-50/day at Bonneville. Juvenile yearling spring Chinook at Lower Granite were about 14,000/day (a bit high for this time of year); 2,800/day at Little Goose; 5,000/day at John Day and 1,000/day at Bonneville. Subyearlings at Bonneville were about 2,000/day. The injury rate of the subyearlings at Bonneville had been averaging about 6% (as high as 15%); Dave Wills, USFWS, noted that this was a higher than normal rate and worrisome to the salmon managers. Steelhead counts at Lower Granite were about 4,000-7,000/day. Lamprey counts at John Day were about 3,900/day and 32,000 total for the season to date. At Bonneville, lamprey counts were 200-300/day.

Water quality – Scott English, COE, reported that the transition to the CWMS 2.1 database has been successful and conversion is complete. All gauges on the river are operational. Involuntary spill has occurred at many of the projects, and has resulted in some TDG exceedances.

Power system – Tony Norris, BPA, reported that they are managing excess water to try to avoid TDG exceedances, and are following the spill priority list.

Next Meeting, 4/18: Conference call, 9:00 am

Agenda items include:

- Updated Water Supply Forecasts
- Hanford Reach Update
- Spring Creek Hatchery Release Update
- Spill Priority List Check In
- Operations Review
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

April 11, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of NOAA, the COE, BPA, USFWS, Oregon, Idaho, BOR, CRITFC/Umatilla Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review March 21, 28 and 29 Meeting Minutes

There were no suggested changes to the official minutes or facilitator's notes for March 21 and 29 so these are considered final. Russ Kiefer, Idaho, will bring comments on the March 28 minutes and notes to the next TMT meeting.

3. Spring Creek Hatchery Update

The scheduled release today of 6.2 million Spring Creek Hatchery fish was halted because a log is stuck in the Bonneville 2nd powerhouse ice and trash sluiceway, Baus reported. Prior to halting the operation 900,000 juveniles had been released. The log needs to be removed for the small fish to pass safely and efforts to remove it have been unsuccessful.

There are two options for removal: (1) close off the ice and trash sluiceway and use a crane to harness the log or (2) install a bulkhead at the 1st powerhouse ice and trash sluiceway which would allow crews to enter the sluiceway and cut up the log. Implementing option 1 would require a rapid drop in the Bonneville forebay elevation, which does not seem realistic at this time due to high inflows. Therefore, option 2 is the most viable, pending feedback from project staff. This operation will take approximately 5 days to complete, including 2 days to install the bulkheads, .5 to 1 day to remove the log and another 2 days to remove the bulkheads.

Hatchery representatives reported on their operations in response to the current situation. It will be several days before fish must be released, which allows time to implement option 2. More than 900,000 Spring Creek Hatchery fish had been released before the process could be halted, Speros Doulas, Hatchery Complex manager, said. The biggest constraint on holding the remaining fish will be water quality, specifically ammonia levels (Spring Creek Hatchery is a water reuse facility). These fish can be held until April 16, maybe April 18 depending on temperatures, which affect water quality.

Food, not water quality, is the biggest operational constraint at Little White Salmon Hatchery, reported Casey Risley, Hatchery Manager. The Little White Salmon Hatchery has enough food to hold fish for another week.

Tom Lorz, CRITFC/Umatilla, asked whether the Bonneville sluiceway could be closed off to fish. Yes, within a couple of hours, Lisa Wright, COE, replied. Bill Proctor, COE suggested closing the sluiceway for log removal while simultaneously allowing the remaining hatchery fish to pass. One **USFWS** concern is that the sluiceway has been modified to provide surface passage in the forebay at the Bonneville 1st powerhouse, Dave Wills said. Of the fish that pass via powerhouse 1 approximately 30-40% of the hatchery fish can be expected to take this route.

Rick Kruger, **Oregon**, proposed an increase in nighttime spill to move fish away from the Bonneville 2nd powerhouse where turbines are operating in the upper half of 1% efficiency. The COE had not considered additional spill because the point of reprogramming these hatchery fish was in order to release at a time that would not require spill beyond the levels identified in the FOP, Baus replied.

The preferred operating range for hatchery releases is not the upper end of 1% efficiency, Lorz commented. Increasing spill at night would help move subyearlings past the turbines without impacting adults. Nighttime spill would benefit all fish in the river, not just those released from Spring Creek, Kruger commented.

Before proceeding with log removal, the COE must consult further with project staff to assess whether 5 business days will be enough time to restore normal passage conditions at Bonneville by April 16, Baus said. TMT considered the extent to which this year's high flows are likely to speed up passage from the hatchery to Bonneville Dam. Last year, the majority of Spring Creek fish passed the project within 24-48 hours of release, Wills recalled. The COE will keep TMT informed via email of progress on the log removal. TMT will revisit the Spring Creek release in its April 18 conference call.

4. NWRFC Water Supply Forecast Update

Baus showed TMT the latest forecasts for the regional water supply in 2012, which are linked to today's agenda. Today's water supply forecast for at The Dalles Dam is 103.5 MAF, 111% of average. Readings of snow/water equivalents from the NRCS SNOTEL sites continue to be well above average, more so in Washington than in Oregon. April final water supply forecasts are listed below:

- The Dalles, April-August – 103.7 MAF, 111% of average
- Lower Granite, April-July – 22.5 MAF, 104 % of average
- Dworshak, April-July – 2966 KAF, 111% of average

- Libby, April-August – 6872 KAF, 117% of average
- Hungry Horse, April-July – 2075 KAF, 104% of average

5. Spill Priority List

Scott English, COE, asked for comments on the spill priority list linked to today's agenda. This list will go into effect on April 23 for performance standards testing at Little Goose, Lower Monumental, McNary and John Day dams. Rick Kruger, **Oregon**, suggested adding language that says the purpose of this list is to facilitate operations for performance standards testing. Scott English replied that this clarification could be added.

Dave Wills, **USFWS**, proposed a special operation beginning today and continuing for the remainder of the Spring Creek release: Move Bonneville to the top of the spill priority list beginning at Level 3. In response to questions, English explained at Levels 1 and 2, the projects would spill in the current order of priority to their gas caps of 120% TDG (including Chief Joseph to 120% TDG as long as 115% TDG is not exceeded in Wells forebay), then BON would be moved to the top of the priority list beginning at Level 3 spill of up to 122% TDG during lack of load conditions. Paul Wagner said **NOAA** would support the USFWS proposal for the next 4 days, given the small numbers of adults arriving at Bonneville. Spill of more than 100 kcfs – the current spring spill level at Bonneville – tends to increase adult fallback and delay upstream adult passage. Wills then proposed ending the spill priority change as of April 16.

Margaret Filardo, FPC, asked about the probability of overgeneration spill to 122% TDG at Bonneville in the next 4 days. There's a lot of water in the river so overgeneration spill is likely, Tony Norris, BPA, replied. Russ Kiefer said **Idaho** would prefer the action agencies wait until most of the Spring Creek fish have been released before moving Bonneville to the top of the Level 3 and 4 lists. Idaho also supported the request made by Oregon to aid subyearling passage by increasing spill at night. Tom Lorz, **CRITFC/Umatilla**, did not oppose moving Bonneville up on the spill priority list beginning today but wondered whether it would make a difference.

USFWS urged the action agencies to do what they can to keep fish away from the Bonneville 2nd powerhouse while turbines are operating at the upper end of 1% efficiency, and to put Bonneville at the top of the priority order beginning at Level 3 while NOAA is willing to support increased spill.

In light of this discussion, the **COE** will place Bonneville at the top of the spill priority list order beginning at Level 3 (spill 122% TDG), effective today until further notice from the salmon managers. The COE will notify TMT via email of plans regarding nighttime spill at Bonneville. TMT will revisit the spill priority list in its April 18 conference call.

6. Operations Review

a. Reservoirs. Grand Coulee is at elevation 1246 feet, headed to an April 30 flood control elevation of 1220.2 feet. Heavy drafting will continue in response to a big increase in the April forecast for The Dalles. Hungry Horse is at elevation 3526.4 feet, drafting to an April 30 flood control elevation of 3521.7 feet. Current discharges are 9 kcfs. Inflows of 3 kcfs are expected to increase over the next few days.

Libby is at elevation 2391.5 feet, with inflows of 5.4 kcfs and discharges of 25 kcfs. Dworshak is at elevation 1516.7 feet, with inflows of 9.7 kcfs and discharges of 19.4 kcfs.

Priest Rapids inflows are 193 kcfs. Lower Granite inflows are 92.5 kcfs. McNary inflows are 293.5 kcfs, and Bonneville inflows are 295.9 kcfs.

b. Fish. Adults: Only 15-16 spring chinook adults have been arriving daily at Bonneville, for a total of 129 fish over the past week, Wagner reported. Steelhead are passing Bonneville at the rate of 30-50 per day. Spring chinook smolt counts of 1000-1500 per day at the Salmon River, Imnaha and Grande Ronde traps are slightly higher than usual for this time of year. Approximately 5000 spring chinook smolts are passing John Day Dam per day, and about 1000 yearling chinook are passing Bonneville per day.

Juveniles: Subyearlings are passing Bonneville at the rate of approximately 2000 per day. Injury rates are higher than usual due to the effects of passing small fish through fully loaded turbines. Mortality rates for subyearlings are currently around 6% which is abnormally high, Wills added. However, some of these injured fish are probably from the White Salmon hatchery, which has been affected by the move last fall of listed tule fall chinook broodstock to the area above Condit Dam before dam removal. Wills commented that the situation in the gatewells at the Bonneville 2nd powerhouse needs to be addressed.

Steelhead subyearlings have been passing at the rates of 4000-7000 per day at Lower Granite, 1000 per day at John Day, and a few hundred per day at Bonneville, Wagner reported. Recently lamprey passage peaked at 32,000 passing John Day, but only a few hundred are passing Bonneville per day.

c. Water Quality. Conversion to the new CWMS 2.1 database has been successfully completed, Scott English, COE, reported. All river gages are operational, and the lower river projects began spill on April 10 with all projects meeting their BiOp spill targets. Some projects have had involuntary spill in excess of hydraulic capacity, meaning there have been TDG exceedances.

d. Power System. It has been challenging to manage the high flows in the river without exceeding TDG limits, Tony Norris reported.

4. Next TMT Meeting

There will be a TMT conference call April 18, with a Vernita Bar update, the Spring Creek Hatchery release and the spill priority list on the agenda. The next regular TMT meeting will be April 25.

<i>Name</i>	<i>Affiliation</i>
Paul Wagner	NOAA
Doug Baus	COE
Tony Norris	BPA
Kim Johnson	COE
Karl Kanbergs	COE
Lisa Wright	COE
Bill Proctor	COE
Scott English	COE

Phone:

Dave Wills	USFWS
Rick Kruger	Oregon
Russ Kiefer	Idaho
John Roache	BOR
Scott Bettin	BPA
Margaret Filardo	FPC
XX	PP&L
Casey Risley	Little White Salmon National Fish Hatchery
Shane Scott	PPC
Ruth Burris	PGE
Heather Dohan	Puget
Alex Cibarra	Grant PUD
Barry Espenson	CBB
Bruce McKay	consultant
Speros Doulas	Columbia River Gorge National Fish Hatchery
Complex	
Greg Lawson	Thompson Reuters
Richelle Beck	Grant PUD
Harvey Hall	EWEB
Rob Allerman	Deutsch Bank
Tom Lorz	CRITFC/Umatilla
Mike Shapley	Snohomish PUD
Peter Richardson	Genscape
Steve Hall	COE
Russ George	WMC

DRAFT SPILL PRIORITY LIST

For Use Beginning April 23rd

Prepared 4/11/12

LEVEL 1 SPILL (115% FOREBAY OR 120% TAILWATER WHICH EVER IS MORE RESTRICTIVE) IF NOT ALL READY SPILLING TO THESE LEVELS AS FOLLOWS:	SPILL CAPS ¹
1) LWG UP TO FISH PASSAGE SPILL CAP	41
2) IHR UP TO FISH PASSAGE SPILL CAP	92
3) TDA UP TO FISH PASSAGE SPILL CAP	140
4) BON UP TO FISH PASSAGE SPILL CAP	100
5) LGS UP TO FISH PASSAGE SPILL CAP	40
6) LMN UP TO FISH PASSAGE SPILL CAP	28
7) MCN UP TO FISH PASSAGE SPILL CAP	150
8) JDA UP TO FISH PASSAGE SPILL CAP	146
9) CHJ UP TO 110%	25

LEVEL 2 SPILL IS AS FOLLOWS:	SPILL CAPS ¹
10) LWG UP TO 120% TDG SPILL CAP	45
11) IHR UP TO 120% TDG SPILL CAP	75
12) TDA UP TO 120% TDG SPILL CAP	135
13) BON UP TO 120% TDG SPILL CAP	100
14) LGS UP TO 120% TDG SPILL CAP	52
15) LMN UP TO 120% TDG SPILL CAP	44
16) MCN UP TO 120% TDG SPILL CAP	140
17) JDA UP TO 120% TDG SPILL CAP	146
18) DWR UP TO 110% TDG SPILL CAP	32%
19) CHJ UP TO 120% SPILL CAP (SHAPED 115% AT WEL, UP TO THE 120% IN THE CHJ TAILRACE, DEPENDING ON EXPECTED DURATION)	60

LEVEL 3 SPILL IS AS FOLLOWS:	SPILL CAPS ¹
20) LWG UP TO 122% TDG SPILL CAP	52
21) IHR UP TO 122% TDG SPILL CAP	85
22) TDA UP TO 122% TDG SPILL CAP	160
23) BON UP TO 122% TDG SPILL CAP	120
24) LGS UP TO 122% TDG SPILL CAP	59
25) LMN UP TO 122% TDG SPILL CAP	60
26) MCN UP TO 122% TDG SPILL CAP	152
27) JDA UP TO 122% TDG SPILL CAP	177
28) CHJ UP TO 120% TDG SPILL CAP	100
29) GCL UP TO 110% TDG SPILL CAP	RO=18

¹ All spill caps are in kcfs unless shown otherwise. Spill caps will be revised regularly based on observed conditions.

LEVEL 4 SPILL IS AS FOLLOWS:	SPILL CAPS ¹
30) LWG UP TO 125% TDG SPILL CAP	63
31) IHR UP TO 125% TDG SPILL CAP	110
32) TDA UP TO 125% TDG SPILL CAP	269
33) BON UP TO 125% TDG SPILL CAP	215
34) LGS UP TO 125% TDG SPILL CAP	70
35) LMN UP TO 125% TDG SPILL CAP	80
36) MCN UP TO 125% TDG SPILL CAP	230
37) JDA UP TO 125% TDG SPILL CAP	190
38) GCL UP TO 120% TDG SPILL CAP	RO=30
39) CHJ NOT TO EXCEED 190 KCFS (CHJ IS EXPECTED TO BE DEGASSING, CURRENT LIMIT FOR DAM SAFETY CONCERNS)	190
40) GCL UP TO 125% SPILL CAP	RO=40

LEVEL 5 SPILL IS AS FOLLOWS:	SPILL CAPS ¹
41) LWG UP TO 127% TDG SPILL CAP	85
42) IHR UP TO 127% TDG SPILL CAP	124
43) TDA UP TO 127% TDG SPILL CAP	294
44) BON UP TO 127% TDG SPILL CAP	234
45) LGS UP TO 127% TDG SPILL CAP	95
46) LMN UP TO 127% TDG SPILL CAP	120
47) MCN UP TO 127% TDG SPILL CAP	280
48) JDA UP TO 127% TDG SPILL CAP	206
49) GCL UP TO 127% TDG SPILL CAP	RO=45

LEVEL 6 SPILL IS AS FOLLOWS:	SPILL CAPS ¹
50) LWG UP TO 130% TDG SPILL CAP	90
51) IHR UP TO 130% TDG SPILL CAP	145
52) TDA UP TO 130% TDG SPILL CAP	360
53) BON UP TO 130% TDG SPILL CAP	250
54) LGS UP TO 130% TDG SPILL CAP	125
55) LMN UP TO 130% TDG SPILL CAP	180
56) MCN UP TO 130% TDG SPILL CAP	321
57) JDA UP TO 130% TDG SPILL CAP	250
58) GCL UP TO 130% TDG SPILL CAP	RO=50

LEVEL 7 SPILL IS AS FOLLOWS:	SPILL CAPS
59) LWG UP TO 135% TDG SPILL CAP	200
60) IHR UP TO 135% TDG SPILL CAP	240
61) TDA UP TO 135% TDG SPILL CAP	400
62) BON UP TO 135% TDG SPILL CAP	240
63) LGS UP TO 135% TDG SPILL CAP	177
64) LMN UP TO 135% TDG SPILL CAP	250
65) MCN UP TO 135% TDG SPILL CAP	375
66) JDA UP TO 135% TDG SPILL CAP	300
67) GCL UP TO 135% TDG SPILL CAP	RO=57

Wed 4/11/2012 5:12 PM

TMT Members and Alternates:

The log removal operation this afternoon was unsuccessful. As discussed this afternoon bulkheads will be installed so project staff may access the ITS and remove the log.

 [Header for Water Supply Information](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(GCDW1) COLUMBIA - GRAND COULEE DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-04-03 Issue Date: 2012-04-04

 [Water Supply Plot for COLUMBIA - GRAND COULEE DAM](#)

For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	68758	73582	115	79981	63990
APR-JUL	56372	60429	112	67516	53850
APR-AUG	64486	68525	114	75283	60290
JAN-JUL	63930	67988	108	75075	62900

with 3 days of QPF

APR-SEP	68822	74355	116	80822	63990
APR-JUL	56849	60908	113	67544	53850
APR-AUG	64950	69452	115	76424	60290
JAN-JUL	64408	68467	109	75103	62900

with 0 days of QPF

APR-SEP	67886	73996	116	79914	63990
APR-JUL	56002	60911	113	66474	53850
APR-AUG	64132	68667	114	75168	60290
JAN-JUL	63562	68470	109	74033	62900

Move the mouse over the desired "Forecast Period" to display a graph.

Hungry Horse April Final forecast

Apr - Jul: 2075 kaf (104%)

Apr - Aug: 2150 kaf (104%)

May - Sep: 1906 kaf (104%)

Jan - Jul: 2261 kaf (102%)

 [Header for Water Supply Information Page](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(TDAO3) COLUMBIA - THE DALLES DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-04-03 Issue Date: 2012-04-04

 [Water Supply Plot for COLUMBIA - THE DALLES DAM](#)

For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	103728	110399	112	121485	98650
APR-JUL	86349	93388	110	104793	84650
APR-AUG	97484	103726	111	115062	93090
JAN-JUL	105813	112852	105	124257	107300

with 3 days of QPF

APR-SEP	103951	111357	113	123644	98650
APR-JUL	87084	94206	111	105334	84650
APR-AUG	97758	105101	113	116793	93090
JAN-JUL	106548	113670	106	124798	107300

with 0 days of QPF

APR-SEP	102341	110979	112	121559	98650
APR-JUL	85914	93447	110	104753	84650
APR-AUG	96037	104671	112	114793	93090
JAN-JUL	105378	112911	105	124217	107300

Move the mouse over the desired "Forecast Period" to display a graph.

 [Header for Water Supply Information](#)

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(LGDW1) SNAKE - LOWER GRANITE DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-04-03 Issue Date: 2012-04-04

 [Water Supply Plot for SNAKE - LOWER GRANITE](#)

For Data Used In Plot Click Here: [CSV](#)

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	23214	25253	105	28578	24140
APR-JUL	20266	22519	104	25710	21550
APR-AUG	21783	24018	105	27290	22870
JAN-JUL	27437	29690	99	32881	30020

with 3 days of QPF

APR-SEP	23256	25696	106	29015	24140
APR-JUL	20350	22909	106	26146	21550
APR-AUG	21849	24474	107	27711	22870
JAN-JUL	27521	30080	100	33317	30020

with 0 days of QPF

APR-SEP	22879	25322	105	29158	24140
APR-JUL	20112	22620	105	26281	21550
APR-AUG	21624	24040	105	27865	22870
JAN-JUL	27283	29791	99	33452	30020

Move the mouse over the desired "Forecast Period" to display a graph.

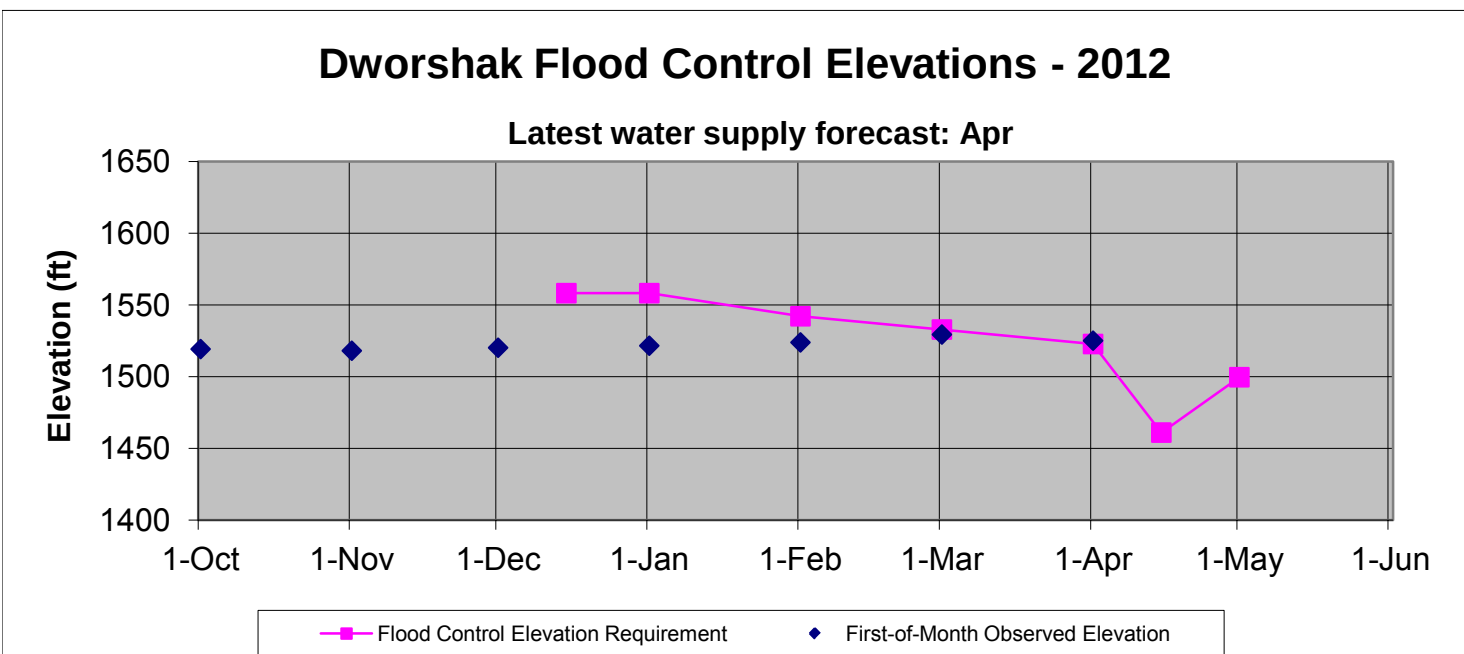
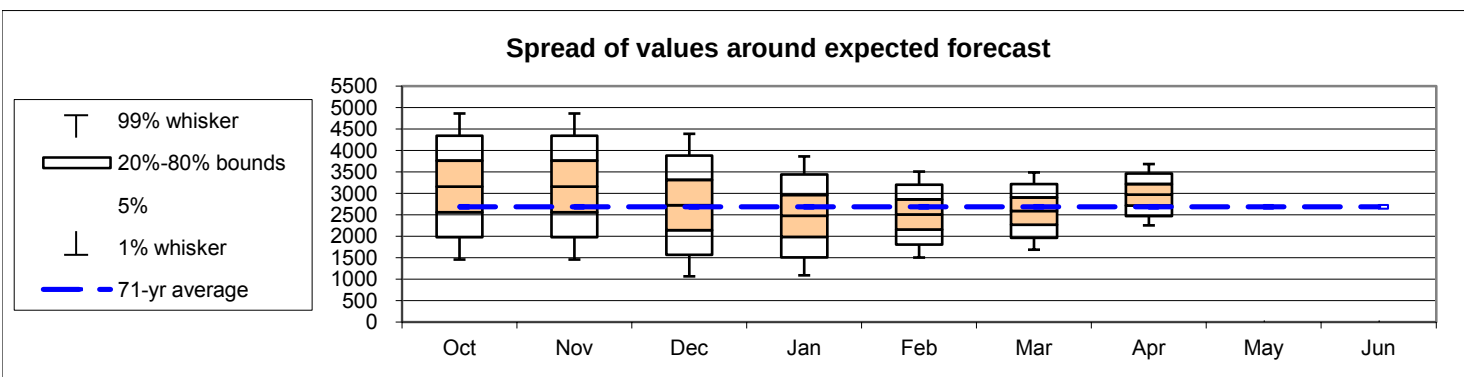
Dworshak : April Runoff Forecast & Flood Control Calculation

WY 2012

Runoff Forecast and Non-Shifted Flood Control			
Most Probable Runoff Volume	Apr-Jul	2966	KAF
	May-Jul	2189	KAF
30-Apr Flood Control Space		1479	KAF
30-Apr Flood Control Elevation		1499.6	ft

1929-1999 Average	Percent of Average
2683	111%
1980	111%

Seasonal Flood Control (assumes no shift of flood control space to Grand Coulee)									
Forecast Date>>	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Apr-Jul Runoff Forecast	3157	3157	2724	2473	2504	2585	2966		
First-of-Month Elev	1519.2	1518.1	1520.2	1521.6	1523.9	1529.4	1525.1		
Date >>	15-Dec	31-Dec	31-Jan	28-Feb	31-Mar	15-Apr	30-Apr		
Flood Control Space	--	700	700	931	1059	1193	1868	1479	
Flood Control Elevation	--	1558.2	1558.2	1542.1	1532.9	1522.8	1461.0	1499.6	



- Notes:
1. The given forecast is the official Corps of Engineers forecast for Dworshak. If you have any questions please contact Jeremy Giovando (509 527 7053), or Steve Hall (509 527 7550).
 2. Due to updated values for precipitation, snow or streamflow, subsequent forecasts may be different from the forecast published herein.
 3. 15-Dec and 31-Dec flood control space is fixed at 700 KAF.
 4. 15-Apr target elevation does not reflect flood control shift operation between Dworshak and Grand Coulee.
 5. 30-Apr target elevation may vary as runoff occurs throughout the month of April.

Dworshak : April Runoff Forecast & Flood Control Calculation

Apr-Jul Runoff Forecast Calculation:					
Variable	Month	Observed Value	% of Average	Regression Coefficient	Marginal Runoff (KAF)
		A		B	=A*B
SOI	Sep	1.00		123.36	123.4
Elk Butte SWE	1-Apr	38.60	95%	15.71	606.4
Hemlock Butte SWE	1-Apr	53.80	110%	15.31	823.7
Hoodoo Basin SWE	1-Apr	48.60	107%	13.92	676.5
Shanghi Summit SWE	1-Apr	30.70	116%	17.92	550.1
DWR January Inflow	Jan	121.39	60%	0.750	91.0
DWR February Inflow	Feb	176.73	65%	0.210	37.1
DWR March Inflow	Mar	453.58	114%	0.440	199.6
Intercept		1		-141.94	-141.9
1-Apr Forecast (KAF)					Σ 2965.9

Data Station	Sept	Nov	Dec	1-Jan	1-Feb	1-Mar	1 Apr	1-May	1-Jun
Climate (Stdzd SOI)									
September SOI	1.00								
Precipitation (monthly depth, inches)									
Headquarters, ID		3.50	3.10						
Snow Water Equiv (first of month SWE depth, inches)									
Elk Butte, ID				10.5	22.6	30.4	38.6	--	--
Hemlock Butte, ID				15.0	29.1	40.3	53.8	--	--
Hoodoo Basin, MT				16.4	29.5	36.2	48.6	--	--
Pierce RS, ID				1.7	6.2	8.4			
Shanghi Summit, ID							30.7	--	--
Lost Lake, ID								--	--
Streamflow (monthly volume, KAF)				Jan	Feb	Mar	Apr	May	Jun
Dworshak Inflow				121	177	454	--	--	--

Libby : April Runoff Forecast & Flood Control Calculation

WY 2012

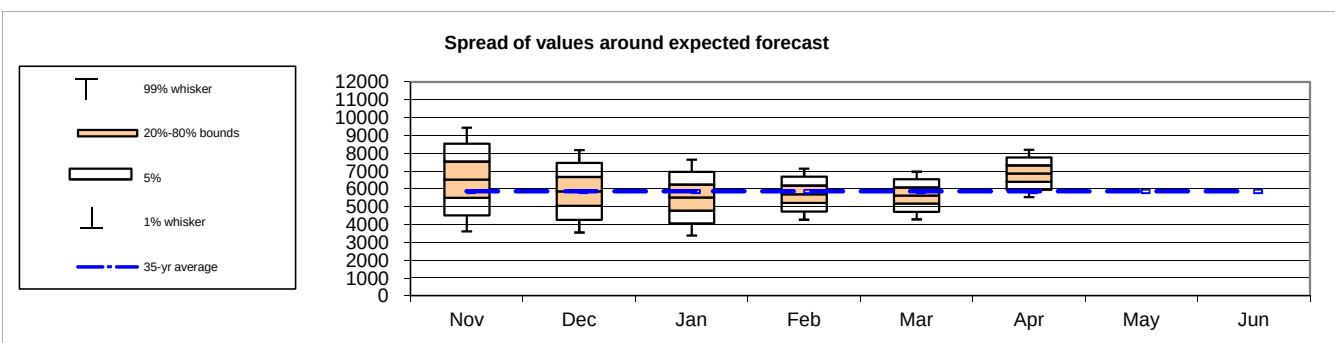
Runoff Forecast and Flood Control

Most Probable Runoff Volume:	Apr-Aug	6872	KAF
	Apr-Jul	6214	KAF
	May-Jul	5621	KAF

30-Apr Flood Control Space	3058	KAF
30-Apr Flood Control Elevation	2377.3	ft

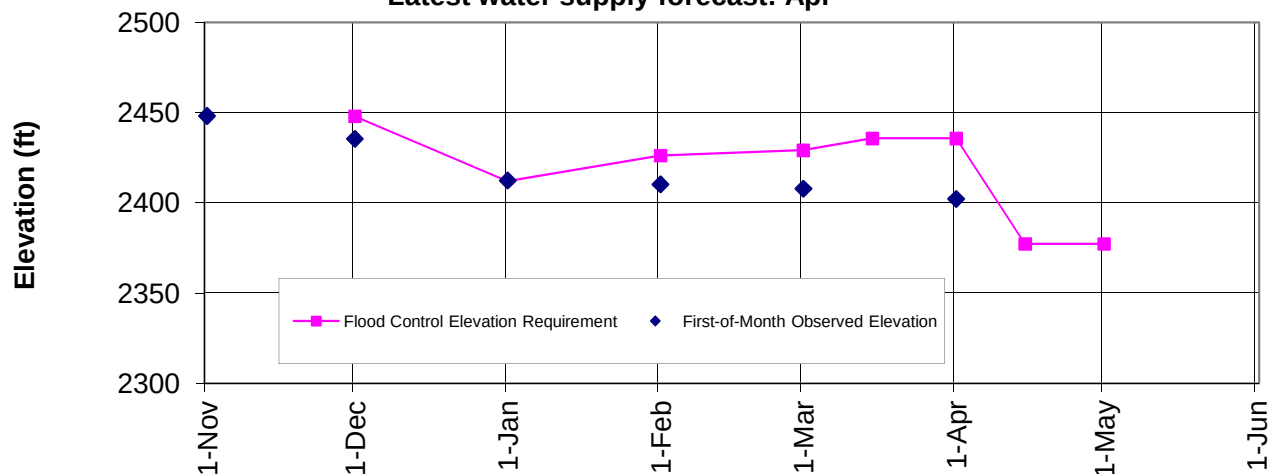
1975-2009 Average	Percent of Average	1929-1999 Average	Percent of Average
5865	117%	6337	108%
5303	117%	5771	108%
4797	117%	5247	107%

Seasonal Flood Control VARQ Flood Control Implemented								
Forecast Date >>	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Apr-Aug Runoff Forecast	6532	5876	5524	5714	5635	6872		
First-of-Month Elev	2448.3	2435.6	2412.5	2410.3	2407.9	2402.3		
Date >>	30-Nov	31-Dec	31-Jan	28-Feb	15-Mar	31-Mar	15-Apr	30-Apr
Flood Control Space	500	1965	1419	1300	1030	1030	3058	3058
Flood Control Elevation	2448.0	2412.0	2426.2	2429.2	2435.7	2435.7	2377.3	2377.3



Libby Flood Control Elevations - 2012

Latest water supply forecast: Apr



Notes:

1. The given forecast is the official Corps of Engineers forecast for Libby. If you have any questions please contact Joel Fenolio (206) 764-6683, Kevin Shaffer (206) 764-3660, or Kristian Mickelson (206) 764-6927.
2. Subsequent forecasts may differ from the originally published forecast due to updated values for precipitation, snow or streamflow.

Libby : April Runoff Forecast & Flood Control Calculation

Apr Aug Runoff Forecast Calculation:

Variable	Month(s)	Units	Observed Value	Percent of Average	Regression Coefficient	Marginal Runoff (KAF)
			A		B	=A*B
QBO	ΣJan:Mar		29.67		-1.8	-54.4
PNA	ΣOct:Jan		0.29		-83.9	-24.3
West Glacier, MT	ΣDec:Mar Prcp	inches	11.58	113%	51.3	594.6
Fernie, BC	ΣDec:Mar Prcp	inches	19.82	113%	41.4	820.7
Sunshine Village, AB	1-Apr SWE	inches	28.43	128%	52.4	1490.8
East Creek, BC	1-Apr SWE	inches	39.42	117%	25.8	1018.5
Stahl Peak, MT	1-Apr SWE	inches	38.90	112%	27.3	1061.2
Gardiner Creek, AB	1-Apr SWE	inches	27.09	117%	18.1	491.0
Three Isle Lake, AB	1-Apr SWE	inches	23.94	126%	51.2	1226.4
Intercept			1		247.9	247.9
1-Apr Forecast (KAF)					Σ	6872.3

Data used in Libby Water Supply Forecast

Data used in Libby Water Supply Forecast						WY	2012				
Climate Data		Jan-11	Feb-11	Mar-11	Jun-11	Jul-11	Oct-11	Nov-11	Dec-11	Jan-12	
SOI					0.20	1.00					
QBO		9.18	10.05	10.44							
PNA							0.86	-0.76	0.06	0.13	
Precipitation Data		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Units	
Eureka, MT		2.17	0.44	0.48	0.79	0.42					inch
Libby 1 NE RS, MT		1.92	2.00	1.74	2.19	0.80					inch
West Glacier, MT		3.90	1.51	2.06	3.48	2.28	3.76			inch	
Fernie, BC		120.10	73.80	52.60	64.90	64.00	321.90			mm	
Snow Water Equiv		1-Jan			1-Feb	1-Mar	1-Apr	1-May	1-Jun	Units	
Floe Lake, BC				409	533	683					mm
Sunshine Village, AB				276	441	513	722			mm	
East Creek, BC				428	668	743	1001			mm	
Stahl Peak, MT				11	19	28	39			inch	
Gardiner Creek, AB				200	354	438	688			mm	
Three Isle Lake, AB				241	365	437	608				mm
Lost Creek South, AB				355	523	677					mm
Morrissey Ridge, BC				285	458	510					mm
Hawkins Lake, MT				14	22	25					inch
Streamflow		Jan			Feb	Mar	Apr	May	Jun	Units	
Libby Inflow Volume				169.0	144.0	217.0				KAF	
Reservoir Elevation		1-Nov	1-Dec	1-Jan	1-Feb	1-Mar	1-Apr	1-May	1-Jun	Units	
Libby FOM Elev		2448.3	2435.6	2412.5	2410.3	2407.9	2402.3			feet	

Apr 11, 2012

unavailable *
 <50%
 50 - 69%
 70 - 89%
 90 - 109%
 110 - 129%
 130 - 149%
 >= 150%

**Provisional data
subject to revision**



Prepared by the USDA/NRCS National Water and Climate Center
Portland, Oregon <http://www.wcc.nrcs.usda.gov/gis/>
Based on data from <http://www.wcc.nrcs.usda.gov/reports/>
Science contact: Jim.Marron@por.usda.gov 503 414 3047

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Friday April 13, 2012 3:00pm - 4:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 5439

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. SOR 2012 - 1Paul Wagner, NOAA Fisheries
 - a. [SOR](#)
3. Other
 - a. Set agenda and date for next meeting - **April 18, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

April 13, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired and facilitated by Doug Baus, COE. Representatives of BPA, COE, CRITFC/Umatilla Tribe, NOAA, Oregon, Idaho, USFWS, Colville Tribe, Washington, Nez Perce Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. SOR #2012-1, Bonneville Operation Over the Next Five Days to Facilitate Spring Creek Release

The purpose of the unscheduled call today was to implement the SOR (2012-1) the COE received today, signed by NOAA, USFWS, the Nez Perce Tribe, CRITFC, Washington, Idaho, and Oregon (although Oregon was not a signatory on the SOR this was a procedural oversight and Oregon acknowledged the intent was for Oregon to be a signatory on the SOR). Speaking on behalf of the signatories, Paul Wagner, NOAA, explained the SOR, whose goal is to minimize injuries and mortalities of Spring Creek Hatchery juveniles when they pass Bonneville Dam.

The SOR asks the Action Agencies (AA) to implement two operations. First, operate Powerhouse Two (PH2) at the mid-point of the 1% best efficiency range. With all available units operational, at the above operational ranges, this would be the powerhouse capacity over the next 5 days; any flows above this powerhouse capacity would be spilled. In the past, limiting generation to the mid-point of the 1% operating range at PH2 has been shown to reduce injury and mortality of juveniles passing through the gatewells of PH2. Second, if powerhouse capacity is reached with the above operational criteria, and spill amounts lead to TDG exceedances below Bonneville Dam, then operate Powerhouse One (PH1) at open geometry outside of the 1% best efficiency range, while maintaining operations at PH2 at the mid-point of the 1% range. This action could reduce spill by routing additional flow through PH1.

Wagner noted that NOAA supports the requested operation as a short-term solution only, while few adults are at Bonneville. Implementing this SOR is likely to result in spill of more than 100 kcfs, at which point adults begin to experience fallback and delays in the tailrace. Ultimately, FPOM needs to work out the long-term solution to the gatewell issue at Bonneville because it will involve tradeoffs. David Wills said USFWS shares NOAA's views on this. Wills emphasized that implementing this SOR would benefit run of the river fish for the next 5 days, not just those from Spring Creek Hatchery.

Baus explained at this time the AA are unable to implement the first component of the SOR. Limiting generation to the mid-point of the 1% operating range at PH2 would result in additional spill at a time when gas caps are being exceeded at Bonneville Dam. Furthermore, the legal and policy level coordination needed for the AA's to voluntarily limit PH2 generation to the mid-point of the 1% range identified in the SOR has not been completed at this time.

However, the AA's provided the Salmon Managers with a modified proposed operation that included components of the SOR the AA's would be able to implement. The AA's modified proposed operation to implement the SOR included the following specifications:

1. Operate PH2 up to 25% of the 1% operating range.
2. To pass additional flow, operate PH1 up to 100% (full capacity) of the 1% operating range.
3. To pass additional flow, increase PH2 units one at a time in the order of priority within the 25-50% of the 1% operating range.
4. To pass additional flow, operate PH1 at best geometry.
5. To pass additional flow, increase PH2 units one at a time in the order of priority within the 50-100% of the 1% operating range.

Russ Kiefer, Idaho, asked what the flow forecast is for the next 5 days. Flows are expected to rise from 285 kcfs to 310 kcfs this weekend, replied Scott Bettin, BPA. Doug Baus indicated the spill cap at Bonneville this weekend is 92 kcfs.

Kiefer said Idaho supports this SOR because it would help avoid unacceptably high rates of juvenile injury and mortality without associated adult fallback and delays. Kiefer and Wills observed that improvements to fish guidance efficiency at Bonneville have constricted the operating range of the PH2 turbines, making the original 1% operating range guidance ineffective. Therefore, it would be prudent to avoid mortalities in the PH2 collection system by capping the operation at the midpoint of 1% operating range.

The flexibility to exceed 1% operating range at PH1 could deliver much of what the salmon managers have requested without formally implementing the SOR, Bettin said. Implementing this provision alone could reroute approximately 12 kcfs from PH2 to PH1 in the best-geometry configuration. Currently PH1 is operating at 100% of 1% operating range.

Several of the Salmon Managers objected to having TDG water quality standards as the reason why PH2 operations would not be restricted at a time when the result could be high rates of juvenile mortality and injury. The whole point of the 120% TDG standard is to provide safe passage for fish, and high mortalities have been documented with PH2 units operating at the upper end of 1%, Margaret Filardo, FPC, said. Mortality rates double when unit flows rise from 14.7 kcfs to 17.8 kcfs with one open gatewell orifice.

Rick Kruger, **Oregon**, said it should be TMT's prerogative to set up an operation that benefits fish, even if that causes gas exceedances. The region should be able to limit hydraulic capacity for the duration of the hatchery release, and any excess flows would be regarded as involuntary spill.

The COE will make best efforts to limit PH2 turbines at the midpoint of 1% operating range through operational adjustments like best geometry at PH1. Should limiting PH2 to the mid-point of the 1% operating range result in exceeding the gas caps, the COE would operate within the full range (up to 100%) of the 1% operating range at PH2 in order not to exceed the gas cap. Managing spill to the gas caps is part of the operations identified in the FOP, and at this time the AA's do not have the discretion to voluntarily spill in excess of the gas cap, Bill Proctor, COE, said. In coordination with the region the AA's do have the discretion to operate PH1 units at best geometry in an effort to minimize the probability PH2 units would be operated in the 50-100% range of the 1% operating range.

TMT members gave their views of the AA's modified proposed action to operate PH1 at best-geometry before increasing PH2 unit operations to the 50 – 100% range of the 1% operating range:

NOAA supported the operation if limited to the 5-day period mentioned in the SOR.

Oregon did not object, but this operation is not the best for fish; Washington shared Oregon's view.

USFWS supported keeping PH1 at the upper end of 1% operating range until the units at PH2 reach the upper end of 1% operating range. At that point, any benefit to PH2 is lost, so it would be prudent to back off on PH1 flows because no data are available to clarify the tradeoffs involved when the PH1 units operate above 1% operating range.

Idaho supported operating PH1 at best geometry in order to maintain PH2 at the midpoint of 1% operating range, but did not support going above 1% operating range at PH1 if the PH2 units would be running in the upper half of 1% operating range anyway. The biological effects of running PH1 at greater than

1% operating range are unknown, making this operation desirable only as an aid in keeping PH2 operations within the desired range. Idaho was amenable to increasing the trigger for ending best-geometry operations from 50% of 1% operating range at PH2 to 75% of 1% operating range.

Washington proposed that the best-geometry operation at PH1 end when the PH2 units hit 75% of 1% operating range (rather than 100% of 1% operating range).

Taking into consideration feedback from TMT, the COE presented the following modified proposal as a way to implement the SOR to the best extent possible:

1. Operate the PH2 units at 25% of the 1% operating range.
2. To pass additional flows, operate PH1 units up to 100% of the 1% operating range.
3. To pass additional flows after PH1 is fully loaded, increase the PH2 units one at a time in the order of priority to 25-50% of the 1% operating range.
4. To pass additional flows after PH1 is fully loaded and all available PH2 units are operating at 50% of 1% operating range, increase the PH1 units to best geometry.
5. To pass additional flows after all available PH1 units are operating at best geometry, increase the PH2 units one at a time in the order of priority to 50-75% of the 1% operating range.
6. To pass additional flows after all available PH2 units are operating at 75% of 1% operating range, decrease PH1 unit operations to 100% of the 1% operating range and increase PH2 unit operations one at a time in the order of priority to 75-100% of the 1% operating range.

TMT members expressed their views of the modified proposal:

- **NOAA** – Supports the operation
- **USFWS** – No objection
- **Washington** – No objection
- **Oregon** – No objection, but wants to know why TMT doesn't set the project operating limits under these circumstances.
- **Colville Tribe** – No objection
- **Idaho** – No objection
- **Umatilla Tribe** – No objection
- **Nez Perce Tribe** – No objection
- **BPA** – Supports the operation

After the meeting, **BOR** expressed support for the operation and **Montana** had no objection.

4. Next TMT Meeting

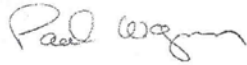
TMT will have a conference call on April 18 and will meet in person on April 25.

<i>Name</i>	<i>Affiliation</i>
Doug Baus	COE
Lisa Wright	COE
Scott Bettin	BPA
Tom Lorz	CRITFC Umatilla
Paul Wagner	NOAA
Rick Kruger	Oregon
Margaret Filardo	FPC
Dave Benner	FPC
Russ Kiefer	Idaho
Scott English	COE
Bill Proctor	COE
Dan Feil	COE
Dave Wills	USFWS
Sheri Sears	Colville Tribe
Charles Morrill	Washington
Dave Statler	Nez Perce

SYSTEM OPERATIONAL REQUEST: #2012-1

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: National Marine Fisheries Service, US Fish and Wildlife Service, Nez Perce Tribe, the Columbia River Inter-Tribal Fish Commission, Washington Department of Fish and Wildlife, and the Idaho Department of Fish and Game.

TO:	Brigadier General McMahon	COE-NWD
	James D. Barton	COE-Water Management
	Doug Baus	COE-RCC
	David Poganis	COE-PDD
	Karl Kanbergs	COE-NWD-NP-WM-RCC
	Col. Bruce A. Estok	COE-Seattle District
	Karl Wirkus	USBR-Boise Regional Director
	Steven Wright	BPA-Administrator
	Tony Norris	BPA-PGPO-5
	Scott Bettin	BPA- KEWR-4
	Steve Oliver	BPA-PG-5
	Lori Bodi	BPA-KE-4



FROM: Paul Wagner, FPAC Chair

DATE: April 13th, 2012

SUBJECT: Bonneville Operation over next Five Days to Facilitate Spring Creek Release

OBJECTIVE: To improve the survival of Subyearling Chinook Salmon at Bonneville Dam over the next five-day period.

SPECIFICATIONS:

Beginning immediately and maintaining for duration of five days:

- i. Operate Powerhouse Two at the mid-point of the 1% best efficiency range. With all available units operational, at the above operational ranges, this would be the powerhouse capacity over the next five days; any flows above this powerhouse capacity would be spilled.
- ii. If powerhouse capacity is reached with the above operational criteria, and spill amounts lead to TDG exceedences below Bonneville Dam, then operate Powerhouse One at Open

Geometry outside of the 1% best efficiency range, while maintaining operations at Powerhouse Two at the mid-point of the of 1% range.

JUSTIFICATION:

Spring Creek National Fish Hatchery (Spring Creek NFH), located upstream of Bonneville Dam on the Columbia River, annually produces tule fall Chinook (*Oncorhynchus tshawytscha*) that are released in the spring of each year as subyearlings. Although Spring Creek NFH Chinook salmon are listed under the Endangered Species Act (ESA) as part of the Lower Columbia River Chinook ESU, they are deemed not necessary for recovery and therefore are available for harvest. Spring Creek NFH tule salmon are important components of Columbia River treaty Indian and non Indian sport and commercial fisheries. Every additional adult salmon available for tribal harvest is critical from a tribal use and cultural perspective. Tribal members are dependent on these salmon for ceremonial and subsistence uses. These fish are also part of the U.S.-Canada treaty production and provide a significant benefit for West Coast fisheries. This includes Canada, Alaska, Oregon and Washington.

On Wednesday, April 11th, 2012 the Spring Creek NFH released approximately 925,000 subyearling fall Chinook tules. These subyearling fall Chinook first arrived at the Bonneville Dam Smolt Monitoring Juvenile Facility at approximately 0040 on April 12, 2012. Since this time, the SMP personnel at Bonneville Dam have been providing updates of mortality for Spring Creek subyearlings during their sub-samples on April 12th and April 13th.

April 12 (0040) – April 12 (0700) → 1,303 CH0 sampled, 68 mortalities → 5.2% mortality rate
April 12 (0700) – April 12 (1200) → 318 CH0 sampled, 56 mortalities → 17.6% mortality rate
April 12 (1200) – April 12 (1500) → 105 CH0 sampled, 31 mortalities → 29.5% mortality rate*

* increased amounts of debris and mortalities observed during this time period was associated with screen cleaning

April 12 (1500) – April 13 (0700) → 274 CH0 sampled, 25 mortalities → 9.1% mortality rate

Table 1. Estimated passage index and sample mortality of subyearling Chinook over past week from SMP data*

Date	CH0 Passage Index	Sample Mortality (%)
Apr 6	3,117	12.6
Apr 7	3,375	4.2
Apr 8	2,700	6.7
Apr 9	1,219	3.4
Apr 10	2,170	2.0
Apr 11	3,446	2.1
Apr 12	104,842	5.6
Apr 13	73,614	15.2

*Prior to April 12th, samples of subyearling Chinook at Bonneville Dam were mostly of Chinook fry (98-100%).

On April 13, 2012, Spring Creek NFH released approximately 5.25 million subyearling fall Chinook tules and Little White Salmon NFH released approximately 1.6 million subyearling fall Chinook tules. Juveniles from Spring Creek NFH typically arrive at Bonneville Dam within 12-24 hours of release.

The 1% efficiency range for turbine operations during the fish passage season at all projects was selected based on fish condition sampling showing low injury and mortality of collected fish in this operation range. Under the original gateway construction conditions, the operation of Powerhouse Two Units within the 1% Efficiency range was consistent with other projects of resulting in low injury and mortality. However, in recent years, the gateway environment at Powerhouse Two has changed. Based on observations of turbine operations and fish condition sampling, it appears the operating range at Bonneville Powerhouse two that results in BiOp anticipated low injury and mortality for subyearling fish is now in the low to Mid-Point of the 1% Range. The Salmon Managers recommend that Powerhouse Two operate at the Mid-Point of the 1% Range for the five day duration of this request. If additional powerhouse capacity is not needed, Powerhouse One should be operated within its typical 1% range. However, if additional powerhouse capacity is needed to reduce TDG below Bonneville Dam, Powerhouse One operations can be modified to the Open Geometry outside of the 1% range.

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday April 18, 2012 9:00am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 8437

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Vernita Bar Update - Russell Langshaw, Grant County PUD
3. Spring Creek Update - Dave Wills, USFWS
4. Other
 - a. Set agenda and date for next meeting - **April 25, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

April 18, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Vernita Bar Update

Russell Langshaw, Grant County PUD, referenced TMT to a hyperlink containing the latest Vernita Bar update. He noted there had not been much change since his last update to TMT – protection flows are still scheduled to begin the weekend of 4/28 and there have been no exceedances to date. Temperatures are tracking well with normal temperatures for this time of year. Russell pointed out the cells showing the first 30 days of this year's operation, with daily constraints and actual daily deltas; and showed current operations for the period 4/7-4/16. He added that some work happening at Priest Rapids will require reduced spill – all signatories have agreed to operate to a 60 kcfs delta if spill levels drop below 150 kcfs. Russell will continue to provide updates at upcoming TMT meetings.

Spring Creek Hatchery Release Update

Dave Wills, USFWS, recapped the Spring Creek hatchery release, including the timing of the release, conditions at Bonneville, and operations at Bonneville from last week. (Summary notes from the 4/11 and 4/13 TMT meetings describe the discussion in more detail.)

Updates for today included:

- The stuck log at Bonneville was successfully removed on Thursday 4/12.
- The rest of the Spring Creek Hatchery fish were released on Friday, 4/13.
- During an unscheduled conference call on 4/13, the salmon managers put forth SOR 2012-1, requesting a special operation for a 5-day period to accommodate passing Spring Creek Hatchery fish. The request was to run Powerhouse II at no greater than the mid-point of 1% efficiency during these very high flows in the system. During the course of that call, the action agencies offered an alternative operation that they felt was implementable and would meet multiple obligations and needs. That operation, while not preferred by the salmon managers, was met with no objection, so the COE planned to implement it as described below:

1. Bonneville (BON) powerhouse 2 (PH2) units will be operated at the 25% of the 1% operating range.

2. To pass additional flows, operate powerhouse 1 (PH1) units up to the 100% (full capacity) of the 1% operating range.

3. *To pass additional flows after PH1 is fully loaded, increase PH2 units one at a time in the order of priority within 25-50% of the 1% operating range.*
4. *To pass additional flow after PH1 is fully loaded and all available PH2 units are operating at 50%, increase operation of PH1 units up to best geometry.*
5. *To pass additional flow after all available PH1 units are operating at best geometry, increase PH2 units one at a time in the order of priority within 50-75% of the 1% operating range.*
6. *To pass additional flow after all available PH2 units are operating at 75%, decrease PH1 unit operation to 100% of the 1% operating range and increase PH2 units one at a time in the order of priority within 75-100% of the 1% operating range.*

Dave Wills reported that since Friday, mortality rates went from a high 15% on 4/13, to 'normal' on 4/14, to a range of 2-5% on 4/15. He reported that as of today, the bulk of the Spring Creek Hatchery fish have passed the dam. The next release, of about 4.8 million fish, is scheduled for 5/2.

Doug Baus, COE, reported that the action agencies implemented the above described operation after the 4/13 meeting. This special operation to facilitate the passage of Spring Creek releases ended on 4/17, since the bulk of the Spring Creek hatchery run had passed the dam. He added specific mortality data for the period of this special operation and said, from the COE's perspective, it was a success:

- 4/13 0700 – 4/14 0700: 1,692 sampled fish; 9 mortalities; 0.5% mortality rate
- 4/14 0700 – 4/15 0700: 330 sampled fish; 18 mortalities/5.5% mortality rate
- 4/15 0700 – 4/16 0700: 322 sampled fish; 8 total mortalities/2.5% mortality rate
- 4/16 0700 – 4/17 0700: 438 sampled fish; 17 mortalities/3.9% mortality rate

Additional questions and comments were raised about the operation –

- While it is clear that the mortality rates went down in PH2, it is not clear whether the PH1 open geometry operation (that which was implemented) was the reason for that, nor whether the salmon managers' request would have been a better operation to minimize mortality rates.
- Is there any empirical data on increases to mortality at Powerhouse I from the operation that was implemented? COE response: ERDC modeling has demonstrated survival benefits when operating PH1 at open geometry when compared to the 1% operating range.
- Special thank you to RCC and the dam crews for their efforts to remove the log in the trash and ice sluiceway in such a timely manner. This helped minimize hazards to the hatchery fish that were passing through that route as well as those that would be passing through the B1 sluiceway once released from the hatchery.
- Is there any data on current TDG levels below Bonneville? COE response: Yes, this information can be found as a link to the TMT page – <http://www.nwd-wc.usace.army.mil/report/total.html>.

TMT will revisit and plan for the next, 5/2, Spring Creek hatchery release at their next meeting on 4/25.

Spill priority list: Paul Wagner, NOAA, commented that since the current Spring Creek Hatchery Release has been completed, Bonneville no longer needs to stay at the top of Levels 3-7 of the spill priority list, and the list can revert back to the order coordinated at TMT on 3/28. So, the order for Level 3 of the Spill Priority List that is now in effect is as follows: Lower Granite, Little Goose, Lower Monumental, Bonneville, John Day, Ice Harbor, McNary, The Dalles, Chief Joseph and Grand Coulee.

Tom Lorz, CRITFC/Umatilla, asked for further clarification from the action agencies on how spill is being managed. Doug Baus replied that they are managing to TDG standards and FOP spill rates. Spill rates at projects are governed by the rates identified in: 1) the FOP, and 2) 120/115% TDG limit. When there is a difference in the two rates, project spill is governed by the lower rate.

Transportation: Paul Wagner also noted that the FCRPS BiOp describes transportation operations to begin at Lower Granite between 4/20 and 5/1. He reported that the salmon managers have discussed this at FPAC and will likely not recommend beginning transportation until 5/1. TMT will revisit this issue at the 4/25 TMT meeting.

Next Meeting, 4/25: 9:00 am at the COE

Agenda items include:

- Spring Creek Hatchery Release
- Operations Review
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

April 18, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of BPA, Colville Tribe, USFWS, Washington, COE, BOR, NOAA, Umatilla Tribe/CRITFC and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Vernita Bar Update

Russell Langshaw, Grant PUD, gave an update on the Hanford Reach fall chinook protection program. The latest information on this year's program is posted to today's agenda. Conditions have not changed much since Langshaw last updated TMT on the Hanford Reach operation. Weekend protection flows are still expected to begin the weekend of April 28. A comparison of this year's temperatures to the mean from 1988 to the present shows this year's temperatures are about a degree F below average. Recent flows have conformed to a combination of the 150 kcfs minimum discharge constraint and the 60 kcfs daily delta constraint. Over the past week, Priest Rapids mean discharges have been 149 kcfs with no exceedances.

Repair work in progress at Priest Rapids Dam requires reduced spill, so Grant PUD has requested flexibility on the 150 kcfs minimum to allow the work to proceed. Signatories agreed that the dam will operate under the 60 kcfs daily delta constraint if releases drop below the 150 kcfs minimum while repairs are underway. To date, the work is proceeding well, and Grant PUD hasn't yet had to make use of this provision. Chinook counts remain low, but passage is expected to pick up in the next week. Langshaw will report again to TMT in a few weeks.

3. Spring Creek Hatchery Update

David Wills, USFWS, gave a recap of challenges the Spring Creek hatchery release has encountered within the past week. Spring Creek and Little White Salmon hatcheries were scheduled to release some 8 million subyearling tule chinook on April 11. The Corps notified the USFWS on the morning of April 11th that the log was still stuck in the powerhouse 1 ice and trash sluiceway, potentially jeopardizing safe passage for fish taking that route. Fortunately only 900,000 of the 8,000,000 fish had already been released. The log was removed on the morning of April 12 and the release was finished on April 13th.

During the afternoon of April 13, in response to rising flow projections, the Salmon Managers requested an unscheduled TMT meeting and presented an SOR to the Action Agencies requesting that Powerhouse 2 be operated to no greater than the midpoint of the 1% operating range. That component of the SOR was declined by the Action Agencies in order to adhere to spill limitations associated with the gas cap, Wills reported. The Salmon Managers did not object to Action Agency plans to increase Powerhouse 1 operations to the open geometry position in order to redirect flows from Powerhouse 2 to Powerhouse 1. This operation was in effect over the weekend, and was used for a portion of the time when the hatchery fish passed.

Wills reported that mortalities were higher than normal except on April 14. The normal rate of mortality for Spring Creek releases is 0.5% of fish passing per day. On April 13, mortalities peaked at 15% of the fish passing. The rate of mortality dropped over the next few days ranging from 0.5%-5% of the fish passing, which is still more than normal. The latest reports from smolt monitoring crews indicate that the bulk of the April hatchery release has already passed Bonneville. The next release will be 4.8 million fish, scheduled for May 2.

Baus reported the operational changes implemented to facilitate the Spring Creek Hatchery release ended on April 17th. These changes included components of operations identified in the SOR as well as changes to the spill priority list. The following data were collected on mortality rates during the operation:

- From 7 am April 13 to 7 am April 14, 1692 Spring Creek fish were sampled with a mortality rate of 0.5% (9 fish).
- From 7 am April 14 to 7 am April 15, 336 Spring Creek fish were sampled with a mortality rate of 5.5% (18 fish).
- From 7 am April 15 to 7 am April 16, 332 Spring Creek fish were sampled with a mortality rate of 2.5% (8).
- From 7 am April 16 to 7 am April 17, 438 Spring Creek fish were sampled with a mortality rate of 3.9% (17).

Tom Lorz, Umatilla/CRITFC, emphasized that while the Salmon Managers didn't object to best-geometry operations at PH1, neither did they agree to it in the April 13 conference call. There is a difference of opinion about what the preferred operation would have been, and the SOR submitted by the Salmon Managers requested a different operation than what was implemented. Wills agreed with these comments and said it was clear on the April 13 call that the SOR as presented by the Salmon Managers was not implemented.

Baus replied that the operation implemented as a result of the April 13 call decreased hydraulic output from PH2, which minimized mortality in the gatewells of PH2. Modeling results at ERDC have demonstrated likely survival benefits

when operating PH1 at open geometry when compared to the 1% operating range.

Wills expressed appreciation for the efforts of Reservoir Control Center and Bonneville Dam employees who successfully removed the log from the PH1 ice and trash sluiceway in time for the Spring Creek arrivals.

4. Other

Spill priority list. Now that the Spring Creek release operation is ended Wagner requested that Bonneville be moved back to the initial position on the spill priority list. Baus reported that Bonneville has been moved from top priority Level 3 spill to its initial position after The Dalles, according to the spill priorities TMT coordinated on March 28. Spill priorities for Levels 3 through 7 have reverted to their initial order: Lower Granite, Little Goose, Lower Monumental, Bonneville, John Day, Ice Harbor, McNary, The Dalles, Chief Joseph and finally Grand Coulee.

Lorz questioned whether Bonneville should be at the top of the Level 3 list, since it is not spilling to its FOP level of 100 kcfs. Wagner and Scott Bettin, BPA, clarified that the FOP spill level of a given project is defined as either the gas cap for 120/115% TDG in the tailrace (now 96 kcfs at Bonneville) or the FOP spill target, whichever is lower.

Start of transportation. The FOP says transportation will begin on the lower Snake projects between April 20 and May 1. At this point FPAC foresees no need to begin transportation until May 1. Baus will convey this information to the Walla Walla District in preparation for transport operations. TMT will revisit this issue at its next meeting April 25.

5. Next TMT Meeting

TMT will meet in person on April 25, with preparations for the May 2 Spring Creek hatchery release and the May 1 start of transportation on the agenda.

Name	Affiliation
Scott Bettin	BPA
Sheri Sears	Colville Tribe
David Wills	USFWS
Cindy LeFleur	Washington
Doug Baus	COE
John Roache	BOR
XX	Thompson Reutters
XX	PPL
John Rector	PPS

Heather Dohan	Puget
Alex Cibarra	Grant PUD
Margaret Filardo	FPC
Ruth Burris	PGE
Bruce McKay	consultant
Russ George	WMC
Steve Hall	COE
Richelle Beck	Grant PUD
Barry Espenson	CBB
Kristi XX	Cargill
Rob Allerman	Deutsch Bank
Paul Wagner	NOAA
XX	Grant PUD
Tom Lorz	Umatilla/CRITFC
Mike Shapley	Snohomish PUD
Shane Scott	PPC
Josh McCall	Puget
Don Tinker	Seattle City Light
Harvey Hall	EWEB
Russell Langshaw	Grant PUD

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday April 25, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 3409

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review April 13, 18, Meeting Minutes
3. Juvenile Transportation - Paul Wagner, NOAA Fisheries
4. Spring Creek Hatchery Release - Doug Baus, COE-NWD
 - a. [BON Ops for Spring Creek Hatchery Release on May 3, 2012](#)
5. Operations Review
 - a. Reservoirs
 - b. Fish

- c. Water Quality
- d. Power System
- 6. Other
 - a. Set agenda and date for next meeting - **May 2, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

April 25, 2012 (Updated 5/18/12)

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Meeting Notes

TMT members said they needed more time to review the 4/13 and 4/18 Official Minutes and Facilitator's Summary, so these sets of notes will be finalized at the 5/2 meeting.

Juvenile Transportation

Paul Wagner, NOAA, reported that the BiOp prescribes start of transportation operations to begin no later than 5/1 at Lower Granite. He reminded the Corps that the barge has problems docking at Lower Granite at a certain level of high flows, and asked that collection only begin if the barge is able to safely dock and transport the fish.

Action: The Corps will keep this in mind as they plan for transportation operations. If a change to the current plan of beginning collection on 5/1 at Lower Granite, on 5/5 at Little Goose and on 5/8 at Lower Monumental is necessary, this change will be communicated with TMT via email and/or during next week's 5/2 TMT meeting.

Spring Creek Hatchery Release Update

Doug Baus and Lisa Wright, Corps, described the action agencies' proposed operating plan to support the next Spring Creek Hatchery release scheduled to begin on 5/3. The timing of the release was coordinated with USFWS to occur just after fish screen cleaning scheduled at Bonneville.

Lisa provided a flow chart that described the proposed operation relative to different flow conditions. This new proposed plan included a change from last week's operation and, she said, was intended to accommodate multiple needs including safe passage of juveniles, safe passage of adults, water quality management and making this an implementable operation. The proposal flow chart is linked to today's agenda.

USFWS' Dave Wills said he appreciated the option put forth by the Corps and would need to run this back through his agency. He said the USFWS still prefers to cap all units at 50% or less and this preference is based on the NOAA study from 2009 indicating that running PH2 units in the 50-100% of the 1 % operating range increases mortality. He added his frustration that this year, like the last few, has required the region to take a 'band aid approach' because a longer term solution has still not been resolved. He hoped to raise more awareness around the issue to prompt the region to move on finding a more permanent solution. The Corps' Dan Feil responded that regional Salmon Managers were part of the recent coordination process involving modifications at PH2 that were designed to improve juvenile survival through PH2. Unfortunately these modifications that were

coordinated with regional Salmon Managers did not yield the desired juvenile survival benefits. The Corps is continuing to work with regional Salmon Managers in other regional forums (FFDWG) in efforts to improve juvenile survival at PH2. Dan also said adult fallback is a real concern and the intent with the Corps' proposed operation was to find a balanced approach to support juvenile and adult passage.

TMT also had some discussion of TDG management. The Corps clarified that they are regulated to and have been exceeding 120% TDG due to high flow conditions. In a very simplified response to a question, the Corps' Laura Hamilton indicated implementing the USFWS request to cap PH2 at the mid-point would result in approximately a 2% increase in TDG. (She also said there are many factors that influence this including system flows, wind, and temperature.)

Tom Lorz, CRITFC/Umatilla, said that with regards to adult fallback, the real concern is with adult delays. Dave Statler, Nez Perce, asked the Corps to articulate how they view their operation as a balanced approach in terms of protecting both adults and juveniles.

TMT discussed the Corps option and explored additional options. Those that stayed on the table for consideration included the Corps options, modifications to the specific units at PH 1 and PH 2; modifying the option to cap all units at 50% at night; and revisiting the proposal put forth in last week's SOR (this was the USFWS stated preferred option).

Action/Next Steps: The salmon managers and action agencies said they needed more time to caucus on these various options and agreed to revisit the issue during a conference call on Friday, 4/27 at 10:00 am. Paul Wagner will provide a memo with the options being explored, and Doug Baus will provide additional justification language for the Corps' current proposed operation. All TMT members were asked to come prepared to move forward toward a solution rather than adding more options to the table on Friday.

Operations Review

Special Operations –Karl Kanbergs, Corps, reported that a barge hit the guide wall below John Day and was grounded yesterday. It was not carrying hazardous materials and the Coast Guard is currently assessing the situation. The project modified spill operations and is currently filling to accommodate the barge removal operation. The Corps planned to begin releasing water again today and noted that performance standard testing is scheduled to start on 4/26. It was unclear at this time if damage had been done to the guide wall.

Action: The Corps will provide an update to TMT during Friday's special conference call (Note: Karl Kanbergs sent an email update to TMT once the barge was unstuck about 1400 hours on 4/25. There was a small hole in the hull which was patched and no indicated guidewall damage. The John Day pool was drafted back down to its seasonal operation level and to provide flood control space by 0900 hours on 4/26).

Tony Norris, BPA, reported that a transmission system emergency occurred yesterday around 4:30 pm and lasted about 40 minutes. BPA re-dispatched generation from McNary to The Dalles and John Day and as a result, the Dalles went outside 1% for about

40 minutes. Line conditions were restored by 8:00 pm that evening. BPA has resolved the source of the problem and will report back to TMT if any additional information is available.

Action: Tony will share relevant information from the assessment with TMT as it is available.

Reservoirs – John Roache reported on Reclamation projects. Grand Coulee was at elevation 1227.4’ and as of yesterday, entered a transition phase between flood control and refill as a result of the ICF date being declared in the next few days. The project will not be drafted to the April 30 flood control elevation of 1220.2’. Hungry Horse was at elevation 3524.6’ with 10.8 kcfs outflows (1kcfs spill) and expected to be reduced to 9.8 kcfs (no spill) this evening. Flows are coming up on the main stem Flathead River so the project may need to be managed to local flood control, which is 14 feet/51 kcfs at Columbia Falls (currently at 41.5 kcfs). With 18 kcfs inflows, the project was filling. Lisa Wright reported on Corps projects. Libby was at elevation 2381.4’, with 23.2 kcfs inflows and 15.9 kcfs outflows – reduced for flood control. Albeni Falls was at elevation 2056.3 feet with 73.2 kcfs inflows and 54.1 kcfs outflows. Priest Rapids inflows were 219.1 kcfs. Dworshak was at elevation 1517.4’ with 35.6 kcfs inflows and 14.4 kcfs outflows. Inflows at Lower Granite were 144.2 kcfs; at McNary were 358.2 kcfs; and at Bonneville were 367.5 kcfs.

Fish – Paul Wagner, NOAA, reported on fish. Adult Spring Chinook counts at Bonneville were 500-1,000/day; at The Dalles were 691/day; and at John Day were 161/day. Juvenile counts were running higher than usual for this time of year. Yearling Chinook counts at Lower Granite were 100,000/day and 68,000/day at McNary. Many traps had been pulled due to high flows in the system and extra debris. Subyearling Chinook counts at Bonneville were 1,400 (Spring Creek hatchery) and steelhead numbers were running higher than usual at Lower Granite (117,000), Little Goose (78,000) and John Day (76,000). Sockeye counts were also high for this time of year, with about 1,000-3,500/day at McNary. Lamprey collection counts at John Day were 500-1,000/day and at Bonneville were less than 100/day.

Water quality – Laura Hamilton, Corps, reported that there has been a lot of involuntary spill throughout the system with accompanying TDG exceedances. This is expected to continue for a while. She also reported on temperature conditions.

Power system – Nothing more to report.

Special Meeting, 4/27: 10:00 am at the Corps

Agenda items include:

- Spring Creek Hatchery Release
- Update on John Day barge

Regularly Scheduled Meeting, 5/2: 9:00 am at the Corps

Agenda items include:

- Spring Creek Hatchery Release
- Transportation Operations
- Vernita Bar Update
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

April 25, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of the Nez Perce Tribe, Montana, BOR, BPA, Oregon, USFWS, NOAA, COE, Idaho, Colville Tribe, Washington and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review April 13 and 18 Meeting Minutes

Review of official minutes and facilitator's notes for these meetings was postponed until the next regular TMT meeting May 2.

3. Juvenile Transportation Update

Paul Wagner, NOAA, gave an update on transportation plans for this year. The BiOp and the FOP both say transportation will be initiated at Lower Granite Dam no later than May 1, but that is a planning date, not a deadline, if the initiation of transportation is not appropriate based on real time conditions. For example, at flows of greater than approximately 180 kcfs there are operational challenges associated with operating (eg. traversing the tailrace, docking, and loading) the transportation barge. If high flows limit the ability to load collected fish then NOAA recommends postponing collection until flows allow for the transportation operation.

The plan, absent these conditions, is to begin collection on May 1 at Lower Granite, on May 5 at Little Goose, and May 8 at Lower Monumental. If forecasted conditions require a change in plans, the COE will inform TMT via email. TMT will revisit the juvenile transport operation at its next meeting May 2.

4. Spring Creek Hatchery Release

The first scheduled Spring Creek Hatchery release of 2012 passed Bonneville Dam in April with operational adjustments coordinated during TMT meetings, Baus reported. On May 3, USFWS will release another 4 million juvenile tule fall chinook salmon from the Spring Creek Hatchery. Lisa Wright reported that the COE has coordinated the second release to coincide with cleaning of the fish screens at Powerhouse 2 (PH2). Juvenile passage is known to improve when screens are free of debris.

Based on feedback received after the first Spring Creek release, the COE will implement a special operation at Bonneville Dam to aid passage for the second release while minimizing adverse impacts to adults and to water quality. Wright shared a flow chart with TMT depicting the proposed operation. In response to requests from TMT members for a written format, she later posted a written summary of the operation which is linked to today's agenda.

Steps the COE will take to manage flows at Bonneville are:

1. Operate all seven Powerhouse 2 (PH2) units to 25% of 1% best efficiency operating range.
2. To pass additional flow, operate all ten Powerhouse 1 (PH1) unit to 100% of 1% best efficiency operating range.
3. To pass additional flow, increase operation of PH2 one unit at a time to 25-50% of 1% best efficiency.
4. To pass additional flow, increase operation of PH1 one unit at a time in the order of priority up to best geometry.
5. To pass additional flow, increase operation of PH2 one unit at a time and no more than four units, up to 100% of the 1% range. As a hard constraint, do not exceed 50% of the 1% range at three of the PH2 units. The goal of the operation is to be generation neutral. Additional generation gained at PH1 resulting from operating at best geometry would be offset to the best extent practicable with equivalent generation limitations at PH2.
6. To pass additional flow above powerhouse capacity, spill involuntarily above the TDG spill cap rate.

Capping all seven PH2 units at the midpoint of the 1% range, as requested today by USFWS, would result in approximately 28 kcfs (4 kcfs per unit) of additional spill.

Step 5 caps three of the PH2 units at 50% of 1% peak efficiency while increasing generation at an equivalent rate up to but not to exceed best geometry at PH1.

The Action Agencies believe this operation effectively balances the passage needs of 4 million smolts with those of significant numbers of adults that were not present two weeks ago. The operation also needs to be consistent with water quality requirements. Step 5 is where this operation differs from the operation to accommodate the April release, which was overly complex and difficult for dam operators to implement.

Wagner asked which of the PH2 units would be capped at 50% of 1% best efficiency. Rick Kruger, Oregon, said the units closer to the corner collector should not run at 100% of 1% efficiency because that's where most of the juveniles will be concentrated. David Wills, USFWS, asked why the project shouldn't spill to a 125%TDG gas cap in the absence of management criteria for

Camas Washougal gage; USFWS would prefer to cap all seven PH2 units at 50% of 1% efficiency or less. Wills reminded everyone that the ideal operation is 25% of 1% efficiency as shown by a NOAA study in 2009. Because operating above that limit is known to kill fish, he urged the COE to find a long-term solution to this problem soon.

The FOP says the COE is to manage spill at this time using the Camas Washougal gage, Dan Feil, COE, replied. Bonneville is currently spilling 150 kcfs, and studies have shown that adult fallback increases when spill exceeds 110 kcfs. Capping all PH2 units at the mid-point does not appear to be a prudent operation. Spill levels in excess of 150 kcfs are currently a concern and the addition of approximately an additional 30 kcfs would have additional adverse impacts on adults (eg delay and fallback). The TDG waivers for Bonneville specify limits of 120% TDG in the tailrace and 115% TDG downstream at Camas Washougal gage, Laura Hamilton, COE, added. Feil said the COE has working with the region for years to improve Bonneville PH2 fish guidance efficiency via the Fish Facilities Design Review Work Group.

Tom Lorz, CRITFC/Umatilla, suggested there could be more flexibility at night to accommodate juveniles because adults don't pass at night. Wills asked what the difference between 12 kcfs and 30 kcfs would be in terms of additional TDG saturation. Hamilton said approximately 10 kcfs of added spill generally equates to a 2% increase in TDG saturation, but high spill can alter that ratio to a 2% increase in TDG saturation per 15 kcfs of added spill.

Russ Kiefer, Idaho, asked whether there is a rationale for capping all seven of the PH2 units at 75% of 1% efficiency instead of capping three at 50% and four at 100% of 1% efficiency. There aren't any survival data on the 75% range, and it is a difficult operation to implement, Wright and Baus replied.

NOAA has found that mortality dramatically increases when turbines exceed 50% of 1% best efficiency, so 75% of 1% would not be a good operation for juvenile passage, Wagner said. The Action Agency proposal is a reasonable one because it attempts to provide juvenile benefits without adversely impacting adults.

Five options emerged from today's brainstorming:

1. The COE proposal as described above.
2. Cap all PH2 units at 50% of 1% efficiency around the clock, which would put an additional 28 kcfs through the Bonneville spillway. Operate PH1 at the 1% operating range (the USFWS proposal).
3. Operate PH1 at full capacity (with or without open geometry), cap the PH2 units at 50% of 1% efficiency and spill the rest.
4. Cap all PH2 units at 75% of 1% efficiency, with PH1 operating at open geometry.

5. Continue the current operation, with spill as needed at night to accommodate juvenile passage through the PH2 turbines.

In response to these ideas, Baus and Wagner will work together on a counter-proposal to the Action Agency proposal. TMT members requested a written description of that proposal, which the COE will post to today's TMT agenda. TMT scheduled a conference call on April 27 to reconsider the Spring Creek Hatchery operation.

5. Operations Review

a. Reservoirs. Karl Kanbergs, COE, reported that peak flows on the Columbia River have created an issue below John Day Dam. A runaway barge got stuck on a gravel bar. Although the cargo is not hazardous, the barge remains stuck, which resulted in curtailment of all spill at John Day last night. Spill at John Day has stabilized at around 86 kcfs plus full turbine operations, so outflows are around 300 kcfs. Nevertheless, John Day pool is filling, and water will need to be released from John Day later today and tonight for flood control. The release is expected to increase Bonneville outflows, now around 350 kcfs, to more than 400 kcfs.

Grand Coulee is at elevation 1227.4 feet and is no longer drafting. Until yesterday, it was drafting to an April 30 flood control elevation of 1220.2 feet, but is currently in a transition phase between drafting for flood control and managing refill as the ICF date is about to be declared.

Hungry Horse is at elevation 3524.6 feet, with outflows of 10.8 kcfs, including 1 kcfs of spill with full turbine capacity. Releases will be reduced to 9.8 kcfs today and may need to be reduced further to provide local flood control on the Flathead River at Columbia Falls. Flood stage at Columbia Falls is 14 feet, which is equivalent to approximately 51 kcfs. With flows at 41.5 kcfs now, there's a good chance the BOR will need to reduce discharges at Hungry Horse for flood control.

Libby is at elevation 2381.4 feet, with inflows of 23.2 kcfs and releases of 15.9 kcfs. Albeni Falls is at elevation 2356.3 feet, with inflows of 73.2 kcfs and releases of 54.1 kcfs. Dworshak is at elevation 1517.4 feet with inflows of 17.6 kcfs and releases of 14.4 kcfs.

Priest Rapids inflows are 219.1 kcfs. Lower Granite inflows are 144.2 kcfs. McNary inflows are 358.2 kcfs, and Bonneville inflows are 367.5 kcfs.

b. Fish. Adults: The spring run has just begun in earnest, Wagner reported. Spring chinook have been arriving at Bonneville at the rate of 4,000-5,000 per day for the past few days. Adults are gradually moving upstream, with

200-700 per day passing The Dalles and John Day dams. McNary is passing less than 100 fish per day.

Juveniles: Lower Granite is passing more than 100,000 fish per day, with a passage index of 155,000 yesterday. Sampling at the Snake River traps has been suspended to avoid harm caused by debris at high flows. Sampling at Little Goose occurs every fourth day, with the latest index count being 64,000 fish. Subyearling chinook peaked at 1 million passing Bonneville on April 14 and went down to 1400 on April 24.

Steelhead index counts for Lower Granite are 17,000 per day, which is high for this time of year. Steelhead index counts are 78,000 per day at Little Goose and 76,000 per day at John Day, also high. Sockeye numbers are surprisingly high – 1,000 passing McNary on April 23. Lamprey passage counts at John Day have been in the range of a few hundred thousand per day for the past few weeks. However, lamprey passage at Bonneville is down to around 100 per day. In general, migration is early this year.

c. Water Quality. There has been a lot of involuntary spill throughout the system, Laura Hamilton, COE, reported. Several sites on the Columbia and Snake rivers have been spilling involuntarily since March 14. All gages are operating and involuntary spill is expected to continue. It is unusual to have this much spill in April. Involuntary spill is more likely in mid-May and June.

d. Power System. Tony Norris, BPA, reported that in the early evening of April 24, a transmission system emergency resulting from problems on BPA transmission lines from McNary to John Day and from McNary to The Dalles caused the Dalles Dam to operate outside of 1% efficiency for about 37 minutes. Normal conditions were restored by 8 pm. BPA is investigating the impacts, if any, to other fish protection measures. Norris will report back to TMT if more information is available.

6. Next TMT Meeting

There will be a TMT conference call on Friday, April 27, to continue the discussion of Spring Creek hatchery operations. The next regular TMT meeting will be on May 2.

Name	Affiliation
Dave Statler	Nez Perce
Jim Litchfield	Montana
John Roache	BOR
Tony Norris	BPA
Rick Kruger	Oregon
Dave Wills	USFWS
Paul Wagner	NOAA

Doug Baus	COE
Dan Feil	COE
Karl Kanbergs	COE

Phone:

Russ Kiefer	Idaho
Havey Hall	EWEB
Laura Hamilton	COE
Sheri Sears	Colville
Cindy LeFleur	Washington
Margaret Filardo	FPC
Shane Scott	PPC
Russ George	WMC
Ruth Burris	PGE
Barry Espenson	CBB
Richelle Beck	Grant PUD
Rob Allerman	Deutsch Bank
Bill Rudolph	NW Fish Letter

Bonneville Operations for Spring Creek Hatchery Release on May 3
Effective beginning at 0001 hours Friday, May 4, 2012 for up to 5 days depending on real-time
observations of passage numbers at the Smolt Monitoring Facility.

The USFWS will release approximately 4 million juvenile tule fall Chinook salmon from the Spring Creek National Fish Hatchery on the morning of Thursday, May 3, 2012. Based on observations from previous hatchery releases, the fish are anticipated to start arriving at Bonneville Dam approximately 15 hours later. The USFWS and Corps have coordinated the hatchery release date to coincide with screen cleaning at Bonneville Dam's powerhouse 2 (PH2) to minimize any chance of fish being negatively impacted by debris at the project. Current flow forecasts at BON on May 3 are in the range of ~355 kcfs. Updated forecast information is available at:

<http://www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?id=BONO3>.

To accommodate the Spring Creek Hatchery release, the Corps will implement a special operation at Bonneville Dam to maximize safe and effective passage conditions for the hatchery smolts while minimizing any adverse impacts to upstream migrating adults or downstream water quality. Operating PH2 units at or below the mid-point (50%) of the 1% best efficiency operating range results in safer passage conditions for juveniles through PH2, and the Corps operates to this constraint throughout the fish passage season unless flows increase to a level that require spill rates in excess of the TDG spill cap (i.e., the Corps would operate all available units at both powerhouses utilizing the full operating range within 1% of peak efficiency before involuntarily spilling above the TDG spill cap, in accordance with the [2012 Fish Operations Plan](#); also see [FPP pg. BON-34](#)). Operating all 7 available PH2 units at the mid-point of the 1% range results in approximately 28 kcfs (~4 kcfs per unit) of additional spill.

Table BON-1. Example of flow capacity (kcfs) per Powerhouse 2 turbine unit within the 1% of peak efficiency operating range at the Lower Limit, 25%, 50%, 75% and Upper Limit (with STS installed at head = 50ft). All kcfs values are approximations and rounded to the nearest whole number for illustrative purposes. Actual kcfs values at each level will vary with project head and other real-time operating conditions.

0% - Lower Limit (Kcfs/unit)	25% (Kcfs/unit)	50% - Mid-point (Kcfs/unit)	75% (Kcfs/unit)	100% - Upper Limit (Kcfs/unit)
11 -8 from 100%	13 -6 from 100%	15 -4 from 100%	17 -2 from 100%	19

Based on feedback from NOAA Fisheries and other salmon managers, spill in excess of 110-120 kcfs may have adverse impacts on upstream migrating adults by increasing delay and potentially increasing incidents of fallback. Therefore, in order to best accommodate the Spring Creek Hatchery release during a time that the project is already involuntarily spilling due to high flows, the Corps proposes to operate PH2 units at a reduced rate to the extent possible by increasing operation of PH1 units to best geometry (above the upper limit of 1%). Operating all 10 units at PH1 to best geometry would allow an additional 12 kcfs to pass through PH1, thereby reducing flow through PH2 units by 12 kcfs. The reduction of 12 kcfs at PH2 would effectively cap three PH2 units at the mid-point (50%) of the 1% operating range. This operation would reduce PH2 unit operation for the benefit of juvenile passage without increasing the level of involuntary spill that may have adverse impacts on adults and downstream water quality.

Therefore, the Corps proposes the following operation with the intent of maximizing benefits and minimizing adverse impacts to juveniles, adults and water quality during a time of high flows and involuntary spill. The following steps 1-6 will be implemented sequentially to pass increasing flows:

1. Operate PH2 all seven available units up to 25% of the 1% peak efficiency range.
2. To pass additional flow, operate PH1 all ten units up to 100% of the 1% range.
3. To pass additional flow, increase operation of PH2 one unit at a time in the order of priority within 25-50% of the 1% range.

Bonneville Operations for Spring Creek Hatchery Release on May 3
Effective beginning at 0001 hours Friday, May 4, 2012 for up to 5 days depending on real-time
observations of passage numbers at the Smolt Monitoring Facility.

4. To pass additional flow, increase operation of PH1 one unit at a time in the order of priority up to best geometry.
5. To pass additional flow, increase operation of PH2 one unit at a time in the order of priority ***at no more than a total of four units*** up to 100% of the 1% range. ***As a hard constraint, do not exceed 50% of the 1% range at three PH2 units.***
6. To pass additional flow above the powerhouse capacity^a as defined above in steps 1-5, spill involuntarily above the TDG spill cap rate.

a) Total powerhouse capacity (PH1 + PH2) for this special operation will not change from powerhouse capacity under normal operating conditions as defined in the Fish Passage Plan and Fish Operations Plan. Any increase in PH1 operation by going above the 1% range will be equivalent to a reduction in PH2 operation below the 1% range.

SPRING CREEK OPERATION: Approximate total powerhouse capacity before spilling above TDG cap =

112 kcfs through PH1 with 10 units operating at best geometry
+76 kcfs through PH2 with 4 units operating at 100% of 1% range
+45 kcfs through PH2 with 3 units operating at 50% of 1% range
= **233 kcfs** (does not include misc. flow of ~12kcfs through B2CC, ITS, etc)

FPP-DEFINED OPERATION: Approximate total powerhouse capacity before spilling above TDG cap =

100 kcfs through PH1 with 10 units operating at 100% of 1% range
+133 kcfs through PH2 with 7 units operating at 100% of 1% range
= **233 kcfs** (does not include misc. flow of ~12kcfs through B2CC, ITS, etc)

IDAHO COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT
COLLEGE OF NATURAL RESOURCES
UNIVERSITY OF IDAHO
P.O. BOX 441141
MOSCOW, ID 83844-1141
(208) 885-2750
Fax (208 885-9080)

10 January 2005

To: David Clugston

From: Chris Peery, University of Idaho

Subject: Bonneville spill and salmon behavior

Date: 27 October 2005

Effects of spill at dams on adult salmon migration and passage has been an ongoing focus of research in the Columbia hydrosystem. Radiotelemetry has been used to determine time for fish to pass Bonneville Dam, and the numbers of fish that fallback at this facility, under different spill levels. Telemetry has also been used to determine where fish will first approach fishways at Bonneville Dam with high and low spill. Results indicated that adult salmon passage can be delayed and that fish will avoid the spillway fishway entrances during periods with high spill (> 100 kcfs). We suspected that fish would be attracted to the spillway tailrace channel during spill periods, but that turbulence associated with high spill would discourage some fish from reaching the fishway entrances. In 2003 and 2004, University of Idaho and NOAA Fisheries used an underwater array of antennas to help monitor more closely the behavior of radio-tagged adult Chinook salmon and steelhead in the area of the Columbia River immediately downstream from Bonneville Dam spillway. During 2003, paired treatments of high (140 kcfs) and low (76 kcfs) spill were used to evaluate fish behavior. During 2004, a constant daytime spill level (68 kcfs) was used. Fish with radio tags were released 8 km downstream from Bonneville Dam and monitored to determine the proportion of fish that entered the spillway channel that subsequently continued on to reach the spillway fish entrances. In 2003 the spillway antenna array appeared to function as designed. In 2004, half of the array was lost, limiting the information available to assess behavior.

In 2003, 835 Chinook salmon were released downstream from the dam, of which 493 were released during the low spill treatment and 342 were released during high spill. Of those fish, 117 (23%) and 104 (30%), respectively, were detected in the spillway channel prior to making a first approach at the dam, and 85 (73%) and 56 (54%) went on to make an approach at the spillway entrances. During 2004, the comparable number was 86% of fish that first moved into the spillway channel eventually moved on to make their first approach at a spillway fishway entrance during low spill levels. We concluded that fish are attracted into the spillway channel during periods of spill, but relatively fewer fish proceed close enough to the dam to be detected near fishway entrances during periods of high spill. This behavior could partially explain the significantly longer passage times seen for fish during high spill periods.

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday April 27, 2012 10:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 8710

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnmw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Spring Creek Hatchery Release - Doug Baus, COE-NWD
 - a. [BON Spill and Adult Fish Behavior](#)
 - b. [Fallback Summary](#)
3. John Day Barge Grounding Update - Doug Baus, COE-NWD
4. Set agenda and date for next meeting - **May 2, 2012**
5. [\[Calendar 2012\]](#)

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

April 27, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Spring Creek Hatchery Release/Bonneville Operations

During the 4/25 TMT meeting, TMT members discussed a proposal from the Corps for Bonneville operations to support the upcoming Spring Creek Hatchery release, that they felt would strike a balance to meet multiple interests and management requirements at the project given current river conditions. At that time, additional options surfaced and were discussed. TMT members agreed to revisit this issue today after they had time to meet with their caucuses to discuss the options. The goal for today was to move to an acceptable solution for operating Bonneville during next week's Spring Creek Hatchery release. Paul Wagner, NOAA, had agreed to draft up the options and Doug Baus, Corps, had agreed to add supplemental information as justification for the Corps' proposed operation.

Today, Paul outlined an option that he said was the salmon managers' preferred alternative and one that considered real time conditions, e.g. flow through the turbines at the present time. He described that there was a high tailwater and lower forebay at Bonneville, and that the objective was to hold Powerhouse 2 at a mid-range of 1% to minimize turbulence through that passageway. The specifics of the salmon managers' proposed operation were:

- o Operate Powerhouse 1 at open geometry.
- o Limit Powerhouse 2 units to 14 kcfs discharge, which from the salmon managers' estimate would maintain a flow neutral operation.
- o Hold the forebay no higher than 73 feet as a soft constraint.

In addition, he proposed that the hatchery release and accompanying operation be implemented on Monday, 4/30 instead of the previously scheduled 5/3 in order to coincide with current system conditions (high flows).

Doug Baus responded that the Corps would be willing to implement this operation so long as it remained a flow neutral operation. This, he said, would support the Corps' policy decision not to willingly exacerbate already high TDG conditions downstream of the project as well as not providing additional spill when there were concerns with adult delays downstream of Bonneville due to high flows.. After some discussion, the question was asked: 'What is the likelihood of achieving the salmon manager proposal given the current flows and need to have a flow neutral operation? The Corps' Bill Proctor responded that the probability was high assuming there is no unit failure at Powerhouse 1.

With that, TMT members were polled on their level of support for moving forward with the implementation of the Salmon Managers' proposed operation, targeting 14 kcfs at Powerhouse 2

so long as it remains a flow neutral operation and given the Corps' stated expectation that the likelihood of being able to implement the operation was high:

- o Idaho – Supports the operation
- o Washington – Supports the operation
- o Oregon – Supports the SOR put forth last week; has concerns for operating Powerhouse 1 at open geometry, but does not object to today's proposed operation
- o Montana – Not present for today's call (contacted April 27 via phone after the TMT meeting and does not object to the operation)
- o Nez Perce – Supports the implementation of the salmon managers' alternative put forward today, given in-river conditions.
- o CTUIR – Supports this operation; does not object to the Corps' need to implement this as a soft constraint, and, will look for modifications in the future that will allow the project not to operate outside 1%.
- o Colville – Supports the operation – wants to see further studies and a permanent solution.
- o NOAA – Supports the operation
- o USFWS – Would be more comfortable if there was regional consensus to maintain flows at the midpoint of 1% at Powerhouse 2, but does not object to today's proposal for this year only, and with the caveat that if the operation goes outside 1% in the future, a study needs to be in place to gather empirical evidence as to the impacts on fish. (Later added that keeping the flows down at Powerhouse 2 would provide an added benefit to adult steelhead, if the operation allows the fish screens to stay in place).
- o BPA – Supports the operation
- o Reclamation – Supports the operation
- o Corps – Supports the operation and will plan to implement beginning Monday, 4/30.

Action/Operation: The Corps will implement the proposed operation as described by the salmon managers today and will manage the operation to remain flow neutral. The operation will be implemented starting Monday, 4/30 and will coincide with the release and passage of Spring Creek Hatchery fish – no longer than a four-day period. Dave Wills, USFWS, said releasing the fish at that time instead of 5/3 would not pose a problem from the hatchery's perspective.

Next Meeting, 5/2 Face to Face:

Agenda items include:

- o Spring Creek Hatchery Release Update
- o Transportation Operations
- o Update on BPA Transmission Outage
- o Operations Review

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

April 27, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired by Doug Baus, COE, and facilitated by Robin Gumpert (DS Consulting). Representatives of the Nez Perce Tribe, BOR, NOAA, USFWS, BPA, COE, Umatilla/CRITFC, Idaho, Washington and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Spring Creek Hatchery Release

The purpose of this call was to conclude the April 25 TMT discussion regarding operation of Bonneville Dam for the May 3 Spring Creek Hatchery release. Brainstorming elicited four options in response to the Action Agency proposal. When the April 25 meeting adjourned, the Salmon Managers planned to caucus and present an alternative proposal to the Action Agency proposal today.

Paul Wagner, NOAA, presented the Salmon Managers' preferred operation, which takes into account real-time conditions at the project. Currently the head (difference between forebay and tailrace elevations) is only 40 feet; typical head at Bonneville is closer to 60 feet. This condition reduces pressure through the turbines, which is favorable for juvenile passage. Operating PH2 in the mid-range of 1% efficiency would produce about 14 kcfs of flow through the turbines under present conditions. The low head is pushing only 15 kcfs through PH2 turbines, which leaves 1 kcfs in needed flow reductions at PH1. Therefore the Salmon Managers are asking the Action Agencies to:

1. Operate Powerhouse 1 (PH1) at open geometry.
2. Limit Powerhouse 2 (PH2) units to 14 kcfs discharge. This would not add to spill, which is currently about 200 kcfs at Bonneville. Generation limitations at PH2 will be offset with an equivalent rate of additional generation at PH1 resulting from operating at best geometry.
3. Maintain a soft constraint of 73 feet elevation (or lower) in the forebay.
4. Consider releasing fish on Monday, April 30, to take advantage of these favorable conditions.

Baus replied that elements 1 and 3 of this operation are viable and the Action Agencies would make best efforts to implement element 2. The goal of the operation is to remain generation neutral to the extent practicable. Any PH2 limitations would be offset with operating PH1 to best geometry. However the Action Agencies would not support any hard constraint on PH2 unit operations that would result a spill rate that would exceed a flow rate that could be passed operating PH1 at open geometry. This would have adverse impacts on adult delay/fallback and TDG. Given that flows are

projected to be in the 400 kcfs range when the Spring Creek operation is implemented, the Action Agencies will commit to shifting approximately 12 kcfs from PH2 to PH1 by operating PH1 to best geometry.

Wagner asked, what is the likelihood that real-time conditions at the project will allow the Action Agencies to implement the Salmon Managers' proposal? Probably higher than 90% as long as there are no unit outages, replied Bill Proctor, COE. Russ Kiefer, Idaho, asked whether the amount of water to be shifted from PH2 to PH1 will be calculated based on actual conditions (low head) or typical conditions (which pass 18 kcfs through a PH2 unit operating to the 1% efficiency range). It will be based on actual conditions, Scott Bettin, BPA, replied. Changing the release date to April 30 would be acceptable if BPA is notified in advance.

Hatchery operators could shift to an April 30 release if it means a better likelihood of favorable passage conditions, Wills said. A study of the impacts of open geometry on fish passage is imperative to inform future decisions regarding PH1 operations above the 1% limit.

TMT members gave their views of the Action Agency proposal:

- **Idaho** – Supports the operation.
- **BPA** – Supports the operation.
- **Washington** – Supports the operation, including the suggestion to start releasing fish on April 30.
- **USFWS** – Advocates capping PH2 units at 50% of 1% best efficiency, but does not object to the proposed operation. Suggests the operation be implemented for four days, beginning when fish arrive at the project.
- **Oregon** – Advocates the SOR as the best option, but doesn't object to the proposed operation. Has concerns about the best-geometry operation.
- **Nez Perce** – Supports the operation.
- **Umatilla** – Prefers the Salmon Managers' proposal but does not object to this operation.
- **Colville** – Supports the operation, including a release date of April 30.
- **NOAA** – Supports the operation.
- **BPA** – Supports the operation.
- **BOR** – Supports the operation.

3. John Day Barge Grounding Update

The COE has sent TMT an email that the grounded barge below John Day was patched and removed.

4. Next TMT Meeting

TMT will meet next in person on May 2, with updates on Spring Creek Hatchery operations and the recent BPA transmission incident on the agenda.

<i>Name</i>	<i>Affiliation</i>
Doug Baus	COE
Lisa Wright	COE
Scott Bettin	BPA
Tom Lorz	CRITFC Umatilla
Paul Wagner	NOAA
Rick Kruger	Oregon
Margaret Filardo	FPC
Dave Benner	FPC
Russ Kiefer	Idaho
Scott English	COE
Bill Proctor	COE
Dan Feil	COE
Dave Wills	USFWS
Sheri Sears	Colville Tribe
Charles Morrill	Washington
Dave Statler	Nez Perce

IDAHO COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

**FALLBACK, REASCENSION AND ADJUSTED FISHWAY ESCAPEMENT
ESTIMATES FOR ADULT CHINOOK SALMON AND STEELHEAD AT
COLUMBIA AND SNAKE RIVER DAMS, 1996-2003.**

by

C. T. Boggs, M. L. Keefer and C. A. Peery
Idaho Cooperative Fish and Wildlife Research Unit
Biological Resources Division, U.S. Geological Survey
University of Idaho, Moscow, Idaho 83844-1144

And

L. C. Stuehrenberg and B. J. Burke
Northwest Fisheries Science Center
NOAA-Fisheries
Seattle, WA

for

U.S. Army Corps of Engineers
Portland and Walla Walla Districts
Portland, Oregon and Walla Walla, Washington

Preface

Studies of adult salmon and steelhead *Oncorhynchus* spp. migrations past dams, through reservoirs, and into tributaries began in 1990 with planning, purchase, and installation of radio telemetry equipment for studies at the Snake River dams. Adult spring–summer Chinook salmon (*O. tshawytscha*) and steelhead (*O. mykiss*) were outfitted with transmitters at Ice Harbor Dam in 1991 and 1992, and at John Day Dam in 1993; reports of those studies are available (Bjornn et al. 1992; 1994; 1995; 1998). The focus of adult salmonid passage studies shifted to include the lower Columbia River dams and tributaries starting in 1996. From 1996 to 2003 we radio-tagged various combinations of spring–summer Chinook salmon, fall Chinook salmon, steelhead and sockeye salmon at Bonneville Dam and monitored them as they migrated upstream. In this report we present summary information on adult salmonid fallback percentages and rates, dam reascension rates, incidence of “overshoot” fallback, and adjusted fishway escapement estimates for the eight dams on the lower Columbia and lower Snake rivers from 1996 to 2003. We also summarize and discuss fallback by known-source (PIT-tagged as juveniles) adult salmonids at these dams from 2000 to 2003.

This and related reports from this research project can be downloaded from the website: <http://www.cnr.uidaho.edu/uiferl/>

Acknowledgements

Many people provided time and assistance during the course of this study. We are especially indebted to T. Bjornn and who initially led the research. R. Ringe, M. Jepson, K. Tolotti, S. Lee, D. Queampts, T. Reischel, G. Naughton, W. Daigle, M. Heinrich, M. Morasch, T. Dick, D. Joosten, C. Nauman, C. Williams, A. Pinson, T. Goniea, B. High, E. Johnson, M. Feeley, P. Keniry and B. Hastings helped with field operations and collection and processing of telemetry data at the University of Idaho. A. Matter, M. Moser, S. McCarthy, and T. Bohn (NOAA Fisheries), helped with data management. We also thank personnel at the Grant, Chelan, and Douglas County Public Utility Districts for cooperation with telemetry data and researchers from throughout the basin who allowed use of fish they had PIT-tagged as juveniles. The U.S. Army Corps of Engineers provided funding for this study; we thank D. Clugston, M. Shutters, B. Dach, M. Langeslay, and T. Mackey, for their assistance.

Table of Contents

Preface.....	i
Acknowledgments.....	i
Abstract.....	iii
Introduction.....	1
Methods.....	2
Study Area and Fish Tagging	2
Telemetry Monitoring.....	5
Data Analysis	6
Results.....	8
Fallback and Reascension.....	8
“Overshoot” Fallbacks.....	13
Fallback by Known-Source Spring and Summer Salmon	15
Last Known Locations of Fallback Fish	17
Fishway Escapement Adjustments	20
Influence of River Flow and Dam Spill on Fallback	21
Fallback Routes at Bonneville Dam	24
Fishway Specific Fallback at Bonneville Dam.....	26
Discussion.....	27
References.....	33

Abstract

During their upstream spawning migration in the Columbia River basin, some adult salmon and steelhead *Oncorhynchus* spp. ascend and then fall back over mainstem hydroelectric dams. Fallback can result in fish injury or death, migration delays and biased fishway counts, the primary index for escapement and the basis for production estimates and harvest quotas. We used radio-telemetry to calculate fallback percentages and rates, reascension rates, biases in fishway escapement estimates due to fallback, and occurrence of behaviorally motivated fallback by fish that passed dams upstream from natal spawning sites. We also evaluated fallback by adult fish that had been PIT tagged as juveniles (known source). The study area included the four Lower Columbia and the four Lower Snake River dams from 1996 to 2003. Research fish were adult spring–summer and fall Chinook salmon *O. tshawytscha* and steelhead *O. mykiss* collected at Bonneville Dam, the first dam Columbia River stocks encounter after leaving the ocean.

With all years combined, about 19% of spring–summer Chinook salmon, 13% of fall Chinook salmon and 24% of steelhead fell back at least once at a dam. Fallback percentages for spring–summer Chinook salmon were generally highest at Bonneville and The Dalles dams and decreased at progressively upstream dams. Fallback rates for spring–summer Chinook salmon were positively correlated with river discharge. Fallback percentages for steelhead and fall Chinook salmon were less variable between years but more variable between dams than for spring–summer Chinook salmon. Reascension percentages at dams ranged widely between runs and sites and were negatively related to the number of fish that entered tributaries downstream from the fallback location (overshoot fallback). Fall Chinook salmon were the most likely to overshoot fallback, though this behavior was also observed with spring–summer Chinook salmon and steelhead. In all years and at all dams, fallback produced positive biases in fishway counts, ranging from 1-16% for spring–summer Chinook salmon, 1-38% for fall Chinook salmon and 1-12% for steelhead.

Analysis of fallback by known-source (PIT tagged as juveniles) spring–summer Chinook salmon and steelhead indicated that fish transported by barge as juveniles from Snake River dams fell back in significantly higher percentages than Chinook salmon and steelhead returning to the Wind River, the Yakima River, Mid Columbia tributaries and non-transported Chinook salmon returning to the Snake River drainage. Known-source steelhead exhibited a similar pattern with transported Snake River fish falling back in significantly higher percentages than steelhead returning to Mid Columbia tributaries or hatcheries or non-transported Snake River fish.

About 79% of spring–summer Chinook that fell back at Columbia and Snake River dams were later detected in spawning tributaries or recaptured at hatcheries and 20% were unaccounted for in the hydrosystem. Fall Chinook and steelhead that fell back escaped to tributaries and hatcheries at lower rates than spring–summer Chinook (65% and 57%, respectively) with 9% of fall Chinook and 12% of steelhead being unaccounted for in the hydrosystem.

Introduction

The study described herein was undertaken because of concerns of the U.S. Army Corps of Engineers (USACE), state and federal fish agencies and tribes, those expressed in section 603 of the Northwest Power Planning Council (NPPC) 1987 Columbia River Basin Fish and Wildlife Program, and later reflected in the Biological Opinions issued in 1995, 1998, and 2000 for operation of the Federal Columbia River Power System. These agencies and opinions recommended studies to ensure that adult salmon and steelhead passage past dams and through reservoirs was as efficient as possible. Results presented here specifically relate to questions of fallback, reascension and associated bias in fishway escapement estimates as outlined in the 2000 Biological Opinion, Action 107 (National Marine Fisheries Service [NMFS] 2000). Study plans were developed in consultation with USACE personnel, and with biologists in other federal, state, and tribal agencies. Research was conducted by the Idaho Cooperative Fish and Wildlife Research Unit (ICFWRU) and National Marine Fisheries Service (NMFS – NOAA Fisheries). Logistical support, cooperation, and funding came from USACE, Bonneville Power Administration (BPA), and the U.S. Geological Survey.

Adult salmon and steelhead migrating upriver and exiting the fishways of Columbia and Snake river dams will occasionally pass back downstream over the dam via spillways, turbine intakes, navigation locks, debris sluiceways, or juvenile fish collection devices—an event referred to as fallback. Migrating anadromous fish are both positively rheotactic and shoreline oriented during migration (Groot and Margolis 1991). When exiting fishways and confronting the impounded water of a dam forebay, migrants may be attracted to water passing through spillways, sluiceways and turbine intakes or orient with the upstream face of the dam and enter these areas. Additionally, salmon or steelhead that migrate upstream beyond their natal stream or hatchery and pass an upstream dam may fall back in an effort to return; this temporary straying or “overshoot” behavior has been described for many salmonids (Ricker 1972).

Fallback has been documented at all Columbia and Snake River hydrosystem dams and attempts have been made to quantify its effects on upriver migrants (reviewed in Bjornn and Peery 1992). While not all fish that fall back die or are injured, death and injury do occur (Wagner and Hilsen 1992) and salmon and steelhead that fall back at dams are less likely to reach spawning tributaries and hatcheries than those that do not fall back (Boggs et al. 2004a; Keefer et al. 2004c). Fallback has been associated with migration delays through the Columbia hydrosystem (e.g. Monan and Liscom 1975, 1979), and significant delays of several days to several weeks were recorded for radio-tagged Chinook salmon and steelhead that fell back in this study (Keefer et al. 2004a).

Fish that fall back and subsequently reascend at dams can pass counting stations more than once, which leads to a positive bias in fish counts and escapement calculations. Counts at dams are also used to estimate run size and to calculate inter-dam conversion rates (dam-to-dam reach survival) (Dauble and Mueller 2000), as well as to evaluate the effects of changes in dam operations such as spill patterns and turbine discharges. Biases in counts at Columbia and Snake River dams can exceed 10% of the total fish run

(Bjornn et al. 2000a; Boggs et al. 2004a) and have important management implications. For instance, several evolutionarily significant steelhead and Chinook salmon populations in the Columbia and Snake rivers are listed as threatened or endangered species (Busby et al. 1996; Meyers et al. 1998) and fish counts at dams are used in making decisions affecting these stocks, including setting harvest quotas and the timing and length of commercial, tribal and sport fishing seasons.

Prior to the advent of large-scale radio telemetry research, characterizing the frequency and implications of fallback in the hydrosystem was constrained by small sample sizes and unknown final fates of fish (Bjornn and Peery 1992). From 1991 to 1994, Bjornn et al. (1998, 2002) radio-tagged about 6,000 adult spring–summer Chinook salmon and steelhead to study their passage at dams and through reservoirs in the lower Snake River, and those samples included fish released at John Day Dam in some years. Concurrently, Blankenship and Mendel (1994) studied radio-tagged adult fall Chinook salmon passage through the lower Snake River, and Stuehrenberg et al. (1995) studied adult Chinook salmon behavior at selected mid-Columbia River dams. These studies (and others) helped establish baseline estimates of adult fallback at mainstem Snake River dams and at some Columbia River dams.

Advances in radio telemetry have facilitated increasingly large-scale monitoring of individual adult fish. In 1996, we began radio-tagging adult salmonids at Bonneville Dam, the most downstream Columbia River site where large numbers of adult fish can be efficiently collected. Over seven years (1996, 1997, 1998, 2000, 2001, 2002 and 2003) we tagged and released more than 18,000 adult salmon and steelhead at or downstream from the dam and monitored them as they migrated upstream through the hydrosystem. Our objectives were to calculate the percentages of radio-tagged spring–summer and fall Chinook salmon and steelhead that fell back at each of the eight lower Columbia and lower Snake River dams, fish reascension rates after fall back, and fishway count adjustment factors for each dam and year. We also determined final known locations and probable fates for fish that fell back and estimated percentages of fish that fell back in order to return to downstream tributaries.

Methods

Study Area and Fish Tagging

The study area included the lower Columbia and Snake rivers and their major tributaries (Figure 1). U.S. Army Corps of Engineers (USACE) dams where fallback behavior was monitored included Bonneville, The Dalles, John Day and McNary dams on the lower Columbia River and Ice Harbor, Lower Monumental, Little Goose and Lower Granite dams on the lower Snake River. Major tributaries between Bonneville and Lower Granite dams were monitored in all years of the study, as were several tributaries downstream from Bonneville Dam in 1996 and 1998. Additional sites were monitored at and upstream from Priest Rapids Dam and in Snake River tributaries; data from these locations were generally not used for fallback analyses, except to identify final fish fates.

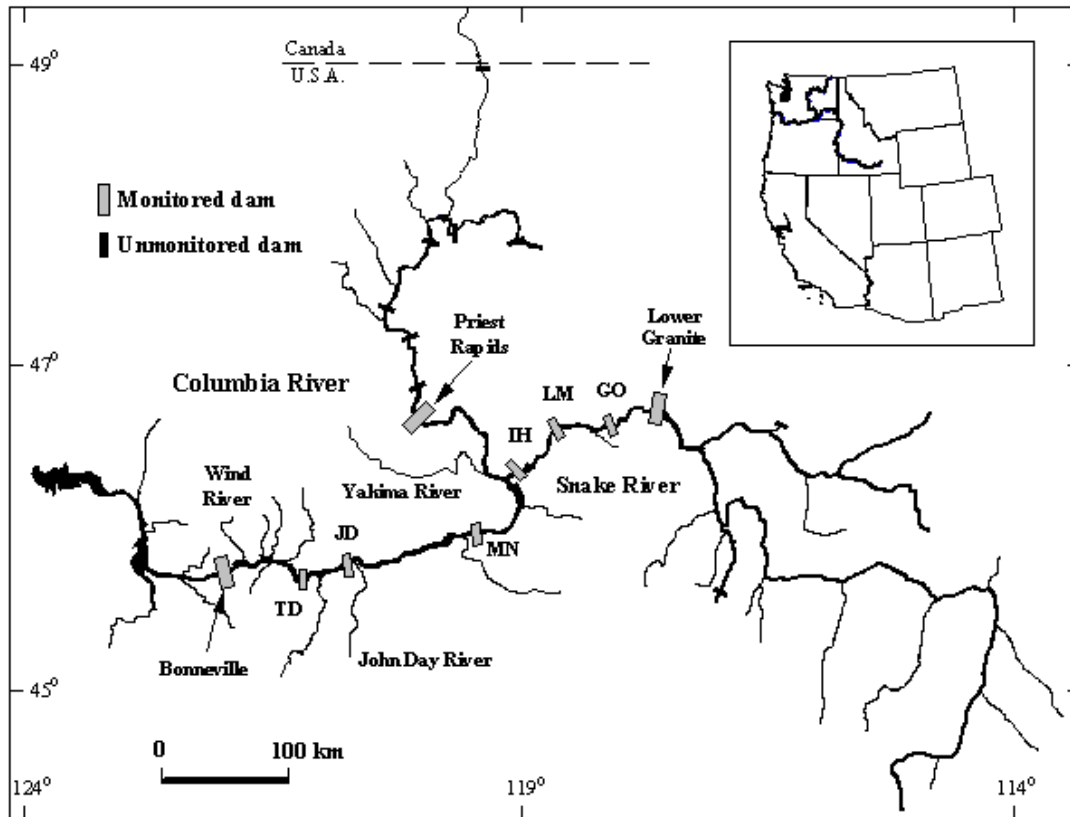


Figure 1. The Columbia and Snake rivers, showing dams monitored with radiotelemetry. For this study, the hydrosystem was bounded by Bonneville, Lower Granite, and Priest Rapids dams. Other monitored dams: The Dalles (TD), John Day (JD), McNary (MN), Ice Harbor (IH), Lower Monumental (LM), and Little Goose (GO). All major Columbia River tributaries upstream from Bonneville Dam were monitored with radio antennas.

Adult salmon and steelhead were trapped in the adult fish facility (AFF) adjacent to the Washington-shore fishway at Bonneville Dam as they migrated upstream to natal streams or hatcheries. In the seven study years, radio transmitters were placed in 18,380 fish: 7,568 spring–summer Chinook salmon, 4,873 fall Chinook salmon and 5,939 steelhead (Table 1). Spring–summer Chinook salmon (primarily stream-type life history) were tagged in all years from April to early or late July and fall Chinook salmon (primarily ocean-type life history) were tagged from early August (2000, 2001, 2002, 2003) or September (1998) through October. Steelhead were tagged from early to mid-June through October (1996, 1997, 2000, 2001, 2002, 2003). Chinook salmon run designations were based on the established separation between spring, summer, and fall-run fish at Bonneville Dam (e.g. USACE 2001). For our analyses, radio-tagged fish kept their initial designation regardless of date of passage at upstream sites.

Each day fish were tagged, a weir in the Washington-shore fishway was lowered into place in the morning to divert fish from the main fishway into the AFF via a short section

of ladder. Diverted adults entered a collection pool with two false weirs at the top of chutes that led to either a channel back to the main ladder or to an anesthetic tank. Fish selected for tagging were directed to the anesthetic tank by activating hydraulic gates in the chutes. We tagged fish as they arrived at the trap, but not randomly because only fish passing the Washington shore ladder were sampled, the proportion sampled each day varied and no fish were sampled at night. In addition, we rejected “jack” (precocious males, by size) Chinook salmon and steelhead with fork lengths less than 50 cm to accommodate transmitter size.

Table 1. Number of adult salmon and steelhead outfitted with radio-transmitters at Bonneville Dam from 1996 to 2003.

Year	Sp-Su Chinook	Fall Chinook	Steelhead	Total
1996	853	-	765	1,618
1997	1,014	-	975	1,989
1998	957	1,032	-	1,989
2000	1,132	1,118	1,160	3,410
2001	1,212	992	1,151	3,355
2002	1,217	1,065	1,273	3,555
2003	1,183	666	615	2,464
Total	7,568	4,873	5,939	18,380

We attempted to tag fish in proportion to their abundance, based on long-term averages of run size at Bonneville Dam. However, run timing varied each year, causing some deviations that could not be compensated for by in-season adjustments to tagging schedules. Because we tagged fish throughout each run, we tended to under-sample during migration peaks and over-sample during passage nadirs. Departures from representative sampling occurred in July 1996, and in the second half of July in 1997 and 1998 when no summer Chinook salmon were tagged, and when high water temperatures precluded tagging fall Chinook salmon in August of 1998. We intentionally radio-tagged more late-migrating (B-group) than early-migrating (A-group) steelhead to increase samples of fish returning to the Snake River.

During fall Chinook tagging, we primarily selected for ‘upriver-bright’ fish that spawn mostly in the Hanford Reach, Snake, Yakima, John Day or Deschutes rivers and limited our collection of the darker colored, sexually mature ‘Tule’ fall Chinook salmon. Tules return only a short distance upstream to Bonneville reservoir hatcheries (Meyers et al. 1998), and during times of high Tule passage we selected against these fish to ensure adequate sample sizes at upstream projects.

In 2000-2003, tagging methods were modified to include use of an automated system (McCutcheon et al. 1994) that identified fish with passive integrated transponder (PIT) tags as they passed through the AFF trap. PIT tags indicated if and where fish were tagged as juveniles (referred to here as “known-source” fish because their natal sites or river drainages were known), and use of PIT-tagged fish allowed us to make stock-specific harvest, escapement, and unaccounted-for loss estimates (see Keefer et al.

2004c). Only approved groups of PIT-tagged fish were available for radio-tagging, and codes for those fish were imported into the automatic detection system at the trap. We attempted to radio tag as many known-source fish as possible within the 2000-2003 tagging schedules. Known-source fish were radio-tagged as they were trapped, and fish without PIT tags made up the remainders of each daily sample. In 2000, 2001, 2002 and 2003 spring–summer Chinook that had been PIT-tagged as juveniles comprised 6, 70, 37, and 26% of the spring–summer Chinook sample, respectively. Known-source fish made up < 1, 13, 6, and 18% of fall Chinook salmon, and < 1, 61, 46, and 17% of steelhead during the four years, respectively.

Anesthetization, fish handling and radio-tag insertion methods were the same in all years and are described in Keefer et al. 2004b. We primarily used 3 volt and 7 volt transmitters, but also used small numbers of radio-data storage transmitters (RDST) and combination acoustic/radio transmitters (CART) (Lotek Wireless, Inc., Newmarket, Ont); all transmitters had a repeat rate of 5 sec. All transmitters were dipped in glycerin before intragastric insertion (Mellas and Haynes 1985). Three-volt tags weighed 11 g in air (4.3 by 1.4 cm), 7-volt tags were 29 g (8.3 by 1.6 cm), RDST tags were 34 g (9.0 by 2.0 cm) and CART tags were 28 g (6.0 by 1.6 cm). Lithium batteries powered transmitters and all but the CART tags had a rated operating life of 8-10 months; CART tags had an operating life of 15 months.

We inserted a unique secondary visual implant (VI) tag into the clear tissue posterior to the eye of each fish during the 1996-2000 study years. We switched secondary tags in 2000 to PIT tags inserted into the abdominal cavities of those fish that had not been PIT-tagged as juveniles; only original PIT tags were used as secondary markers for fish with juvenile PIT tags. After tagging, fish were moved to a 2275 L transport tank where they were held (< 3 h) until release.

All fish radio-tagged from 1996, 1997, 1998, and 2003 were released about 9.5 km downstream from Bonneville Dam at sites on both banks of the Columbia River. In 2000, 91% of spring Chinook, 74% of summer Chinook, 67% of fall Chinook salmon and 73% of steelhead were released at the downstream sites and the remainders were released in the Bonneville Dam forebay within 1 km of the dam. In 2001 and 2002, 57 to 72% and 71 to 74% of each run, respectively, was released at the downstream sites. Fish released in the Bonneville forebay were not used in Bonneville Dam fallback analyses, but were included in fallback summaries at upstream dams. For a description of fallback behavior at Bonneville Dam by fish released in the Bonneville Dam forebay, see Boggs et al. 2004b.

Telemetry Monitoring

We assessed radio-tagged fish movements and fallback using fixed radio telemetry sites in all years. We used aerial Yagi antennas connected to SRX scanning receivers (Lotek Wireless, Inc.) to monitor forebay and tailrace areas at dams and the mouths of major tributaries, and underwater antennas made of coaxial cable to monitor movements in and around fishway entrances, inside fishways, and at fishway exits at dams. Digital

spectrum processors (DSP) added to SRX receivers could simultaneously monitor several frequencies and antennas at sites with underwater antennas. Trucks and boats outfitted with aerial antennas were used to track fish in areas not monitored by fixed-site receivers, including mainstem reservoirs, unimpounded reaches and accessible tributaries. Mobile-tracking efforts were most extensive in the lower Columbia River reservoirs, and in Lower Columbia and Snake River tributaries.

Data Analysis

Fallbacks by radio-tagged fish were determined exclusively from telemetry records. To qualify as a fallback event a fish first needed to be recorded exiting from the top of a fishway at a dam (or be conclusively detected at a telemetry site upstream from a dam), and then be recorded at a telemetry site downstream from that dam. Given the large number of monitoring sites, most fallback events were easily identified.

Fallback percentage, the percentage of each run that fell back at a dam, was calculated by dividing the number of unique radio-tagged fish that fell back at a dam by the number of unique radio-tagged fish known to have passed the dam. Fallback rate, which included multiple fallback events by individual fish at a dam, was the total number of fallback events at a dam divided by the number of unique radio-tagged fish known to have passed the dam. Reascension proportion was the proportion of unique fish that fell back at a dam that subsequently reascended the dam where the fallback occurred and were last located upstream from that dam. Last known locations of fish that fell back were determined from telemetry records from fixed site receivers at dams and the mouths of tributaries, from mobile tracking records, and from recaptures of tagged fish in fisheries, hatcheries and from spawning ground surveys. All transmitters used in this study were inscribed with return and reward information and found tags or those recovered from fish captured in fisheries were eligible for rewards of US\$10 to \$100. Information from returned tags was helpful in determining last known locations for some radio-tagged fish.

Steelhead that fell back over dams after entering spawning areas during historic spawning periods (e.g. March through May) were considered post-spawn (kelts) and not included in any fallback calculations. Fallbacks by Chinook salmon that occurred after likely spawning were similarly excluded.

We estimated errors in fishway counts (e.g. USACE 2001) at Columbia and Snake River dams by calculating count adjustment factors based on passage, fallback, and reascension rates of radio-tagged fish at each dam. Adjustment factors were calculated by the formula:

$$AF = (LP_K + NLP_K - FB_{UF} + R_{UF}) / TLP_K$$

LP_K was the number of unique fish with transmitters known to have passed the dam via the fishways (assumes that unrecorded fish passed dam via fishways), NLP_K was the number of unique fish with transmitters known to have passed the dam via the navigation lock (only Bonneville and McNary locks monitored), FB_{UF} was the number of unique fish that fell back at the dam one or more times, R_{UF} was the number of unique fish that

reascented the dam and stayed upstream from the dam regardless of the number of fallbacks, and TLP_K was the total number of times unique fish with transmitters were known to have passed the dam via fishways (includes initial passage and all reascension).

Count adjustments were based on the assumption that radio-tagged fish were good surrogates for the remainder of each run, and were calculated by pooling data for the entire passage period at each dam. Pooling data could bias adjustments by masking temporal variability in both fallback and reascension rates. To address potential biases, we calculated additional adjustments using stratified sampling methods during consecutive 5-d blocks weighted by the number of fish passing the dam during each block. In earlier multi-year studies, the weighted adjustment factors were typically within 2% of pooled adjustment factors (Bjornn et al. 2000a; 2000b; 2000c) and so only pooled values are reported here.

We tested the influence of dam, run and year on fallback percentages and rates using two separate MANOVA models followed by univariate ANOVAs with pairwise comparisons performed using a Tukey test (Zar 1999). The effects of run and dam and the interaction of these two factors on fallback were tested using observations across years as the replicates. The effect of year was tested by using observations at each dam, within runs, as the replicates. The interaction of run and year could not be tested because not all runs were sampled in all years. Fallback percentages and rates were log transformed to improve normality, and fall Chinook salmon fallback percentages and rates at Little Goose and Lower Granite dams were excluded due to high variability and small sample sizes for this analysis.

Stock specific fallback was evaluated using the known-source component of radio-tagged spring–summer Chinook salmon and steelhead. Spring–summer Chinook were divided into several groups based on where they were PIT-tagged as juveniles: 1) fish from the Wind River (Carson National Fish Hatchery), 2) fish from Mid Columbia River tributaries or dams upstream of McNary Dam (excluding the Snake River), 3) fish from the Yakima River drainage, 4) fish from the Snake River and its tributaries that were not transported, and 5) fish that had been collected and barged from Snake River dams. Steelhead were divided into the Mid Columbia and the two Snake River groups only. Contingency tables and a Pearson Chi-square statistic were used to compare the fallback percentages of each group at each of the Lower Columbia River dams.

We used linear regression to evaluate the relationship between mean Columbia and Snake River discharge and fallback rates for spring–summer Chinook salmon. Mean discharge at each dam from April through July, a period including the annual snowmelt event and spilling at the dams, was used as the independent variable. Similar regressions were not performed for fall Chinook salmon or steelhead because the majority of those runs passed dams after river discharge declined to near base levels, summer spill had ended, and the range in flow was insufficient to detect differences.

Results

Fallback and Reascension

With all years combined, at least 19% of spring–summer Chinook salmon, 24% of steelhead and 13% of fall Chinook salmon with radio transmitters that passed a dam fell back over at least one dam one or more times during their upstream migration in the lower Columbia and Snake rivers. The range in annual fallback percentages was 11 to 32% for spring–summer Chinook salmon, 18 to 27% for steelhead and 12 to 18% for fall Chinook salmon.

The mean percentage of spring–summer Chinook salmon that fell back at lower Columbia River dams during the seven study years was 9.6% (*range* 4.1-14.6%) at Bonneville Dam, 9.5% (*range* 5.4-14.4%) at The Dalles Dam, 7.3% (*range* 3.0-11.9%) at John Day Dam, and 5.6% (*range* 1.4-9.3%) at McNary Dam (Table 2). Spring–summer Chinook fallback rates, which included multiple fallback events by individual fish, were 0.8 to 5.3% higher than fallback percentages each year at Bonneville and The Dalles dams, and 0.3 to 2.7% higher than percentages at John Day and McNary dams. Mean fallback percentages for fall Chinook at Columbia River dams were 4.0% (*range* 3.5-4.8%) at Bonneville Dam, 8.8% (*range* 6.9-10.2%) at The Dalles Dam, 2.5% (*range* 1.7-3.7%) at John Day Dam and 2.8% (*range* 2.0-3.5%) at McNary Dam (Table 2). Fall Chinook fallback rates were higher than fallback percentages by 0.7 to 2.1% each year at Bonneville and The Dalles dams and 0 to 0.4% higher at John Day and McNary dams.

Mean percentages of steelhead that fell back at Columbia River dams were 5.8% (*range* 3.6-9.1%) at Bonneville Dam, 7.1% (*range* 6.0-10.5%) at The Dalles Dam, 6.9% (*range* 4.3-10.1%) at John Day Dam and 7.9% (*range* 4.9-10.7%) at McNary Dam (Table 2). Steelhead fallback rates at lower Columbia River dams were higher than fallback percentages by 0.2 to 3.1% except at The Dalles Dam in 2003 when the fallback rate exceeded the fallback percentage by 7.0%.

Fallback percentages and rates for spring–summer Chinook salmon and steelhead were generally lower at Snake River dams than at lower Columbia River dams (Table 3). In contrast, relatively large percentages of fall Chinook salmon fell back at Snake River dams, though sample sizes were small. Mean fallback percentages for spring–summer Chinook and steelhead at Snake River dams ranged from 2.4% to 6.4% and were less than 10% at all dams in all years (Table 3). Mean fall Chinook fallback percentages were 9.8% at Ice Harbor Dam, 4.3% at Lower Monumental Dam, 16.0% at Little Goose Dam and 16.7% at Lower Granite Dam.

Table 2. Percentages of radio-tagged Chinook salmon and steelhead that fell back at lower Columbia River dams and fallback rates at each dam during 1996-2003. NP_K = number of fish known to pass dam, FB_U = number of unique fish that fell back, FB_T = total fallback events, Fallback Percent = FB_U / NP_K , Fallback Rate = FB_T / NP_K .

Year	Fallback			NP _K	FB _U	FB _T	Fallback			NP _K	FB _U	FB _T
	Percent	Rate					Percent	Rate				
<u>Bonneville Dam</u>						<u>The Dalles Dam</u>						
<u>Spring-Summer Chinook</u>												
1996	13.8	16.4	809	112	133	13.3	18.3	497	66	91		
1997	14.6	19.9	950	139	189	14.4	18.6	714	103	133		
1998	11.2	15.8	932	104	147	11.5	14.3	763	88	109		
2000	13.0	16.8	951	124	160	9.6	12.2	844	81	103		
2001	4.1	7.0	773	32	54	5.5	7.0	1,032	57	72		
2002	6.1	6.9	881	54	61	5.4	6.9	981	53	68		
2003	4.7	6.2	1,089	51	67	6.6	8.1	849	56	69		
<u>Fall Chinook</u>												
1998	3.5	4.2	913	32	38	10.2	11.6	629	64	73		
2000	3.9	5.2	659	26	34	8.5	9.6	738	63	71		
2001	4.8	6.9	521	25	36	6.9	8.4	713	49	60		
2002	3.8	4.6	676	26	31	8.9	10.2	744	66	76		
2003	4.0	4.8	583	23	28	9.3	10.8	453	42	49		
<u>Steelhead</u>												
1996	4.9	5.3	720	35	38	6.0	6.9	580	35	40		
1997	9.1	9.9	916	83	91	6.6	7.6	683	45	52		
2000	6.9	7.4	811	56	60	6.3	7.2	871	55	63		
2001	4.3	4.5	775	33	35	6.1	8.8	963	59	85		
2002	3.6	4.4	909	33	40	7.1	10.2	1,136	81	116		
2003	5.9	8.3	564	33	47	10.5	17.5	506	47	78		

Table 2 continued.

Year	Fallback			NP _K	FB _U	FB _T	Fallback			NP _K	FB _U	FB _T
	Percent	Rate					Percent	Rate				
<u>John Day Dam</u>						<u>McNary Dam</u>						
<u>Spring-Summer Chinook</u>												
1996	11.9	14.1	377	45	53	9.3	10.3	301	28	31		
1997	9.9	12.6	629	62	79	8.0	10.6	587	47	62		
1998	10.6	11.6	639	68	74	9.2	10.9	576	53	63		
2000	6.0	6.5	681	41	44	4.3	5.4	626	27	34		
2001	3.0	3.3	969	29	32	1.4	1.7	908	13	15		
2002	4.9	5.7	837	41	48	4.7	5.8	770	36	45		
2003	4.5	4.9	719	32	35	2.3	3.1	656	15	20		
<u>Fall Chinook</u>												
1998	3.7	3.7	483	18	18	2.1	2.1	428	9	9		
2000	2.6	2.6	570	15	15	2.0	2.0	456	9	9		
2001	2.6	2.8	580	15	16	3.5	3.9	482	17	19		
2002	1.8	1.8	570	10	10	3.5	3.5	479	17	17		
2003	1.7	1.7	350	6	6	2.7	4.1	293	8	12		
<u>Steelhead</u>												
1996	10.1	11.2	457	46	51	7.4	8.6	394	29	34		
1997	7.9	9.0	554	44	50	10.7	12.9	487	52	63		
2000	4.3	4.5	748	32	34	9.8	10.2	645	63	66		
2001	5.3	5.6	869	46	49	7.1	7.6	790	56	60		
2002	4.6	5.0	920	42	46	4.9	5.8	831	41	48		
2003	9.1	10.4	395	36	41	7.2	7.5	333	24	25		

Table 3. Percentages of radio-tagged Chinook salmon and steelhead that fell back at lower Snake River dams and fallback rates at each dam during 1996-2003. NP_K = number of fish known to pass dam, FB_U = number of unique fish that fell back, FB_T = total fallback events, Fallback Percent = FB_U / NP_K , Fallback Rate = FB_T / NP_K .

Year	Fallback			NP _K	FB _U	FB _T	Fallback			NP _K	FB _U	FB _T
	Percent	Rate					Percent	Rate				
<u>Ice Harbor Dam</u>						<u>Lower Monumental Dam^a</u>						
<u>Spring-Summer Chinook</u>												
1996	7.5	8.3	120	9	10	-	-	-	-	-	-	
1997	9.1	10.4	318	29	33	5.1	5.8	311	16	18		
1998	7.4	7.4	256	19	19	4.0	4.0	252	10	10		
2000	9.6	13.7	249	24	34	4.5	4.5	246	11	11		
2001	1.4	1.4	555	8	8	0.9	0.9	551	5	5		
2002	4.5	5.6	376	17	21	3.7	3.7	374	10	10		
2003	5.2	6.4	327	17	21	2.5	2.8	323	8	9		
<u>Fall Chinook</u>												
1998	6.9	6.9	29	2	2	3.6	3.6	28	1	1		
2000	3.0	3.0	33	1	1	9.1	9.1	33	3	3		
2001	11.8	11.8	93	11	11	5.9	5.9	85	5	5		
2002	10.9	10.9	73	8	8	3.1	3.1	65	2	2		
2003	16.2	16.2	37	6	6	-	-	33	0	0		
<u>Steelhead</u>												
1996	5.6	6.3	319	18	20	-	-	-	-	-	-	
1997	4.9	5.4	387	19	21	4.0	4.8	375	15	18		
2000	4.7	5.1	486	23	25	1.7	1.7	471	8	8		
2001	3.9	4.7	489	19	23	2.8	3.0	472	13	14		
2002	4.5	5.4	652	29	35	4.2	4.6	637	27	29		
2003	5.1	5.8	275	14	16	2.6	2.6	271	7	7		

^a Lower Monumental and Little Goose dams were not monitored in 1996

Table 3 continued

Fallback						Fallback				
Year	Percent	Rate	NP _K	FB _U	FB _T	Percent	Rate	NP _K	FB _U	FB _T
<u>Little Goose Dam^a</u>						<u>Lower Granite Dam</u>				
<u>Spring–Summer Chinook</u>										
1996	-	-	-	-	-	1.0	1.0	101	1	1
1997	8.9	8.9	302	27	27	5.8	5.8	292	17	17
1998	5.6	6.0	249	14	15	4.3	4.8	230	10	11
2000	3.7	3.7	241	9	9	2.9	2.9	238	7	7
2001	1.5	1.5	543	8	8	0.6	0.6	538	3	3
2002	3.7	3.7	370	10	10	3.1	3.1	360	11	11
2003	2.8	3.5	318	9	11	2.3	2.3	309	7	7
<u>Fall Chinook</u>										
1998	20.0	30.0	20	4	6	25.0	37.5	8	2	3
2000	35.5	58.1	31	11	18	40.0	56.0	25	10	14
2001	10.8	12.2	74	8	9	4.8	6.5	62	3	4
2002	6.9	6.9	58	4	4	6.8	11.4	44	3	5
2003	6.9	6.9	29	2	2	7.1	7.1	28	2	2
<u>Steelhead</u>										
1996	-	-	-	-	-	8.4	9.2	262	22	24
1997	8.4	9.0	335	28	30	5.9	6.9	306	18	21
2000	5.3	5.3	450	24	24	3.7	3.7	407	15	15
2001	5.2	5.2	445	23	23	2.7	2.9	445	12	13
2002	5.3	5.5	606	32	33	4.6	4.8	522	24	25
2003	6.0	6.4	266	16	17	2.4	2.8	254	6	7

^a Lower Monumental and Little Goose dams were not monitored in 1996

Dam, year, and the dam × run interaction had a significant effect on fallback percentage and rate (MANOVA, $P < 0.001$); the effect of run was not significant. Individual ANOVA for each run indicated dam had significant effect on fallback rates for all runs ($P < 0.05$); year affected fallback rates of spring–summer Chinook and steelhead ($P < 0.05$). Pairwise comparison of dams revealed spring–summer Chinook fallback rates at Bonneville Dam were significantly ($P < 0.05$) higher than rates at McNary Dam and all Snake River dams, rates at The Dalles Dam were significantly ($P < 0.01$) higher than at

Lower Monumental, Little Goose and Lower Granite dams, and rates at John Day Dam were significantly higher than at Lower Monumental Dam ($P < 0.01$). Steelhead fallback rates at Bonneville, The Dalles and John Day, McNary and Little Goose dams were significantly ($P < 0.05$) higher than rates at Lower Monumental Dam and fallback rates at McNary and The Dalles dams were significantly ($P < 0.05$) higher than rates at Lower Granite Dam. Fall Chinook fell back at significantly ($P < 0.05$) higher rates at Bonneville and The Dalles dams than at John Day Dam, and rates at The Dalles and Ice Harbor dams were significantly ($P < 0.01$) higher than at McNary Dam. Pairwise comparisons of years indicated spring–summer Chinook fallback rates in 2001 were significantly ($P < 0.001$) lower than in all other study years and 2003 had significantly

($P < 0.01$) lower fallback rates than 1997 and 1998. Spring–summer Chinook fallback rates in 1997 were significantly ($P < 0.001$) higher than in 2002. Steelhead fallback rates in 2000 and 2001 were marginally significantly ($P < 0.08$) lower than in 1997. ANOVA and pairwise comparisons of fallback percentages for all runs showed similar results as fallback rates and are not reported.

The proportions of fallback fish that reascended at dams and remained upstream were widely variable among dams and between runs (Table 4). Mean reascension percentages for spring–summer Chinook salmon were highest at Bonneville (85.0%) and Lower Granite (76.2%) dams and were between 47 and 66% at all other dams. Mean steelhead reascension percentages were highest at Bonneville (76.4%) and The Dalles (70.1%) dams and were between 44 and 63% at all other dams. In contrast, mean reascension percentages for fall Chinook salmon were less than 15% at Lower Monumental Dam, between 22 to 38% at The Dalles, John Day, McNary, Ice Harbor and Little Goose dams, 49.4% at Bonneville Dam, and 50.8% at Lower Granite Dam.

“Overshoot” Fallbacks

Many Chinook salmon and steelhead that fell back at dams entered tributaries or were recaptured at hatcheries downstream from the fallback location. Some, though not all, of these fallbacks were likely behaviorally motivated, or “overshoot” fallbacks. Others may have been temporary or permanent strays from other basins. Percentages of spring–summer Chinook salmon that entered downstream tributaries or hatcheries after falling back at lower Columbia River dams ranged from a mean of 14.4% at The Dalles Dam to 34.8% at McNary Dam over the seven study years (Table 5). Tributaries downstream from Bonneville Dam were monitored in 1996 and 1998 only, and 4.5% (1996) and 2.9% (1998) of spring–summer Chinook salmon that fell back at Bonneville Dam were last located in downstream drainages. Spring–summer Chinook salmon that fell back at Snake River dams entered downstream tributaries or hatcheries in mean percentages ranging from 10.1% at Lower Granite Dam to 24.7% at Ice Harbor Dam (Table 5).

Table 4. Percentages of radio-tagged salmon and steelhead that reascended fishways at Columbia and Snake River dams after falling back.

Spp/Year	Columbia River Dams				Snake River Dams			
	BO	TD	JD	MN	IH	LM ^a	GO ^a	GR
Spring–Summer Chinook								
1996	89.3	54.5	57.8	32.1	77.8	-	-	100.0
1997	92.1	68.9	61.3	48.9	69.0	62.5	77.8	70.6
1998	82.7	61.4	63.2	58.5	52.6	40.0	42.9	50.0
2000	92.7	72.8	68.3	77.8	79.2	45.5	44.4	71.4
2001	75.8	64.9	58.6	61.5	25.0	60.0	55.5	66.7
2002	83.3	77.4	80.5	38.9	76.5	60.0	70.0	90.0
2003	80.4	64.3	62.5	46.7	82.4	62.5	66.7	85.7
Fall Chinook								
1998	37.5	25.0	5.6	33.3	0	0	25.0	50.0
2000	50.0	34.9	6.7	22.2	0	0	18.2	30.0
2001	60.0	26.5	13.3	29.4	18.2	40.0	37.5	100.0
2002	43.2	30.3	30.0	11.8	0	0	0	0
2003	21.7	14.3	14.3	16.7	66.7	0	100.0	50.0
Steelhead								
1996	85.7	77.1	45.7	41.4	38.9	-	-	36.4
1997	77.1	75.6	75.0	46.2	52.6	26.7	42.9	38.9
2000	91.1	80.0	62.5	47.6	52.2	50.0	43.5	66.7
2001	78.8	76.3	78.3	64.3	47.4	92.3	87.0	50.0
2002	72.7	76.5	59.5	36.6	37.9	37.3	56.3	68.2
2003	54.5	36.2	61.1	29.2	71.4	71.4	68.8	66.7

^a Lower Monumental and Little Goose dams not monitored in 1996

Fall Chinook salmon that fell back at Columbia and Snake River dams were more likely to enter downstream tributaries or hatcheries than spring–summer Chinook salmon. At lower Columbia River dams, mean percentages of fall Chinook salmon that entered tributaries downstream after falling back ranged from 42.2% at The Dalles Dam to 50.1% at John Day Dam; in 1998, 31.3% of fall Chinook salmon that fell back at Bonneville dam entered monitored tributaries or hatcheries downstream from the dam. Mean fall Chinook salmon overshoot percentages at Snake River dams ranged from 16.0% at Lower Granite to 78.0% at Ice Harbor Dam (Table 5).

Overshoot fallbacks by steelhead at Columbia River dams ranged from a mean of 4.5% at The Dalles Dam to 29.1% at McNary Dam; 5.7% of steelhead that fell back at Bonneville Dam entered downstream tributaries or hatcheries in 1996. At Snake River dams, fallback steelhead entered downstream tributaries in mean percentages ranging from 8.6% at Lower Granite Dam to 18.5% at Ice Harbor Dam (Table 5).

Table 5. Percentages of adult salmon and steelhead that fell back at Columbia River or Snake River dams that were known to have entered tributaries or hatcheries downstream from the fallback location (possible “overshoot” fallbacks). Tributaries downstream from Bonneville Dam monitored in 1996 and 1998 only.

Spp/Year	Columbia River Dams				Snake River Dams			
	BO	TD	JD	MN	IH	LM	GO	GR
Spring–Summer Chinook								
1996	4.5	27.3	22.4	46.4	22.2	-	-	0
1997	-	19.4	25.8	23.4	17.2	18.8	18.5	17.6
1998	2.9	19.3	22.1	24.5	21.1	10.0	14.3	10.0
2000	-	13.6	17.1	40.7	20.8	45.5	55.6	28.6
2001	-	10.5	13.8	23.1	62.5	20.0	12.5	0
2002	-	1.9	4.9	38.9	11.8	20.0	10.0	0
2003	-	10.7	3.1	46.7	17.6	25.0	33.3	14.3
Fall Chinook								
1998	31.3	45.3	50.0	66.6	100.0	100.0	75.0	50.0
2000	-	44.4	53.3	33.3	100.0	33.3	45.5	30.0
2001	-	32.7	40.0	41.2	81.8	60.0	62.5	0
2002	-	40.9	50.0	64.7	75.0	0	33.3	0
2003	-	47.6	57.1	33.3	33.3	0	0	0
Steelhead								
1996	5.7	11.4	26.1	24.1	22.2	-	-	4.5
1997	-	0	6.8	26.9	26.3	20.0	25.0	22.2
2000	-	7.3	18.8	31.7	13.0	12.5	4.3	0
2001	-	5.1	13.0	17.9	21.1	0	4.3	16.7
2002	-	1.2	11.9	19.5	6.9	14.8	12.5	8.3
2003	-	2.1	2.8	54.2	21.4	28.6	12.5	0

Fallback by Known-Source Spring and Summer Chinook Salmon

At all dams, four-year mean fallback percentages for the five groups of known-source spring–summer Chinook salmon were less than 2% for the Yakima River and Mid Columbia groups, ranged from 0.5% to 3.4% for the non-transported Snake River group and ranged from 3.4% to 13.8% for transported Snake River salmon. The Wind River group had the smallest sample size (49 fish) and fell back at Bonneville Dam at a mean of 10.2%. Sample sizes for other dam-group combinations ranged from 155 to 427 salmon (Table 6). At all dams, Chi tests indicated significant differences in fallback percentages among stocks ($P < 0.001$) with the transported Snake River group deviating the greatest amount from expected frequencies. Additionally, the Wind River group fell back at higher than expected frequencies at Bonneville Dam.

Table 6. Annual (2000-2003) percentages (*n*) of known-source spring–summer Chinook salmon that fell back at lower Columbia River dams.

Stock	Year	Fallback percentage (<i>n</i>)			
		Bonneville	The Dalles	John Day	McNary
Wind River	2000	0 (1)	-	-	-
	2001	-	-	-	-
	2002	8.6 (35)	-	-	-
	2003	15.4 (13)	-	-	-
	Total	10.2 (49)	-	-	-
Yakima River	2000	-	-	-	-
	2001	0 (82)	0 (109)	0 (109)	0 (109)
	2002	4.6 (65)	1.1 (91)	2.3 (86)	0 (84)
	2003	0 (8)	0 (8)	0 (8)	0 (8)
	Total	1.9 (155)	0.5 (208)	1.0 (203)	0 (201)
Mid Columbia	2000	2.7 (37)	5.4 (37)	3.0 (33)	0 (33)
	2001	0 (96)	0 (127)	0.8 (127)	0 (127)
	2002	1.4 (73)	2.1 (94)	1.1 (92)	2.2 (90)
	2003	1.1 (180)	2.4 (169)	2.0 (152)	0.7 (143)
	Total	1.0 (386)	1.9 (427)	1.5 (404)	0.8 (393)
Snake R., no transport	2000	15.4 (13)	9.1 (11)	0 (11)	0 (11)
	2001	1.1 (182)	0.8 (236)	1.3 (236)	0.4 (236)
	2002	6.0 (116)	0.8 (119)	2.6 (115)	0.9 (112)
	2003	2.3 (44)	0 (43)	0 (38)	0 (38)
	Total	3.4 (355)	1.0 (409)	1.5 (400)	0.5 (397)
Snake R., transport	2000	28.6 (14)	27.3 (11)	18.2 (11)	10.0 (10)
	2001	9.7 (103)	13.5 (148)	6.1 (148)	3.4 (148)
	2002	17.0 (47)	17.0 (41)	10.0 (40)	5.3 (38)
	2003	4.5 (41)	7.7 (39)	2.6 (39)	0 (37)
	Total	11.7 (205)	13.8 (239)	6.7 (238)	3.4 (233)

Four-year mean fallback percentages for known-source fall Chinook from the Snake River ranged from 3.9% at Bonneville Dam to 1.0% at John Day and McNary dams (Table 7). There were no fallbacks by known-source fall Chinook except in 2001. Approximately 10% of known-source fall Chinook were barged as juveniles.

Table 7. Annual (2000-2003) percentages (*n*) of known-source Snake River¹ fall Chinook salmon that fell back at lower Columbia River dams.

Stock	Year	Fallback percentage (<i>n</i>)			
		Bonneville	The Dalles	John Day	McNary
Snake River	2000	0 (6)	0 (7)	0 (7)	0 (6)
	2001	11.5 (26)	3.7 (54)	2.0 (51)	2.0 (49)
	2002	0 (34)	0 (33)	0 (31)	0 (26)
	2003	0 (11)	0 (11)	0 (10)	0 (10)
	Total	3.9 (77)	1.9 (105)	1.0 (99)	1.0 (99)

¹ Approximately 10% were barged as juveniles

Known-source steelhead fell back in percentages similar to spring–summer Chinook salmon with four-year mean fallback proportions for the Mid Columbia and non-transported Snake River groups ranging from 0.9% to 3.0% at the four dams. Transported Snake River steelhead four-year mean rates ranged from 5.8% to 11.7% (Table 8). Again, Chi tests indicated significant differences in fallback percentages among stocks ($P < 0.001$) with the transported Snake River group deviating the greatest amount from expected frequencies.

Table 8. Annual (2000-2003) percentages (n) of known-source steelhead that fell back at lower Columbia River dams.

Stock	Year	Fallback percentage (n)			
		Bonneville	The Dalles	John Day	McNary
Mid Columbia	2000	0 (2)	0 (1)	0 (1)	0 (1)
	2001	1.1 (183)	2.8 (284)	2.3 (257)	1.7 (235)
	2002	1.2 (82)	3.4 (117)	0 (107)	1.0 (104)
	2003	-	-	-	-
	Total	1.1 (267)	3.0 (402)	1.6 (365)	1.5 (340)
Snake R., no transport	2000	0 (6)	0 (7)	0 (7)	0 (7)
	2001	2.5 (120)	1.9 (154)	1.4 (144)	0.7 (142)
	2002	1.7 (180)	2.2 (179)	1.8 (164)	1.3 (157)
	2003	0 (33)	0 (30)	0 (29)	0 (28)
	Total	1.8 (339)	1.9 (370)	1.5 (344)	0.9 (334)
Snake R., transport	2000	0 (1)	0 (1)	0 (1)	-
	2001	7.3 (110)	11.8 (161)	11.9 (151)	10.6 (132)
	2002	2.3 (175)	8.1 (197)	2.8 (180)	3.0 (166)
	2003	13.6 (59)	26.0 (50)	20.5 (44)	8.6 (35)
	Total	5.8 (345)	11.7 (409)	8.5 (376)	6.6 (333)

Last Known Locations of Fallback Fish

Percentages of fallback spring–summer Chinook that eventually entered tributaries or hatcheries up or downstream from the fallback location were relatively consistent (71.3-86.2%) for all dams with a mean of 74.7% at Columbia River dams and 82.3% at Snake River dams. Between 3.7 and 5.5% (*mean* 4.6%) of the spring–summer Chinook salmon that fell back at Columbia River dams were reported recaptured in mainstem fisheries. Percentages of fallback spring–summer Chinook salmon that were last located in the mainstem rivers (unknown fate, or unaccounted for) ranged from 13.8 to 25.0%, with means of 20.7% and 17.7% for fish that fell back at Columbia and Snake River dams, respectively (Table 9).

Table 9. Percentages of spring–summer Chinook salmon (all years combined) that fell back at dams that were last recorded in tributaries or hatcheries, reported recaptured in mainstem fisheries or last recorded at mainstem sites but whose fate was unknown. Percentages above line entered tributaries downstream from the fallback site, except for fish that fell back at Snake River dams and subsequently passed Priest Rapids Dam in the upper Columbia River.

	Columbia River Dams				Snake River Dams			
	BO	TD	JD	MN	IH	LM	GO	GR
Fallback fish (N)	617	504	318	219	123	60	77	55
<u>In Tributaries or Hatcheries (%)</u>								
Below Bonneville	1.5	0.8	0.9					
Bonneville Pool	15.9	14.9	6.0	3.2	0.8	1.7		
The Dalles Pool	8.3	6.3	10.1	5.0	1.6	1.7	1.3	
John Day Pool	2.8	2.2	5.0	25.6	11.4	13.3	7.8	3.6
McNary Pool ¹	4.2	1.0	6.3	7.8	5.7	1.7	1.3	1.8
Lower Snake ²	0.5	1.0	0.9	1.9	4.1		15.6	5.5
Above L. Granite ³	30.6	39.3	37.7	26.9	60.2	51.7	55.8	70.9
Above P. Rapids ³	7.6	7.7	9.4	7.8	2.4	5.0	2.6	1.8
Total	71.3	73.2	76.3	78.1	86.2	75.0	84.4	83.6
<u>In Mainstem (%)</u>								
Recapture	5.5	5.2	3.8	3.7				
Unknown	23.2	21.6	19.8	18.3	13.8	25.0	15.6	16.4

¹ Includes Walla Walla and Yakima rivers and Ringold and Priest Rapids hatcheries

² Includes Tucannon River and Lyons Ferry Hatchery

³ Includes all sites upstream from Lower Granite or Priest Rapids dams

Between 46.2 and 73.3% (*mean* 59.3%) of fall Chinook salmon that fell back at Columbia River dams were last located in tributaries or hatcheries (Table 10); percentages ranged from 55.6 to 89.3% (*mean* 70.9%) for fall Chinook salmon that fell back at Snake River dams, where sample sizes were small. Between 4.5 and 14.1% (*mean* 9.4%) of fall Chinook salmon that fell back at Columbia River dams were reported recaptured in mainstem fisheries. Fall Chinook salmon that fell back and were last located at mainstem sites (unknown fate) ranged from 18.3 to 49.2% (*mean* 31.3%) for Columbia River dams and from 10.7 to 44.4% (*mean* 22.7%) for Snake River dams. Fall Chinook salmon that returned to the Hanford Reach were considered successful migrants.

Table 10. Percentages of fall Chinook salmon (all years combined) that fell back at dams that were last recorded in tributaries, reported recaptured in mainstem fisheries or last recorded at mainstem sites but whose fate was unknown. Percentages above line entered tributaries downstream from the fallback site, except for fish that fell back at Snake River dams and subsequently passed Priest Rapids Dam on the upper Columbia River. Fall Chinook that returned to the Hanford Reach of the Columbia River were considered successful migrants.

	Columbia River Dams				Snake River Dams			
	BO	TD	JD	MN	IH	LM	GO	GR
Fallback fish (N)	132	285	64	60	28	11	28	18
<u>In Tributaries or Hatcheries (%)</u>								
Below Bonneville	15.9	1.8	1.6					
Bonneville Pool	17.4	40.4	23.4	8.3	3.6			
The Dalles Pool	3.0	4.6	25.0	11.7				
John Day Pool	1.5	0.7		26.7	21.4	9.1		
McNary Pool ¹	5.3	8.4	4.7	20.0	42.9	27.3	7.1	
Lower Snake ²	0.8	0.4		1.7	3.6		35.7	22.2
Above L. Granite ³	1.5	1.8	3.1	5.0	10.7	18.2	28.6	33.3
Above P. Rapids ³	0.8	0.4	1.6		7.1	9.1	3.6	
Total	46.2	58.2	59.4	73.3	89.3	63.6	75.0	55.6
<u>In Mainstem (%)</u>								
Recapture	4.5	10.5	14.1	8.3	0.0	0.0	0.0	0.0
Unknown	49.2	31.2	26.6	18.3	10.7	36.4	25.0	44.4

¹ Includes Walla Walla and Yakima rivers and Ringold and Priest Rapids hatcheries

² Includes Tucannon River and Lyons Ferry Hatchery

³ Includes all sites upstream from Lower Granite or Priest Rapids dams

Percentages of steelhead that entered tributaries or hatcheries after falling back ranged from 44.3 to 65.4% (*mean* 57.3%) at Columbia River dams and from 45.7 to 67.2 % (*mean* 57.7%) at Snake River dams (Table 11). Between 8.5 and 14.7% (*mean* 11.5%) of steelhead that fell back at Columbia River dams and from 3.3 to 6.6% (*mean* 5.1%) of those that fell back at Snake River dams were reported recaptured in mainstem fisheries. Percentages of fallback steelhead with unknown fate at mainstem sites ranged from 26.0 to 41.0% (*mean* 31.2%) for Columbia River dams and 26.2 to 50.0% (*mean* 37.2%) for Snake River dams.

Table 11. Percentages of steelhead (all years combined) that fell back at dams that were last recorded in tributaries, reported recaptured in mainstem fisheries or last recorded at mainstem sites but whose fate was unknown. Percentages above line entered tributaries downstream from the fallback site, except for fish that fell back at Snake River dams and subsequently passed Priest Rapids Dam on the upper Columbia River.

	Columbia River Dams				Snake River Dams			
	BO	TD	JD	MN	IH	LM	GO	GR
Fallback fish (N)	273	322	246	265	122	70	122	97
<u>In Tributaries or Hatcheries (%)</u>								
Below Bonneville	1.1							
Bonneville Pool	7.7	3.4	1.6					
The Dalles Pool	4.8	9.0	12.2	3.8	0.8			
John Day Pool	6.2	8.7	12.2	23.8	5.7	2.9	0.8	
McNary Pool ¹	2.2	1.6	3.3	4.5	9.8	7.1	1.6	1.0
Lower Snake ²	1.1	0.6		0.4	3.3	1.4	9.8	8.2
Above L. Granite ³	19.0	30.1	32.5	28.7	35.2	34.3	54.9	53.6
Above P. Rapids ³	2.2	2.2	3.7	2.6				
Total	44.3	55.6	65.4	63.8	54.9	45.7	67.2	62.9
<u>In Mainstem (%)</u>								
Recapture	14.7	13.7	8.5	9.1	3.3	4.3	6.6	6.2
Unknown	41.0	30.7	26.0	27.2	41.8	50.0	26.2	30.9

¹ Includes Walla Walla and Yakima rivers and Ringold and Priest Rapids hatcheries

² Includes Tucannon River and Lyons Ferry Hatchery

³ Includes all sites upstream from Lower Granite or Priest Rapids dams

Fishway Escapement Adjustments

Fishway escapement (count) adjustments were most precise for Bonneville and McNary dams, where we monitored all passage routes including through navigation locks from 1997-2003. Mean adjustment factors for counts at Bonneville Dam were 0.892 (*range* 0.839-0.943) for spring–summer Chinook, 0.974 (*range* 0.954-0.999) for fall Chinook and 0.959 (*range* 0.923-0.992) for steelhead (Table 12). Mean adjustments at McNary Dam were 0.941 (*range* 0.904-0.988), 0.974 (*range* 0.961-0.998) and 0.920 (*range* 0.880-0.946) for the three runs, respectively.

We did not monitor navigation lock passage at The Dalles or John Day dams, but telemetry records at fishway and upstream sites indicated that few (estimated < 2%) fish passed those dams via the locks. Mean adjustment factors at The Dalles Dam, uncorrected for passage through the lock, were 0.894 for spring–summer Chinook, 0.914 for fall Chinook salmon and 0.905 for steelhead; means at John Day Dam were 0.912 for spring–summer Chinook salmon, 0.975 for fall Chinook salmon and 0.928 for steelhead (Table 12).

Mean adjustment factors at lower Snake River dams were between 0.933 and 0.973 at all dams for all spring–summer Chinook salmon and steelhead runs; mean adjustments for fall Chinook salmon were 0.906 at Ice Harbor Dam, 0.957 at Lower Monumental Dam, 0.846 at Little Goose Dam and 0.812 at Lower Granite Dam (Table 13).

Positive bias estimates, or overcounts, at lower Columbia River dams ranged from about 3,000 to more than 30,000 spring–summer Chinook salmon, from a few hundred to nearly 33,000 fall Chinook salmon and from about 1,600 to more than 48,000 steelhead (Table 10). Approximate over-counts at Snake River dams were between 75 and 5,900 for spring–summer Chinook salmon, 100 and 3,000 for fall Chinook salmon and 2,100 and 13,000 for steelhead (Table 11). Numerically, the largest positive biases tended to be in 2001 and 2003, years with very large adult returns; biases were also quite high at some dams in 1997, the study year with the highest flow and spill levels and high fallback rates.

Influence of River Flow and Dam Spill on Fallback

Columbia River discharge during the seven study years varied widely and included one of the lowest-discharge years on record (2001), two high-discharge years (1997, 1996) and four near-average years (1998, 2000, 2002, 2003). Mean daily discharge at Bonneville Dam from April through July averaged $6,768 \text{ m}^3 \cdot \text{s}^{-1}$ from 1972 to 2001. April–July means were $9,289 \text{ m}^3 \cdot \text{s}^{-1}$ (137% of the 1972–2001 average) in 1996, $10,988 \text{ m}^3 \cdot \text{s}^{-1}$ (162%) in 1997, $7,250 \text{ m}^3 \cdot \text{s}^{-1}$ (107%) in 1998, $6,655 \text{ m}^3 \cdot \text{s}^{-1}$ (98%) in 2000, $3,483 \text{ m}^3 \cdot \text{s}^{-1}$ (51%) in 2001, $7,253 \text{ m}^3 \cdot \text{s}^{-1}$ (107%) in 2002, and $6,366 \text{ m}^3 \cdot \text{s}^{-1}$ (94%) in 2003. Peak discharge occurred in late May or early June in 1996, 1997, 1998 and 2003, in late April 2000 and in mid-May 2001; two peaks occurred in 2002, one in mid-April and a second in early June. Mean discharge typically drops to between 3,000 and 4,000 $\text{m}^3 \cdot \text{s}^{-1}$ by early September in all years, but was $\sim 5,000 \text{ m}^3 \cdot \text{s}^{-1}$ in fall 1997. Between-year differences in discharge at other Columbia and Snake River dams were proportionally similar to those at Bonneville Dam.

Daily flow and spill from April through July were strongly correlated at all dams in 1996, 1997 and 1998 with a mean correlation coefficient of 0.92 (*range* 0.82–0.99). In 2000, strong correlations between flow and spill existed at McNary Dam and at Snake River dams (mean correlation coefficient was 0.86, *range* 0.78–0.93), and correlations were weaker at Bonneville, The Dalles and John Day dams (mean correlation coefficient was 0.39, *range* 0.16–0.61) where spill was being manipulated as part of a large-scale experiment. In 2001, near-record low river flows resulted in no spill at Snake River dams and greatly reduced duration and volume of spill at Columbia River dams. In 2002, the mean flow-spill correlation was 0.84 (*range* 0.69–0.97) at Columbia River dams and was 0.65 (*range* 0.50–0.82) at Snake River dams. In 2003, correlations were higher at Snake River dams (*mean* = 0.86, *range* 0.73–0.94) and lower at Columbia River dams (*mean* = 0.69, *range* 0.43–0.93).

Table 12. Fish count adjustment factors (AF) with USACE estimated fishway escapement, adjusted estimated escapement and escapement bias for spring-summer Chinook, fall Chinook and steelhead at Columbia River dams in 1996-1998 and 2000-2001. USACE escapement estimates are based on 16 h counts from April through October and precocious males (jacks) are excluded.

Year	AF	USACE escapement	Adjusted escapement	Bias	AF	USACE escapement	Adjusted escapement	Bias
<u>Bonneville Dam</u>					<u>The Dalles Dam</u>			
<u>Spring-Summer Chinook</u>								
1996	0.863	67,527	58,276	9,251	0.845	36,900	31,181	5,719
1997	0.839	141,939	119,087	22,852	0.837	89,566	74,966	14,600
1998	0.871	59,775	52,064	7,711	0.870	40,687	35,398	5,289
2000	0.860	208,918	179,669	29,249	0.930	127,260	118,352	8,908
2001	0.934	467,523	436,666	30,857	0.924	375,374	346,846	28,528
2002	0.935	396,249	370,493	25,756	0.931	292,603	272,413	20,190
2003	0.943	306,818	289,329	17,489	0.923	231,212	213,409	17,803
<u>Fall Chinook</u>								
1998	0.999	189,085	188,896	189	0.941	92,932	82,524	10,408
2000	0.998	192,793	192,407	386	0.913	124,967	114,095	10,872
2001	0.961	400,205	384,597	15,608	0.919	181,316	166,629	14,687
2002	0.957	472,309	452,000	20,309	0.901	245,938	221,590	24,348
2003	0.954	607,670	579,717	27,953	0.895	313,697	280,759	32,938
<u>Steelhead</u>								
1996	0.992	205,213	203,571	1,642	0.937	162,447	152,213	10,234
1997	0.939	258,385	242,624	15,761	0.926	164,657	152,472	12,185
2000	0.965	351,370	339,072	12,298	0.930	205,241	188,616	16,625
2001	0.978	633,073	619,145	13,928	0.919	503,327	462,558	40,769
2002	0.958	480,309	460,136	20,173	0.898	387,920	348,352	39,568
2003	0.923	361,412	333,583	27,829	0.822	273,172	224,547	48,625
<u>John Day Dam</u>					<u>McNary Dam</u>			
<u>Spring-Summer Chinook</u>								
1996	0.864	30,481	26,336	4,145	0.904	32,934	29,772	3,162
1997	0.882	82,761	72,995	9,766	0.910	78,766	71,677	7,089
1998	0.892	38,046	33,937	4,109	0.907	35,641	32,326	3,315
2000	0.879	109,576	96,317	13,259	0.966	85,191	82,295	2,896
2001	0.968	328,363	317,855	10,508	0.988	326,603	322,684	3,919
2002	0.946	243,064	229,939	13,125	0.943	235,541	222,115	13,426
2003	0.954	195,307	186,323	8,984	0.970	186,512	180,917	5,595
<u>Fall Chinook</u>								
1998	0.963	78,237	75,342	2,895	0.984	63,791	62,770	1,021
2000	0.974	102,903	100,228	2,675	0.998	67,572	67,437	135
2001	0.973	124,747	121,379	3,368	0.961	110,517	106,207	4,310
2002	0.983	164,920	162,116	2,804	0.963	141,682	136,440	5,242
2003	0.980	215,501	211,191	4,310	0.966	178,951	172,867	6,084
<u>Steelhead</u>								
1996	0.895	156,924	140,447	16,477	0.925	124,177	114,864	9,313
1997	0.916	159,442	146,049	13,393	0.880	129,817	114,239	15,578
2000	0.957	220,328	210,854	9,474	0.913	130,332	118,993	11,339
2001	0.943	483,409	455,855	27,554	0.932	398,784	371,667	27,117
2002	0.954	390,300	372,346	17,954	0.946	286,805	271,318	15,487
2003	0.903	286,176	258,417	27,759	0.924	230,418	212,906	17,512

Table 13. Fish count adjustment factors (AF) with USACE estimated fishway escapement, adjusted estimated escapement and escapement bias for spring-summer Chinook, fall Chinook and steelhead at Snake River dams in 1996-1998 and 2000-2003. USACE escapement estimates are based on 16 h counts from April through October and precocious males (jacks) are excluded.

Year	AF	USACE escapement	Adjusted escapement	Bias	AF	USACE escapement	Adjusted escapement	Bias
<u>Ice Harbor Dam</u>					<u>Lower Monumental Dam</u>			
<u>Spring-Summer Chinook</u>								
1996	0.929	11,757	10,922	835	--	--	--	--
1997	0.904	50,594	45,737	4,857	0.944	47,632	44,965	2,667
1998	0.929	17,907	16,636	1,271	0.961	14,888	14,307	581
2000	0.891	43,391	38,661	4,730	0.956	40,200	38,431	1,769
2001	0.986	186,443	183,833	2,610	0.991	200,107	198,306	1,801
2002	0.947	111,596	105,681	5,915	0.974	99,781	97,187	2,594
2003	0.942	98,704	92,979	5,725	0.973	89,126	86,720	2,406
<u>Fall Chinook</u>								
1998	0.931	4,220	3,929	291	0.964	3,046	2,936	110
2000	0.970	6,652	6,452	200	0.909	5,447	4,951	496
2001	0.884	13,516	11,948	1,568	0.943	13,297	12,539	758
2002	0.890	15,248	13,571	1,677	0.969	15,193	14,722	471
2003	0.854	20,998	17,932	3,066	1.000	13,641	13,641	0
<u>Steelhead</u>								
1996	0.940	97,250	91,415	5,835	--	--	--	--
1997	0.947	102,900	97,446	5,454	0.953	85,602	81,579	4,023
2000	0.952	131,426	125,118	6,308	0.981	112,616	110,476	2,140
2001	0.954	283,694	270,644	13,050	0.967	252,923	244,577	8,346
2002	0.949	202,173	191,862	10,311	0.955	212,639	203,070	9,569
2003	0.948	186,474	176,777	9,697	0.978	172,596	168,799	3,797
<u>Little Goose Dam</u>					<u>Lower Granite Dam</u>			
<u>Spring-Summer Chinook</u>								
1996	--	--	--	--	0.989	6,814	6,739	75
1997	0.916	47,246	43,277	3,969	0.950	44,564	42,336	2,228
1998	0.941	14,810	13,936	874	0.953	14,209	13,541	668
2000	0.963	38,533	37,107	1,426	0.971	37,761	36,666	1,095
2001	0.985	191,036	188,170	2,866	0.995	185,693	184,765	928
2002	0.973	97,794	95,154	2,640	0.969	96,870	93,867	3,003
2003	0.972	83,107	80,780	2,327	0.984	86,695	85,308	1,387
<u>Fall Chinook</u>								
1998	0.739	2,032	1,502	530	0.667	1,908	1,273	635
2000	0.769	3,588	2,759	829	0.620	3,694	2,290	1,404
2001	0.873	10,550	9,210	1,340	0.954	8,915	8,505	410
2002	0.915	12,905	11,808	1,097	0.857	12,215	10,468	1,747
2003	0.935	13,950	13,043	907	0.964	11,595	11,178	417
<u>Steelhead</u>								
1996	--	--	--	--	0.912	85,129	77,638	7,491
1997	0.914	74,219	67,836	6,383	0.936	91,957	86,062	5,895
2000	0.949	101,030	95,877	5,153	0.966	113,211	109,362	3,849
2001	0.951	232,669	221,268	11,401	0.960	262,568	252,065	10,503
2002	0.949	203,494	193,116	10,378	0.965	218,718	211,063	7,655
2003	0.939	161,026	151,203	9,823	0.977	180,072	175,930	4,142

Annual fallback rates of spring–summer Chinook salmon for the seven study years were positively correlated with mean daily flow (from April to July) at all Columbia and Snake River dams (Figure 2). Linear regression models of mean daily flow ($\text{m}^3 \cdot \text{s}^{-1}$) and fallback rates were significant for The Dalles ($r^2 = 0.70$, $P = 0.018$), John Day ($r^2 = 0.72$, $P = 0.015$), McNary ($r^2 = 0.69$, $P = 0.020$), Lower Monumental ($r^2 = 0.74$, $P = 0.028$), and Little Goose ($r^2 = 0.99$, $P < 0.001$) dams and nearly so for Bonneville Dam ($r^2 = 0.52$, $P = 0.067$). The lower correlation for Bonneville Dam was likely a result of a shift in Powerhouse priority at that dam starting in 2001. The shift resulted in more flow directed to Powerhouse 2, and consequently more fish passed the dam via the Washington-shore ladder, where fallback rates have historically been lower than for fish that pass via the Bradford Island ladder (see Table 12). The two points that fall below the regression line for Bonneville Dam in Figure 2 were for the 2002 and 2003 migrations and reflect the response to the priority change. Fallback rate-flow models were non-significant for Ice Harbor ($r^2 = 0.20$, $P = 0.21$) and Lower Granite ($r^2 = 0.39$, $P = 0.13$) dams.

Fallback Routes at Bonneville Dam

From 2000 to 2003, our telemetry antenna arrays at Bonneville Dam provided sufficient resolution to determine specific routes of fallback. During three of these four years, more than 80% of spring–summer Chinook fallbacks were determined to have occurred via the spillway. The exception to this was 2001 when low river flows truncated amounts and periods of spill and only 32% of fallbacks were through the spillway with 34% and 17% occurring via the ice and trash spillway and the navigation lock, respectively. In the years other than 2001, between 6% and 12% of fallbacks occurred through the ice and trash sluiceway and between 2% and 4% occurred through the navigation lock.

Fall Chinook salmon fallback routes during these years were quite different than those of spring–summer Chinook, likely due to dam operations during their time of migration. Between 41% and 75% of all fall Chinook fallbacks likely occurred via the navigation lock with 4% to 15% occurring via the ice and trash sluiceway and 0 to 15% occurring via the spillway.

Steelhead fallback routes at Bonneville Dam were more variable between years than Chinook routes and we were unable to determine routes for a higher percentage of fallbacks likely due to their timing; many steelhead fallbacks occurred during winter months when our receivers were down for routine maintenance. During the four years, between 9% and 60% of all steelhead fallbacks were by undetermined routes. Nearly 84% of steelhead fallbacks occurred via the spillway in 2000 though after powerhouse priority had shifted to Powerhouse 2 in 2001, this percentage dropped to between 7 and 25% for the remaining three years. The ice and trash sluiceway and navigation lock accounted for between 2% and 11% and for between 7% and 37% of all fallback routes, respectively.

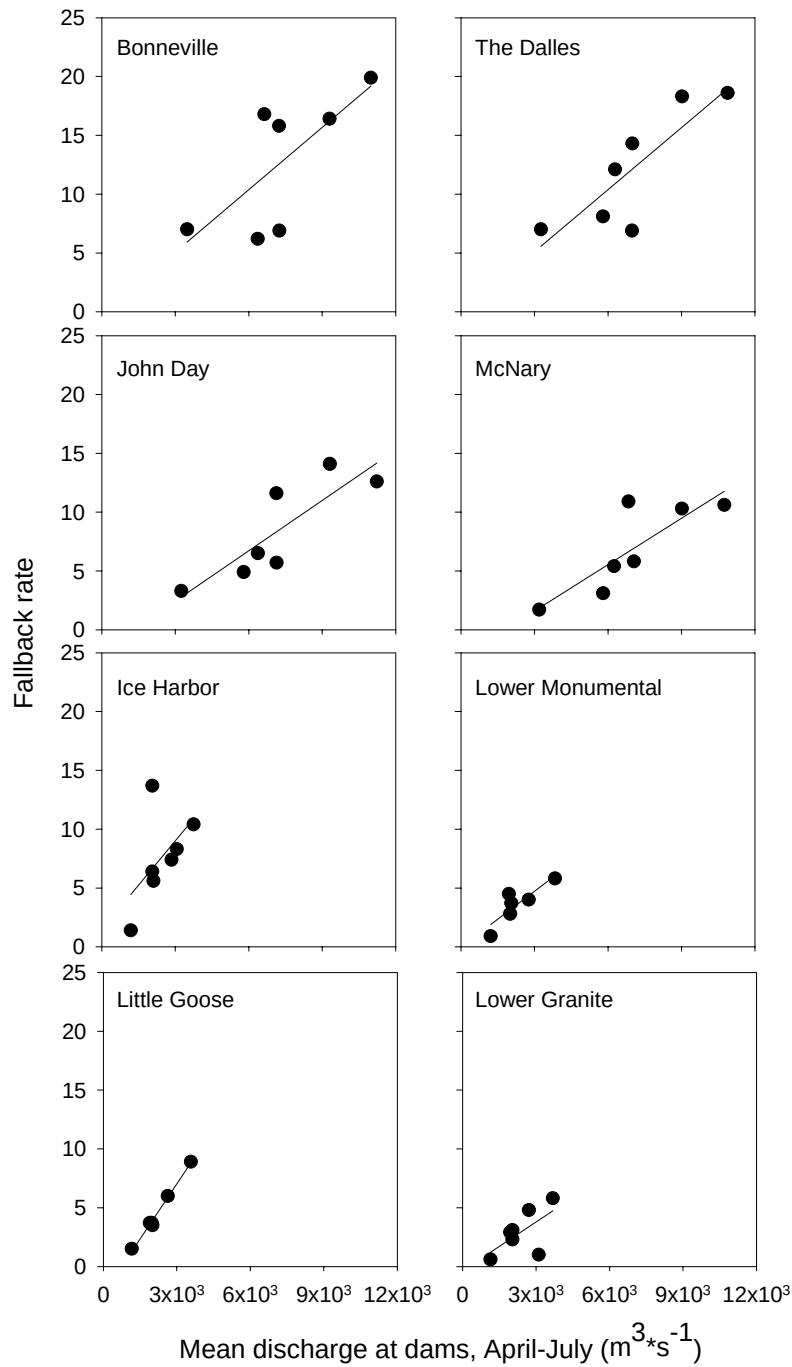


Figure 2. Linear regressions between annual fallback rates of spring-summer Chinook salmon at dams on the lower Columbia River (Bonneville, The Dalles, John Day, and McNary) and the lower Snake River (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) and mean April-July river discharge at each dam (1996-2003). The fallback rate (expressed as a percentage) was calculated as the total number of fallback events divided by the number of unique, radio-tagged fish known to have passed the dam.

Fishway Specific Fallback at Bonneville Dam

The Bradford Island and the Washington shore fishways at Bonneville Dam had significantly different fallback rates in thirteen of eighteen species-year combinations. Fallback rates for the two fishways were not significantly different during the 2001 spring–summer Chinook run, the 2002 and 2003 steelhead run and the 2001 and 2002 fall Chinook run. In all species-run combinations but two, the fallback rate for fish passing the Bradford Island fishway was higher than that for fish passing the Washington shore fishway (Table 14). Differences in spring–summer Chinook fallback rates between the two fishways averaged 15.8% from 1996 to 2000 and 2.4% from 2001 to 2003. Differences in steelhead fallback rates averaged 10.2% from 1996 to 2000 and 1.6% from 2001 to 2003.

Table 14. Fishway specific fallback rates for the Bradford Island (BI) fishway and the Washington shore (WA) fishway at Bonneville Dam for all runs of spring–summer Chinook salmon (CK), steelhead (SH), and fall Chinook salmon (FC) from 1996 to 2003 with Chi-square comparison of respective fallback rates.

	Unique fish To pass BI	Fallback events	BI fishway fallback rate	Unique fish To pass WA	Fallback events	WA fishway fallback rate
1996 CK	429	109	25.4*	416	23	5.5*
1997 CK	486	134	27.8*	522	53	10.2*
1998 CK	533	105	19.7*	441	40	9.1*
2000 CK	559	128	22.9*	376	29	7.7*
2001 CK	338	17	5.0	427	33	7.7
2002 CK	375	35	9.3**	496	25	5.0**
2003 CK	398	38	9.8*	681	28	4.1*
1996 SH	367	32	8.7*	334	6	1.8*
1997 SH	492	74	15.0*	412	14	3.4*
2000 SH	382	52	13.6*	402	6	1.5*
2001 SH	308	24	7.8*	449	11	2.4*
2002 SH	381	16	4.2	487	20	4.1
2003 SH	233	18	7.7	318	27	8.5
1998 FC	410	18	4.4*	478	13	2.7*
2000 FC	385	22	5.7**	245	4	1.6**
2001 FC	206	13	6.3	303	14	4.6
2002 FC	283	13	4.6	385	10	2.6
2003 FC	211	16	7.6*	365	10	2.7*

* Chi-square $P < 0.01$, ** Chi-square $P < 0.05$

Average fallback rates for fall Chinook at the two fishways during these two time periods were the same at 2.9%. The proportion of radio-tagged fish to pass Bonneville Dam using the two fishways also shifted during these two time periods with radio-tagged

spring–summer and fall Chinook and steelhead passing the two fishways at approximately a 1:1 ratio from 1996 to 2000. From 2001 to 2003, the ratio of Bradford Island passages to Washington shore passages changed to approximately 2:3 (Table 14). The changes in the difference of average fallback rates and of the ratio of fishway use coincide with shifts in priority between the two Bonneville Dam powerhouses during these time frames. Previous to 2001, the powerhouse located adjacent to the Bradford Island fishway (Powerhouse I) discharged higher volumes of water than the fishway located adjacent to the Washington shore fishway (Powerhouse II). During and after 2001, this was reversed with Powerhouse II discharging the majority of flow.

Discussion

The percentage of upriver-migrating salmon and steelhead that fall back at lower Columbia and Snake River dams varies widely depending on the run, species and project involved and river conditions when fish are migrating. In terms of salmon and steelhead fallback behavior, each dam on the Columbia and Snake rivers is unique; physically as a structure, operationally as a combination of river inflow, dam spill and turbine discharges at any given time, and geographically in its location relative to the natal spawning tributaries and hatcheries to which fish are returning. These factors and the timing, size and composition of anadromous fish runs appear to influence fallback behavior at dams. For example, a large return run to the Umatilla or John Day rivers could result in high fallback percentages at McNary Dam—the project just upstream from those tributaries—through increased overshoot fallback.

With a few exceptions, percentages of spring–summer Chinook that fell back were highest at Bonneville Dam and decreased at progressively upstream dams, with years characterized by high river flows (1996 and 1997) having higher percentages of fallback fish. Spring–summer Chinook migration overlaps with peak river discharge and fallback by this run appears to be most influenced by flow levels and associated forced spill at dams. As the spring–summer Chinook salmon migration proceeds upriver and snowmelt runoff ebbs in mid summer, portions of the run are exposed to decreasing river flow and spill, the dams the run is passing become smaller and less complex and the number of proximate tributaries fish could overshoot become fewer, all of which would be expected to decrease overall fallback percentages at upstream dams. Most steelhead enter the lower Columbia River in summer and fall when discharge is low (Robards and Quinn 2002) and many steelhead pass dams between September and November after spill conditions have typically ceased. Lower flow and reduced or no-spill conditions may account for the lower between-year variation in fallback percentages for steelhead and fall Chinook salmon we observed compared to spring–summer Chinook salmon. Fall Chinook salmon also migrate after peak river flows and the majority of this run pass dams after spill has ceased. Fall Chinook salmon fallback percentages were more variable at Snake River dams, possibly reflecting searching behaviors by Hanford Reach and Lyons Ferry Hatchery stocks, though sample sizes were small.

Fall Chinook salmon were the most likely to enter a downstream tributary or hatchery after falling back. Based on final records at downstream tributaries or hatcheries, about 47% of the fall Chinook that fell back at The Dalles, John Day and McNary dams may have passed natal tributary spawning sites and fell back in an effort to return. With all years combined, 20 of 28 (71%) fall Chinook that fell back at Ice Harbor Dam were later located in the Umatilla or Yakima rivers or in the Hanford Reach of the Columbia River and most fall Chinook salmon that fell back at Little Goose and Lower Granite dams returned downstream to these same spawning areas or to Lyons Ferry Hatchery. Overshoot behavior was also apparent but to a lesser degree by spring–summer Chinook salmon and steelhead. Fourteen to 35% of spring–summer Chinook salmon and 5 to 29% of steelhead that fell back at The Dalles, John Day and McNary dams entered tributaries downstream from these projects, including the Klickitat, Deschutes, John Day and Umatilla rivers. It is likely not all of these fish were destined to return to the drainages or hatcheries where they were last located but had strayed into them either temporarily or permanently. Permanent straying rates (spawning at non-natal sites) have not been well documented for most Columbia basin stocks, but estimates for fall Chinook salmon have ranged from less than 2% (Quinn and Fresh 1984) to more than 25% (Quinn et al. 1991). Temporary straying rates (entering non-natal spawning areas before resuming migration) are likely higher than permanent straying rates, particularly for steelhead and fall Chinook salmon that seek thermal refugia during summer (Gonia 2002; High 2002; Keefer et al. 2002). From 2000 to 2003, many of the spring–summer Chinook salmon and steelhead we radio-tagged at Bonneville Dam were PIT-tagged as juveniles providing information on adult destinations. Telemetry records for these fish indicated a mean of 2.2% of spring–summer Chinook (*range* 1.6% in 2001 to 4.5% in 2000) and 6.8% of steelhead (*range* 6.1% in 2002 to 9.1% in 2000) were last detected in major tributaries other than their natal spawning area (University of Idaho, *unpublished data*). It is likely some of these fish had strayed temporarily into lower reaches of non-natal drainages and were harvested before they resumed migration. When corrected for fish known harvested in non-natal drainages, the pooled spring–summer Chinook salmon straying rate dropped to 1.4% and pooled steelhead straying rate dropped to 4.7%. These relatively low estimates of total straying rates suggest most of the fish falling back at dams and entering downstream tributaries are destined to return to these drainages.

By selecting returning adult fish that had been PIT tagged as juveniles for radio-tagging, we were able to detect differences in fallback behavior by groups of Columbia Basin salmon and steelhead stocks. Given the small numbers of returning known-source adults, in some cases pooling of sub-basin stocks was necessary to achieve adequate sample sizes. Most of the fallback percentages for Yakima River and Mid Columbia spring–summer Chinook salmon were very low with four-year means for the dam-group combinations not exceeding 2%. This may be due in part to the majority of these stocks being summer Chinook and their peak migration being later in the season after river flow has begun dropping. The Wind River group fell back at Bonneville Dam only, though at relatively high percentages, the majority of these were likely overshoot fallbacks. Fallback percentages for transported Snake River spring–summer Chinook were higher than non-transported spring–summer Chinook in every dam-year combination and four-year mean percentages by dam were from nearly three to thirteen times greater for

transported versus non-transported salmon. Considering that these two groups are migrating concurrently, it is not likely these differences are caused by operational or physical disparities. Known-source steelhead behaved similarly with both Mid Columbia and non-transported Snake River groups falling back at low percentages and transported Snake River steelhead fallback percentages being at least three times greater. We hypothesize that the transportation of migrating juveniles somehow disrupts the sequential imprinting necessary for their efficient homing to spawning tributaries. While permanent straying rates are low, it appears many returning adult salmon and steelhead that were transported as juveniles have increased wandering and searching behavior in the lower Columbia River which, in turn, increases their likelihood of falling back.

We were able to determine a last location for most fallback fish, but about 19% of spring–summer Chinook salmon, 30% of fall Chinook salmon and 34% of steelhead that fell back were not recorded in tributaries or reported recaptured at hatcheries or in fisheries. These fish may have been fallback-related or migration-related mortalities, could have been captured in fisheries and not reported to us, may have entered tributaries undetected, or may have spawned at mainstem sites. It is possible that some fallback fish with unknown final fates regurgitated transmitters in deep water, where radio signals are attenuated (Eiler 1990). Steelhead in this study had the highest detected transmitter regurgitation rates, perhaps because their migration was more protracted than for Chinook salmon runs (Keefer et al. 2004b). Some fall Chinook salmon with unknown fates may have spawned at mainstem sites, though we suspect this number is low. Limited fall Chinook spawning has been documented in tailrace sites at Snake River dams (Dauble et al. 1999), but few redds have been found and this behavior has proven difficult to verify with radio telemetry (Mendel and Milks 1995).

In all years of this study, lower proportions of Chinook salmon and steelhead that fell back at Bonneville Dam escaped to tributaries, hatcheries, or past Lower Granite or Priest Rapids dams than fish that did not fall back (Bjornn et al. 2000b; Boggs et al. 2004a). System-wide, harvest-adjusted escapement estimates averaged 6.5% (*range* 3.0-9.7%) lower for fallback spring–summer Chinook salmon, 19.5% (*range* 11.2-25.9%) lower for fallback fall Chinook salmon, and 13.3% (*range* 7.8-20.2%) lower for fallback steelhead, when compared to fish that did not fall back during migration (Keefer et al. 2004c). Patterns of significantly lower escapement for fallback fish were observed for both known-source stocks and unknown-source random samples. Research into the relationships between fallback and escapement is ongoing, with increased emphasis on spawning success rather than simply escapement beyond the monitored hydrosystem. The lower escapements we observed for fish that fell back suggest that either the physical trauma of the fallback event, migration delay related to fallback (Keefer et al. 2004a), or increased exposure to fisheries or marginal environmental conditions such as gas-supersaturated tailrace waters (Backman and Evans 2002) may reduce adult survival. It is also possible that fish that fall back are less physically fit upon system entry than those that do not fall back, and investigation of this possibility is recommended. In any case, fallback and reascension behavior at dams is almost certainly bioenergetically expensive and may exhaust energy reserves for some fish, much like delay at dams (Geist et al.

2000), long migrations (Bernatchez and Dodson 1987), or difficult passage areas (Hinch et al. 1996).

Our results indicate that high river flow and associated high spill volumes at dams increase the percentages of fish that fall back at dams. Fallback rates of spring–summer Chinook salmon in particular were strongly correlated with mean seasonal river flow at Columbia and Snake River dams. This influence was evident in 2001, when near-record low river flows resulted in only 70 days of spill at Bonneville Dam (10 y *mean* = 136 days) and annual fallback percentages at the dam were roughly one third those observed in most other study years. Another period of no spill occurred at Bonneville Dam in April of 1998 during which 7 of 152 (4.6%) spring–summer Chinook salmon that passed the dam fell back. During the remainder of the spring–summer Chinook salmon migration that year, spill occurred (up to 150 kcfs) and 139 of 898 (15.5%) spring–summer Chinook salmon fell back. Reischel and Bjornn (2003) also reported significant positive correlations between fallback by Chinook and sockeye salmon and spill volume at Bonneville Dam in 1997 and 1998, when most fallback events occurred via the dam spillway. Ongoing research into the relationship between fallback, river flow and dam spill includes experimental manipulation of spill volume at Bonneville, The Dalles and John Day dams in 2002 and 2003.

Generally speaking, when spill is occurring at a dam the vast majority of fallback events will occur via the spillway. Migrating salmonids are rheotactic and when large volumes of water are being passed through spillways this route of fallback is likely to predominate. At Bonneville Dam from 2000 to 2003 we were able to determine routes for most fallbacks by Chinook salmon and steelhead. More than 80% of spring–summer Chinook fallbacks occurred via the spillway in all years but 2001, the year of near-record low flows and reduced periods of spill. Spring–summer Chinook migration overlaps with peak river flows and in most years spill is occurring throughout their entire migration period. Only the first part of fall Chinook and steelhead migrations experience spill conditions at dams, these generally exist from April through August. This results in a smaller proportion of total fallback to occur via the spillway, though when the spillway is available as a fallback route it is used disproportionately to other available, albeit smaller scale, routes.

Percentages of salmon and steelhead runs that fall back may also be influenced by dam operations other than spill, including activities that attract (or deter) upstream migrants to different fishways. For example, increasing the discharge of turbines or spill bays near the entrances to a fishway can affect the total proportion of the fish run attracted to that fishway (Bjornn and Peery 1992) and also affect the behavior of migrants in the forebay of the dam after fishway exit (Boggs et al. 2004b). At Bonneville Dam, fish that pass via the Bradford Island fishway have historically fallen back at much higher rates than those that pass the dam's other fishway, located on the Washington shore (Bjornn and Peery 1992). When the proportion of fish passing via the Bradford Island fishway increases, total dam fallback percentages also increase because many fish exiting this fishway follow the Bradford Island shoreline directly into the spillway forebay (Reischel and Bjornn 2003). During the spring–summer Chinook migration of 2000, Bonneville Dam's

Powerhouse I, adjacent to Bradford Island and its fishway, discharged significantly more water than Powerhouse II, located adjacent to the Washington shore fishway. About 60% of radio-tagged spring–summer Chinook and 50% of radio-tagged steelhead passed the Bradford Island fishway during that year. In 2001, powerhouse priority had switched with the majority of turbine discharge occurring through Powerhouse II. As a result, about 45% of radio-tagged Chinook passage and 41% of radio-tagged steelhead passage occurred through the Bradford Island fishway (Boggs et al. 2004a).

Fallback and reascension at dams can significantly reduce the accuracy of fishway counts (Blankenship and Mendel 1993; Dauble and Mueller 2000). Lack of precision in fish counts has raised concerns that the use of count data for escapement estimates or harvest management could harm ESA-listed stocks such as threatened Snake River fall and spring–summer Chinook salmon or endangered upper Columbia River spring Chinook salmon (Dauble and Mueller 2000). The largest biases we detected were for fall Chinook salmon at Little Goose (23%) and Lower Granite (38%) dams in 2000. Biases in spring–summer Chinook salmon counts at Bonneville Dam ranged from almost 6% in 2003 to 16% in 1997. Biases between 5 and 15% were common with all runs at most other dams. Because we did not tag fall Chinook in August 1998 or summer Chinook in July 1996, count adjustments for those runs may be less accurate than for other species-years.

The count adjustments we calculated using pooled telemetry data should be considered approximate because passage through navigation locks was not monitored at most dams, fallback and reascension rates varied through time and radio-tagged samples were small for some groups (e.g., fall Chinook salmon at Snake River dams) and also varied through time. However, adjustment factors should be reasonably accurate: we found that pooled estimates minimized the impact of within-year variability in adjustment calculations and were similar to stratified, weighted count adjustments for Bonneville, The Dalles, and John Day dams where fallback rates were highest and most variable (Bjornn et al. 2000a; 2000b; 2000c). It would be inappropriate to apply the pooled estimates provided here, which included all stocks within each annual run, to temporally separated sub-basin stocks within a run (e.g. Keefer et al. 2004d), as each stock could be exposed to divergent river environments and have differing fallback responses. More fine-scale adjustments should be used for evaluating the impacts of fallback on specific stocks or to assess specific management activities at dams.

Radio-telemetry has been the most reliable method for obtaining fallback and reascension estimates. Recent innovations in passive integrated transponder (PIT) tag technology, such as the increase in detection range that allows for detector deployment in fishways and near counting windows, could provide fallback data for addressing count biases. However, PIT technology cannot identify fish that fall back and do not reascend and, because PIT-tag detectors lack the resolution of radio-telemetry, cannot determine specific routes of fallback (B. Burke, *personal communication*).

In conclusion, dam operation, river environment and adult salmon and steelhead migration behaviors (i.e. searching for natal sites) all appear to contribute to fallback at Columbia and Snake River hydroelectric dams. The consequences of fallback, in terms

of direct or delayed mortality, escapement to spawning sites, spawning success and permanent inter-basin straying, appear to be costly for some fish, including listed stocks from each run studied. Managers of anadromous Columbia basin fisheries and operators of hydroelectric projects should focus on strategies to reduce unintentional fallback, and also work to facilitate benign downstream passage for adult fish, including “overshoot” pre-spawn migrants and post-spawn out-migrants such as steelhead kelts.

References

- Backman, T.W.H., and A.F. Evans. 2002. Gas bubble trauma incidence in adult salmonids in the Columbia River basin. *North American Journal of Fisheries Management* 22:579-584.
- Bernatchez, L. and J.J. Dodson. 1987. Relationship between bioenergetics and behavior in anadromous fish migrations. *Canadian Journal of Fisheries and Aquatic Sciences* 44:399-407.
- Bjornn, T.C., and C.A. Peery. 1992. A review of literature related to movements of adult salmon and steelhead past dams and through reservoirs in the Lower Snake River. U.S. Fish and Wildlife Service and Idaho Cooperative Fish and Wildlife Research Unit. U.S. Army Corps of Engineers, Walla Walla, Washington.
www.cnr.uidaho.edu/coop/download.htm
- Bjornn, T.C., K.R. Tolotti, J.P. Hunt, P.J. Keniry, R.R. Ringe, and C.A. Peery. 1998. Passage of Chinook salmon through the lower Snake River and distribution into the tributaries. Part I of the final report for: Migration of adult Chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and tributaries. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, for the U.S. Army Corps of Engineers, Walla Walla, Washington.
www.cnr.uidaho.edu/coop/download.htm
- Bjornn, T.C., M.L. Keefer, C.A. Peery, K.R. Tolotti, R.R. Ringe, and L.C. Stuehrenberg. 2000a. Adult Chinook and sockeye salmon, and steelhead fallback rates at Bonneville Dam, 1996-1998. Technical Report 2000-1. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho for the U.S. Army Corps of Engineers, Portland, Oregon. www.cnr.uidaho.edu/coop/download.htm
- Bjornn, T.C., M.L. Keefer, C.A. Peery, M.A. Jepson, K.R. Tolotti, R.R. Ringe, and L.C. Stuehrenberg. 2000b. Adult Chinook and sockeye salmon, and steelhead fallback rates at The Dalles Dam, 1996, 1997, and 1998. Technical Report 2000-2. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho for the U.S. Army Corps of Engineers, Portland, Oregon.
www.cnr.uidaho.edu/coop/download.htm
- Bjornn, T.C., M.L. Keefer, C.A. Peery, K.R. Tolotti, M.A. Jepson, R.R. Ringe, and L.C. Stuehrenberg. 2000c. Adult Chinook and sockeye salmon, and steelhead fallback rates at John Day Dam, 1996, 1997, and 1998. Technical Report 2000-3. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho for the U.S. Army Corps of Engineers, Portland, Oregon.
www.cnr.uidaho.edu/coop/download.htm

- Bjornn, T.C., K.R. Tolotti, J.P. Hunt, P.J. Keniry, R.R. Ringe, and C.A. Peery. 2002. Passage of steelhead through the lower Snake River and distribution into the tributaries, 1991-1994. Part 2 of final report for: Migration of adult Chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, for the U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington. www.cnr.uidaho.edu/coop/download.htm
- Blankenship, H.L. and G.W. Mendel. 1994. Upstream passage, spawning, and stock identification of fall Chinook salmon in the Snake River, 1992. Bonneville Power Administration, Division of Fish and Wildlife Report DOE/BP-60415-1.
- Boggs, C.T., M.L. Keefer and C.A. Peery. 2004a. Adult Chinook salmon and steelhead fallback at Bonneville Dam, 2000-2001. Technical Report 2004-1. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, for the U.S. Army Corps of Engineers, Portland and Walla Walla Districts, Portland, Oregon. www.cnr.uidaho.edu/coop/download.htm
- Boggs, C.T., M.L. Keefer, K.R. Tolotti, C.A. Peery and T.C. Bjornn. 2004b. Migration behavior of adult chinook salmon and steelhead released in the forebay of Bonneville Dam, 2000-2001. Technical Report 2004-7. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, for the U.S. Army Corps of Engineers, Portland District, Portland, Oregon. www.cnr.uidaho.edu/coop/download.htm
- Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-27.
- Dauble, D.D., R.L. Johnson, and A.P. Garcia. 1999. Fall Chinook salmon spawning in the tailraces of lower Snake River hydroelectric projects. Transactions of the American Fisheries Society 128:672-679.
- Dauble, D.D., and R.P. Mueller. 2000. Difficulties in estimating survival for adult Chinook salmon in the Columbia and Snake rivers. Fisheries 25(8):24-34.
- Eiler, J.H. 1990. Radio transmitters used to study salmon in glacial rivers. American Fisheries Society Symposium 7:364-369.
- Geist, D.R., C.S. Abernethy, S.L. Blanton, and V.I. Cullinan. 2000. The use of electromyogram telemetry to estimate energy expenditure of adult fall Chinook salmon. Transactions of the American Fisheries Society 129:126-135.
- Gonia, T.M. 2002. Temperature influenced migratory behavior and use of thermal refuges by upriver bright fall Chinook salmon. Masters thesis, University of Idaho, Moscow.

- Groot, C., and L. Margolis, editors. 1991. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia, Canada.
- High, B. 2002. Effect of water temperature on adult steelhead migration behavior and survival in the Columbia River basin. Master's thesis. University of Idaho, Moscow, ID.
- Hinch, S.G., R.E. Diewart, T.J. Lissimore, A.M.J. Prince, M.C. Healey, and M.A. Henderson. 1996. Use of electromyogram telemetry to assess difficult passage areas for river-migrating adult sockeye salmon. Transactions of the American Fisheries Society 125:253-260.
- Keefer, M.L., T.C. Bjornn, C.A. Peery, K.R. Tolotti, R.R. Ringe, P.J. Keniry, and L.C. Stuehrenberg. 2002. Migration of adult steelhead past Columbia and Snake River dams, through reservoirs and distribution into tributaries, 1996. Technical Report 2002-2. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho for the U.S. Army Corps of Engineers, Portland, Oregon.
www.cnr.uidaho.edu/coop/download.htm
- Keefer, M.L., C.A. Peery, T.C. Bjornn and M.A. Jepson. 2004a. Hydrosystem, dam, and reservoir passage rates of adult chinook salmon and steelhead in the Columbia and Snake rivers. Transactions on the American Fisheries Society 133: 1413-1439.
- Keefer, M.L., C.A. Peery, R.R. Ringe, and T.C. Bjornn. 2004b. Regurgitation rates of intragastric radio transmitters by adult Chinook salmon and steelhead during upstream migration in the Columbia and Snake rivers. North American Journal of Fisheries Management 24; 47-54.
- Keefer, M.L., C.A. Peery, W.R. Daigle, M.A. Jepson, S.R. Lee, C.T. Boggs, K.R. Tolotti, and T.C. Bjornn. 2004c. Escapement, harvest and unaccounted-for loss of radio-tagged adult chinook salmon and steelhead in the Columbia-Snake River hydrosystem, 1996-2002. U.S. Geological Survey, Idaho Cooperative Fish and Wildlife Research Unit. University of Idaho, Moscow, Idaho 83844-1141 for the U.S. Army Corps of Engineers, Portland District, Portland, Oregon.
- Keefer, M.L., C.A. Peery, M.A. Jepson, K.R. Tolotti, and L.C. Stuehrenberg. 2004d. Stock-specific migration timing of adult spring-summer Chinook salmon in the Columbia River basin. North American Journal of Fisheries Management 24:1145-1162.
- McCutcheon, C.S., E.F. Prentice, and D.L. Park. 1994. Passive monitoring of migrating adult steelhead with PIT tags. N. Am. J. Fish. Manage. 14: 220-223.

- Mellas, E.J., and J.M. Haynes. 1985. Swimming performance and behavior of rainbow trout (*Salmo gairdneri*) and white perch (*Morone americana*): effects of attaching telemetry transmitters. *Canadian Journal of Fisheries and Aquatic Sciences* 42:488-493.
- Mendel, G. and D. Milks. 1995. Upstream passage and spawning of fall Chinook salmon in the Snake River. Washington Department of Fish and Wildlife, Hatcheries Program, Olympia, Washington.
- Monan, G.E., and K.L. Liscom. 1975. Radio tracking studies to determine the effects of spillway deflectors and fallback on adult Chinook salmon and steelhead trout at Bonneville Dam, 1974. National Marine Fisheries Service, Northwest Fisheries Center, Seattle.
- Monan, G.E., and K.L. Liscom. 1979. Radio tracking studies relating to fallback at hydroelectric dams on the Columbia and Snake rivers. Pages 39-53 in *Fifth Progress Report on Fisheries Engineering Research Program 1973-1978*. U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.
- Quinn, T.P., and K. Fresh. 1984. Homing and straying in Chinook salmon (*Oncorhynchus tshawytscha*) from Cowlitz River Hatchery, Washington. *Canadian Journal of Fisheries and Aquatic Sciences* 41:1078-1082.
- Quinn, T.P., R.S. Nemeth, and D.O. McIsaac. 1991. Homing and straying patterns of fall Chinook salmon in the lower Columbia River. *Transactions of the American Fisheries Society* 120:150-156.
- Reischel, T.S. and T.C. Bjornn. 2003. Influence of fishway placement on fallback of adult salmon at Bonneville Dam on the Columbia River. *North American Journal of Fisheries Management* 23:1214-1223.
- Ricker, W.E. 1972. Hereditary and environmental factors affecting certain salmonid populations. In R.C. Simon and P.A. Larkin (eds.), *The stock concept in Pacific salmon*. p. 27-160. H.R. MacMillan Lectures in Fisheries, Univ. British Columbia, Vancouver, B.C.
- Robards, M.D., and T.P. Quinn. 2002. The migratory timing of adult summer-run steelhead in the Columbia River over six decades of environmental change. *Transactions of the American Fisheries Society* 131:523-536.

- Stuehrenberg, L.C., G.A. Swan, L.K. Timme, P.A. Ocker, M.B. Eppard, R.N. Iwamoto, B.L. Iverson, and B.P. Sandford. 1995. Migrational characteristics of adult spring, summer, and fall Chinook salmon passing through reservoirs and dams of the mid-Columbia River. Coastal Zone and Estuarine Studies Division, Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle WA. Final Report. 117 p.
- U.S. Army Corps of Engineers (USACE). 2001. Annual fish passage report. U.S. Army Engineer Districts, Portland, Oregon and Walla Walla, Washington.
- Wagner P. and T. Hilsen. 1992. 1991 evaluation of adult fallback through the McNary Dam juvenile bypass system. Washington Department of Fisheries, Habitat Management Division, Olympia, WA.
- Zar, J. 1999. Biostatistical Analysis. Fourth addition. Prentice Hall Press, New Jersey.

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday May 2, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 6015

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review April 13, 18, Meeting Minutes
3. Spring Creek Hatchery Release - Doug Baus, COE-NWD
4. Vernita Bar Update - Russell Langshaw, Grant County PUD
 - a. [Program Update](#)
5. Operations Review
 - a. Reservoirs
 - b. Fish

- c. Water Quality
- d. Power System
- 6. Other
 - a. Set agenda and date for next meeting - **May 9, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

May 2, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Meeting Minutes/Facilitator's Notes Review

TMT members did not offer edits to the 4/13 Official Minutes, so they were considered final today. More time was needed to review 4/18 notes – these and the 4/25 and 4/27 notes will be finalized at the next face to face TMT meeting.

Spring Creek Hatchery Release/Bonneville Operations

Doug Baus, Corps, reported that the Spring Creek Hatchery fish had arrived at Bonneville about 10.5 hours after their release on 4/30. According to a 5/1 report, from 2200 hours on 4/30 to 0700 hours on 5/1, the fish were found to be in 'excellent' condition and of 675 sampled, there was 1 mortality, no descaling and 1 injury. Dave Wills, USFWS, added that from 0700 hours on 5/1 to 0700 hours on 5/2, 176 fish were sampled and there was 1 mortality, no descaling and no injuries. The Fish Passage Center also reported that as of today, 101,000 fish had passed Bonneville. Doug and Tony Norris, BPA, said the powerhouses so far have been operated to meet the salmon managers' recommendation and TMT agreement made on 4/27. Tony will be providing a full account of actual operations to the USFWS upon conclusion of the operation. The operation was intended to continue until Friday or when all the fish were past the project, whichever occurred sooner.

Paul Wagner, NOAA, raised a concern that adult passage at Bonneville had seen a recent drop in numbers which were much lower than the average for this time of year. He said studies have indicated that during high flows above 130 kcfs spill (the project was currently releasing 190 kcfs spill), adults tend to delay, and currently, sea lion predation below the dam is a concern. Given this, Paul requested that TMT consider a special one day operation 'test' at Bonneville to determine whether operating Bonneville at lower flows could influence adult passage. It would involve reducing spill to about 110 kcfs during the period 0500-0900 hours when adults typically stage and begin their movement. Paul said his preference (and that of the other salmon managers) would be to accommodate this request with minimal to no impact on the Spring Creek Hatchery operation currently in place.

TMT discussed this recommendation and identified potential impacts which included:

- Impact to the Spring Creek hatchery operation/safe passage for the hatchery fish.
- Impact on debris build-up at the project with potential for having to remove fish screens; and impact on debris downstream of the project.
- Impact to treaty fishing near Bonneville, given changes in forebay and tailwater elevations.
 - Bill Proctor, Corps RCC Chief, discussed with Tom Lorz, CRITFC/CTUIR, how the operation could be managed to minimize elevation fluctuations, and they

determined that if the operation would not exceed a 2 foot pool elevation change, tribal fishing would not be adversely impacted. Tom added that he would need to give the tribes a heads up and inquire as to any concerns. The Action Agencies said they would not implement this operation if it has any potential adverse impacts on the treaty fishery.

Considering these potential impacts and the action agencies' ability to coordinate and implement the operation from an operator's perspective, TMT discussed options for the timing of the operation. While starting Friday or later would allow time for most if not all of the Spring Creek fish to pass, Thursday was identified as a preferred option because the operation could be implemented while still meeting the specifications of operating Powerhouses 1 and 2 for the Spring Creek release, and crews would be at the project to help manage and monitor conditions.

TMT members were polled on their level of agreement for implementing NOAA's request for operating Bonneville at 110 kcfs from 0500-0900 hours on Thursday, 5/3:

- o Oregon – Ok
- o Idaho – Ok
- o Washington – OK
- o Montana – Ok
- o Nez Perce – Ok
- o CTUIR – Ok so long as no adverse impacts on the current treaty fishery
- o Colville – Ok
- o USFWS – No objection
- o NOAA – Supports the operation – appreciates the action agencies' coordination efforts to implement the request
- o Reclamation – Ok
- o BPA – Ok
- o Corps – Ok

Action/Operation: Tom Lorz, CRITFC/CTUIR, will talk with the tribal fishers and make sure this operation does not cause any serious concerns to the treaty fishery. He will coordinate with Doug Baus at the Corps. Assuming no problems for tribal fishing, the Corps planned to implement the operation as specified above. TMT will reconvene for a brief phone conference on Friday, 5/4 at 1:00 PST to debrief the operation and determine a path forward.

Lower Monumental Operations

Paul Wagner, NOAA, observed that flows at Lower Monumental are in the transition period between spill patterns (140 kcfs and above using uniform pattern and 140 kcfs and below using bulk pattern). The salmon managers had discussed this issue during FPAC and recommended the Corps continue with the uniform pattern over the next week to minimize already elevated gas levels in the system. TMT reviewed the language in the Fish Operations Plan and agreed that this recommendation would align with guidance in the FOP:

‘Consistent with adjustments made in 2011 spring operations through regional coordination, when total river flow is likely to exceed turbine capacity and spill over the 120% TDG gas cap

(occurs at a total river flow of ~140 kcfs) for three or more days, the project will use the uniform spill pattern. This may also occur if spill over the 120% TDG gas cap is required due to “lack of demand” spill at any river flow level.’

Action/Operations Plan: The Corps will continue to operate Lower Monumental using the uniform spill pattern in accordance with the Fish Operations Plan.

Vernita Bar Update

Russell Langshaw, Grant County PUD, provided a brief update on Hanford Reach operations. He said the operation is still on track, with 6/19 estimated completion date. Average outflows have been 203 kcfs with 67 kcfs as the mean daily delta. Priest Rapids has operated at a minimum 150 kcfs (159.5 kcfs on the weekends) and there have been no exceedances. Fish numbers are expected to pick up soon. Russell will provide an update to TMT at the 5/16 TMT meeting.

Operations Review

Reservoirs – John Roache reported on Reclamation projects. Grand Coulee was at elevation 1238.1 feet and managing refill to accommodate the expected peak freshet yet to come. Hungry Horse was at elevation 3532.5 feet, with 9.2 kcfs outflows. In response to a question, John said with the current transmission limitations, the project is able to release about 9-10 kcfs through the power plant. Lisa Wright reported on Corps projects. Libby was at elevation 2391.2 feet, with 28.5 kcfs inflows and 13.4 kcfs outflows. Albeni Falls was operating at free flow, at elevation 2059.3 feet with 83.4 kcfs inflows and 78.3 kcfs outflows. Priest Rapids inflows were 256.8 kcfs. Dworshak was at elevation 1533.5 feet, with 22.7 kcfs inflows and 14.4 kcfs outflows. Inflows at Lower Granite were 137.1 kcfs; at McNary were 408.2 kcfs; and at Bonneville were 409.9 kcfs.

Fish – Paul Wagner, NOAA, reported on fish passage. Juvenile yearling Chinook and steelhead are seeing an early peak run, both with highest passage numbers at Lower Granite on 4/26. Subyearling Chinook at Bonneville have seen a peak passage count of 359,000/day. Sockeye counts were 636 at Lower Granite on 4/30; Russ Kiefer, Idaho, added that 24 PIT-tagged fish from the Red Fish Lake Creek were counted at Lower Granite – a good migration sign. Lamprey counts at McNary were 6,000 and at John Day were 9,500.

Transportation – Given the above information and the early and fast travel time of the fish runs, Paul recommended a slight adjustment to the transportation operations schedule. Lower Granite collection began on 5/1 and the fish were transported on 5/2. Paul recommended that collection start on 5/3 at Little Goose and on 5/5 at Lower Monumental.

Action: Doug Baus, Corps, reported on behalf of Walla Walla District that they are able to accommodate this schedule change and will proceed with operations as specified above.

Power System – Tony Norris, BPA, reported that there has been lack of market spill and curtailed wind. The system hit a peak hourly wind generation of 4,000 MW last week. He also followed up from his report at the 4/25 TMT meeting on the transmission system emergency that was declared, which forced The Dalles to operate outside 1% for about 40 minutes. He said there were no additional impacts to report and introduced Jim Burns from the Transmission Group to answer any questions from TMT. Jim provided a little more detail about the event that led to the

emergency declaration. Tony offered to coordinate a TMT site visit to the dispatch center in Vancouver at a future date.

Water quality – Scott English, Corps, reported that involuntary spill has continued and with it, TDG exceedances. He said the Bonneville tailwater gauge at Cascade Island has gone out due to high flows and the Corps is working on a long term solution. In the interim, the Warrendale gauge is being used to monitor/manage TDG below Bonneville.

Next Meeting, 5/4 Conference Call:

- Bonneville Operations will be discussed

Next Face to Face Meeting, 5/16:

Agenda items include:

- Water supply forecasts
- Prep for Libby/Sturgeon pulse operations SOR
- Vernita Bar Update
- Upper Snake Flow Augmentation
- Operations Review
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

May 2, 2012
Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of Montana, BPA, COE, NOAA, Oregon, USFWS, Washington, Idaho, BOR, Umatilla/CRITFC, Nez Perce Tribe, Colville Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

Paul Wagner, NOAA, added three items to today's agenda: transportation scheduling, adult passage at Bonneville, and Lower Monumental operations.

2. Review April 13 and 18 Meeting Minutes

The April 13 minutes were approved as final. Review of the April 18 minutes was postponed until the next TMT meeting.

3. Spring Creek Hatchery Release

Baus had good news to report on the special operation of Bonneville Dam for the Spring Creek Hatchery release. Four million smolts were released early on April 30 per the Salmon Managers' request at the last TMT meeting and began arriving at the project about 10.5 hours after release. Fish condition had been excellent so far and mortality was negligible. From 2245-0700 hours (30 April – 1 May), 674 sampled, 1 mortality, 0.1% mortality rate. No descaling and 1 injury.

David Wills, USFWS, reported from 0700 hours 1 May through 0700 hours 2 May 176 sampled, 1 mortality, 0.6% mortality rate. No descaling or injuries.

Bonneville project staff have been cleaning the fish screens of debris daily, which has helped keep injuries and mortalities low, Baus reported. The majority of fish have most likely passed and passage numbers will drop off today or tomorrow, Wills said. Today's passage index is 101,000 subyearling Chinook, Margaret Filardo, FPC, said.

Dave Statler, Nez Perce Tribe, asked how closely the actual operation begun yesterday matches the Salmon Managers' recommendations. The operation was carried out as coordinated at TMT, Baus replied. Tony Norris, BPA, said data from yesterday indicate that all powerhouses were operating within their recommended ranges.

The Action Agencies will provide TMT with data after the operation ends. It is currently scheduled to end May 4, but this could change based on fish passage data.

4. Bonneville Adult Passage Issues

Wagner, who added this item to today's agenda, reported that 2500 fish passed Bonneville on April 25 and counts decreased to a low of 600 fish on April 28, then rose again to 2200 fish per day on May 1. Bonneville is currently spilling 180-190 kcfs; adult delay is a known problem when spillway flows exceed 100-120 kcfs. It's getting late in the season for adult passage and these numbers indicate that spill could be delaying adults, exposing them to sea lion predation.

Speaking on behalf of the Salmon Managers, Wagner recommended a test operation at Bonneville from 5 am to 9 am in the next few days to find out whether limiting spill to 100-120 kcfs at Bonneville would benefit adult passage.

Tony Norris, BPA, cautioned that the stage at Stevenson would limit forebay elevation increases to about 2 feet, which equates to an 80 kcfs flow reduction for 4 hours. Wagner said this change might not help adults much and asked how it would affect the Spring Creek operation. That depends on whether the cap at the midpoint of the 1% range is maintained at three of the Powerhouse 2 (PH2) units, and whether the best-geometry operation at Powerhouse 1 (PH1) continues, Norris replied.

Changing the hydraulics at the project at this time could impact the screen cleaning operation, Baus cautioned. To date daily cleanings have kept debris accumulation under control, but changing the head associated with this operation could impact the screen cleaning operation and if the project was unable to keep up with cleaning then the project would pull screens.

Because the end of the Spring Creek run is estimated based on index counts, Wills wanted to see tomorrow's index counts before a decision is made to change turbine operations. He also requested a pinniped update to quantify the risk adults face below the dam. The 2012 sea lion hazing report, linked to the TMT webpage, says the maximum number of Steller sea lions seen on any day is 29 and the maximum number of California sea lions is 14, Baus reported. The average 2012 California sea lion count to date is the lowest since 2002, perhaps in response to removal of 6 California sea lions last year.

Jim Litchfield, Montana, asked for a fisheries update. Fisheries below Bonneville are closed, but the tribal fishery above Bonneville has been extended for 4 more days, Cindy LeFleur, WDFW, reported. In order to evaluate the potential impacts of limiting spill on tribal fishing Tom Lorz, Umatilla/CRITFC, said he would need to see an outline of the current operation. The treaty fishery will continue until catch quotas are met.

TMT discussed timing of the spill reduction test so it occurs after the Spring Creek operation has ended. The window of opportunity for this special operation will be short because flows are expected to increase, Norris said. Adult passage at Bonneville should be peaking now, according to the 10-year average, Wagner replied. USFWS

would be comfortable with doing the test on May 3, Wills said. Scott Bettin, BPA, said the generation-neutral Spring Creek operation may continue through May 3.

Water stored from a one-day operation can be released over a period of more than 24 hours, Bill Proctor, COE, reported. Rick Kruger, Oregon, asked whether the test will influence the Action Agencies' ability to operate the PH2 units at the mid point of the 1% best efficiency range. BPA will make best efforts to operate the units to the mid range, Norris replied. However, the operation for adults will change the head at the project, which affects the mid-point of 1% operating range during the operation.

Regarding impacts to the treaty fishery, Lorz said tribal fishers would probably accept a 2-foot elevation increase to 75 feet in the Bonneville forebay tomorrow morning if he communicates with them today. Lorz will report back to Baus later today if the tribes object to the planned operation for adults. The COE is not intending on implementing the operation if analysis indicates it would result in more than a 2-foot rise in the elevation of Bonneville forebay, Proctor assured Lorz. Bonneville pool will be operation within the normal forebay operating range (71.5 to 76.5 ft.) for this special operation.

TMT members gave their views of the proposal to cap spill at 110-120 kcfs from 5 am to 9 am tomorrow while maintaining current powerhouse operations for the Spring Creek Hatchery release. Details of the proposal are: At 5 am on May 3, cap spill at 120 kcfs at Bonneville. For the subsequent hours of 6-9 am, make best efforts to maintain a spill rate of 110 kcfs.

- **Oregon** – This test is worth a try.
- **Montana** – Agrees with Oregon.
- **Idaho** – Willing to find out whether the operation helps adults.
- **Washington** – No objection.
- **Nez Perce** – No objection.
- **CRITFC** – Supports the operation as long as it conforms to treaty fishery needs as discussed today.
- **USFWS** – No objection, assuming that normal Fish Passage Plan operations do not resume at Bonneville until the Spring Creek Hatchery release has passed, as determined by index counts for May 3.
- **NOAA** – Supports the operation.
- **BOR** – Supports the operation.
- **BPA** – Supports the operation.
- **COE** – Supports the operation.
- **Colville Tribe** – Supports the operation.

TMT will reconvene at 1 pm on May 4 to discuss the outcome of the test and decide if additional steps are required.

5. Lower Monumental Operations

This item was added to today's agenda at the request of Paul Wagner. Flows at Lower Monumental are near the transition point (approximately 140 kcfs) when the FOP calls for a switch from uniform to bulk spill. However, because TDG levels on the Snake River are currently elevated, the Salmon Managers recommend continuing the uniform spill pattern, which produces less gas, for the next week even if flows drop into the 130-140 kcfs range.

Over the next 10 days, inflows at Lower Monumental are forecasted to decline, meaning flows could drop below the 140 kcfs threshold that triggers the switch to bulk spill, Laura Hamilton, COE, said. Yesterday flows ranged from 127-149 kcfs with an average of 136 kcfs. The project is currently operating to a uniform spill pattern. The intended operation for this year, like last year, is to switch from bulk spill to uniform spill when observed or forecasted inflows exceed 140 kcfs for 72 hours, Baus said. The COE will exercise best professional judgement in managing this operation. Continuing the uniform spill pattern makes the most sense as long as inflows stay in the 130-140 kcfs range, Wagner said.

If flows continue to drop, the COE will make the switch to a bulk spill pattern, Baus said. Lisa Wright referred TMT to page 13 of the Fish Operations Plan, which says:

"Consistent with adjustments made in 2011 spring operations through regional coordination, when total river flow is likely to exceed turbine capacity and spill over the 120% TDG gas cap, which is at a total river flow of about 140 kcfs for 3 or more days, the project will use the uniform spill pattern. This may also occur if spill over the 120% TDG gas cap is required due to lack of demand spill at any river flow level."

Russ Kiefer, **Idaho**, advised against switching to a bulk spill pattern if the SYSTDG model predicts that doing so would result in TDG exceedances in the Lower Monumental tailwater or the Ice Harbor forebay.

If Ice Harbor operates above powerhouse capacity, it would be inconsistent with TDG spill waivers to use a bulk spill pattern when uniform spill would produce less gas, said Rick Kruger, **Oregon**.

If Lower Granite and Little Goose continue to send high gas levels into Lower Monumental forebay, it would be good TDG management to use the uniform pattern because it generates less gas, said Paul Wagner, **NOAA**.

The FOP language is consistent with maintaining uniform spill if daily average flows continue to be a little less than 140 kcfs, said Bill Proctor, **COE**. There were no objections to continuing the current operation of uniform spill at Lower Monumental. TMT will revisit this issue at its next meeting May 16.

6. Vernita Bar Update

Russell Langshaw, Grant PUD, gave an update on the Hanford Reach fall chinook protection program. Estimated completion date is June 19. For the past week, mean daily outflows have been 203 kcfs with a mean daily delta of 67.1 kcfs. A 60 kcfs delta constraint has been in effect since the beginning of the 2012 program with the exception of April 27. All constraints have been met and there have been no exceedances. Field crews are still reporting low numbers of stranded or entrapped fish. Langshaw will give TMT another update on May 16.

7. Operations Review

a. Reservoirs. Grand Coulee is at elevation 1238.1 feet. The BOR is managing refill at a controlled rate and maintaining enough space to accommodate peak runoff. Hungry Horse is at elevation 3532.5 feet, with releases of 9.2 kcfs, which will probably continue for the next few weeks. This operation reflects transmission limitations and a unit outage.

Libby is at elevation 2391.2 feet with inflows of 28.5 kcfs and releases of 13.4 kcfs. Albeni Falls is on free flows. Dworshak is at elevation 1533.5 feet with inflows of 22.7 kcfs and releases of 14.4 kcfs.

Priest Rapids inflows are 256.8 kcfs. Lower Granite inflows are 137.1 kcfs. McNary inflows are 408.2 kcfs, and Bonneville inflows are 409.9 kcfs.

b. Fish. Transportation: Peak juvenile passage at Lower Granite probably occurred around April 26, at least two weeks earlier than usual, Wagner reported. Various passage forecasts suggest the run is more than 50% complete, and yesterday's index count suggests the peak is long past. In light of this information, collection at Lower Granite began on May 1 with the first barge leaving on May 2.

Because travel times are shorter when flows are high as they are now, yesterday FPAC agreed to recommend that collection at Little Goose begin on May 3 and at Lower Granite on May 5, instead of the previously scheduled dates. Baus said the COE will be able to make these changes to the barging schedule.

Adults: This topic was covered in today's discussion of spill at Bonneville.

Juveniles: Most of the Snake River traps have been pulled due to high flows and debris, Wagner reported. Peak passage at Lower Granite occurred on April 26 and 71,000 fish passed Little Goose on April 30. Rock Island Dam chinook index counts have been around 1,000 fish per day, with the most recent count at 600. The first index counts were 184,000 fish at McNary, 233,000 fish at John Day, and 45,000 fish at Bonneville. This is prime passage time for juveniles.

Like adult passage, juvenile passage is occurring earlier this year than usual, and steelhead passage is also early. Spring chinook peaked at Bonneville with 359,000 fish

(the Spring Creek Hatchery release) passing on April 26, the same day steelhead passage peaked with 296,000 fish at Lower Granite. On April 30, 195,000 steelhead passed Little Goose, and substantial numbers of steelhead also passed at McNary, John Day and Bonneville. Steelhead passage at Lower Granite is approximately half done, which is much earlier than usual.

Recent sockeye counts were 636 at Dworshak, 1000 at Rock Island and 22,000 at John Day. Some 6,000 lamprey have passed McNary and 9,000 lamprey have passed John Day. Russ Kiefer reported that Idaho's work to establish sockeye in Redfish Lake is having positive results. Recently, 24 PIT tagged fish from the lake were detected at Lower Granite; most of these were naturally produced fish. The cumulative population index for combined hatchery and wild fish is 12 million this year, the highest number ever seen, Wagner said.

c. Water Quality. Involuntary spill has been on the increase system-wide since the last TMT meeting, with correspondingly high TDG readings, Scott English, COE, reported. Unfortunately high flows washed out the upgraded Bonneville tailwater station, which had just been rebuilt on higher ground after being inundated last year. The COE is working on a long-term solution to this problem. Meanwhile, adjusted values from the Warrandale gauge are being used to monitor conditions in Bonneville tailrace.

d. Power System. Peak hourly wind generation exceeded 4,000 MW for the first time about a week ago, Norris reported. BPA has not identified any additional adverse effects on fish protection measures as a result of an April 24 transmission emergency that caused The Dalles to operate outside of 1% efficiency for 37 minutes. Jim Burns, BPA, gave a detailed explanation of what caused the transmission outage. Loss of a major transformer at McNary required BPA to operate the grid to lower required reliability limits. This limited transmission out of the McNary area, and generation had to be redispatched. BPA called for a voluntary redispatch but none was available in the area needed, and an emergency was declared. The Dalles violated its 1% efficiency range. Norris will keep TMT informed of any fish-related impacts BPA finds from this incident.

Several TMT members expressed interest in seeing the Dittmer dispatch center in Vancouver, WA, so Norris offered to arrange a TMT site visit.

6. Next TMT Meeting

There will be a TMT conference call on Friday, May 4. The next regular TMT meeting will be on May 16. Baus gave TMT a heads-up that coordination of the SOR for the sturgeon pulse at Libby has begun, with discussion scheduled for May 23.

Name	Affiliation
Jim Litchfield	Montana
Tony Norris	BPA
Lisa Wright	COE

Doug Baus	COE
Paul Wagner	NOAA
Rick Kruger	Oregon
Scott English	COE
Bill Proctor	COE
Jim Burns	BPA transmission
Laura Hamilton	COE
Kim Johnson	COE

Phone:

Dave Wills	USFWS
Cindy LeFleur	Washington
Russ Kiefer	Idaho
John Roache	BOR
Tom Lorz	Umatilla/CRITFC
Gabriel Banks	XX
Scott Richter	Energy GPS
Steve Hall	COE Walla Walla
Russ George	WMC
Heather Dohan	Puget
Harvey Hall	EWEB
Bruce McKay	hydro consultant
Richelle Beck	Grant PUD
Barry Espenson	CBB
Margaret Filardo	FPC
Shane Scott	PPC
Ruth Burris	PGE
Dave Statler	Nez Perce
Sheri Sears	Colville Tribe

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Friday May 4, 2012 1:00pm - 2:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 5430

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Bonneville Special Operation - Doug Baus, COE-NWD
3. Other
 - a. Set agenda and date for next meeting - **May 9, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

May 4, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Bonneville Special Operation

TMT reconvened after their 5/2 meeting to follow up on a special operation that had been agreed to for the period 0500-0900 hours on 5/3 to support adult passage at Bonneville. Doug Baus, Corps, reported on actual operations. Spill was reduced to 138 kcfs at 0500 hours, followed by 121 kcfs at 0600 hours, 116 kcfs at 0700 hours, 126 kcfs at 0800 hours and 135 at 0900 hours. Forebay elevations ranged 74.8' to 75.5'. An unforeseen unit outage occurred as well as unforeseen elevated precipitation that resulted in elevated inflows into the system which did not allow the Corps to get to the 120/110 kcfs spill rate requested, nor the elevation they had anticipated (although they stayed within their normal forebay operating range).

Adult fish passage numbers increased to 2,506 on May 3 from 1,746 on May 2. Doug also noted that Spring Creek operation ended on 5/3 at 1100 hours at which time Bonneville reverted back to normal unit operations as identified in the 2012 Fish Passage Plan. Spring Creek data from the Smolt Monitoring Facility:

- April 30 at 2245 to May 1 at 0700 = 674 sampled, 1 mortality (0.1% mortality rate), no descaling or injuries.
- May 1 at 0700 hours to May 2 at 0700 = 176 sampled, 1 mortality (0.6% mortality rate), no descaling or injuries.
- May 2 at 0700 to May 3 at 0700 = 33 sampled, 0 mortalities, no injuries or descaling.

Paul Wagner, NOAA asked if there were any screen cleaning issues to which Doug responded that nothing extreme resulted from this operation. Paul said the increase in adult numbers was not as much as he had hoped for, but was appreciative of the efforts to implement the operation. Tom Lorz, CRITFC/CTUIR, said during that time, Powerhouse 2 did go outside of the mid-range of 1% and there was an increase in juvenile mortalities on 5/4 (though the actual numbers were low). He said he too appreciated the efforts to coordinate and implement this operation, and encouraged TMT to try to do a better job thinking through and coordinating these special operations so that we are making the best decisions and so that all affected parties (including tribal fishers) are coordinated with ahead of time, to the best of our ability. Paul Wagner, NOAA, agreed that this was a very short turnaround, and said it was because the time period may have offered the only opportunity to do such an operation given the expected additional water in the system. He acknowledged that the timing turned out not to be the best.

There was some discussion of how to better understand what is happening with the adults this year. An adult tracking study is planned for next year, but this year the region will need to rely on traditional passage count data to monitor and analyze their movements.

Next steps – The action agencies will continue with ‘normal’ operations at Bonneville, as defined in the 2012 Fish Passage Plan.

Other

- o Lower Monumental Operations – the Action Agencies will continue implementing a uniform spill pattern using the criteria from the Fish Operations Plan.
- o Question about the % spill tab on the TMT site – will that be updated for 2012? Corps: Yes – it has been a CWMS 2.0 conversion issue and 2012 data will be available very soon.

Next Face to Face Meeting, 5/16:

Agenda items include:

- Water supply forecasts
- Prep for Libby/Sturgeon pulse operations SOR
- Vernita Bar Update
- Upper Snake Flow Augmentation
- Operations Review
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

May 4, 2012
Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired by Doug Baus, COE, and facilitated by Robin Gumpert (DS Consulting). Representatives of Washington, BPA, the Colville Tribe, NOAA, CE, Umatilla/CRITFC and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Bonneville Special Operations

The purpose of today's call was to follow up on the special operation to improve adult passage that was coordinated at the May 2 TMT meeting in response to an apparent downturn in adult passage at Bonneville Dam.

The preferred operation discussed on May 2 had two elements: (1) At 5 am on May 3, cap spill at 120 kcfs at Bonneville. (2) For the subsequent hours of 6-9 am, make best efforts to maintain a spill rate of 110 kcfs. Baus recalled the concerns TMT members voiced regarding the effect fluctuations in the Bonneville forebay elevation might have on treaty fisheries upstream. He reported to TMT on the actual operation for adults:

1. At 5 am on May 3, spill at Bonneville was capped at 138 kcfs.
2. By 6 am, spill was capped at 121 kcfs; by 7 am, 116 kcfs; by 8 am, 126 kcfs; and by 9 am, spill rose to 145 kcfs.
3. Subsequent forebay elevations during this operation were held at a range of 74.8 to 75.5 feet.

The higher spill rates than desired were the result of two issues: 1) An unanticipated unit outage and, 2) higher flows than anticipated, Baus said. Adult chinook passage for May 3 at Bonneville was 2506 fish, an improvement over the previous day's count of 1746 fish. Nevertheless, the results of the test were not as positive as the Salmon Managers had hoped.

The special operation for Spring Creek Hatchery smolts also ended on May 3, based on passage index counts. Baus gave TMT some preliminary data gathered during the hatchery operation:

- From 7 am on May 2 to 7 am on May 3, there were 33 fish sampled with no mortalities, injuries or descaling.
- From 7 am May 1 through 7 am May 2, there were 176 fish sampled with 1 mortality and no descaling or injuries (a mortality rate of 0.6%).
- From 7 am on April 30 to 7 am May 1, there were 674 fish sampled with one mortality and no descaling or injury, 0.1% mortality rate.

Wagner thanked the COE for its efforts to improve adult passage and asked whether screen cleaning became a problem during the operation; Baus said no. Wagner expressed reluctance to continue the special operation or repeat the experiment in light of the results. This is unfortunate because current adult passage numbers are low.

Tom Lorz, Umatilla/CRITFC, said the operation for adults may have adversely impacted juveniles. According to Tom, PH2 operated outside of 1% best efficiency because there was an increase in subyearling mortalities. The lack of adult response to the test begs the question, how many adults were actually below Bonneville? We need to coordinate future operations of this nature far enough in advance to avoid such problems and ensure we can carry out the operation as intended, Lorz commented.

Scott Bettin, BPA, clarified that PH2 did not operate outside of 1%; rather, when the Spring Creek operation was ended on May 3, the project resumed operating both PH1 and PH2 within the full 1% range consistent with the Fish Passage Plan.

NOAA, CRITFC and the **COE** all agreed the experiment is not worth continuing. Therefore normal FPP operations at Bonneville will resume until the COE hears from TMT that a change is desired.

3. Lower Monumental Operations

The COE will continue to operate Lower Monumental in the uniform spill pattern, per the criteria described in the FOP and discussed at the May 2 TMT meeting, Baus reported.

4. Next TMT Meeting

TMT will meet again in person on May 16. There will be a conference call May 9 if needed.

<i>Name</i>	<i>Affiliation</i>
Charles Morrill	Washington
Scott Bettin	BPA
Cindy LeFleur	WDFW
Sheri Sears	Colville Tribe
Paul Wagner	NOAA
Doug Baus	COE
Shane Scott	PPC
Tony Norris	BPA
Dave Benner	FPC
Margaret Filardo	FPC
Brandon Chockley	FPC
Tom Lorz	Umatilla/CRITFC

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday May 16, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 9382

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review May 2 and 4 Meeting Minutes
3. Water Supply Forecast - Doug Baus, COE-NWD
 - a. [TDA Water Supply Forecast](#)
 - b. [NRCS SNOTEL](#)
 - c. [RFC Snow](#)
4. Vernita Bar Update - Russell Langshaw, Grant County PUD
 - a. [Program Update](#)

5. Upper Snake Flow Augmentation - *John Roache, BOR*
6. Bonneville Dam PH2 Operations - *Paul Wagner, NOAA Fisheries*
 - a. [Sockeye Descaling Numbers May 8-14](#)
7. Libby Dam Releases for Sturgeon and Bull Trout Augmentation Flows - *Doug Baus, Corps*
8. Operations Review
 - a. Reservoirs
 - b. Fish
 - c. Water Quality
 - d. Power System
9. Other
 - a. Set agenda and date for next meeting - **May 23, 2012 - 10:30am Conference Call**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:

[Doug Baus](#) at (503) 808-3995

John Day Dam				Bonneville Dam			
Species	Date	# Examined	% Descaled	Species	Date	# Examined	% Descaled
CH1	5/8/2012	947	3.1%	CH1	5/8/2012	433	6.2%
	5/9/2012	768	2.1%		5/9/2012	558	8.1%
	5/10/2012	667	2.2%		5/10/2012	333	5.1%
	5/11/2012	1175	3.1%		5/11/2012	334	6.9%
	5/12/2012	787	1.4%		5/12/2012	365	7.4%
	5/13/2012	863	1.9%		5/13/2012	373	6.4%
	5/14/2012	829	2.8%		5/14/2012	239	3.3%
ST	5/8/2012	448	2.0%	ST	5/8/2012	66	4.5%
	5/9/2012	309	4.2%		5/9/2012	77	2.6%
	5/10/2012	220	1.4%		5/10/2012	47	0.0%
	5/11/2012	417	2.6%		5/11/2012	35	2.9%
	5/12/2012	277	3.2%		5/12/2012	14	0.0%
	5/13/2012	277	1.8%		5/13/2012	21	4.8%
	5/14/2012	356	2.2%		5/14/2012	15	6.7%
CO	5/8/2012	37	0.0%	CO	5/8/2012	61	1.6%
	5/9/2012	13	0.0%		5/9/2012	90	3.3%
	5/10/2012	13	0.0%		5/10/2012	35	2.9%
	5/11/2012	36	2.8%		5/11/2012	49	6.1%
	5/12/2012	60	0.0%		5/12/2012	41	4.9%
	5/13/2012	90	0.0%		5/13/2012	41	2.4%
	5/14/2012	44	0.0%		5/14/2012	57	0.0%
SO	5/8/2012	153	2.0%	SO	5/8/2012	202	6.9%
	5/9/2012	122	3.3%		5/9/2012	247	15.0%
	5/10/2012	208	4.3%		5/10/2012	75	6.7%
	5/11/2012	294	3.1%		5/11/2012	134	7.5%
	5/12/2012	297	2.7%		5/12/2012	127	23.6%
	5/13/2012	287	9.1%		5/13/2012	178	19.7%
	5/14/2012	171	2.9%		5/14/2012	201	23.4%
CH0	5/8/2012			CH0	5/8/2012	5	0.0%
	5/9/2012				5/9/2012	4	0.0%
	5/10/2012				5/10/2012	1	0.0%
	5/11/2012				5/11/2012		
	5/12/2012				5/12/2012		
	5/13/2012				5/13/2012	4	25.0%
	5/14/2012				5/14/2012	3	0.0%

* Incidates inadequate sample sizes of less than 20 fish examined

2011-2012 Hanford Reach Fall Chinook Protection Program (HRFCPP) Weekly operations update

PRD Discharge (kcfs)

Date	Mean	Minimum	Maximum	Daily or Weekend Delta	Daily Delta Constraint	WAN Inflow weekend estimate
5/8/2012	237.4	165.2	290.8	125.6	150	
5/9/2012	255.2	175.3	320.2	144.9	150	
5/10/2012	259.9	176.5	311.2	134.7	150	
5/11/2012	237.6	193.2	301.6	108.4	150	
5/12/2012	209.8	173.8	301.8	128.0	168.8	225.0
5/13/2012	194.3	170.9	243.8	130.9	168.8	225.0
5/14/2012	220.3	158.8	265.0	106.2	150	
5/15/2012		0.0	0.0	0.0	150	
5/16/2012	0.0	0.0	0.0	0.0	20	
Mean	230.6	173.4	290.6	125.5	155.4	

ATUs (celcius) through 05/14/12	Current Period	HRFCPP	Next ATU milestone	Date of next ATU milestone
<36 kcfs elevation	1438.9	Emergence & Rearing	1400 after EoS	6/16/2012
36-50 kcfs elevation	1328.1	Emergence & Rearing	1400 after EoS	6/16/2012
>50 kcfs elevation	1328.1	Emergence & Rearing	1400 after EoS	6/16/2012
End of spawning (EoS)	996.6	Post-Hatch	1000	5/15/2012
Temperature on 05/14/12	11.0			

CJADII weekends	Weekend minimum
1st weekend	4/28/2012 169.5
2nd weekend	5/5/2012 224.2
3rd weekend	5/12/2012 168.8
4th weekend	5/19/2012

River Operation:	Begin	End
RLF	10/15/2011	11/20/2011
PLF	10/19/2011	5/15/2012
CJAD	11/26/2011	5/15/2012
Stranding	3/8/2012	6/16/2012
CJAD II	4/28/2012	5/20/2012

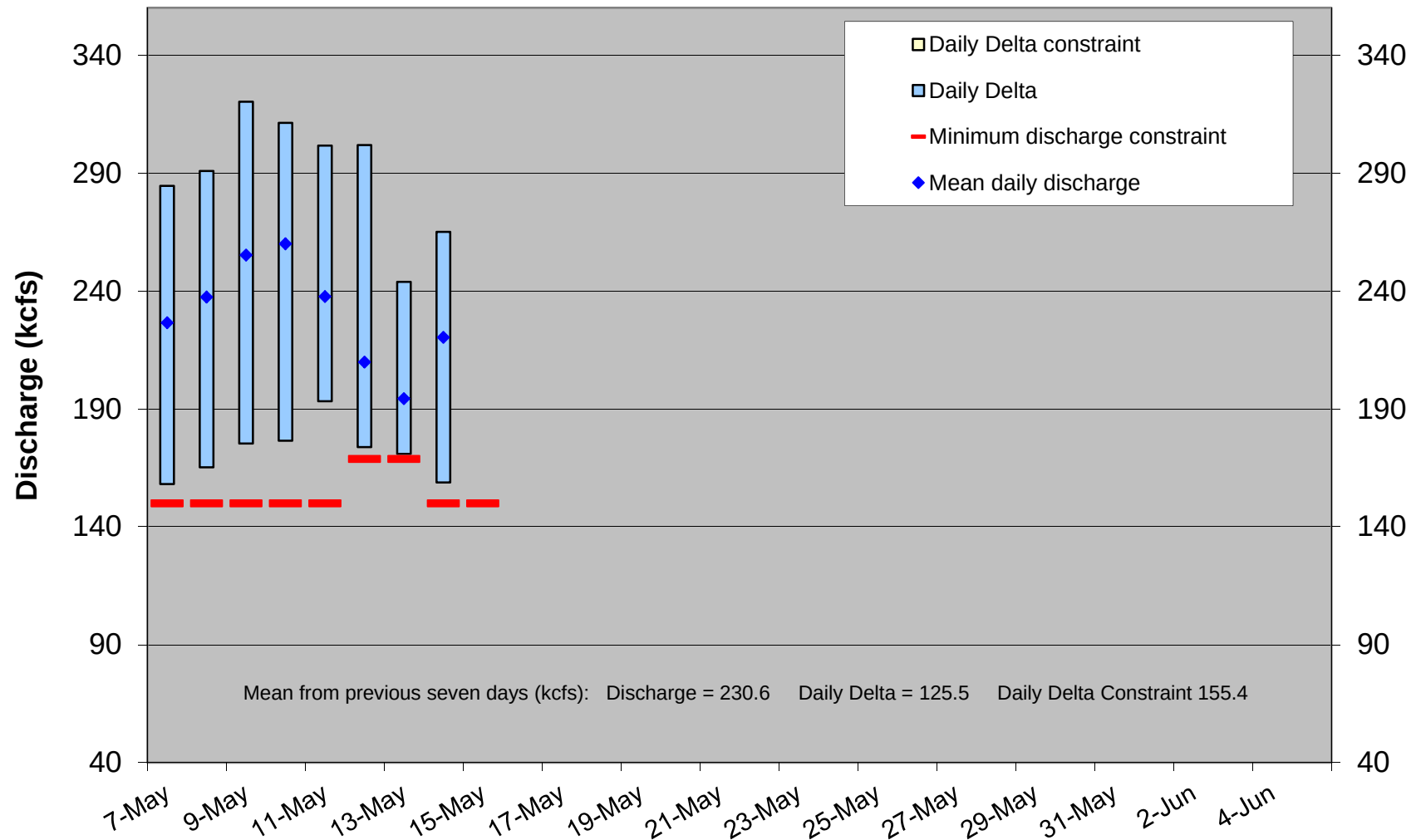
Cell are highlighted in yellow when dates are met.

Cell are highlighted in red when these operations are currently in effect

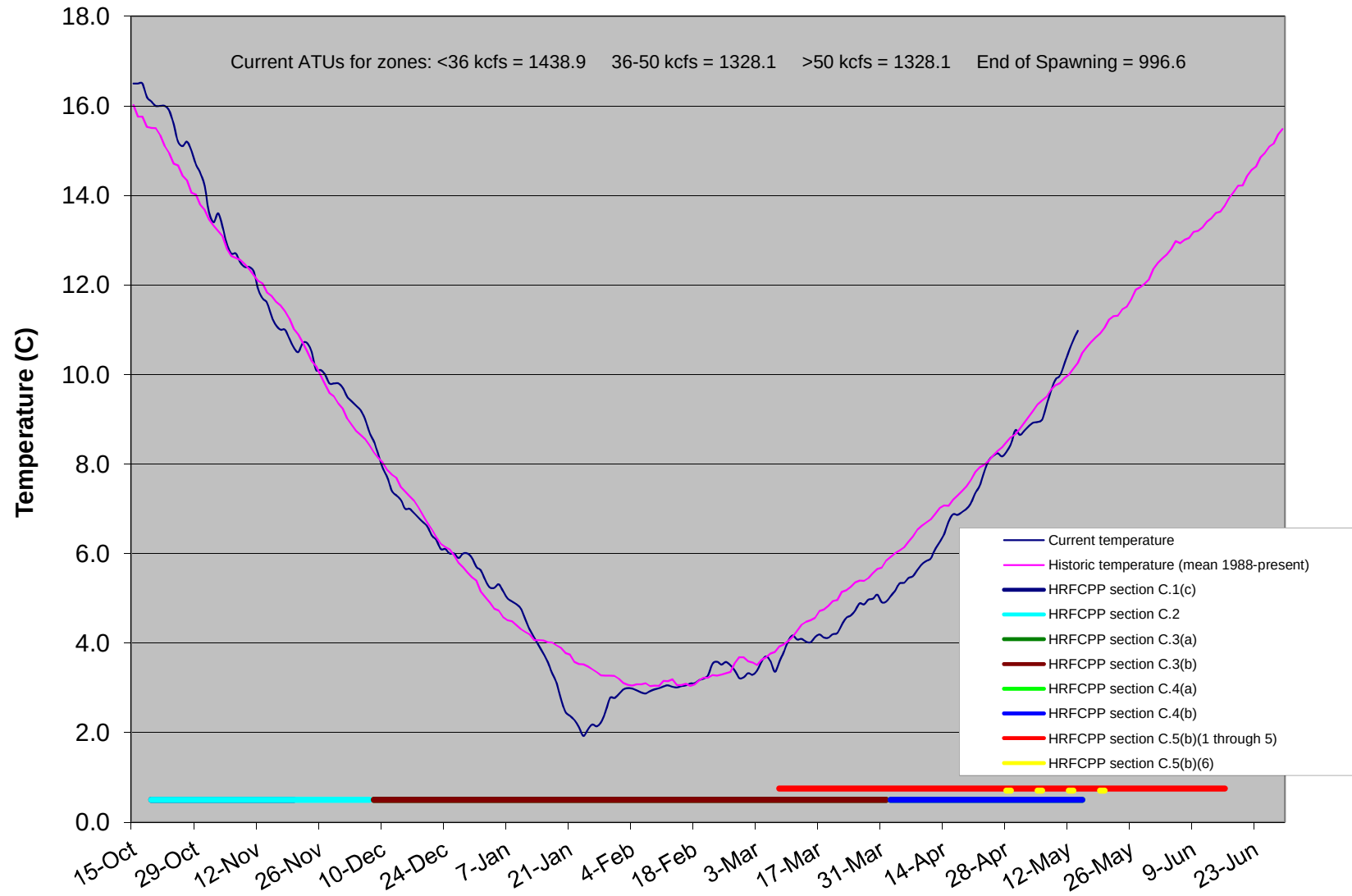
Dates with red text are predicted based on current conditions and data from 1988 to present

Priest Rapids Dam Operations 2012

Number of exceedances: 0



2011-2012 PRD Tailrace Temperatures and HRF CPP constraints



COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

May 16, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Meeting Minutes

The following comments on the meeting notes were provided:

- 5/2 Facilitator's Summary: Clarify under section about Bonneville operations that the discussion was around 'spill' (not total flow)
- 4/25 Facilitator's Summary: John Roache, Reclamation, will provide clarifying language under Operations Review for Grand Coulee and Hungry Horse

With these changes, new versions of the summaries will be posted to the TMT page, and all notes through 5/4 will be considered final.

Water Supply Forecasts

Doug Baus, Corps, provided updated water supply forecasts. As of today, The Dalles April-August forecast was 111 MAF (120% of average). May final forecasts were: The Dalles April-August 110 MAF (119% of average); Lower Granite April-July 23 MAF (107% of average); Libby April-August 7.155 MAF (122% of average); and Dworshak April-July 3.226 MAF (120% of average). The Corps added that the residual volume above Grand Coulee as of 5/13 was 77%.

John Roache shared forecast information for Reclamation projects. Hungry Horse May-July was 1,563 kaf (92% of average) and the April-August forecast was 2,209 kaf (107% of average). John noted that the early runoff that happened in April this year, while not seen in a few years, was not unusual.

Doug also shared NRCS SNOTEL and RFC snow site information, indicating variability across the basin.

Vernita Bar Update

Russell Langshaw, Grant County PUD, shared information from the PUD's website about the previous week's Hanford Reach conditions and Priest Rapids operations. He noted that protection flows had officially ended yesterday, that the daily delta was 125.5 kcfs and that there had been no exceedances. Stranding and entrapment crews were out sampling fish and had not observed any problems. Priest Rapids tailrace temperatures were within normal; overall, Russell called this a 'typical year'. He will provide another update at the 5/6 TMT meeting.

Upper Snake Flow Augmentation

John Roache, Reclamation, reported that Upper Snake flow augmentation releases would likely be the full 487 kaf: Preliminary rough estimates on location and timing are as follows: about 200 kaf above Milner in June; about 80 kaf of 'natural flow' (non-diverted) throughout the season;

about 40 kaf out of Boise in late June/early July; and about 170 kaf out of the Payette, mostly in July/August. He will provide updates to TMT as the season progresses.

Bonneville Powerhouse 2 Operations

Paul Wagner, NOAA, reported on higher than usual sockeye descaling at Bonneville – over 23% on 5/14 – leading to a discussion at FPAC about ways to remedy the situation. Upon investigation, they found that the fish screens were clean which suggested it was more likely from the turbulence the fish experienced in the gate well. With peaking passage numbers and a 10% mortality rate, the salmon managers made a request for a special operation to hold the PH2 turbines to the mid-range of 1% for a 3-5 day period (they later clarified their request to implement this operation until Monday 5/21 at 6:00pm).

After some discussion, the Corps' response on behalf of the Action Agencies was to try to meet the request while maintaining a flow/generation neutral operation so as not to exacerbate TDG exceedances downstream, as well as concerns associated with adverse impacts on adult passage associated with delay in the tailrace, as well as fallback. They would take the same approach used for the Spring Creek Hatchery release – operate Powerhouse 2 up to the mid-range of 1% and send any displaced flow through Powerhouse 1 up to open geometry (then go to involuntary spill above the TDG spill cap).

The salmon managers responded that they did not agree with operating Powerhouse 1 to open geometry given that TDG levels were not as high as were seen previously during the Spring Creek release. They were looking for flexibility around TDG management to minimize the risk of uncertainty around how fish are impacted with an open geometry configuration. Several other biological factors were raised for consideration:

- Safe passage of sockeye included PIT-tagged wilds from the Snake River basin that had been detected at Bonneville and John Day dams.
- Delay of adult passage and risk of adult fallback have been observed at spill rates in excess of 110-120 kcfs (currently spilling around 117 kcfs and inflows are forecasted to increase from 340 kcfs to near 400 kcfs over the next several days)..
- Potential debris issues, though the project is currently managing debris so that it is not an issue at this time.

Another alternative was to pull the fish screens. Because this could have a detrimental effect on steelhead, the salmon managers did not prefer this alternative. For the long term, all TMT members agreed that a more permanent solution is needed. Discussions about future operations, structural modifications and studies of open geometry are being held in various regional forums including FPOM, FFDRWG and SRWG. There is regional commitment to address and resolve the issues at Bonneville.

TMT reviewed guidance in the Fish Passage Plan, under the Bonneville Section 5.2.1 about this operation:

‘Turbine units at PH2 will operate at the mid to lower 1% range (unless total dissolved gas waivers are exceeded in the tailrace) of best efficiency and within cavitation limits at various head ranges as shown in **Table BON-16.**’

The Corps clarified that TDG in the tailrace is currently exceeding the 120% state waiver gas cap and that they were managing TDG consistent with guidance described in the 2012 Fish Operations Plan. Tailrace TDG levels are being calculated with the SYSTDG model until the Cascades Island gauge is returned to service. The gauge at Warrendale can be used in an analog to calculate an approximate value that equates to tailrace TDG, but at this time the SYSTDG model is the preferred methodology to calculate tailrace TDG.

Planned Operation and Polling:

After further deliberations, the Corps shared its plan to operate Bonneville in the following sequence beginning today and through Monday evening, 5/21, at 6:00 pm:

- Operate PH 2 up to the 25% of 1% of Best Efficiency Operating Range
- Operate PH 1 up to the upper limit (100%) of 1%
- As needed, operate PH 2 within the 25-50% range of 1%
- As needed to remain flow neutral, operate PH 1 up to best geometry
- As necessary, involuntary spill above the TDG spill cap.

TMT members were polled on their level of support for this planned operation:

- Idaho – No objection
- Washington – No objection
- Oregon—no objection
- Montana – No objection
- CTUIR (Umatilla)– No objection. Strong concerns to operating PH 1 to open geometry; does not feel this is the best adaptive management choice, but will not object
- Colville Tribe – No objection
- Salish-Kootenai Tribe – No comment
- Nez Perce Tribe (polled during the break) – No objection
- USFWS – No objection. Not in support of operating Powerhouse 1 to open geometry
- NOAA – No objection
- BPA – Support the operation
- Reclamation – Support the operation
- Corps – Support the operation. Will implement the operation as described above

Next Steps: The salmon managers will monitor passage numbers, descaling and mortalities and coordinate a call early next week to discuss the impacts from this operation and determine their recommended next steps. TMT will revisit this discussion during a conference call on 5/23.

Libby Operations for Sturgeon Pulse and Bull Trout Minimums

Doug Baus, Corps, reported that an SOR for Libby operations was posted to next week's 5/23 TMT agenda and will be discussed in detail at that time. The goal is to poll TMT members on their level of support for the operation then so implementation can be planned. TMT members asked some clarifying questions, and USFWS' Dave Wills said the expectation is that this operation will look similar to last year's, except it will be in "Tier 4" given this year's river conditions. TMT members will review the request and be prepared to discuss it next week.

Operations Review

Reservoirs – John Roache, Reclamation, reported on projects. Hungry Horse was at elevation 3533.4 feet, with 9 kcfs outflows and preparing to reduce to 7 kcfs. Grand Coulee was at elevation 1240.7 feet. Doug Baus, Corps, reported on projects. Libby was at elevation 2,400 feet; Albeni Falls was at elevation 2,057 feet; and Dworshak was at elevation 1,550 feet. Inflows at Priest Rapids were 212 kcfs; at Lower Granite were 107 kcfs; and at Bonneville were 336 kcfs. Doug also updated TMT that Lower Monumental was switched back to a uniform spill pattern as of yesterday.

Fish – Paul Wagner, NOAA, reported on fish passage. Adults were seeing good and consistent passage at Bonneville, even after a very high peak of 18,000/day last week. The salmon managers noticed a discrepancy in passage numbers between Lower Monumental and Little Goose, but the numbers picked up again. They will monitor and discuss this at FPOM, and Paul gave a heads up that may also need to use the TMT process if they see a need to recommend an adaptive management operation. Charles Morrill, Washington, also reported on adults. The latest TAC report showed that 67% of passage at Bonneville had occurred so far. Season totals were forecasted at 192,000-217,000. Treaty fishing was continuing.

Paul reported that the juvenile yearling Chinook run was remaining consistent with good daily passage numbers after a very high peak. Subyearling passage counts were about 3,000-7,000/day at Lower Granite – passage is earlier than normal. Steelhead numbers had peaked but daily passage counts had remained consistent so far. Lamprey passage was about 2,000/day at McNary.

Water quality – Scott English, Corps, reported that there had been some TDG stabilization in the system, but that forebay exceedances were continuing. Spill had gone down some, and forecasts predict another rise in total river flow over the next few days.

Power system – Nothing to report.

Next Meeting, 5/23 Conference Call

Agenda items include:

- Libby SOR
- Bonneville Powerhouse 2 Operations

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

May 16, 2012
Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of COE, Montana, USFWS, Oregon, BOR, BPA, NOAA, Washington, Idaho, CRITFC/Umatilla, Colville, Salish-Kootenai tribes and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review May 2 and 4 Meeting Minutes

The May 2 and 4 official minutes were approved as final. Paul Wagner, NOAA, commented on the May 2 facilitator notes, and John Roache, BOR, commented on the April 25 facilitator notes. The revised notes will be reposted to the TMT website.

3. Water Supply Forecast

Baus shared water supply forecast information for the region with TMT, attached in three links to today's agenda. Baus and Roache gave the May final water supply volume forecasts for individual projects:

- The Dalles (April-August) – 110 MAF, 119% of average
- Lower Granite (April-July) – 23 MAF, 107% of average
- Libby (April-August) – 7155 KAF, 122% of average
- Dworshak (April-July) – 3226 KAF, 120% of average
- Hungry Horse (May-July) – 1563 KAF, 92% of average
- Hungry Horse (April-August) – 2209 KAF, 127% of average.

Residual volume is about 77% above Grand Coulee as of May 13, Karl Kanbergs, COE, reported. According to the NRCS SNOTEL site, water supply conditions are at or below average in Oregon, while in Washington conditions are above average.

4. Vernita Bar Update

Russell Langshaw, Grant PUD, gave an update on the Hanford Reach fall chinook protection program. Protection flows ended at midnight May 15. Stranding and entrapment measures are expected to end on May 16, as are rearing protections. This coming weekend will be the fourth and final one of weekend protections. The average daily weekend delta (the difference between minimum and maximum flows) is 125.5 kcfs. There have been no program exceedances to date this year. Langshaw will give another update on June 6.

5. Upper Snake Flow Augmentation

The BOR is expecting to be able to provide the full 487 KAF of flow augmentation out of the upper Snake River this passage season, John Roache, BOR, reported. Estimates of where flow augmentation will come from (and when) are:

- 200 KAF from the upper Snake above Milner (mid June-mid-July)
- 80 KAF from natural flows i.e. unclaimed irrigation rights (April-August)
- 40 KAF from the Boise system (June-early July)
- 170 KAF from the Payette system (mid June-July)

Roache emphasized that these are approximate numbers. He will follow up with refined estimates when they are available.

6. Bonneville Powerhouse 2 Operations

TMT discussed the need today for a repeat of the Bonneville powerhouse 2 (PH2) operation the COE implemented in early May to accommodate passage of the second Spring Creek Hatchery release of 2012.

The issue at present is descaling of juvenile sockeye at Bonneville while passage of the run is peaking, Paul Wagner, NOAA, explained. Sockeye are particularly susceptible to descaling and mortality, and it's clear the injuries are caused by turbulence in the gatewells, not debris on fish screens. Descaling rates in general have been between 3-9% of sockeye passing at John Day Dam but increase at Bonneville Dam to rates of 7-24%. Mortality rates for all fish passing Bonneville have been as high as 10% over the past 3 days.

Therefore FPAC is requesting that the Action Agencies (AAs) operate the Bonneville PH2 turbines not to exceed the mid-point (50%) of the 1% of best efficiency operating range for approximately 4-5 days, and then evaluate whether to continue the special operation. Wagner said the request for 4-5 days was based on the fact that sockeye tend to pass in a condensed group. There was general agreement on a proposal to continue the operation until 6:00pm on May 21, unless FPAC's determination on Monday is to extend the special operation.

In response to the FPAC request, Baus said, the AAs propose a flow-neutral operation consistent with the previous Spring Creek operations. The AAs would make best efforts to limit PH2 units not to exceed the mid-point (50%) of the 1% operating range. Flow that would have passed PH2 units under normal operating conditions above the mid-point of the 1% range (approximately 28 kcfs) would be shifted to PH1 by operating PH1 units above the 1% range up to the open geometry point. This proposal would shift up to approximately 28 kcfs of flow away from PH2 to PH1 to reduce gatewell turbulence pressures and fish mortalities. The goal of this operation is to be flow and generation-neutral by increasing generation at PH1 at a rate equivalent to the generation reduction at PH2. Specifics of the Action Agency proposal are as follows, to be implemented sequentially as flows increase:

1. Operate all available PH2 units up to 25% of the 1% operating range.
2. As flows increase, operate all available PH1 units up to the upper limit (100%) of the 1% operating range.
3. As flows increase, operate all available PH2 units one at a time in the order of priority up to the mid-point (50%) of the 1% operating range.
4. As flows increase, operate all available PH1 units one at a time in the order of priority up to the open geometry point.
5. Anything in excess of powerhouse capacity is involuntary spill.

Several Salmon Managers expressed concern that the AAs would operate PH2 units above the mid-point of 1% rather than spill when so many fish are passing. Baus said the AAs are currently managing spill at Bonneville to the 120%/115% TDG spill cap as identified in the FOP. The current TDG spill cap at Bonneville is 95 kcfs. Currently, the AAs are already exceeding the spill cap and inflows are forecasted to increase over the next several days. Therefore the AAs would not be able to restrict PH2 flow at the mid-point of the 1% range without increasing flows through PH1 due to current and anticipated TDG exceedances based on forecast conditions. Scott English, COE, said Bonneville is in involuntary spill, above the FOP and fish passage spill caps.

The Salmon Managers commented on the Action Agency proposal:

CRITFC/Umatilla Tribe – When mortality rates are at 10% for all fish and 22% for sockeye at Bonneville, this operation should not be generation neutral. Has concerns about the unknown effects of open geometry.

Oregon – Agrees with CRITFC comments above. This is a prime time to pursue funding for research to investigate the effects of open geometry – yesterday SRWG began its process of reviewing one-page research proposals.

Idaho – PIT-tagged Snake River sockeye have been found at Bonneville, so it's not just Upper Columbia River sockeye being harmed in the gatewells.

USFWS – Commented during the recent Spring Creek Hatchery release discussions that the effects of operating PH1 to open geometry should be evaluated the next time this remedy is used. USFWS generally does not favor open geometry because it's not fully vetted by FPOM.

Washington – Would prefer that PH1 not operate to open geometry.

Montana – It's important to look at the downside of spill in relation of operating PH1 at open geometry.

Colville Tribe – Favors limiting PH1 to 1% of best efficiency if TDG levels are low and fallback is not a problem.

The AAs will continue to coordinate with the region on this important issue, Baus said. In addition to biological implications, the AAs are obligated to consider policy implications, including the potential impacts to juveniles, adults and water quality. Taking these issues into account, the AAs propose a flow and generation-neutral operation that has no potential for adverse effects on adults. Baus noted that ERDC modeling on the open geometry operation suggests that it benefits fish. Russ Kiefer, Idaho, recalled that modeling efforts were what led to altering the gatewell conditions in PH2 in a way that causes turbulence.

There was discussion of Bonneville spill levels, adult fallback and juvenile passage numbers. Passage rates have been around 8,000 juveniles per day, Paul Wagner, NOAA, reported. Adult fallback rates are not measured on an ongoing basis, but higher fallback rates typically are seen when spill reaches 120 kcfs. Currently, inflows at Bonneville are around 330-340 kcfs and the project is spilling around 120 kcfs. Forecasts indicate inflows will continue to increase, requiring increased spill above 120 kcfs. Capping PH2 to the mid-point (50%) of the 1% range would result in approximately 28 kcfs that would need to pass the project either via the spillway or PH1. Increasing spill by 28 kcfs at a time when AAs are already spilling in excess of 120 kcfs could have an adverse effect on the significant number of adults currently passing Bonneville Dam by delaying their passage of the project, and potentially increasing fallback rates as well. The project head (difference between forebay and tailwater elevation) plays a big role in how much the turbines can pass, Dave Wills, USFWS, said. Another factor is debris, Baus noted.

Kiefer referred to section 5.2.1 on page BON-34 of the 2012 Fish Operations Plan which says, "Turbine units at PH2 will operate at the mid to lower 1% range (unless TDG gas waivers are exceeded in the tailrace) of best efficiency and within cavitation limits at various head ranges as shown in Table BON-16." Baus clarified that Bonneville is already exceeding the TDG gas cap due to involuntary spill, which is forecasted to increase over the next several days. The current TDG reading at the Camas Washougal gauge is 115.4% TDG with involuntary spill of 117 kcfs, which is over the FOP spill requirement of 100 kcfs, Scott English, COE, reported. Bonneville operations are currently limited not by the 120% standard in the tailrace but by the 115% downstream standard. Charles Morrill, Washington, said language in the state waiver allows for TDG levels of more than 120%¹.

Discussion turned to the use of Camas Washougal gauge. Lorz and Kruger wondered why the FOP couldn't be changed to eliminate Camas Washougal gauge from consideration if the FOP could be changed for the sake of MOP operations. Kim Johnson, COE, replied that the COE manages to Camas Washougal gauge in accordance with the court order to implement a rollover operation.

¹ The Washington State TDG requirements waiver states: "A maximum TDG one hour average of 125% must not be exceeded during spillage for fish passage." The Oregon State TDG requirements waiver states: "TDG may not exceed 125% of saturation for more than 2 hours in every 24 hours in the forebay and tailrace."

After extended discussion, TMT members were polled regarding implementation of the Action Agency proposal. AAs contacted the Nez Perce Tribe, not represented today, for their view during the break. Poll results were:

- **Idaho** – No objection.
- **Washington** – No objection.
- **Montana** – No objection.
- **Umatilla/CRITFC** – No objection, although this isn't the best operation.
- **Colville** – No objection.
- **Nez Perce** – No objection.
- **Salish-Kootenai** – Attended meeting by phone but did not vote.
- **USFWS** – No objection, but does not support open geometry at PH1.
- **Oregon** – No objection. Considered abstaining pending internal consultation, but did not object so the proposed operation could be implemented without delay. Because it deviates from the FOP, regional consensus is required for the operation to be implemented.
- **NOAA** – No objection.
- **BOR** – Supports the operation.
- **BPA** – Supports the operation.
- **COE** – Supports the operation.

The COE will implement the proposed operation beginning today through 6 pm, May 21. Results will be discussed at next week's TMT call on May 23.

7. Libby Releases for Sturgeon and Bull Trout Augmentation Flows

The SOR for 2012 sturgeon and bull trout augmentation flows at Libby is posted to the TMT website and will be discussed and polled on during next week's TMT call, Baus said. The requested operation is similar to last year except it will involve less volume because 2012 is a tier 4 year, not tier 5 like 2011. Wills said enough volume is expected this year to reach the elevation required per the SOR for a spill test at Libby. The spillway crest is located at elevation 2405 feet, Brian Marotz, Montana, noted. The SOR includes details and triggers for the operation. TMT will discuss the SOR in detail and poll on May 23.

8. Operations Review

a. Reservoirs. Grand Coulee is at elevation 1240.7 feet, managing refill with residual volume. Hungry Horse is at elevation 3533.4 feet. Discharges of 9 kcfs through May are being reduced to 7 kcfs today.

Libby is at elevation 2400 feet. Albeni Falls is at elevation 2057 feet. Dworshak is at elevation 1550 feet.

Priest Rapids inflows are 212 kcfs, Lower Granite inflows are 107 kcfs, and Bonneville inflows are 336 kcfs. Baus informed TMT that Lower Monumental Dam switched from a bulk to uniform spill for TDG management and a rising inflow forecast .

b. Fish. Adults: This week is peak passage time for adults at Bonneville with a high count of 18,436 fish, Wagner reported. Passage has since fallen into the range of 7-8000 fish per day. Jack counts are picking up, setting a new record for lateness in the year. Spring chinook passage this year set a record with the single daily highest count since 1938. On May 13, adult passage at Bonneville was 67% complete based on the 5-year average, Charles Morrill, Washington, reported.

Wagner reported that adults were apparently being delayed at Little Goose, as evidenced by counts of only 3,000 fish per day compared to counts at Lower Granite of 14,000 fish per day. FPOM was considering whether the spillway weir at Little Goose was causing problems when passage numbers returned to normal: 1100 fish yesterday and 1500 fish today. Wagner noted that flows were around 90 kcfs and spill was in the 30% range at the time the problem occurred. FPOM will continue to monitor this issue and report to TMT as needed.

Juveniles: Yearling chinook passage at Lower Granite is in the range of 50,000 fish per day which is good news, Wagner reported. Passage counts downstream are 175,000 fish per day at McNary, 100,000 fish per day at John Day and 100,000 fish per day at Bonneville. Kruger and Morrill noted that yearling chinook passage is earlier and much higher this year than in recent years. Subyearlings are showing up at Snake River projects at the rate of about 3000-7000 fish per day with more to come. Steelhead are following the same pattern as chinook, with peak passage occurring a few weeks ago. Now is prime sockeye time: 211,000 fish passed McNary a week ago and have been showing up at Bonneville at the rate of nearly 100,000 per day over the past few days. Lamprey passage is 2,000 per day at McNary and 100 per day at John Day.

c. Water Quality. Scott English, COE, gave an update. Levels of TDG saturation throughout the region have recently stabilized after several forebay exceedances over the past few days. Governing factors have been low wind and high ambient temperatures, water temperatures are increasing in many reaches also, but conditions seem to be improving. Flows are forecasted to rise through the Snake and Columbia rivers, and several projects are already spilling involuntarily. High flows late April put the Bonneville tailwater gauge gaugeout of commission, and the Portland District is working on getting that gauge back online as soon as possible.

d. Power System. There was nothing to report today.

6. Next TMT Meeting

There will be a TMT conference call on May 23 and another May 30. The next regular TMT meeting will be on June 6.

Name	Affiliation
Doug Baus	COE
Paul Wagner	NOAA
David Wills	USFWS
Rick Kruger	Oregon

Lisa Wright	COE
Jim Litchfield	Montana
John Roache	BOR
Kim Johnson	COE
Karl Kanbergs	COE
Scott Bettin	BPA

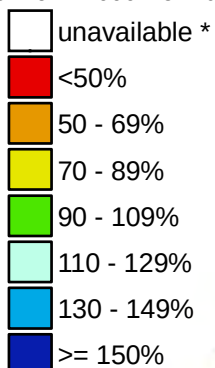
Phone:

Charles Morrill	Washington
Tom Lorz	CRITFC/Umatilla
Sheri Sears	Colville
Stu Leavitt	Salish-Kootenai
Heather Dohan	Puget
Russ George	WMC
Ruth Burris	PGE
Ed Polk	Snohomish PUD
Barry Espenson	CBB
Richelle Beck	Grant PUD
Greg Lawson	Thompson Reutters
Bill Rudolph	NW Fish Letter
Shane Scott	PPC
Laura Hamilton	COE
Russell Langshaw	Grant PUD
Russ Kiefer	Idaho
Brian Marotz	Montana

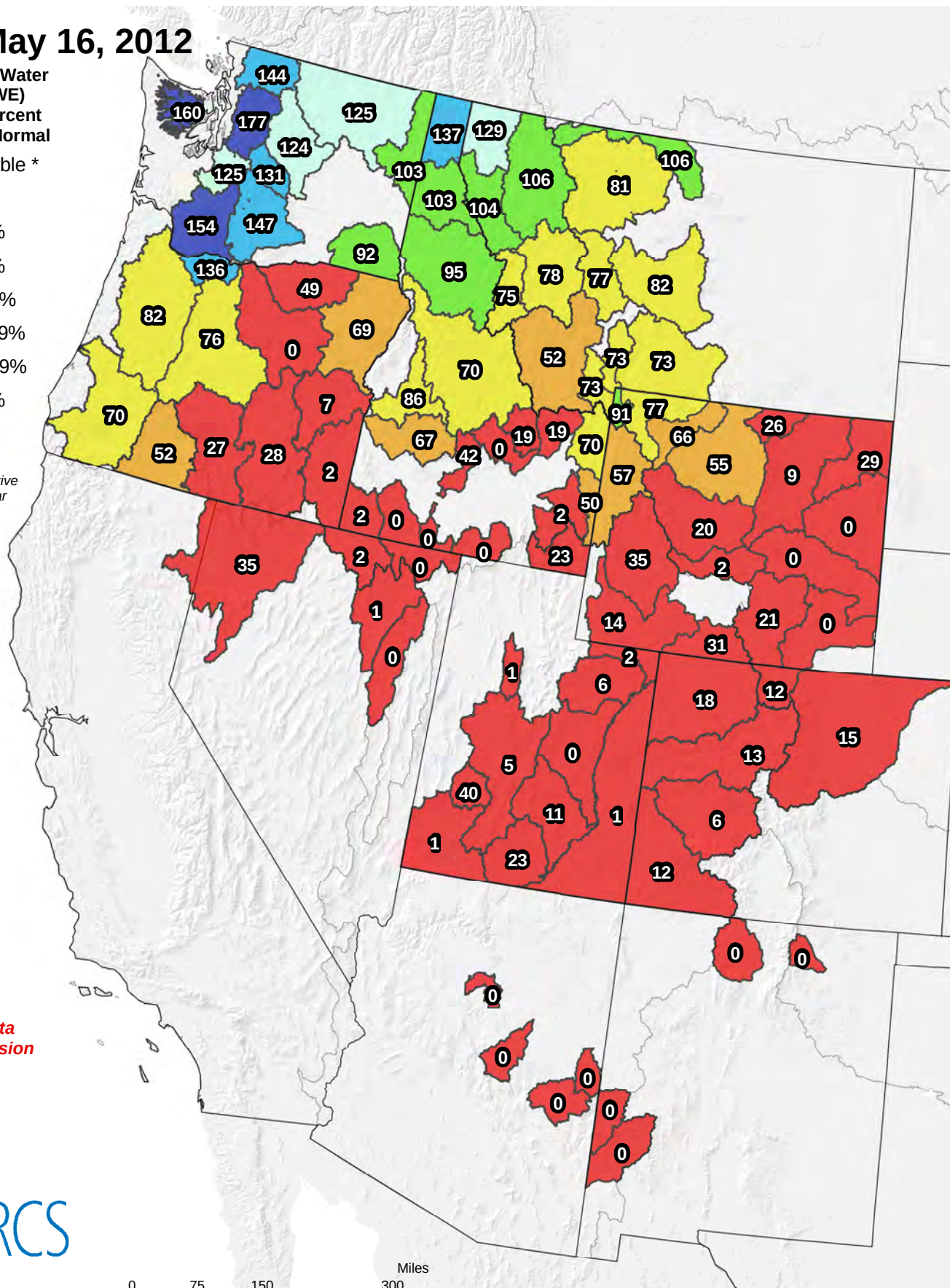
Westwide SNOTEL Current Snow Water Equivalent (SWE) % of Normal

May 16, 2012

Current Snow Water Equivalent (SWE)
Basin-wide Percent
of 1971-2000 Normal



* Data unavailable
at time of posting
or measurement
is not representative
at this time of year



Provisional data
subject to revision



The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by the USDA/NRCS National Water and Climate Center
Portland, Oregon <http://www.wcc.nrcs.usda.gov/gis/>
Based on data from <http://www.wcc.nrcs.usda.gov/reports/>
Science contact: Jim.Marron@por.usda.gov 503 414 3047

SYSTEM OPERATIONAL REQUEST: FWS #1

TO:	BG John R. McMahon	COE-NWD
	Jim Barton	COE-Water Management
	Steve Barton	COE-RCC
	David Ponganis	COE-PDD
	Col. Bruce Estok	COE-Seattle District
	J. William McDonald	USBR-Boise Regional Director
	Steven Wright	BPA-Administrator
	Steve Oliver	BPA-PG-5

FROM: Brian Kelly, State Supervisor, U.S. Fish and Wildlife Service, Idaho Fish and Wildlife Office, on behalf of the Libby BO Policy Group

DATE: May 14, 2012

SUBJECT: 2012 Libby Dam Releases for Sturgeon and Bull Trout Augmentation Flows

SPECIFICATIONS:

Based on the Fish and Wildlife Service's February 2006 Biological Opinion (2006 BO) on operations of Libby Dam, and the May final April-August volume runoff forecast of 7.155 million acre-feet, we are within a Tier 4 operations year for Kootenai River white sturgeon. The minimum recommended release volume for sturgeon conservation in a Tier 4 year is 1.18 million acre-feet and we recommend the following procedures for discharge of at least this minimum volume from Libby Dam:

Begin releases of sturgeon volume from Libby Dam once the following conditions are met: Kootenai River temperatures at Bonners Ferry reach 8° C, and Koocanusa Reservoir elevation reaches at least 2,415' MSL; at least one tagged F4 sturgeon is positioned at Ambush Rock; and the forebay of Koocanusa Reservoir warms such that 20-35,000 cubic feet per second (cfs) can be released in unison through the turbines and over the spillway without decreasing Libby Dam release temperatures by more than 2° C.

Ascending Limb: When these conditions are met, increase discharge from Libby Dam (according to ramping rates in the 2006 BO) to 15,000 cfs for 3 days, followed by discharge of 20,000 cfs for 3 days, discharge of full powerhouse capacity (PHC) for 3 days, and maintain peak discharge of PHC plus spill of up to 10,000 cfs for 7 days.

Alternatively, if discharges from Libby Dam are higher than 15,000 cfs prior to commencement of sturgeon operations, once the conditions described above are met, increase discharge from Libby Dam (according to ramping rates in the 2006

BO) to 20,000 cfs for 4 days, followed by discharge of PHC for 5 days, and maintain peak discharge of PHC plus spill of up to 10,000 cfs for 7 days.

Descending Limb: At approximately 6:00 AM, following peak outflow, reduce discharge from Libby Dam to PHC for 4 days. After four days at PHC, reduce discharge to 20,000 cfs for at least 3 days. This discharge period may be extended if necessary to reduce the rate of reservoir refill.

- If the modeled summer flat flow (targeting reservoir elevation of 2,439' at the end of September) is 15,000 cfs or greater, maintain discharge of 17,000 cfs until the sturgeon volume is exhausted.
- If the modeled summer flat flow is less than 15,000 cfs, then starting at about 6:00 AM, following the period of 17,000 cfs discharge, reduce Libby Dam discharge to 15,000 cfs, then maintain 15,000 cfs discharge until the sturgeon volume is exhausted, or gradually reduce discharge to the summer flat flow. During this gradual discharge reduction, the Corps should avoid a double peak in outflow between sturgeon and summer operations.

Note: The intent of extending flow at this rate is to delay reservoir refill until inflows recede to below turbine discharge capacity, and to make a smooth transition from the spring peak to the lower, stabilized summer flow.

As always, flood risk reduction operations supersede sturgeon flow augmentation, and dam managers will coordinate operations with regional sturgeon managers.

Sturgeon augmentation discharge may be extended for additional days if the Corps elects to provide volume in excess of the minimum volume requirement in the 2006 BO and to control the refill rate of Libby Dam.

Provide stable or gradually declining discharge through the end of September following ramping rates and minimum flow guidelines in the 2006 BO for bull trout and white sturgeon.

Additional recommendations may be provided as water supply forecasts are updated.

JUSTIFICATION:

A continued effort is needed to provide spawning and incubation flows to meet habitat attributes for depth, velocity and temperature in the Kootenai River as defined in the 2008 BO Clarified Reasonable and Prudent Alternative (RPA) for Kootenai River white sturgeon (Table 1). The clarified RPA states that if 2008 and 2009 sturgeon operations at Libby Dam are determined to be “not successful”, the action agencies (the Corps and BPA) will operate Libby Dam in 2010 through 2012 to provide additional flows by spilling in excess of powerhouse capacity consistent with a waiver of the Total Dissolved Gas (TDG) water quality standard provided by the State of Montana. The Service issued

its determination of “not successful” for 2008 sturgeon operations on April 20, 2009, and issued a “not successful” determination for 2009 operations on December 16, 2009, thus triggering the action agencies to implement provisions to provide flows in excess of powerhouse capacity in operating years 2010 through 2012.

The USGS performed data analysis of the 2006 through 2009 sturgeon augmentation flows in order to assess depth attribute attainment as per the 2006 BO. Kootenay Lake backwater extent varied, but in general a flow of roughly 35,000 cfs at Bonners Ferry provided river depth in the braided reach (RM 152 to RM 157) that met or exceeded the minimum 16.5 ft depth attribute.

Table 1. Kootenai Sturgeon Habitat Attributes from 2008 Libby Dam BO RPA Clarification.

Attribute	Measure	Objective
Area: RM 141.4 to RM 159.7		
Timing of Augmentation Flows	May into July (triggered by sturgeon spawning condition), in all years except for Tier 1.	Provide conditions for normal migration and spawning behavior.
Duration of Peak Augmentation Flows for Adult Migration and Spawning	Maximize peak augmentation flows with available water for as many days as possible, up to 14 days during the peak of the spawning period with pulses ¹ , in all years except for Tier 1.	Through in-season management, provide peak augmentation flows that lead to a biological benefit for sturgeon to maximize migration and spawning behavior via a normalized hydrograph.
Duration of Post-Peak Augmentation Flows for Incubation and Rearing	Maximize post-peak augmentation flows with available water for as many days as possible, up to 21 days, in all years except for Tier 1.	Through in-season management, provide post-peak augmentation flows that lead to a biological benefit for sturgeon to maximize embryo/free-embryo incubation and rearing via descending limb of a normalized hydrograph.
Minimum Flow Velocity ²	3.3 ft/s and greater in	Provide conditions for

¹ Kootenai sturgeon spawn on the descending limb of the hydrograph. “Pulses” refer to slight reductions in flow during this two-week period to initiate spawning.

² In order to develop an agreed-upon estimate and measurement of the areal extent of the velocity and depth attributes, the Action Agencies shall, together with the Service and in collaboration with other involved parties as needed, develop appropriate assessment tools (e.g., hydrologic models) of the braided reach.

	approximately 60% of the area of rocky substrate in the area of RM 152 to RM 157 during post-peak augmentation flows.	spawning and embryo/free-embryo incubation and rearing.
Temperature Fluctuation	Optimize temperature releases at Libby Dam to maintain 50° F with no more than a 3.6° F drop.	Provide conditions for normal migration and spawning behavior via a normalized thermograph.
Depth at Spawning Sites	Intermittent depths of 16.5 to 23 ft or greater in 60% of the area of rocky substrate from RM 152 to RM 157 during peak augmentation flows.	Provide conditions for normal migration and spawning behavior.
Substrate Extent/Spawning Structures	Approximately 5 miles of continuous rocky substrate; create conditions/features that improve the likelihood of recruitment success.	Provide habitat for embryo/free-embryo incubation and rearing.
Minimum Frequency of Occurrence	To facilitate meeting the attributes via: <u>powerhouse plus up to 10,000 cfs flow test</u>: a flow test will occur 2010 through 2012 (or until the Kootenai River Restoration Project is implemented) if the Service determines in 2008 and 2009 that the success criteria described in Action 1.3(b) have not been met. <u>Habitat improvement projects and other options</u>: through adaptive management, as noted in RPA Components 2 and 5, implement the Kootenai River Restoration Project by the aspirational date of 2012-2016.	

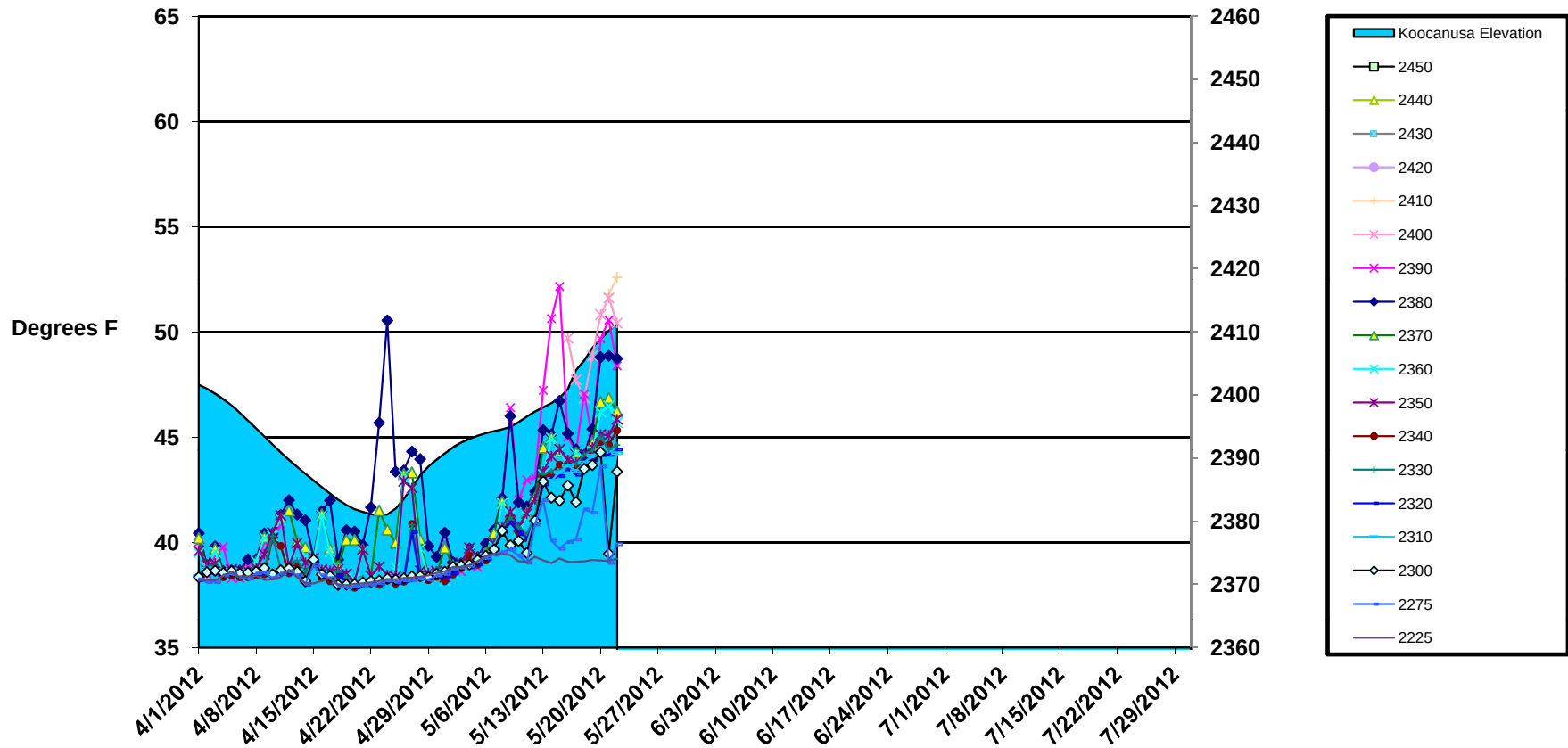
The 2012 sturgeon pulse and thermograph will be managed to maximize the upstream migration of adults and to optimize conditions during the egg incubation and embryonic stages. Additional flows from spill will coincide with discharges through the powerhouse

to ensure release temperatures can be sustained at or above 50° F at Bonners Ferry. The operation will attempt to avoid a sudden decline in temperature during the spawning and incubation phase.

The operating parameters outlined in this SOR are intended to provide some guidance on how to achieve the attributes listed in Table 1 of the 2006 USFWS BO, given the current water supply forecast. Previous years operations have shown that conditions at Libby Dam and in the Kootenai River basin can change rapidly. Recognizing this, the start date and exact shape of the operation will need to be developed and modified in-season as more is known. The in-season coordination will occur in the sturgeon technical team and with a final recommendation coordinated through the action agencies and the Technical Management Team.

**Koocanusa Reservoir Temperatures
2012 Sturgeon (1 April - 31 July)**

The graph displays water temperature data for sturgeon in Koocanusa Reservoir from April 1 to July 31, 2012. The left y-axis represents temperature in Degrees F (35 to 65), and the right y-axis represents elevation in feet (2360 to 2460). A blue shaded area indicates the reservoir's elevation profile. Multiple lines with markers represent temperature data from different depths (elevation points). The legend on the right lists the elevation points: 2450, 2440, 2430, 2420, 2410, 2400, 2390, 2380, 2370, 2360, 2350, 2340, 2330, 2320, 2310, 2300, 2275, and 2225 feet. The data shows a general warming trend, with a significant spike in temperature at the 2380-foot depth in late May/early June.



TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday May 23, 2012 10:30am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 5097

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Libby Dam Releases for Sturgeon and Bull Trout Augmentation Flows - Jason Flory USFWS and Joel Fenolio COE-NWS
 - a. [SOR 2012-FWS#1](#)
 - b. [Libby Dam Forecast & BiOp Requirements](#)
 - c. [Koocanusa Reservoir Temperatures](#)
3. Bonneville Dam Powerhouse Two Operations - Paul Wagner NOAA Fisheries and Doug Baus COE-NWD
 - a. [Weekly Descaling Report](#)
 - b. [Weekly Mortality Report](#)
4. Other
 - a. Set agenda and date for next meeting - **May 30, 2012**
 - b. [\[Calendar 2012\]](#)

Libby Dam Forecast and BiOp Requirements

- 1- May forecast of 7155 KAF for the Apr-Aug Inflow Volume
 - ▶ 122% of average
- 1-May forecast set the following criteria
 - ▶ The Sturgeon Volume to 1.18 MAF
 - ▶ Summer tiered Bull Trout Minimum to 9 kcfs through the end of August



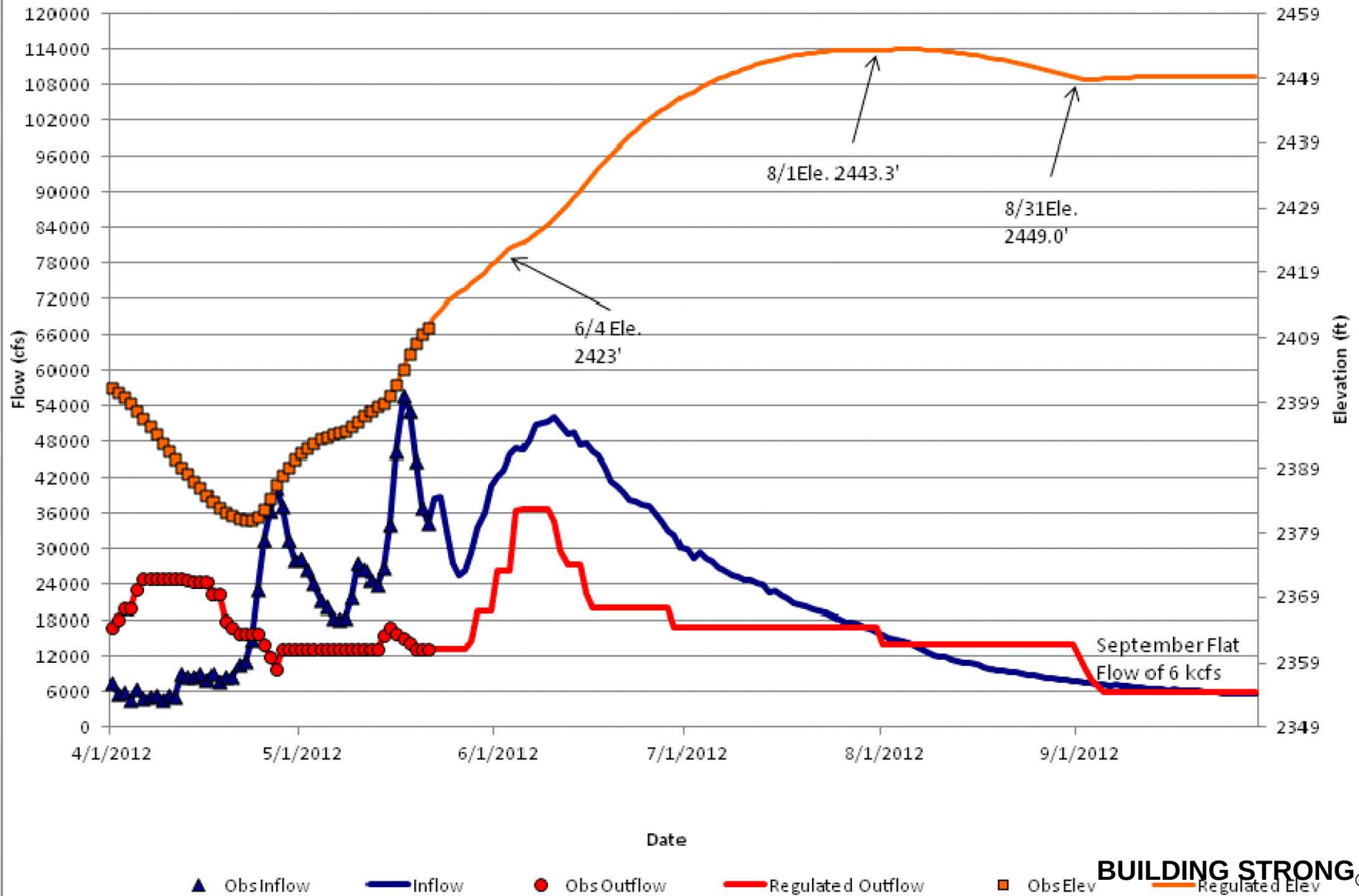
Key Targets and Dates though Sept 2012

- Sturgeon Spill Test –USFWS BiOp
 - ▶ Forebay elev 2415 ft to spill 5 kcfs
 - ▶ Forebay elev 2420 ft to spill 10 kcfs
 - ▶ Target within a foot of 1764 ft at Bonners Ferry
- NOAA BiOp
 - ▶ Target 2449 ft end of August for 2012 (SOR 2012-1)
 - ▶ Target was changed from Sept to Aug to support the Kootenai Tribe of Idaho's habitat work in Sept and Oct which requires low flows.
- Refill within 5 ft of 2459 ft – Generally occurs 1st half of August
 - ▶ Exact date to be determined in season



BUILDING STRONG®

Libby Apr-Sep Ops WY 2012, Inflows based on Median ESP Trace from May 16th



COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

May 23, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Libby Dam Releases – SOR 2012-FWS#1

Jason Flory, USFWS, described this year's request to implement operations in support of a sturgeon pulse and meeting bull trout minimums per 2008 settlement of the 2006 USFWS Libby BiOp. Jason described this as a 'Tier 4' year, meaning 1.1 MAF volume will be available for the sturgeon pulse. Temperature, reservoir elevation and presence of spawning ready females as triggers are identical to the triggers used last year, as is the ascending limb approach to the operation. Jason briefly described the operation, and said they expected, given forecasts and current conditions, to hit the triggers this weekend. Joel Fenolio, USACE Seattle District, provided additional information via Powerpoint slides attached to the meeting agenda to show what implementation of this request would look like given forecasts – and said this would be subject to change with shifting conditions. He showed BiOp requirements, May forecasts, and reminded TMT of the agreement reached earlier this year to support the Kootenai Tribe habitat project which moved the 2449' target elevation from the end of September to the end of August. He also said that with warmer temperatures expected to hit the basin in early June, the runoff flows should correspond well with the expected timing of the spill test. The spill test will likely commence between approximately June 1 and 4.

A question was asked about other scenarios that were considered by the Corps, e.g. lower flows in July to ensure meeting refill targets later. Joel responded that they did consider this option, but found it would not be feasible without forcing a double peak in flows. Jason Flory also clarified that the regional team of salmon biologists had determined that success criteria defined for the sturgeon operation were not met in 2008 and 2009, and this was the reason for doing the spill tests (not related to the Kootenai habitat project).

TMT Poll/Planned Operation:

TMT members were polled and all members present supported and/or did not object to the SOR: Montana, Washington, Oregon, Nez Perce, CTUIR (Umatilla Tribes), USFWS, NOAA, BPA, Reclamation and Corps. With that, the Corps planned to begin implementing the operation per the request and will continue to monitor and discuss the operation with TMT as the season progresses. Idaho was contacted by phone after the meeting and did not object to this operation.

Bonneville PH2 Operations

FPAC co-chairs Paul Wagner, NOAA, and Tom Lorz, CRITFC/CTUIR, shared that Snake River sockeye from the PIT-tagged group were expected to arrive at Bonneville around 5/26 based on

data from last year's flows and passage timing. Based on FPC data from 5/16 to 5/22 sockeye arriving at the project have seen variable descaling rates (Low on 5/17 of 5.0% to High on 5/21 of 24.1%) and mortality rates (Low on 5/21 of 0.0% and High on 5/16 of 9.8%) and at times these rates have been higher than normal, and therefore the salmon managers were requesting a special operation at Bonneville to improve passage conditions for the fish passing through Powerhouse 2 gatewells. Charles Morrill, Washington, updated with today's passage index data, saying there were 13,699 sockeye at the project with 9.2% mortality and 23.7% descaling rates. He added additional data about other fish passing the project. Given the increase in the number of sockeye observed at the project this morning, the salmon managers agreed they would like the special operation to begin as soon as possible and felt that protection of all sockeye, regardless of origin, was important. They proposed beginning an operation today and continuing through Tuesday evening, 5/29, at 6:00 pm.

The Corps' Doug Baus outlined the planned operation to meet the interests of this request, and said the specifics of the operation would be identical to what was provided last week. Baus provided a recap of the operation, as follows: To pass flows, the project will operate PH2 up to the mid-point (50%) of the operating range, then operate PH1 up to the upper limit (100%) of the 1% range. Then as flows increase, any water that would normally pass the project via PH2 units operating above the mid-point would instead be passed through PH1 units operating up to the best geometry point. Any flows that exceed the powerhouse capacity will be additional involuntary spill. He said TDG levels below Bonneville were continuing to exceed gas standards and therefore the action agencies required this operation to be flow-neutral so as not to knowingly exacerbate TDG. The salmon managers reiterated their concern and disagreement with operating PH 1 to open geometry, given the uncertainty of the biological impact to the passing fish. Paul Wagner added that the adult spring Chinook counts were down, signaling the likely end of the run and therefore there was not as big a concern for adult fallback or delays as had previously been discussed around operating Bonneville flows greater than 110 kcfs.

TMT poll/planned operation:

All TMT members present on the call today either supported or did not object to the Corps' planned operation: **Montana, Oregon, Washington, Nez Perce, CTUIR (Tom reiterated his concerns with the way this operation would be implemented), USFWS, NOAA, BPA, Reclamation and Corps.** With that, the Corps planned to begin this special operation today, 5/23, and continue through 6:00 pm on Tuesday, 5/29. The salmon managers via FPAC will monitor the operation and passage; and descaling and mortality issues, and determine whether to recommend continuation of the special operation. The 5/30 TMT conference call will stay on the schedule for now; Doug Baus and Paul Wagner will coordinate on 5/29 to determine if the meeting should be cancelled, and a notice of this cancellation will occur by 3:00 pm on Tuesday, 5/29.

Follow up email from Doug Baus 5/23/2012:

Please include no objection from IDFG Pete Hassemer (IDFG alternate) on both polled operations (LIB SOR and BON PH2) that occurred. Russ was not available during the call. Pete was followed up via phone.

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

May 23, 2012
Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of NOAA, Montana, Oregon, BOR, Washington, BPA, CRITFC/Umatilla Tribe, USFWS, COE, Nez Perce Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Libby Dam Releases for Sturgeon and Bull Trout Augmentation Flows (SOR 2012 FWS#1)

Jason Flory, USFWS, introduced the SOR which requests an operation for the third (and probably the last) year of spill testing for sturgeon under the 2008 Libby BiOp settlement agreement. The May final forecast is 7.1 MAF, which makes this a tier 4 year equivalent to 1.1 MAF of sturgeon volume. The SOR spells out the triggers for beginning the sturgeon pulse and gives details of the ascending and descending limb. These details are nearly identical to last year's SOR. The triggers are:

- Kootenai River temperature of at least 8 degrees C at Bonners Ferry.
- At least one spawning female sturgeon at Ambush Rock.
- Forebay conditions that allow flows to be released without causing river temperatures to drop more than 2 degrees C.

Flory said the sturgeon operation will probably be triggered this weekend or on Memorial Day. The SOR requests the following operation:

On the ascending limb of the hydrograph: 15,000 cfs for 3 days, followed by discharge of 20,000 cfs for 3 days, discharge of full powerhouse capacity (PHC) for 3 days, and maintain peak discharge of PHC plus spill of up to 10,000 cfs for 7 days.

On the descending limb of the hydrograph: at approximately 6:00 AM, following peak outflow, reduce discharge from Libby Dam to PHC for 4 days. After four days at PHC, reduce discharge to 20,000 cfs for at least 3 days. This discharge period may be extended if necessary to reduce the rate of reservoir refill.

Additional details regarding the SOR may be found on the following website:

http://www.nwd-wc.usace.army.mil/tmt/sor/2012/SOR_2012-FWS1.pdf

Joel Fenolio, COE, gave a presentation on how the operation, once triggered, will unfold. He discussed information contained in two links to this item on today's agenda, which provide details of the SOR as well as USFWS and NOAA BiOp requirements at Libby Dam.

This year's water supply forecast for Libby from April-August is 7.155 MAF, about 122% of average and about 1 MAF less than last year, Fenolio reported. According to the May volume forecast for Libby, the Action Agencies need to release 1.18 MAF in sturgeon flows this year. The May forecast also serves as the basis for the tiered bull trout minimum flow, set at 9 kcfs through August when the sturgeon pulse is done.

The sturgeon spill test calls for a forebay elevation of 2415 feet to spill 5 kcfs, and 2420 feet to spill 10 kcfs. Fenolio said these targets should be achieved by June 1-4. The sturgeon operation also targets an elevation within a foot of flood stage at Bonners Ferry.

The NOAA BiOp sets a target elevation for Libby reservoir of 2449 feet at the end of September, based on a forecast of over 7.2 MAF at The Dalles. However, in order to facilitate the implementation of SOR 2012-01 (Kootenai River Habitat Restoration Project Phase 2) the AAs coordinated with the TMT (March 28, 2012 meeting) and adjusted the target date for a Libby reservoir elevation of 2449 feet at the end of August. Another target is to maintain Libby forebay at 5 feet from full (2454 feet) during the summer months. Fenolio estimated the Libby forebay elevation will be within a foot of 2454 feet during the first half of August, with the exact date to be determined in season. VARQ outflows are expected to be 13.4 kcfs until May 28, when outflows ramp up to 15 kcfs and the sturgeon pulse begins.

When the operation ends, the project will release an estimated 17 kcfs from July 1 until the end of July, followed by another ramp down to 13-14 kcfs in August to attain 2449 feet by the end of August. The maximum projected elevation is 2453.3 feet on August 1. It was noted that the slide with a graph of elevations had an incorrect value for the maximum elevation. The graph shows 2443.3 but should be 2453.3. The project will ramp down in September to 6 kcfs, which is the minimum flow for bull trout.

Jim Litchfield, Montana, asked whether any other flow augmentation scenarios were considered beyond the one illustrated today. Would a lower flow in July help refill Libby reservoir? Fenolio said no, it's hard to get the reservoir up to 2454 feet or within 5 feet of full without creating a double peak, as it does in many scenarios. TMT members were polled on their views of the proposed sturgeon operation:

- **Montana** – Supports the SOR.
- **Washington** – Supports the SOR.
- **Oregon** – No objection.
- **Nez Perce** – No objection.
- **Umatilla** – No objection.
- **NOAA** – Supports the SOR.
- **USFWS** – Supports the SOR.
- **BPA** – Supports the SOR.
- **BOR** – Supports the SOR.
- **COE** – Supports the SOR.
- **Idaho** – No objection (TMT alternate polled via phone after today's meeting).

The COE will implement the operation as requested in the SOR and keep TMT informed as the sturgeon pulse progresses.

3. Bonneville Dam Powerhouse 2 Operations for Sockeye

This topic was added to today's agenda at the request of Paul Wagner, NOAA, on behalf of the Salmon Managers. PIT tagged Snake River sockeye have been passing Lower Granite and Little Goose dams over the past few days. Wagner showed TMT the descaling and mortality data for sockeye passing John Day and Bonneville dams over the past week (through May 23), linked to the TMT page. The conservative estimated arrival date at Bonneville Dam for these fish is May 26, based on the current flows of 380 kcfs in the Columbia (as compared to 500 kcfs at this time last year).

High descaling rates for sockeye have already been observed for fish passing PH2. Even with PH2 operating at the mid-point (50%) of 1% operating range, sockeye descaling rates through PH2 were in the range of 17-22% over the past few days, which is significantly higher than for other sampled species. Sockeye mortality rates at Bonneville are also higher than for other species. Therefore, Wagner said, the FPAC request is for a modified PH2 operation at Bonneville beginning at 6 pm May 26 through 6 pm May 29.

Charles Morrill, Washington, quoted statistics from an email update on sockeye that was sent out this morning. These statistics were so new that FPAC and TMT members had not yet had a chance to review them. Today's passage index for sockeye at Bonneville is 13,699 fish, higher than any count over the past 3 days, Morrill reported. Today the mortality rate for sockeye was 9.2% and the descaling rate was 23.7%. Mortality rates for most other species at Bonneville were 0.0% except for yearling Chinook at 2.9%. Descaling rates for other species ranged from zero for subyearling chinook to 9.5% for steelhead.

There was immediate consensus among the Salmon Managers present that this information means the requested operation to limit PH2 to the mid-point (50%) of the 1% operating range should begin immediately. There was also general agreement that these sockeye need protection regardless of whether they have been identified as endangered Snake River sockeye or mid-Columbia sockeye. Wagner noted that adult spring Chinook counts are down at Bonneville, probably indicating the end of the run as well as the potential tradeoff between adults and juveniles.

In light of these recommendations and current TDG levels, Baus outlined the operation the COE will implement to aid passage of juvenile sockeye at Bonneville. It is essentially the same flow neutral operation the AAs have implemented in coordination with TMT to limit PH2 to the mid-point (50%) of the 1% operating range:

1. Operate all PH2 units up to 25% of 1% operating range.
2. To pass additional flows, operate all PH1 units up to 100% of the 1% operating range.
3. To pass additional flows, operate all PH2 units within 25-50% of the 1% operating range.
4. To pass additional flows, increase operation of PH1 units one at a time in the order of priority up to the best geometry point.

5. Any additional flow would exceed powerhouse capacity and would be passed as additional involuntary spill.

Baus said the AAs are currently managing TDG at Bonneville Dam as identified in the FOP to not exceed 120% in the tailrace and 115% in the next downstream forebay (equivalent is gauge at Camas-Washougal). TDG has been and continues to exceed 120% in the tailrace (high of 123.5% on May 18 and low of 122.3 on May 22) as well as exceed 115% at Camas Washougal (high of 118.2 on May 21 and low of 115.3 on May 18). Spilling flow associated with capping PH2 to the mid-point (50%) of the 1 % range would equate to approximately 28kcfs of additional spill that would knowingly exacerbate already problematic levels of TDG downstream of the Bonneville Dam. Since this would not be consistent with current water quality requirements identified in the FOP the AAs will continue to support a flow neutral operation that redistributes flow from PH2 (an approximate 28 kcfs flow decrease resulting from capping PH2 to the 50% of the 1% operating range) to PH1 (an approximate 28 kcfs flow increase resulting from operating at best geometry) as this operation would improve PH2 passage conditions while not exacerbating current 120%/115% TDG water quality exceedances.

TMT members were polled on the operation for juvenile sockeye:

- **Montana** – No objection.
- **Washington** – No objection.
- **Oregon** – No objection.
- **Nez Perce** – Concurs with the operation.
- **Umatilla** – Concurs with the operation but has concerns about the effects of implementation.
- **USFWS** – No objection.
- **NOAA** – Supports the operation.
- **BPA** – Supports the operation.
- **BOR** – Supports the operation.
- **COE** – Supports the operation.
- **Idaho** – No objection (TMT alternate polled via phone after today's meeting).

The COE will implement the proposed operation for sockeye at Bonneville effective today through 6 pm, May 29.

4. Next TMT Meeting

A tentative conference call was scheduled for May 30 if needed to discuss sockeye passage at Bonneville. The next regular TMT meeting will be June 6.

<i>Name</i>	<i>Affiliation</i>
Doug Baus	COE
Lisa Wright	COE
Scott Bettin	BPA
Tom Lorz	CRITFC Umatilla
Paul Wagner	NOAA

Rick Kruger	Oregon
Margaret Filardo	FPC
Dave Benner	FPC
Russ Kiefer	Idaho
Scott English	COE
Bill Proctor	COE
Dan Feil	COE
Dave Wills	USFWS
Sheri Sears	Colville Tribe
Charles Morrill	Washington
Dave Statler	Nez Perce

FISH PASSAGE CENTER

Last Updated: 5/23/2012 7:37

Lower Granite Dam				
Species	Date	Number Examined	Percent Descaled	
CH1	5/16/2012	403	3.5%	
	5/17/2012	547	2.0%	
	5/18/2012	648	4.2%	
	5/19/2012	354	3.1%	
	5/20/2012	252	4.8%	
	5/21/2012	222	2.7%	
	5/22/2012	97	0.0%	
ST	5/16/2012	322	3.4%	
	5/17/2012	397	4.5%	
	5/18/2012	442	3.4%	
	5/19/2012	322	6.5%	
	5/20/2012	414	5.8%	
	5/21/2012	386	5.7%	
	5/22/2012	249	5.6%	
CO	5/16/2012	23	0.0%	
	5/17/2012	32	0.0%	
	5/18/2012	63	0.0%	
	5/19/2012	36	0.0%	
	5/20/2012	19	0.0%	*
	5/21/2012	20	0.0%	
	5/22/2012	17	0.0%	*
SO	5/16/2012	5	0.0%	*
	5/17/2012	9	0.0%	*
	5/18/2012	52	1.9%	
	5/19/2012	34	0.0%	
	5/20/2012	25	0.0%	
	5/21/2012	22	9.1%	
	5/22/2012	19	0.0%	*
CH0	5/16/2012	15	0.0%	*
	5/17/2012	8	0.0%	*
	5/18/2012	13	0.0%	*
	5/19/2012	11	0.0%	*
	5/20/2012	6	0.0%	*

Little Goose Dam				
Species	Date	Number Examined	Percent Descaled	
CH1	5/16/2012	152	1.3%	
	5/17/2012	237	0.8%	
	5/18/2012	335	0.3%	
	5/19/2012	291	0.3%	
	5/20/2012	198	1.5%	
	5/21/2012	132	0.8%	
	5/22/2012	119	0.8%	
ST	5/16/2012	160	0.0%	
	5/17/2012	212	0.9%	
	5/18/2012	242	2.5%	
	5/19/2012	419	0.5%	
	5/20/2012	163	1.8%	
	5/21/2012	108	0.0%	
	5/22/2012	94	0.0%	
CO	5/16/2012	22	0.0%	
	5/17/2012	17	0.0%	*
	5/18/2012	27	3.7%	
	5/19/2012	31	0.0%	
	5/20/2012	19	0.0%	*
	5/21/2012	12	0.0%	*
	5/22/2012	10	0.0%	*
SO	5/16/2012	9	0.0%	*
	5/17/2012	5	0.0%	*
	5/18/2012	6	0.0%	*
	5/19/2012	19	0.0%	*
	5/20/2012	7	0.0%	*
	5/21/2012	6	0.0%	*
	5/22/2012	8	0.0%	*
CH0	5/16/2012	1	0.0%	*
	5/17/2012	1	0.0%	*
	5/18/2012	1	0.0%	*
	5/19/2012	1	0.0%	*
	5/20/2012	5	0.0%	*

5/21/2012	15	0.0%	*	5/21/2012	3	0.0%	*
5/22/2012	24	0.0%		5/22/2012	2	0.0%	*

* Incidates inadequate sample sizes of less than 20 fish examined

Lower Monumental Dam				
Species	Date	Number Examined	Percent Descaled	
CH1	5/16/2012	362	1.1%	
	5/17/2012	548	2.6%	
	5/18/2012	631	2.7%	
	5/19/2012	669	2.2%	
	5/20/2012	399	3.0%	
	5/21/2012	446	2.9%	
	5/22/2012	599	1.8%	
ST	5/16/2012	647	2.9%	
	5/17/2012	624	2.9%	
	5/18/2012	800	3.4%	
	5/19/2012	999	4.5%	
	5/20/2012	849	6.0%	
	5/21/2012	1117	3.5%	
	5/22/2012	638	4.4%	
CO	5/16/2012	7	0.0%	*
	5/17/2012	11	0.0%	*
	5/18/2012	16	0.0%	*
	5/19/2012	39	0.0%	
	5/20/2012	21	14.3%	
	5/21/2012	20	5.0%	
	5/22/2012	35	2.9%	
SO	5/16/2012	9	11.1%	*
	5/17/2012	4	0.0%	*
	5/18/2012	7	0.0%	*
	5/19/2012	16	0.0%	*
	5/20/2012	23	0.0%	
	5/21/2012	41	4.9%	
	5/22/2012	43	0.0%	
CH0	5/16/2012			
	5/17/2012	1	0.0%	*
	5/18/2012	2	0.0%	*

McNary Dam				
Species	Date	Number Examined	Percent Descaled	
CH1	5/16/2012			
	5/17/2012	503	2.6%	
	5/18/2012			
	5/19/2012	237	4.2%	
	5/20/2012			
	5/21/2012	161	1.9%	
	5/22/2012			
ST	5/16/2012			
	5/17/2012	52	1.9%	
	5/18/2012			
	5/19/2012	45	4.4%	
	5/20/2012			
	5/21/2012	18	11.1%	*
	5/22/2012			
CO	5/16/2012			
	5/17/2012	38	0.0%	
	5/18/2012			
	5/19/2012	31	3.2%	
	5/20/2012			
	5/21/2012	16	0.0%	*
	5/22/2012			
SO	5/16/2012			
	5/15/2012	295	7.1%	
	5/16/2012			
	5/17/2012	92	4.3%	
	5/18/2012			
	5/19/2012	54	9.3%	
	5/20/2012			
CH0	5/16/2012			
	5/17/2012	2	0.0%	*
	5/18/2012			

5/19/2012	3	0.0%	*	5/19/2012	1	0.0%	*
5/20/2012	3	0.0%	*	5/20/2012			
5/21/2012	4	0.0%	*	5/21/2012	2	0.0%	*
5/22/2012	2	0.0%	*	5/22/2012			

** Incidates inadequate sample sizes of less than 20 fish examined*

John Day Dam			
Species	Date	Number Examined	Percent Descaled
CH1	5/16/2012	1577	1.5%
	5/17/2012	919	1.5%
	5/18/2012	1450	3.8%
	5/19/2012	854	4.7%
	5/20/2012	626	2.2%
	5/21/2012	719	2.6%
	5/22/2012	1503	1.4%
ST	5/16/2012	489	1.6%
	5/17/2012	221	5.0%
	5/18/2012	312	1.3%
	5/19/2012	297	3.4%
	5/20/2012	295	3.1%
	5/21/2012	182	2.2%
	5/22/2012	352	1.1%
CO	5/16/2012	194	2.1%
	5/17/2012	99	1.0%
	5/18/2012	188	3.7%
	5/19/2012	195	1.5%
	5/20/2012	86	0.0%
	5/21/2012	55	0.0%
	5/22/2012	225	2.2%
SO	5/16/2012	564	8.3%
	5/17/2012	332	6.3%
	5/18/2012	566	8.1%
	5/19/2012	289	9.7%
	5/20/2012	140	7.9%
	5/21/2012	186	11.3%
	5/22/2012	346	7.5%
CH0	5/16/2012		

Bonneville Dam			
Species	Date	Number Examined	Percent Descaled
CH1	5/16/2012	379	4.5%
	5/17/2012	213	2.8%
	5/18/2012	207	1.9%
	5/19/2012	209	1.9%
	5/20/2012	235	4.3%
	5/21/2012	173	5.8%
	5/22/2012	246	4.5%
ST	5/16/2012	32	0.0%
	5/17/2012	19	5.3%
	5/18/2012	19	0.0%
	5/19/2012	17	5.9%
	5/20/2012	15	0.0%
	5/21/2012	14	0.0%
	5/22/2012	28	3.6%
CO	5/16/2012	90	1.1%
	5/17/2012	67	1.5%
	5/18/2012	62	1.6%
	5/19/2012	54	1.9%
	5/20/2012	45	0.0%
	5/21/2012	40	12.5%
	5/22/2012	59	1.7%
SO	5/16/2012	185	17.8%
	5/17/2012	80	5.0%
	5/18/2012	66	6.1%
	5/19/2012	45	17.8%
	5/20/2012	44	22.7%
	5/21/2012	29	24.1%
	5/22/2012	54	16.7%
CH0	5/16/2012	5	0.0%

5/17/2012				5/17/2012	1	0.0%	*
5/18/2012				5/18/2012	4	0.0%	*
5/19/2012				5/19/2012	5	0.0%	*
5/20/2012	1	0.0%	*	5/20/2012	9	0.0%	*
5/21/2012	1	0.0%	*	5/21/2012	19	0.0%	*
5/22/2012	8	0.0%	*	5/22/2012	34	5.9%	

* Incidates inadequate sample sizes of less than 20 fish examined

Rock Island Dam			
Species	Date	Number Examined	Percent Descaled
CH1	5/16/2012	464	0.9%
	5/17/2012	355	0.6%
	5/18/2012	243	0.4%
	5/19/2012	226	0.9%
	5/20/2012	295	0.7%
	5/21/2012	260	0.0%
	5/22/2012	210	0.0%
ST	5/16/2012	291	0.7%
	5/17/2012	251	1.2%
	5/18/2012	230	0.9%
	5/19/2012	217	0.0%
	5/20/2012	197	0.0%
	5/21/2012	217	0.0%
	5/22/2012	104	0.0%
CO	5/16/2012	1684	0.3%
	5/17/2012	1212	0.4%
	5/18/2012	1211	0.4%
	5/19/2012	776	0.1%
	5/20/2012	825	0.2%
	5/21/2012	637	0.3%
	5/22/2012	595	0.7%
SO	5/16/2012	640	1.6%
	5/17/2012	404	1.2%
	5/18/2012	362	0.8%
	5/19/2012	223	0.0%
	5/20/2012	310	0.3%
	5/21/2012	386	0.5%

Salmon River Trap at Whitebird			
Species	Date	Number Examined	Percent Descaled
CH1	5/16/2012		
	5/17/2012		
	5/18/2012		
	5/19/2012		
	5/20/2012		
	5/21/2012		
	5/22/2012		
ST	5/16/2012		
	5/17/2012		
	5/18/2012		
	5/19/2012		
	5/20/2012		
	5/21/2012		
	5/22/2012		
CO	5/16/2012		
	5/17/2012		
	5/18/2012		
	5/19/2012		
	5/20/2012		
	5/21/2012		
	5/22/2012		
SO	5/16/2012		
	5/17/2012		
	5/18/2012		
	5/19/2012		
	5/20/2012		
	5/21/2012		

	5/22/2012	217	1.4%	
CH0	5/16/2012	5	0.0%	*
	5/17/2012	4	0.0%	*
	5/18/2012	3	0.0%	*
	5/19/2012	6	0.0%	*
	5/20/2012	4	0.0%	*
	5/21/2012	8	0.0%	*
	5/22/2012	19	0.0%	*

	5/22/2012			
CH0	5/16/2012			
	5/17/2012			
	5/18/2012			
	5/19/2012			
	5/20/2012			
	5/21/2012			
	5/22/2012			

* Incidates inadequate sample sizes of less than 20 fish examined

Snake River Trap at Lewiston				
Species	Date	Number Examined	Percent Descaled	
CH1	5/16/2012	262	0.0%	
	5/17/2012	340	0.3%	
	5/18/2012	552	0.0%	
	5/19/2012	173	0.0%	
	5/20/2012	53	0.0%	
	5/21/2012	49	0.0%	
	5/22/2012	46	0.0%	
ST	5/16/2012	57	0.0%	
	5/17/2012	79	0.0%	
	5/18/2012	146	0.0%	
	5/19/2012	15	0.0%	*
	5/20/2012	49	4.1%	
	5/21/2012	27	0.0%	
	5/22/2012	29	0.0%	
CO	5/16/2012			
	5/17/2012			
	5/18/2012			
	5/19/2012			
	5/20/2012			
	5/21/2012			
	5/22/2012			
SO	5/16/2012			
	5/17/2012			
	5/18/2012			
	5/19/2012			

Grande Ronde River Trap				
Species	Date	Number Examined	Percent Descaled	
CH1	5/16/2012	314	0.6%	
	5/17/2012	207	0.5%	
	5/18/2012	183	0.0%	
	5/19/2012	59	0.0%	
	5/20/2012	28	0.0%	
	5/21/2012	19	0.0%	*
	5/22/2012	30	0.0%	
ST	5/16/2012	74	10.8%	
	5/17/2012	90	12.2%	
	5/18/2012	57	17.5%	
	5/19/2012	25	12.0%	
	5/20/2012	17	11.8%	*
	5/21/2012	19	15.8%	*
	5/22/2012	14	0.0%	*
CO	5/16/2012			
	5/17/2012			
	5/18/2012			
	5/19/2012			
	5/20/2012			
	5/21/2012			
	5/22/2012			
SO	5/16/2012			
	5/17/2012			
	5/18/2012			
	5/19/2012			

	5/20/2012		5/20/2012		
	5/21/2012		5/21/2012		
	5/22/2012		5/22/2012		
CH0	5/16/2012		CH0	5/16/2012	1 0.0% *
	5/17/2012			5/17/2012	2 0.0% *
	5/18/2012			5/18/2012	3 0.0% *
	5/19/2012			5/19/2012	1 0.0% *
	5/20/2012			5/20/2012	
	5/21/2012			5/21/2012	
	5/22/2012			5/22/2012	7 0.0% *

** Incidates inadequate sample sizes of less than 20 fish examined*

Imnaha River Trap				
Species	Date	Number Examined	Percent Descaled	
CH1	5/16/2012	8	0.0%	*
	5/17/2012	2	0.0%	*
	5/18/2012	4	0.0%	*
	5/19/2012	6	0.0%	*
	5/20/2012	6	0.0%	*
	5/21/2012			
	5/22/2012			
ST	5/16/2012	447	4.0%	
	5/17/2012	286	8.4%	
	5/18/2012	161	0.0%	
	5/19/2012	97	8.2%	
	5/20/2012	80	3.8%	
	5/21/2012			
	5/22/2012			
CO	5/16/2012			
	5/17/2012			
	5/18/2012			
	5/19/2012			
	5/20/2012			
	5/21/2012			
	5/22/2012			
SO	5/16/2012			
	5/17/2012			

	5/18/2012
	5/19/2012
	5/20/2012
	5/21/2012
	5/22/2012
CHO	5/16/2012
	5/17/2012
	5/18/2012
	5/19/2012
	5/20/2012
	5/21/2012
	5/22/2012

** Incidates inadequate sample sizes of less than 20 fish examined*

FISH PASSAGE CENTER WEEKLY MORTALITY REPORT

Last Updated: 5/23/2012 7:40

Lower Granite Dam					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012	405	2	0.5%	53
	5/17/2012	548	1	0.2%	69
	5/18/2012	703	0	0.0%	51
	5/19/2012	354	0	0.0%	35
	5/20/2012	253	1	0.4%	21
	5/21/2012	225	3	1.3%	14
	5/22/2012	98	1	1.0%	23
ST	5/16/2012	322	0	0.0%	4
	5/17/2012	398	1	0.3%	4
	5/18/2012	487	0	0.0%	2
	5/19/2012	324	2	0.6%	5
	5/20/2012	414	0	0.0%	2
	5/21/2012	387	1	0.3%	4
	5/22/2012	249	0	0.0%	2
CO	5/16/2012	23	0	0.0%	1
	5/17/2012	32	0	0.0%	3
	5/18/2012	63	0	0.0%	5
	5/19/2012	36	0	0.0%	4
	5/20/2012	19	0	0.0%	1
	5/21/2012	20	0	0.0%	1
	5/22/2012	17	0	0.0%	1
SO	5/16/2012	5	0	0.0%	0
	5/17/2012	9	0	0.0%	0
	5/18/2012	52	0	0.0%	4
	5/19/2012	35	1	2.9%	5
	5/20/2012	25	0	0.0%	6
	5/21/2012	22	0	0.0%	3
	5/22/2012	19	0	0.0%	4
CH0	5/16/2012	17	2	11.8%	7
	5/17/2012	8	0	0.0%	3
	5/18/2012	14	0	0.0%	10
	5/19/2012	11	0	0.0%	5
	5/20/2012	6	0	0.0%	4

Little Goose Dam					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012	152	0	0.0%	6
	5/17/2012	237	0	0.0%	5
	5/18/2012	338	3	0.9%	41
	5/19/2012	292	1	0.3%	23
	5/20/2012	198	0	0.0%	50
	5/21/2012	134	2	1.5%	29
	5/22/2012	182	1	0.5%	7
ST	5/16/2012	161	1	0.6%	2
	5/17/2012	212	0	0.0%	1
	5/18/2012	242	0	0.0%	9
	5/19/2012	419	0	0.0%	4
	5/20/2012	163	0	0.0%	3
	5/21/2012	108	0	0.0%	3
	5/22/2012	133	0	0.0%	8
CO	5/16/2012	22	0	0.0%	0
	5/17/2012	17	0	0.0%	0
	5/18/2012	27	0	0.0%	0
	5/19/2012	31	0	0.0%	0
	5/20/2012	19	0	0.0%	0
	5/21/2012	12	0	0.0%	0
	5/22/2012	10	0	0.0%	0
SO	5/16/2012	9	0	0.0%	0
	5/17/2012	5	0	0.0%	0
	5/18/2012	6	0	0.0%	0
	5/19/2012	19	0	0.0%	0
	5/20/2012	7	0	0.0%	0
	5/21/2012	6	0	0.0%	0
	5/22/2012	8	0	0.0%	0
CH0	5/16/2012	1	0	0.0%	0
	5/17/2012	1	0	0.0%	0
	5/18/2012	2	0	0.0%	0
	5/19/2012	1	0	0.0%	0
	5/20/2012	5	0	0.0%	0

5/21/2012	16	1	6.3%	5
5/22/2012	24	0	0.0%	0
Lamprey 5/16/2012				
Juveniles 5/17/2012				
5/18/2012				
5/19/2012				
5/20/2012				
5/21/2012				
5/22/2012				

5/21/2012	3	0	0.0%	0
5/22/2012	2	0	0.0%	0
Lamprey 5/16/2012	1	0	0.0%	0
Juveniles 5/17/2012				
5/18/2012				
5/19/2012				
5/20/2012				
5/21/2012				
5/22/2012	1	0	0.0%	0

Lower Monumental Dam					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012	363	1	0.3%	13
	5/17/2012	552	4	0.7%	13
	5/18/2012	635	4	0.6%	11
	5/19/2012	674	5	0.7%	23
	5/20/2012	402	3	0.7%	14
	5/21/2012	446	0	0.0%	26
	5/22/2012	599	0	0.0%	15
ST	5/16/2012	648	1	0.2%	4
	5/17/2012	626	2	0.3%	9
	5/18/2012	800	0	0.0%	5
	5/19/2012	999	0	0.0%	6
	5/20/2012	851	2	0.2%	0
	5/21/2012	1119	2	0.2%	7
	5/22/2012	639	0	0.0%	5
CO	5/16/2012	7	0	0.0%	0
	5/17/2012	11	0	0.0%	1
	5/18/2012	16	0	0.0%	0
	5/19/2012	39	0	0.0%	0
	5/20/2012	21	0	0.0%	0
	5/21/2012	20	0	0.0%	6
	5/22/2012	35	0	0.0%	1
SO	5/16/2012	9	0	0.0%	1
	5/17/2012	4	0	0.0%	0
	5/18/2012	7	0	0.0%	0
	5/19/2012	16	0	0.0%	0
	5/20/2012	23	0	0.0%	0
	5/21/2012	41	0	0.0%	0
	5/22/2012	43	0	0.0%	0
CH0	5/16/2012				
	5/17/2012	1	0	0.0%	0
	5/18/2012	2	0	0.0%	0
	5/19/2012	3	0	0.0%	0
	5/20/2012	3	0	0.0%	0
	5/21/2012	4	0	0.0%	0

McNary Dam					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012				
	5/17/2012	509	6	1.2%	7
	5/18/2012				
	5/19/2012	327	0	0.0%	6
	5/20/2012				
	5/21/2012	255	2	0.8%	2
	5/22/2012				
ST	5/16/2012				
	5/17/2012	52	0	0.0%	0
	5/18/2012				
	5/19/2012	55	0	0.0%	3
	5/20/2012				
	5/21/2012	26	0	0.0%	0
	5/22/2012				
CO	5/16/2012				
	5/17/2012	38	0	0.0%	0
	5/18/2012				
	5/19/2012	31	0	0.0%	0
	5/20/2012				
	5/21/2012	16	0	0.0%	0
	5/22/2012				
SO	5/16/2012				
	5/17/2012	299	4	1.3%	2
	5/18/2012				
	5/19/2012	92	0	0.0%	2
	5/20/2012				
	5/21/2012	55	1	1.8%	0
	5/22/2012				
CH0	5/16/2012				
	5/17/2012	7	0	0.0%	0
	5/18/2012				
	5/19/2012	8	0	0.0%	0
	5/20/2012				
	5/21/2012	17	0	0.0%	0

5/22/2012	2	0	0.0%	0
Lamprey 5/16/2012				
Juveniles 5/17/2012				
5/18/2012				
5/19/2012				
5/20/2012				
5/21/2012				
5/22/2012	1	0	0.0%	0

5/22/2012				
Lamprey 5/16/2012				
Juveniles 5/17/2012	5	0	0.0%	0
5/18/2012				
5/19/2012	5	1	20.0%	0
5/20/2012				
5/21/2012	5	0	0.0%	0
5/22/2012				

John Day Dam					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012	1588	11	0.7%	0
	5/17/2012	921	2	0.2%	0
	5/18/2012	1454	4	0.3%	0
	5/19/2012	858	4	0.5%	0
	5/20/2012	628	2	0.3%	0
	5/21/2012	720	1	0.1%	0
	5/22/2012	1505	2	0.1%	0
ST	5/16/2012	489	0	0.0%	0
	5/17/2012	221	0	0.0%	0
	5/18/2012	312	0	0.0%	0
	5/19/2012	297	0	0.0%	0
	5/20/2012	296	1	0.3%	0
	5/21/2012	182	0	0.0%	0
	5/22/2012	352	0	0.0%	0
CO	5/16/2012	195	1	0.5%	0
	5/17/2012	99	0	0.0%	0
	5/18/2012	189	1	0.5%	0
	5/19/2012	195	0	0.0%	0
	5/20/2012	86	0	0.0%	0
	5/21/2012	55	0	0.0%	0
	5/22/2012	226	1	0.4%	0
SO	5/16/2012	571	7	1.2%	0
	5/17/2012	336	4	1.2%	0
	5/18/2012	568	2	0.4%	0
	5/19/2012	290	1	0.3%	0
	5/20/2012	142	2	1.4%	0
	5/21/2012	187	1	0.5%	0
	5/22/2012	350	4	1.1%	0
CH0	5/16/2012	3	0	0.0%	0
	5/17/2012	4	0	0.0%	0
	5/18/2012	2	0	0.0%	0
	5/19/2012	3	0	0.0%	0
	5/20/2012	4	0	0.0%	0
	5/21/2012	4	0	0.0%	0

Bonneville Dam					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012	387	8	2.1%	0
	5/17/2012	216	3	1.4%	0
	5/18/2012	210	3	1.4%	0
	5/19/2012	210	1	0.5%	0
	5/20/2012	236	1	0.4%	0
	5/21/2012	173	0	0.0%	0
	5/22/2012	251	5	2.0%	0
ST	5/16/2012	32	0	0.0%	0
	5/17/2012	19	0	0.0%	0
	5/18/2012	19	0	0.0%	0
	5/19/2012	17	0	0.0%	0
	5/20/2012	15	0	0.0%	0
	5/21/2012	14	0	0.0%	0
	5/22/2012	28	0	0.0%	0
CO	5/16/2012	92	2	2.2%	0
	5/17/2012	67	0	0.0%	0
	5/18/2012	62	0	0.0%	0
	5/19/2012	54	0	0.0%	0
	5/20/2012	45	0	0.0%	0
	5/21/2012	41	1	2.4%	0
	5/22/2012	59	0	0.0%	0
SO	5/16/2012	205	20	9.8%	0
	5/17/2012	82	2	2.4%	0
	5/18/2012	66	0	0.0%	0
	5/19/2012	47	2	4.3%	0
	5/20/2012	44	0	0.0%	0
	5/21/2012	29	0	0.0%	0
	5/22/2012	58	4	6.9%	0
CH0	5/16/2012	7	1	14.3%	0
	5/17/2012	4	0	0.0%	0
	5/18/2012	5	0	0.0%	0
	5/19/2012	6	0	0.0%	0
	5/20/2012	9	0	0.0%	0
	5/21/2012	20	0	0.0%	0

	5/22/2012	12	0	0.0%	0
Lamprey	5/16/2012	31	0	0.0%	0
Juveniles	5/17/2012	15	0	0.0%	0
	5/18/2012	27	0	0.0%	0
	5/19/2012	28	0	0.0%	0
	5/20/2012	27	0	0.0%	0
	5/21/2012	17	0	0.0%	0
	5/22/2012	84	0	0.0%	0

	5/22/2012	36	0	0.0%	0
Lamprey	5/16/2012	5	0	0.0%	0
Juveniles	5/17/2012				
	5/18/2012				
	5/19/2012	3	0	0.0%	0
	5/20/2012				
	5/21/2012	3	1	33.3%	0
	5/22/2012				

Rock Island Dam					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012	465	0	0.0%	1
	5/17/2012	355	0	0.0%	0
	5/18/2012	243	0	0.0%	0
	5/19/2012	226	0	0.0%	0
	5/20/2012	295	0	0.0%	0
	5/21/2012	260	0	0.0%	0
	5/22/2012	211	1	0.5%	0
ST	5/16/2012	292	0	0.0%	1
	5/17/2012	252	0	0.0%	1
	5/18/2012	230	0	0.0%	0
	5/19/2012	217	0	0.0%	0
	5/20/2012	199	0	0.0%	2
	5/21/2012	217	0	0.0%	0
	5/22/2012	106	0	0.0%	2
CO	5/16/2012	1688	0	0.0%	4
	5/17/2012	1221	0	0.0%	6
	5/18/2012	1221	1	0.1%	8
	5/19/2012	783	0	0.0%	5
	5/20/2012	829	0	0.0%	4
	5/21/2012	639	0	0.0%	1
	5/22/2012	597	0	0.0%	2
SO	5/16/2012	646	1	0.2%	5
	5/17/2012	408	0	0.0%	4
	5/18/2012	365	0	0.0%	3
	5/19/2012	224	0	0.0%	1
	5/20/2012	314	0	0.0%	4
	5/21/2012	388	0	0.0%	2
	5/22/2012	220	2	0.9%	1
CH0	5/16/2012	17	0	0.0%	0
	5/17/2012	27	0	0.0%	1
	5/18/2012	29	0	0.0%	0
	5/19/2012	29	0	0.0%	3
	5/20/2012	20	0	0.0%	1
	5/21/2012	16	0	0.0%	0
	5/22/2012	22	0	0.0%	0

Salmon River Trap at Whitebird					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012				
	5/17/2012				
	5/18/2012				
	5/19/2012				
	5/20/2012				
	5/21/2012				
	5/22/2012				
ST	5/16/2012				
	5/17/2012				
	5/18/2012				
	5/19/2012				
	5/20/2012				
	5/21/2012				
	5/22/2012				
CO	5/16/2012				
	5/17/2012				
	5/18/2012				
	5/19/2012				
	5/20/2012				
	5/21/2012				
	5/22/2012				
SO	5/16/2012				
	5/17/2012				
	5/18/2012				
	5/19/2012				
	5/20/2012				
	5/21/2012				
	5/22/2012				
CH0	5/16/2012				
	5/17/2012				
	5/18/2012				
	5/19/2012				
	5/20/2012				
	5/21/2012				
	5/22/2012				

Lamprey 5/16/2012	1	0	0.0%	0
Juveniles 5/17/2012				
5/18/2012				
5/19/2012	1	0	0.0%	0
5/20/2012	2	0	0.0%	0
5/21/2012				
5/22/2012				

Lamprey 5/16/2012	
Juveniles 5/17/2012	
5/18/2012	
5/19/2012	
5/20/2012	
5/21/2012	
5/22/2012	

Snake River Trap at Lewiston					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012	307	0	0.0%	0
	5/17/2012	482	0	0.0%	0
	5/18/2012	815	0	0.0%	0
	5/19/2012	358	0	0.0%	0
	5/20/2012	106	0	0.0%	0
	5/21/2012	116	0	0.0%	0
	5/22/2012	789	0	0.0%	0
ST	5/16/2012	59	0	0.0%	0
	5/17/2012	81	0	0.0%	0
	5/18/2012	148	0	0.0%	0
	5/19/2012	15	0	0.0%	0
	5/20/2012	49	0	0.0%	0
	5/21/2012	28	0	0.0%	0
	5/22/2012	31	0	0.0%	0
CO	5/16/2012	3	0	0.0%	0
	5/17/2012	8	0	0.0%	0
	5/18/2012	7	0	0.0%	0
	5/19/2012	1	0	0.0%	0
	5/20/2012				
	5/21/2012				
	5/22/2012	1	0	0.0%	0
SO	5/16/2012	130	0	0.0%	0
	5/17/2012	66	0	0.0%	0
	5/18/2012	28	0	0.0%	0
	5/19/2012	4	0	0.0%	0
	5/20/2012	5	0	0.0%	0
	5/21/2012	4	0	0.0%	0
	5/22/2012	1	0	0.0%	0
CH0	5/16/2012	17	0	0.0%	0
	5/17/2012	16	0	0.0%	0
	5/18/2012	60	0	0.0%	0
	5/19/2012	52	0	0.0%	0
	5/20/2012	16	0	0.0%	0
	5/21/2012	14	0	0.0%	0

Grande Ronde River Trap					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012	315	1	0.3%	0
	5/17/2012	207	0	0.0%	0
	5/18/2012	183	0	0.0%	0
	5/19/2012	59	0	0.0%	0
	5/20/2012	28	0	0.0%	0
	5/21/2012	19	0	0.0%	0
	5/22/2012	30	0	0.0%	0
ST	5/16/2012	75	1	1.3%	0
	5/17/2012	90	0	0.0%	0
	5/18/2012	57	0	0.0%	0
	5/19/2012	25	0	0.0%	0
	5/20/2012	17	0	0.0%	0
	5/21/2012	19	0	0.0%	0
	5/22/2012	14	0	0.0%	0
CO	5/16/2012				
	5/17/2012				
	5/18/2012				
	5/19/2012				
	5/20/2012				
	5/21/2012				
SO	5/16/2012				
	5/17/2012				
	5/18/2012				
	5/19/2012				
	5/20/2012				
	5/21/2012				
CH0	5/16/2012	1	0	0.0%	0
	5/17/2012	2	0	0.0%	0
	5/18/2012	5	1	20.0%	0
	5/19/2012	3	0	0.0%	0
	5/20/2012	1	0	0.0%	0
	5/21/2012	3	0	0.0%	0

5/22/2012	44	0	0.0%	0
Lamprey 5/16/2012				
Juveniles 5/17/2012				
5/18/2012				
5/19/2012				
5/20/2012				
5/21/2012				
5/22/2012				

5/22/2012	9	0	0.0%	0
Lamprey 5/16/2012				
Juveniles 5/17/2012				
5/18/2012				
5/19/2012				
5/20/2012				
5/21/2012				
5/22/2012				

Imnaha River Trap					
Species	Date	Sample Count	Sample Morts	Percent Sample	Facility Morts
CH1	5/16/2012	8	0	0.0%	0
	5/17/2012	2	0	0.0%	0
	5/18/2012	4	0	0.0%	0
	5/19/2012	6	0	0.0%	0
	5/20/2012	6	0	0.0%	0
	5/21/2012				
	5/22/2012				
ST	5/16/2012	1394	2	0.1%	0
	5/17/2012	962	0	0.0%	0
	5/18/2012	651	0	0.0%	0
	5/19/2012	300	0	0.0%	0
	5/20/2012	286	0	0.0%	0
	5/21/2012				
	5/22/2012				
CO	5/16/2012				
	5/17/2012				
	5/18/2012				
	5/19/2012				
	5/20/2012				
	5/21/2012				
	5/22/2012				
SO	5/16/2012				
	5/17/2012				
	5/18/2012				
	5/19/2012				

	5/20/2012
	5/21/2012
	5/22/2012
CHO	5/16/2012
	5/17/2012
	5/18/2012
	5/19/2012
	5/20/2012
	5/21/2012
	5/22/2012
Lamprey	5/16/2012
Juveniles	5/17/2012
	5/18/2012
	5/19/2012
	5/20/2012
	5/21/2012
	5/22/2012

High 12 Hour Average TDG Using the Oregon Method of Calculation April 2012

	FDRW	GCGW	CHJ	CHQW	WEL	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW	JDY	JHAW	TDA	TDDO	BON	CCIW	WRNO	CWMW
Gas Cap %	110	110	110	110	115	115	120	115	120	115	120	115	120	115	120	115	120	115	120	115	120	120	115
4/1/2012	103.8	101.2	101.9	104.3	•	102.4	115.9	107	113.3	109	118.8	107.9	119.2	106.7	122.5	107.5	120.7	112.3	116	112	120.1	114	111.5
4/2/2012	102.3	99.9	100.5	116.2	•	100.6	111.4	105.6	111.8	106.9	120.7	110.3	119.1	107.1	121	106.9	121.8	119	120.9	115.4	121.5	116.9	113.2
4/3/2012	103.6	103.3	102.1	118.4	•	104.5	114.3	108.2	117.7	112	119.9	112.4	119.4	108.3	120.6	108.1	122.2	121.1	123.3	119.6	121.4	119.9	117
4/4/2012	103.7	122.7	101.9	118.3	•	105.2	109.9	109	113.5	109.6	119.1	113.2	119	108.2	120	109.3	122.3	118.1	120.1	120	123.6	120.6	118
4/5/2012	103.3	112.9	105.1	118.7	•	103.9	109.6	106.7	113	112	118.8	110.9	118.6	109.2	119.1	111.2	120.7	118.7	120.6	116.5	117.6	116.7	116.8
4/6/2012	103.2	109.7	114.7	118.2	116.2	103.2	109.1	106	113.1	110.5	118.4	111.9	118.9	109.6	120.2	111	120.7	115.6	118.1	116.7	118.8	117.3	115.3
4/7/2012	104.7	106.5	112.2	115.5	115.1	104.6	111.8	106.2	113	111.3	118.8	112.5	118.4	109.9	120.7	109.7	120.7	114.9	117.6	116.7	121.3	117.8	115.3
4/8/2012	105	105.3	109.9	115.8	112.6	105.9	110.2	106.9	112.4	112.5	119.2	113.7	118.4	112	119.3	110.6	120.9	115	120.3	116.8	119.3	117.5	114.7
4/9/2012	105.6	111.8	106.7	113.1	112.4	107.5	111	108.5	113	113.3	119.2	115	118.8	113.9	119.9	112.8	120	116.6	119	119.9	118	118.8	116.6
4/10/2012	107.5	105	108.3	113.4	109.2	108.1	110.7	111.1	114.1	113.5	119.6	116.5	118.9	114.9	117.8	115.4	120.1	114.6	119.1	119.6	118.7	119.1	118
4/11/2012	108.1	109	111.6	114.2	111.1	108.3	111.1	111.9	114.2	114.3	119.5	116.8	119.4	115.3	118.4	116.6	116.8	113.4	118	116.4	121.1	117.8	116.8
4/12/2012	107.4	105.2	105.1	113.7	109.7	106.9	113	110.6	114.4	113.2	119.7	114.8	119.6	114	117.6	115.5	116.9	113.7	118	115.8	121.2	116.6	116.1
4/13/2012	108.8	105.3	108.6	112.4	108.8	106	113.1	110	115	113.8	119.4	114.7	119.8	113.2	118.4	115.4	117.1	114	117.9	116.4	120.8	116.8	115.8
4/14/2012	107.6	105.1	105	107.1	108.2	105.4	115.3	110.8	116.4	114.3	119.5	114.8	119.4	113.8	117.9	114.1	118.2	112.4	117.6	115.4	119.3	115.7	115.1
4/15/2012	107.5	106.4	105	113.3	105.6	104.7	114	109.3	114.8	113.2	118.7	114.7	119.1	113.8	117.7	112.1	117.6	113.2	116.8	113.7	119.6	114.4	114.1
4/16/2012	108.2	112.4	106.4	112.5	107.6	105.1	110.7	108.8	113.7	115.6	119.7	114.8	118.9	113.6	117.4	112.7	115.8	112.7	117.2	115.3	119.6	116.1	113.9
4/17/2012	107.9	114.7	107.4	111.1	107.6	105.2	110.3	109.7	113.9	112.4	118.7	114.3	119.2	112.5	117.4	112.8	116.1	112.3	116.5	115.2	120	115.9	114.6
4/18/2012	108.4	105.9	114.7	114.4	107	105.1	110.6	106.9	113.9	113.3	119.2	114.9	119.7	112.5	117.6	113.7	117.3	112.6	117	115.9	119.7	116.3	115.3
4/19/2012	108.2	111	114.5	115.8	112.9	105.5	113.6	106.2	114.8	112.7	118.7	114.3	119.7	113.6	117.5	113.5	117.9	113.8	116.9	115.7	118.7	116.2	114.1
4/20/2012	108.7	109.3	106.4	118.1	110.2	105.5	113.2	106.2	115.9	113.1	119.2	114.2	119.7	113.3	118.1	113.5	118.1	114.5	118	115.5	118.7	115.8	114.6
4/21/2012	109	107.1	113.3	114.5	109.9	105.6	110.8	108.6	114.3	114.8	119.4	114.7	119.8	114.2	118.2	114.8	118	114.3	116.7	117.6	119	117.4	117
4/22/2012	112.5	108.3	108.6	115.1	112.5	106.3	113.8	109.1	115.2	115.8	119.8	117	119.9	117.6	119.3	116.1	118.5	115.2	117.3	117.7	121.1	118.5	118.2
4/23/2012	112.5	119.2	109.1	120	111.1	106.8	117.7	109	116.3	116.2	120.4	117.7	120.6	118	120	118.3	119.7	117.3	120	118	123.9	119.8	119.5
4/24/2012	112.3	114.5	113.1	122	114	106.2	123.4	110.5	123.1	116.5	125.4	117	123.6	117.7	121.2	118.6	121.8	118.2	122.7	117.1	121.3	118.7	117.6
4/25/2012	112.6	109.7	117.4	120.8	116	105.4	127.2	114.2	125.9	124.2	125.8	120.5	128	116.7	126.8	118.5	125.7	117.4	122	120.9	123.4	123.2	119.5
4/26/2012	112.6	116.3	114.4	115.9	117.5	105.9	126.6	117.7	123.3	127.4	124.1	122.4	125.3	117.6	123.1	118.3	123.1	120.6	122.7	120.5	117.1	125.5	123.2
4/27/2012	110.3	116.3	108.5	116.5	110.1	103.2	130.6	113.6	126.2	118.5	126.2	117	128	112.4	122.5	113.3	121.4	113.5	118.4	117.7	130.78	122	121.2
4/28/2012	110.5	108.3	115	113.2	110.2	105.5	128.8	118.1	123.8	124.1	123.4	120.8	126.1	115.7	122.4	114.3	122.1	116.1	119.8	118.5	131.23	123.4	122.5
4/29/2012	112.1	117.9	115.9	115.9	116	107.7	122.7	121.4	119.9	124.1	121.2	122	122.6	119.5	121	113.7	120.4	115.1	118.7	119.5	130.67	123.5	124
4/30/2012	112.7	119.5	113.4	122.1	113.8	107.9	118.5	120.5	119.4	123.2	119.9	121.6	120.3	118.8	121.4	115.9	120.3	114.8	121.3	117.3	129.24	121.3	121.3

Red text denotes exceedances.

Bold large text denotes the TDG gauge is out of service and the TDG reading is a calculated value using SYSTDG model.

High 12 Hour Average TDG Using the Oregon Method of Calculation May 2012

	FDRW	GCGW	CHJ	CHQW	WEL	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW	JDY	JHAW	TDA	TDDO	BON	CCIW	WRNO	CWMW
5/1/2012	112.3	119.2	117.2	120.3	114.6	105.7	119	113.9	117.6	117.5	120.4	115.9	119.8	111.8	122	115	122.4	116.1	121.6	117.5	126.2	118.6	116.7
5/2/2012	112.9	120	117.6	116.7	116.2	104.1	117.2	109.8	117	116.8	119.3	114.8	119.8	112.1	122.2	112.9	122.5	116	122.4	121.3	128.31	122.4	121
5/3/2012	113.5	121.1	118.2	116.2	115.7	105	115.4	111.2	116	116.6	118.7	116.5	119.2	115.7	122.4	111.4	123	115.8	122.5	122.1	129.31	123.4	121.3
5/4/2012	113.2	118.1	118.9	117.2	116.2	104.5	117.8	109.2	118.4	113.9	119.2	113.8	118.9	114.5	121.9	110.2	121.7	112.7	118.9	118.3	128.92	121.7	119.5
5/5/2012	112.2	109.8	118.6	117.4	115.9	102.5	117.9	105.6	116.8	113.2	116.8	112.2	117.9	112.1	121.5	111.2	121.8	112.3	118.7	115.4	126.13	118.7	117.9
5/6/2012	112.2	109.7	110.7	116.1	114.3	102.5	111.8	107.7	113.2	115.5	112.9	113.4	117.1	114.9	119.4	111.5	120.6	115.1	119.4	118.8	126.12	120.7	119.7
5/7/2012	113.4	110.6	110.7	115.1	111.7	104.5	111.3	112.5	115.4	114.6	120.6	115.1	118	117.5	119.3	113.8	119.8	115.4	122.1	119.9	124.36	121	120.1
5/8/2012	114.6	114.8	111.9	116.4	112.6	106.3	115.9	115.1	115.7	116.3	121.8	116.5	118.6	119.2	119.5	117.7	119.2	116.1	118.9	121	121.59	120.8	119.5
5/9/2012	115.1	112.5	114	116.8	113.6	105.7	118.2	112.1	118.2	116.7	119.4	116.9	118.3	118.4	119.9	117.3	118.7	114.3	121.9	115.1	120.22	117.1	116.8
5/10/2012	114.5	111.8	115.4	117.5	115.3	103.5	114.1	109.3	114.1	115	119.2	115.8	116.4	114.9	119.6	114.4	118.8	114.9	120.7	117.6	122.78	118	116.9
5/11/2012	114.7	111.8	112.1	114.8	112.7	102.3	110.6	112.4	114.8	114.5	119.5	115.5	116.5	114.5	120.2	114.1	119.4	115.6	118.2	119	121.51	119.6	118.1
5/12/2012	115	112	112.7	111	112.5	103.4	110.6	113.9	114.6	113.4	119.3	115.9	116.8	116.6	119.7	114.6	118.9	114.9	117.5	117.9	123.08	119.3	117
5/13/2012	115.8	113	113.4	111.2	112.3	104.7	110.8	110.1	113.5	115.7	119.9	116.2	118.3	117.6	117.1	117.4	117.5	116	118.2	118	121.34	118.8	118.7
5/14/2012	116.5	113.8	114.3	112.2	113.1	105.9	111	109.9	113.8	115.7	119.8	117.1	117.9	118.8	118.4	119.6	119	117.3	119.2	118.3	119.29	118	118.5
5/15/2012	117.5	114.3	114.9	113	113.9	106.1	111.5	111	114.4	114.9	119.2	118	117.5	117.9	119.8	119.6	119.2	117.1	118.8	116.8	121.71	117.9	117.9
5/16/2012	117.9	115.3	114.9	113.8	113	105.9	115.4	111.5	116.9	115.1	115.3	117.5	118.4	117	118.8	118.3	118.3	115.3	118.1	114.3	120.42	116.1	116.1
5/17/2012	118.9	115.6	115.4	115.9	113.4	105.7	119.3	110.3	119.8	117	120.9	116.2	120.2	116.1	119.9	115.7	119.7	113.5	121	113.3	120.05	114.7	114.5
5/18/2012	118.7	115.4	114.9	114.7	113.7	104.7	118.6	111.6	116.9	117.8	117.5	115	120.1	114.2	121.8	113.2	120.6	113.6	118.6	114.8	123.69	116.8	115.3
5/19/2012	118.7	115.6	115.6	115	114.3	105	117.2	114.3	117	116.6	115.5	115.7	119	114.3	120.4	113	120.4	115.2	119.2	116.5	125.23	118.6	118.8
5/20/2012	118.8	116	115.9	115.2	114.5	106	111.8	115.5	115.9	117.9	114.2	116.3	117.6	115.6	120.1	114.1	119.7	114.2	117.4	118.7	123.31	119.8	119.2
5/21/2012	119.3	116.7	116.2	116.3	114.9	106.7	111.6	116.4	115.1	116.9	114.3	116.7	117	116.1	120.6	116.7	119.3	114.6	117.1	116.7	123.24	118.8	118.2
5/22/2012	119.4	116.3	116	114.9	114.6	105.9	116.6	110	113.1	116.1	113.8	115.9	118.7	115.1	120.3	116.6	120	114.7	118	113.9	122.26	116.4	115.6
5/23/2012	118.8	116	115.7	115.2	113.5	104.6	118.3	108	117.5	112.4	118.9	112.4	119.8	111.7	120.5	114.2	119.6	113.5	120.4	114.9	122.95	116.9	114.6
5/24/2012	119.2	115.9	115.6	114.9	114.6	104.8	116.7	110.7	114.4	113.7	113.8	112.7	119.2	112.8	120.5	112	119.9	113.5	117.1	117.5	122.95	118.6	117.9
5/25/2012	118.7	114.8	115.3	114.1	114	105.5	111.5	112.2	114.1	113.5	112.2	112.7	114.7	113.4	119	110.8	118.3	112.3	116.2	115.4	122.3	117.4	117.2
5/26/2012	117.8	115	115.5	115.3	114.6	105.9	111.3	112.4	114.2	113.6	119	111.9	115.4	113.6	118.9	111.1	118.9	112.7	116.6	113.9	123.5	116.3	116.8
5/27/2012	117.9	115	115.5	114.1	114.2	104.7	110.3	109.7	113.3	114.2	118.8	111.9	114.5	113	119.8	111.8	118.7	111.8	117	112.6	121.3	113.8	114.3
5/28/2012	117.4	114.6	115.1	113.8	113.4	103.8	110.6	109.1	113.1	113.5	118.8	112.9	115.2	112.9	117.3	111.4	117.7	112	117.4	113.7	121.3	114.7	113.6

Red text denotes exceedances.

Bold large text on the CCIW gauge denotes the TDG gauge is out of service and the TDG reading is a calculated value using SYSTDG model.
For spill management purposes, the SYSTDG calculated TDG levels for CCIW may be adjusted for predictive error.

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday May 30, 2012 10:30am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 9043

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Bonneville Dam Powerhouse Two Operations - Tom Lorz, Umatilla and Doug Baus, COE-NWD
 - a. [SOR 2012-2 Bonneville Operations](#)
3. Other
 - a. Set agenda and date for next meeting - **June 6, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

May 30, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Bonneville PH2 Operations

Tom Lorz, CRITFC/CTUIR, presented SOR 2012-2 for Bonneville operations to address descaling of juvenile sockeye moving past the project. Tom reported that descaling had fluctuated between 7% and 23%, and today's preliminary data showed 5.6% descaling. Those that signed on to the SOR were concerned with these levels of descaling and recommended a special operation to try to address the concern. The specifics described in the SOR were:

'In accordance with the 2012 Fish Passage Plan, Section 5.2.1, the Salmon Managers are requesting that Bonneville Powerhouse Two be operated to the lower end (25%) of the 1% range in an effort to minimize sockeye descaling and potential future mortality associated with that descaling. Operate Bonneville Dam Powerhouse Two at the lower 1% range (25% of the 1% range) while operating Powerhouse One within the 1% Efficiency Range, and spilling the balance of water up to Bonneville Tailrace Total Dissolved Gas Cap. This operation should be implemented immediately and remain in place until the Salmon Managers have reviewed the available Smolt Monitoring Data to determine the juvenile sockeye run has passed Bonneville Dam.'

Russ Kiefer, Idaho, added that PIT-tag data was showing another wave of ESA-listed Snake River sockeye would be reaching Bonneville in the next few days. Idaho signed on to the SOR and hoped the operation would be implemented in time and through the duration of passage for these fish. Tom added that the salmon managers had looked at hourly TDG data that showed a decline in TDG levels, and hoped this would provide the action agencies more flexibility to meet the request. Doug Baus, Corps, pointed out a link to the Corps' official TDG management value; the latest for the Cascade Island gauge was 118.6% TDG and Camas/Washougal 115.9% TDG.

In response to the SOR, the Action Agencies agreed to implement the same operation that had been implemented over the past few weeks, effective today through Monday, 6/4 at 6:00 pm:

- Operate PH 2 up to the 25% of 1% of Best Efficiency Operating Range
- Operate PH 1 up to the upper limit (100%) of 1%
- As needed, operate PH 2 within the 25-50% range of 1%
- As needed to remain flow neutral, operate PH 1 up to best geometry
- As necessary, involuntary spill above the TDG spill cap.

Doug suggested that system flows could recede over this time period which would increase the likelihood of being able to meet the request to limit PH2 units to 25% of the 1% range. The salmon managers reiterated their desire to restrict Powerhouse II to the lower end of 1% to the extent possible, and, without exceeding TDG standards, spill any excess water. If TDG would be

exceeded, the salmon managers supported running PH 1 up to open geometry while keeping PH 2 at the lower end of 1%. Doug Baus responded that the Corps had concerns with adult fallback and delay from spilling more than 100 kcfs and stated a desire to find a balance between the multiple needs of the system. At this point, the Corps was not willing to explore the option of spilling beyond this level. There were disagreements over the impacts of different levels of spill on adults.

Topics relevant to the issue at Bonneville of mortality and descaling during periods of high flow were identified. To the extent possible, TMT members identified the specific forums and timing in which these discussions will occur. TMT members acknowledged that many of these issues will not likely be resolved in time to inform today's (or even this season's) deliberations, that TMT will focus primarily on operational recommendations, and that these topics are important to tee up discussion and future resolution of the problem:

- Impacts on adult delay/fallback from >100 kcfs spill at Bonneville – NOAA and Corps biologists are in discussions; there may be a need for a more robust data review around this issue (SRWG is looking at this; specific next steps TBD).
- TDG analysis and management – there is continued confusion and/or disagreement about which data is being used for management purposes and to meet state water quality standards/waivers. This issue needs to be resolved at the policy level (TBD) and, while not a topic for TMT deliberation, will inform their discussions of operations recommendations.
 - Scott English, Corps, shared that the FMS repair work was underway and expected to be complete this week. The gauge will be operational soon after.
- Impacts to juveniles from PH I open geometry – 6/5 SRWG meeting will include discussion of developing a study design to better understand these impacts.
- Long term structural improvements of PH2 gatewells – this topic will be added to the 6/7 FFDRWG agenda.

TMT poll/planned operation:

TMT members present on the call today were polled on their level of support for the Corps' planned operation to meet the request:

- Oregon – Disappointed that the planned operation is not different from what was provided before. Does not support the operation as described. Will not object.
- Idaho – No objection
- Nez Perce – No objection with the understanding that the Corps will implement the request to the extent possible without exceeding TDG standards
- CTUIR – No objection, but very concerned that the Corps is not willing to implement the SOR.
- Colville – Very concerned; strongly prefers the SOR be implemented; will not object to the planned operation.
- Salish-Kootenai – Agree with the other tribes on today's call; will not object to the planned operation.
- NOAA – Supports the Corps' proposal
- BPA – Supports the Corps' proposal
- Reclamation – Supports the Corps' proposal

With that, the Corps planned to begin this special operation today, 5/30, and continue through 6:00 pm on Monday, 6/4. The salmon managers via FPAC will monitor the operation and passage; and descaling and mortality issues, and determine whether to recommend continuation of the special operation. TMT will revisit this issue at their next, 6/6, TMT meeting.

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

May 30, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of Oregon, Idaho, the Nez Perce Tribe, BPA, NOAA, BOR, COE, Salish-Kootenai Tribe, Colville Tribe, CRITFC/Umatilla Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Bonneville Dam Powerhouse 2 Operations (SOR 2012-2)

Tom Lorz, CRITFC/Umatilla, introduced this SOR which requests a special operation at Bonneville to reduce descaling of juvenile sockeye. Sockeye mortality rates had a wide range of variability (0.0% to 6.9%) throughout the implementation of last week's special operation (5/17 to 5/22). Descaling rates also had a wide range of variability (5.0% to 24.1%) throughout the operation. Today's descaling rate was 5.6% which amounts to 36 descaled fish, Margaret Filardo, FPC, noted. Although the data has been highly variable Salmon Managers indicated limiting PH2 units to the 25-50% of the 1% operating range has reduced mortalities and descaling in PH2 gatewells.

Based on NOAA data that indicate sockeye fare better when the Bonneville PH2 units are operated at the lower end of 1% efficiency, the SOR asks the Action Agencies to operate the PH2 units up to 25% of the 1% efficiency range, while operating PH1 within 1% efficiency and spilling the balance up to the Bonneville tailrace gas cap. The SOR requests that this operation continue through 6 pm Monday, June 4. Signatories to the SOR (USFWS, Oregon, Washington, Idaho, Colville Tribe and CRITFC) based their request on language in section 5.2.1 of the Fish Passage Plan that states, "Turbine units at PH2 will operate at the mid to lower 1% range (unless total dissolved gas waivers are exceeded in the tailrace) of best efficiency and within cavitation limits at various head ranges as shown in **Table BON-16**." The signatories want to test whether operating to the lower end of 1% will reduce sockeye descaling, Lorz said. Idaho signed the SOR because PIT tag data indicate the majority of the 2012 Snake River sockeye run will reach Bonneville within the next few days, Russ Kiefer noted.

Baus asked for clarification on what TDG fixed monitoring stations were used to conclude that TDG was not exceeding levels identified in the waivers that would allow for the implementation of this operation. Lorz indicated that the Warrendale gauge had been reading below 120% TDG (5/28 reading of 114.7%) therefore the AA's would be able to accommodate the additional spill associated with this operation. Baus clarified as identified in the FOP the AA's are currently managing spill at Bonneville Dam to 120%/115% TDG limits as measured at Cascade Island (CCIW) and Camas/Washougal (CWMW). TDG continues to exceed the 120%/115% TDG limits and subsequently the

AA's are unable to accommodate the request to spill more and knowingly exacerbate already problematic levels of TDG downstream of Bonneville Dam. CCIW continues to be out of service and during the interim period until CCIW returns to service the region may access TDG information used to manage Bonneville Dam spill on the 2012 Spill Information found under the hyperlink titled "Bonneville Tailwater (CCIW calculated high 12 hr. TDG)" on the following website:

<http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/>

Scott English, COE, added that the Cascade Island gage station will be returned to service soon.

Consistent with previous PH2 limitation operations the AA will implement this SOR by continuing to spill in accordance with the Fish Operations Plan, Baus said. The FOP calls for 100 kcfs spill at Bonneville 24 hours a day, but not to exceed 120%/115% TDG limits. TDG levels in the Bonneville tailrace have and continue to exceed these limits. Spilling flow associated with capping PH2 to the 25% of the 1 % range would equate to approximately 35kcfs of additional spill that would knowingly exacerbate already problematic levels of TDG downstream of the Bonneville Dam. Since this would not be consistent with current water quality requirements identified in the FOP the AAs will continue to support a flow neutral operation that redistributes flow from PH2 to PH1 as this operation would improve PH2 passage conditions while not exacerbating current 120%/115% TDG water quality exceedances. The AAs will attempt to operate PH2 to 25% of best efficiency as specified in the SOR by using best geometry at PH1 until 6 pm Monday, June 4. As needed to pass inflow the project would be managed in the following manner:

1. Operate all PH2 units up to 25% of 1% best efficiency.
2. To pass additional flows, operate all PH1 units up to 100% of the 1% operating range.
3. To pass additional flows, operate all PH2 units at 25-50% of the 1% operating range.
4. To pass additional flows, operate PH1 units to best geometry, one at a time in the order of priority.

Russ Kiefer, Idaho, highlighted the two changes this SOR requests from the previous operation for sockeye: limit PH2 unit operations to 25% of best efficiency, and limit PH1 unit operations to the upper end of 1% to the best extent possible. Baus explained why the Action Agencies would not commit to achieving these nuances. First, TDG exceedances at Bonneville allow no opportunity for spill at present. Furthermore, adult delay and fallback have been associated with spill in the 100-120 kcfs range. The Action Agencies will therefore operate PH2 in the 25% range of best efficiency to the best extent possible under these circumstances.

Lorz pointed out the Bradford Island area is responsible for around 80% of adult delays. Calibration problems during data gathering for the fallback studies mean the spill estimates are suspect, especially at lower rates of spill.

Filardo asked what the difference would be in flow volume between 25% and 50% of best efficiency. That equates to an additional 11 kcfs of flows that would need to be released through PH1 or via the spillway in addition to 100 kcfs of spill, Lisa Wright, COE, replied. The passage index for today is 1183 juvenile sockeye. Scott Bettin, BPA, clarified that 7 of the 10 units at PH1 are now operating to open geometry.

Baus indicated the NWRFC forecast indicates lower Bonneville Dam inflows (approximately 275-300kcfs) over the next 5 days. Lower inflows will improve the likelihood of implementing this operation.

Four issues emerged from this discussion as needing long-term resolution:

- Disparities in measuring TDG levels at Bonneville.
- Impacts of adult delay and fallback on survival.
- Impacts of operating PH1 at open geometry.
- A solution to gatewell problems at Bonneville.

Baus said regional discussions regarding PH2 gatewell conditions and Bonneville PH operations are continuing in various forums including SRWG, FFDRWG and FPOM. The SRWG is planning a large study next year that should include adult fallback, Tony Norris, BPA, added.

TMT members stated their level of support for the operation proposed by the COE in response to SOR 2012-2:

- **Oregon** – Did not object, but is disappointed by the lack of change from the previous special operation.
- **Idaho** – No objection.
- **Nez Perce** – No objection, as long as every effort is made to meet the criteria defined in the SOR.
- **CRITFC** – No objection, but not happy with the outcome.
- **Colville** – No objection, as long as every effort is made to meet the criteria defined in the SOR.
- **Salish-Kootenai** – No objection, as long as every effort is made to meet the criteria defined in the SOR.
- **NOAA** – Supports the COE proposal.
- **BPA** – Supports the COE proposal.
- **BOR** – Supports the COE proposal.

Hearing these views, the COE will extend the current operation at Bonneville until 6 pm Monday, June 4. If there is regional interest in continuing the operation

beyond June 4, the Salmon Managers and the COE will coordinate via email. TMT will revisit Bonneville operations at its next regular meeting.

4. Next TMT Meeting

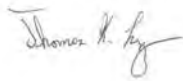
The next TMT meeting will be at the COE's offices on June 6.

<i>Name</i>	<i>Affiliation</i>
Rick Kruger	Oregon
Tony Norris	BPA
Scott Bettin	BPA
Russ Kiefer	Idaho
Dave Statler	Nez Perce
Paul Wagner	NOAA
Doug Baus	COE
Stu Leavitt	Salish Kootenai
Shane Scott	PPC
John Roache	BOR
Margaret Filardo	FPC
Bill Rudolph	NW Fish Letter
Richelle Beck	Grant PUD
John Richter	Energy GPS
Gabriel XX	XX
Dave Benner	FPC
Christine Cargill	JP Morgan
Lisa Wright	COE
Laura Hamilton	COE
Karl Kanbergs	COE
Jason Ward	COE
Chuck Rushwood	Colville Tribe (for Sheri Sears)
Tom Lorz	CRITFC/Umatilla

SYSTEM OPERATIONAL REQUEST: #2012-2

The following State, Federal, and Tribal Salmon Managers have participated in the preparation and support this SOR: US Fish and Wildlife Service, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, the Idaho Department of Fish and Game, the Colville Tribes, and the Columbia River Inter-Tribal Fish Commission.

TO:	Brigadier General McMahon	COE-NWD
	James D. Barton	COE-Water Management
	Doug Baus	COE-RCC
	David Poganis	COE-PDD
	Karl Kanbergs	COE-NWD-NP-WM-RCC
	Col. Bruce A. Estok	COE-Seattle District
	Lorri Lee	USBR-Boise Regional Director
	Steven Wright	BPA-Administrator
	Tony Norris	BPA-PGPO-5
	Scott Bettin	BPA- KEWR-4
	Steve Oliver	BPA-PG-5
	Lori Bodi	BPA-KE-4



FROM: Tom Lorz, FPAC Vice-Chair

DATE: May 29, 2012

SUBJECT: Bonneville Operations

OBJECTIVE: To Reduce Descaling of Sockeye at Bonneville Dam

SPECIFICATIONS: In accordance with the 2012 Fish Passage Plan, Section 5.2.1, the Salmon Managers are requesting that Bonneville Powerhouse Two be operated to the lower end (25%) of the 1% range in an effort to minimize sockeye descaling and potential future mortality associated with that descaling. Operate Bonneville Dam Powerhouse Two at the lower 1% range (25% of the 1% range) while operating Powerhouse One within the 1% Efficiency Range, and spilling the balance of water up to Bonneville Tailrace Total Dissolved Gas Cap. This operation should be implemented immediately and remain in place until the Salmon Managers have reviewed the available Smolt Monitoring Data to determine the juvenile sockeye run has passed Bonneville Dam.

JUSTIFICATION:

Previously, the Salmon Managers requested Bonneville to limit the operation of PH2 to 25% and not more than 50% of the 1% efficiency range in conjunction with trying to operate PH1 within the 1% efficiency range to protect Sockeye at Bonneville Dam. Given prior flows and TDG constraints, the Action Agencies were unable to fully implement the Managers request, but the steps taken did help reduce mortality and descaling. However, at this point in time the Salmon Managers believe that present flows and TDG should not be a significant constraint to meeting the proposed objectives to protect Sockeye.

The operations begun last week at Bonneville following the TMT discussion reduced mortality at Bonneville Dam; however descaling rates remained elevated. Mortality rates for juvenile Sockeye sampled at Bonneville Dam have been lower over the past 5 days of sampling (Table 1). However, descaling percentages have remained elevated with descaling rates at or above 14% in the sample on May 28 and May 29. Descaling does impact subsequent juvenile survival as research studies have shown decreased survival in migrating juvenile salmon (Hostetter et al. 2011). In addition, descaling has been associated with delayed mortality of fish sampled at juvenile bypass systems (Hawkes et al. 1992).

Table 1. Sockeye Mortality and Descaling in Bonneville Powerhouse Two samples for the dates May 20 to May 29, 2012.

Sampledate	Sample count	Morts	Pct. Morts	Exams Descaling	Descaled	Pct. Descaled
5/20/2012	44	0	0.00%	44	10	22.7%
5/21/2012	29	0	0.00%	29	7	24.1%
5/22/2012	58	4	6.90%	54	9	16.7%
5/23/2012	65	6	9.23%	59	14	23.7%
5/24/2012	64	5	7.81%	59	12	20.3%
5/25/2012	28	0	0.00%	28	2	7.1%
5/26/2012	53	0	0.00%	53	6	11.3%
5/27/2012	81	2	2.47%	79	6	7.6%
5/28/2012	58	1	1.72%	57	9	15.8%
5/29/2012	34	0	0.00%	34	5	14.7%

The 2012 Fish Passage Plan stipulates in Bonneville section 5.2.1 that “Turbine units at PH2 will operate at the mid to lower 1% range (unless total dissolved gas waivers are exceeded in the tailrace) of best efficiency and within cavitation limits at various head ranges as shown in **Table BON-16.**” Therefore, this requested operation is in accordance with the 2012 Fish Passage Plan.

Literature Cited

Hawkes, L.A., R.D. Martinson, and W.W. Smith. 1992. Monitoring of downstream salmon and steelhead at federal hydroelectric facilities – 1991. Annual Report to Bonneville Power Administration, Contract No. DE-AI79-85BP20733.

Hostetter, N.J, A. F. Evans, D. D. Roby, K. Collis, M. Hawbecker, B. P. Sandford, D. E. Thompson & F. J. Loge (2011): Relationship of External Fish Condition to Pathogen Prevalence and Out-Migration Survival in Juvenile Steelhead, Transactions of the American Fisheries Society, 140:5, 1158-1171

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday June 6, 2012 10:00am - 12:00pm

NOTE NEW START TIME OF 10:00

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 3507

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review May 23 and 30 Meeting Minutes
3. Water Supply Forecast - Doug Baus, COE-NWD
 - a. [NWRFC June Final WSF](#)
(Also available at: www.nwd-wc.usace.army.mil/tmt/documents/NWRFC_Forecast/index.html)
4. Bonneville Operations - Doug Baus, COE-NWD

- a. [BON Sockeye Descaling & Mortality Data for May 16-June 13](#)
- 5. Operations Review
 - a. Reservoirs
 - b. Fish
 - c. Water Quality
 - d. Power System
- 6. Other
 - a. Set agenda and date for next meeting - **June 13, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

June 6, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Introductions

Tom Skyles, CRITFC Hydro Team, was introduced and welcomed. He will serve as an alternate on TMT to represent CRITFC and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

Meeting Minutes

No comments were raised on the 5/23 or 5/30 Official Meeting Minutes or Facilitator's Notes, but some TMT members asked for more time to review the 5/30 set. If no additional edits are sent in, they will be considered final.

Water Supply Forecasts

Doug Baus, Corps, noted that the official June final forecast would be published at COB today and linked to today's agenda item. The latest forecasts, which were expected to be close to the final, were as follows: Libby April-August was at 7,240 kaf (123% of average); Dworshak April-July was 3,236 kaf (121% of average); and The Dalles April-August was 113 MAF (122% of average).

Bonneville PH2 Operations

Doug updated TMT about the special operation at Bonneville being implemented to minimize descaling and mortalities of juvenile sockeye passing the project, resulting impacts. The operation had continued, per coordination with NOAA on Monday, and was scheduled to end tonight at 6:00 pm. During the last iteration of this special operation, descaling ranged from 15.8% on 5/28 to 3.4 % on 6/1. Mortalities ranged from 2.5% on 5/27 to 0% on various days during the operation. The summary of these results was shared as a link to the agenda.

Russ Kiefer, Idaho, reported that, according to estimates from sockeye researchers, 20-25% of the fish that have passed Lower Granite have not yet reached Bonneville, and their migration could continue through mid-June. Given this, Russ recommended that the special operation continue through Monday 6/11 at 6 pm to try to minimize descaling at the project. Charles Morrill, Washington, added that descaling is a concern because it impacts a juvenile's ability to move through the stressful transition from a freshwater to salt water environment.

TMT members looked at the latest TDG data. The Corps' official management gauges, Cascade Island, read 117.7% and Camas/Washougal read 117.6. It was also noted that involuntary spill was occurring at every project upstream and these high flows were expected to reach Bonneville soon. Also, Doug clarified the Corps' management position, which is to operate Bonneville to 115%/120% TDG or up to 100 kcfs, whichever is less.

TMT explored the option of revising the spill priority list to try to gain some operating flexibility. With the caveat that the forecasted high flows coming in to the system would likely result in the action agencies' inability to control the project any more than it had been, there was no objection to putting a temporary spill priority list in place that moved Bonneville, at all tiers, up to the 3rd spot above The Dalles for the duration of this special operation.

Planned Operation:

The Action Agencies agreed to implement the same operation that had been implemented over the past few weeks, effective today through Monday, 6/11 at 6:00 pm:

- Operate PH 2 up to the 25% of 1% of Best Efficiency Operating Range
- Operate PH 1 up to the upper limit (100%) of 1%
- As needed, operate PH 2 within the 25-50% range of 1%
- As needed to remain flow neutral, operate PH 1 up to best geometry
- As necessary, involuntary spill above the TDG spill cap.

In addition, they will revise the spill priority list to place Bonneville, at all tiers, up to the third spot in front of The Dalles during this temporary operation.

Next Steps/Post Operation Analysis:

TMT members expressed a desire to review, analyze and learn from this year's special operation to help inform future decision making around efforts to minimize descaling and mortalities of juveniles at Bonneville during high flow periods. To that end, TMT members agreed to pull the data together and convene a discussion (either at the TMT Year End Review or special session sooner than that) on this issue. The review will look at the impacts from the operation on descaling, so the data should be as precise as possible (daily/hourly operations, daily/hourly descaling sample data). It should also include analysis of use of the temporary spill priority list if applicable.

As needed, TMT will reconvene for a conference call on 6/13 to discuss whether to extend the operation; otherwise this issue will be revisited at the next face to face meeting on 6/20.

Operations Review

Reservoirs – John Roache reported on Reclamation projects. Grand Coulee was at elevation 1263' and the expected high inflows coming in would impact the project's elevation and outflows. Hungry Horse was at elevation 3548.2', with inflows around 30 kcfs; the project may need to adjust for local flood control. Lisa Wright reported on Corps projects. Libby was at elevation 2426' with 52.7 kcfs inflows and outflows dropping to 12 kcfs to manage to local flood control elevation 1,764' at Bonners Ferry. Natural flows have provided good conditions for the sturgeon, and to date, temperatures were still within an acceptable range of 8° C or higher. Future adjustments to the selective withdrawal system at Libby may need to be made to manage temperatures for sturgeon. Albeni Falls was at elevation 2060.1', with 73.1 kcfs inflows and 74 kcfs outflows. Priest Rapids inflows were 159.0 kcfs. Dworshak elevation was 1586.6', with 22.1 kcfs inflows and 9.6 kcfs outflows. Lower Granite inflows were 119.9 kcfs; 306.4 kcfs at McNary; and 305 kcfs at Bonneville.

Fish – Paul Wagner, NOAA, reported on fish. Yearling Chinook passage numbers were less than 1,000 at Lower Granite, 2,000 at Little Goose, 10,000 at McNary and 3,400 at Bonneville. Paul described this as a protracted run. Subyearling Chinook passage numbers were 43,000 at Lower Granite, about 45,000 at Little Goose, 16,000 at Lower Monumental, 5,000 at McNary, 2,000 at John Day and 7,000 at Bonneville. Juvenile steelhead passage counts were 8,000 at Lower Granite and 8,000 at Little Goose –indicating a very late run. Juvenile sockeye at John Day were 2,500-3,500 and 1,800 at Bonneville; and juvenile lamprey counts at John Day were down to 2,000/day.

Doug Baus, Corps, shared a heads up that with performance standard testing beginning and fish arriving at the projects, the action agencies intended to shift from spring to summer operations as soon as hydraulic conditions allowed for it. SRWG and FPOM would be notified as to the specifics of the operations. An FPOM meeting was scheduled for next week. There was some discussion and disagreement about the date for making this change – the Fish Operations Plan indicates June 20 and it also says that presence of fish and flow criteria should be used to make the change and should be coordinated through the region.

A concern was raised that there had not been enough lead time to respond to pending changes to the Little Goose surface weir height, and there also was not a clear rationale for making this change. While substantively this is an FPOM issue, TMT members urged the Corps to provide a better coordination process on the changes for shifting from spring to summer operations – by giving the region enough time to provide input and then by clearly articulating the rationale for the change.

Paul resumed his report on fish, with an adult passage update. The season total for spring Chinook was 158,089 and the total to date passage of summer Chinook was 10,000. Spring jacks totaled 7,500 (a very low run), but summer jack counts were high so far. Sockeye numbers were about 200-300/day. Further downstream, spring chinook counts at Lower Granite were 56,000; and jacks were 2,800.

Water quality – Scott English, Corps, reiterated that flows are coming up and involuntary spill was expected to come through the system, but just for a short duration. The Cascade Island tailwater fixed monitoring station was being fixed (some equipment was being completely replaced) and they hoped to have it back on line in the next day or two. Meanwhile, information was being logged and will be posted ASAP.

Power System – Tony Norris, BPA, reported that the system experienced another wind peak earlier this week, over 4,100 MW of power. The graph showed a dramatic upswing in wind on to the system over a short period of time.

Next Meeting, Wednesday, June 20

Agenda items include:

- Bonneville PH 2 Operations Update/Report
- Dworshak Operations
- Libby Operations
- Shift from Spring to Summer Spill

- Grand Coulee Refill
- Upper Snake Flow Augmentation Update
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

June 6, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of Oregon, CRITFC/Umatilla, BPA, COE, NOAA, Montana, Washington, Nez Perce, Idaho, BOR, Colville Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review May 23 and 30 Meeting Minutes

The May 23 facilitator's notes and minutes were approved as final, pending any further comments. Review of the May 30 notes and minutes was postponed until the next TMT meeting.

3. Water Supply Forecast

The final NWRFC water supply forecast for June will be released at 5 pm today and posted to the TMT website tomorrow, Baus reported. The final June forecast is not expected to differ much from today's forecast. Current volume forecasts for individual projects are:

- Libby (April-August)– 7240 KAF, 123% of average
- Dworshak (April-July – 3236 KAF, 121% of average
- The Dalles (April-August) – 113 MAF, 122% of average

4. Bonneville Operations

Baus led a discussion of the special operation approved by TMT to reduce descaling of juvenile sockeye at Bonneville Dam. That operation was scheduled to end today, but Russ Kiefer, Idaho, requested that it continue through 6 pm, June 11, because an estimated 20-25% of the PIT tagged Snake River sockeye that passed Lower Granite have yet to pass Bonneville. Last year, juvenile sockeye showed up in significant numbers in June. Charles Morrill, Washington, concurred with Idaho's recommendation.

Baus showed TMT a summary of the mortality and descaling rates for juvenile sockeye at Bonneville, linked to today's agenda. Since the special operation was implemented on May 25, the highest observed rate of descaling was 15.8% on May 28, and the lowest was 3.4% on June 1. The highest observed mortality rate was 2.5% on May 27, and there were several days with a mortality rate of 0.0%.

Tom Lorz, CRITFC, asked about current gas levels at Bonneville. Morrill pointed out that fish passing Bonneville are two days' travel from entering saltwater, a stressful transition. Descaling makes survival more difficult at this stage and mortality may result. Paul Wagner, NOAA, said the relationship between descaling and prior injury is still unclear. Margaret Filardo, FPC, reported that none of the descaled sockeye observed this year had predator marks on them. The samplers look only for fresh descaling; fish with wounds that are beginning to heal are not counted as descaled.

Dan Feil, COE, asked whether there are clear indications that the special operation at Bonneville reduces sockeye descaling. Lorz urged the COE to take advantage of this opportunity to test a cap of 25% of the 1% operating range at Bonneville powerhouse 2 in light of previous findings that operating at the lower end of 1% significantly reduces descaling.

Kiefer said the operation currently in effect has clearly reduced impacts to sockeye up to this point. He asked whether gas levels at Bonneville would allow spill of 110-120 kcfs without causing a significant increase in adult fallback rates. Baus replied in accordance with the FOP spring spill rates at Bonneville Dam have been and continued to be a function of the lower rate as governed by: 1) 120%/115% TDG limits, or 2) 100 kcfs. TDG readings at Bonneville have been and continue to exceed TDG limits. Scott English, COE, said a wave of involuntary spill is working its way downstream toward Bonneville. The Dalles is already spilling to 123.8% TDG in the tailwater, Laura Hamilton, COE, reported.

In light of these flow increases, Kiefer suggested moving Bonneville up to third place on the spill priority list for any involuntary spill needed at all levels of spill. That would be acceptable as long as it doesn't interfere with performance testing, Bill Proctor, COE, said.

Inflow forecasts and gas levels can only be expected to increase over the next several days, Baus said. It's highly unlikely that the COE will be able to cap PH2 operations at 25% of the 1% operating range, as requested in the SOR to reduce sockeye descaling. However, every effort will be made to meet the conditions outlined in the SOR by using the same four-step approach to previous operations of this nature over the past several weeks.

The COE will implement Idaho's request to move Bonneville up to third place on the spill priority list until 6 pm on June 11, although it was noted that flows may be too high for the change to provide any benefit. The COE also agreed to extend the special operation at Bonneville through 6 pm, June 11, as requested.

Dave Statler, Nez Perce, asked whether there will be an analysis of impacts after the Bonneville special operation has ended. Kruger and Filardo agreed that an hourly analysis of turbine operations would be particularly useful. Litchfield suggested a biological assessment of the extent to which the Bonneville operation actually improved

conditions for fish. Some TMT participants suggested this operation would be a good topic for the TMT year end review.

TMT scheduled a tentative conference call on June 13 if needed to wrap up coordination on this issue.

5. Operations Review

a. Reservoirs. Grand Coulee is at elevation 1263 feet, and inflows are forecasted to be high over the next few days. Hungry Horse is at elevation 3548.2 feet, discharging 6.4 kcfs. Releases will be ramped down if needed for flood control at Columbia Falls.

Libby is at elevation 2426 feet, with inflows of 52.7 kcfs and releases of 12 kcfs, which have been sharply reduced over the past few days because inflows are rising and flood control is needed for Bonner's Ferry. Current elevation at Bonner's Ferry is 1763.57 feet. There was discussion of possible impacts of flood control on the sturgeon operation. Brian Marotz reported that Montana is working on maintaining a water temperature of 8 degrees C at Libby for sturgeon. Discharges were reduced to accommodate the flood stage (1764 feet) at Bonner's Ferry and temperatures at Libby stayed in the targeted temperature zone. In order to ensure water temperatures remain in the targeted range signatories to the sturgeon SOR for Libby are considering requesting the use of selective withdrawal gates to manage temperatures during the current operation.

Albeni Falls is at elevation 2060.1 feet, with inflows of 73.1 kcfs and discharges of 74 kcfs. Dworshak is at elevation 1586.6 feet, with inflows of 22.1 kcfs and discharges of 9.6 kcfs.

Priest Rapids inflows are 159.0 kcfs, Lower Granite inflows are 119.9 kcfs, and Bonneville inflows are 305 kcfs.

b. Fish. Juveniles: Yearling chinook passage is winding down with less than 1000 fish per day passing Lower Granite, Wagner reported. Daily passage counts indicate a remarkably protracted run – approximately 2000 at Little Goose, 1000 at Lower Monumental, 10,000 at McNary, 6000 at John Day, and 3000-4000 at Bonneville. Meanwhile, subyearling passage is on the increase, with daily counts of more than 43,000 fish passing Lower Granite and a similar number at Little Goose, 16,000 at Lower Granite, 5000 at McNary, and 7000 at Bonneville.

Based in the increase in subyearling counts at Lower Monumental Dam (LMN) Baus informed TMT the Action Agencies are planning to implement the LMN spill operation (17kcfs) as soon as conditions allowed in order to facilitate performance standard testing as identified in the FOP. Furthermore, consistent with FPOM coordination a change from the spring (40%) to the summer (50%) spill operation at McNary Dam (MCN) would be forthcoming soon. Changes from spring to summer spill

operations at LMN and MCN are being coordinated at this time for performance standard testing. Some TMT members expressed concern regarding the timing of the change of spill operations at LMN and MCN for performance standard testing. Final dates of these operational changes will continue to be coordinated with the region as soon as possible via SRWG and FPOM.

Adults: Steelhead passage is nearing its end, with daily counts of around 8000 fish at Lower Granite and Little Goose, 2000 at Lower Monumental and 1500 at Bonneville, Wagner reported. Spring chinook passage is finished, with a total count of 158,000 fish. Summer chinook are on their way – 10,000 have already passed Bonneville to date. Although jack counts have been high in recent years, Wagner noted that hasn't always translated into large adult returns. This year's jack counts are low, with 7500 jacks returning to Bonneville, which is about 40% or less of the 10-year average. Sockeye are passing Bonneville at the rate of 200-300 per day, which is expected to increase.

c. Water Quality. As Scott English reported earlier, a short period of involuntary spill is anticipated system-wide. Gas levels are currently under the waiver limits, but that is expected to change soon. Restoration of the Cascade Island monitoring station below Bonneville Dam will be finished today or tomorrow with the installation of a new communication cable.

d. Power System. A peak in wind power production over the past few days set another record of 4100 MW, Tony Norris reported. BPA was able to manage overgeneration without curtailing wind power.

6. Next TMT Meeting

There will be a TMT conference call on June 13 if needed to discuss Bonneville operations. The next regular TMT meeting will be on June 20. That agenda will include updates on Dworshak operations, Libby operations, the sturgeon pulse, the shift to summer operations, treaty fishing, Grand Coulee flow objectives, and upper Snake flow augmentation.

Name	Affiliation
Rick Kruger	Oregon
Tom Lorz	CRITFC/Umatilla
Tony Norris	BPA
Lisa Wright	COE
Paul Wagner	NOAA
Jim Litchfield	Montana
Tom Stiles	CRITFC/Umatilla
Doug Baus	COE
Laura Hamilton	COE
Dan Feil	COE
Bill Proctor	COE

Karl Kanbergs
Scott English

COE
COE

Phone:

Charles Morrill
Dave Statler
Brian Marotz
Russ Kiefer
John Roache
Derek Fryer
Jim Baldwin
Margaret Filardo
Russ George
Bruce McKay
Barry Espenson
Steve Hall
Richelle Beck
Greg Hoffman
XX
Bill Rudolph
Dave Rule
Sheri Sears

Washington
Nez Perce
Montana
Idaho
BOR
COE Walla Walla
Energy GPS
FPC
WMC
hydro consultant
CBB
COE Walla Walla
Grant PUD
COE Libby
Grant PUD
NW Fish Letter
RVC
Colville

The official water supply forecast is typically taken on the 4th working day of the month, but that is not the case in June and July per the official calendar. The June WSF is taken on 04 June and the July WSF is taken on 03 July.

[Close](#)
[Archive](#)
[Data/Normals](#)
[Rankings](#)
[Adjustments](#)
[Verification](#)
[Verify All Years](#)
[Help](#)

(GCDW1) COLUMBIA - GRAND COULEE DAM Forecasts for Water Year 2012 Ensemble Date: 2012-06-03 Issue Date: 2012-06-04					
Official Forecast with 10 days of QPF					
Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	74820	77686	121	81079	63990
APR-JUL	62606	64087	119	67326	53850
APR-AUG	70264	72802	121	76245	60290
JAN-JUL	70165	71646	114	74885	62900
with 3 days of QPF					
APR-SEP	73247	77636	121	80919	63990
APR-JUL	61708	64306	119	67402	53850
APR-AUG	69032	72599	120	76252	60290
JAN-JUL	69267	71865	114	74961	62900
with 0 days of QPF					
APR-SEP	71684	75980	119	79473	63990
APR-JUL	60008	62778	117	65919	53850
APR-AUG	67415	71160	118	74309	60290
JAN-JUL	67567	70338	112	73478	62900

☒ [Water Supply Plot for COLUMBIA - GRAND COULEE](#)

APR-SEP

Move the mouse over the desired "Forecast Period" to display a graph.

Overlay

☐ ESP10 ☐ ESP3 ☐ ESP0

Data Files

[CSV \(ESP10 / APR-SEP\)](#)

100 0 0

The official water supply forecast is typically taken on the 4th working day of the month, but that is not the case in June and July per the official calendar. The June WSF is taken on 04 June and the July WSF is taken on 03 July.

[Close](#)
[Archive](#)
[Data/Normals](#)
[Rankings](#)
[Adjustments](#)
[Verification](#)
[Verify All Years](#)
[Help](#)

(LYDM8) KOOTENAI - LIBBY DAM Forecasts for Water Year 2012 Ensemble Date: 2012-06-03 Issue Date: 2012-06-04					
Official Forecast with 10 days of QPF					
Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	7448	7802	118	8561	6638
APR-JUL	6325	6624	117	7160	5642
APR-AUG	7007	7379	118	8105	6248
JAN-JUL	6863	7162	114	7698	6306
with 3 days of QPF					
APR-SEP	7371	7816	118	8614	6638
APR-JUL	6370	6707	119	7414	5642
APR-AUG	7028	7412	119	8175	6248
JAN-JUL	6908	7245	115	7952	6306
with 0 days of QPF					
APR-SEP	7126	7622	115	8490	6638
APR-JUL	6095	6529	116	7176	5642
APR-AUG	6799	7202	115	8030	6248
JAN-JUL	6633	7067	112	7714	6306

 [Water Supply Plot for KOOTENAI - LIBBY DAM](#)

APR-SEP

Move the mouse over the desired "Forecast Period" to display a graph.

Overlay

☐ ESP10 ☐ ESP3 ☐ ESP0

Data Files

[CSV \(ESP10 / APR-SEP\)](#)

100 0 0

The official water supply forecast is typically taken on the 4th working day of the month, but that is not the case in June and July per the official calendar. The June WSF is taken on 04 June and the July WSF is taken on 03 July.

[Close](#)
[Archive](#)
[Data/Normals](#)
[Rankings](#)
[Adjustments](#)
[Verification](#)
[Verify All Years](#)
[Help](#)

(DWRI1) CLEARWATER - DWORSHAK DAM Forecasts for Water Year 2012 Ensemble Date: 2012-06-03 Issue Date: 2012-06-04					
Official Forecast with 10 days of QPF					
Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	3158	3252	116	3390	2803
APR-JUL	3003	3083	117	3220	2644
JAN-JUL	3755	3835	108	3972	3547
with 3 days of QPF					
APR-SEP	3203	3297	118	3544	2803
APR-JUL	3055	3133	118	3350	2644
JAN-JUL	3807	3885	110	4102	3547
with 0 days of QPF					
APR-SEP	3090	3206	114	3412	2803
APR-JUL	2947	3050	115	3249	2644
JAN-JUL	3699	3802	107	4001	3547

☒ [Water Supply Plot for CLEARWATER - DWORSHAK](#)

APR-SEP

Move the mouse over the desired "Forecast Period" to display a graph.

Overlay

☐ ESP10
 ☐ ESP3
 ☐ ESP0

Data Files

100 0 0

The official water supply forecast is typically taken on the 4th working day of the month, but that is not the case in June and July per the official calendar. The June WSF is taken on 04 June and the July WSF is taken on 03 July.

Close

Archive

Data/Normals

Rankings

Adjustments

Verification

Verify All Years

Help

(LGDW1) SNAKE - LOWER GRANITE DAM

Forecasts for Water Year 2012

Ensemble Date: 2012-06-03 Issue Date: 2012-06-04

☒ [Water Supply Plot for SNAKE - LOWER GRANITE DAM](#)

APR-SEP

Official Forecast with 10 days of QPF

Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	23564	24043	100	24676	24140
APR-JUL	20938	21349	99	21917	21550
APR-AUG	22324	22766	100	23409	22870
JAN-JUL	28109	28520	95	29088	30020

with 3 days of QPF

APR-SEP	23855	24506	102	26074	24140
APR-JUL	21210	21822	101	23262	21550
APR-AUG	22623	23254	102	24777	22870
JAN-JUL	28381	28993	97	30433	30020

with 0 days of QPF

APR-SEP	23191	24006	99	25453	24140
APR-JUL	20579	21327	99	22670	21550
APR-AUG	21982	22770	100	24184	22870
JAN-JUL	27750	28498	95	29841	30020

Move the mouse over the desired "Forecast Period" to display a graph.

Overlay

☐ ESP10 ☐ ESP3 ☐ ESP0

Data Files

100 0 0

The official water supply forecast is typically taken on the 4th working day of the month, but that is not the case in June and July per the official calendar. The June WSF is taken on 04 June and the July WSF is taken on 03 July.

(TDAO3) COLUMBIA - THE DALLES DAM					
Forecasts for Water Year 2012					
Ensemble Date: 2012-06-03 Issue Date: 2012-06-04					
Official Forecast with 10 days of QPF					
Forecast Period	Forecasts Are in KAF				30 Year Average
	90 %	50 %	% Average	10 %	
APR-SEP	112855	116587	118	120365	98650
APR-JUL	96448	98314	116	102896	84650
APR-AUG	106358	109605	118	113710	93090
JAN-JUL	115912	117778	110	122360	107300
with 3 days of QPF					
APR-SEP	111730	116443	118	121339	98650
APR-JUL	95865	99118	117	103303	84650
APR-AUG	105314	109675	118	114630	93090
JAN-JUL	115329	118582	111	122767	107300
with 0 days of QPF					
APR-SEP	109456	114118	116	119206	98650
APR-JUL	93265	96930	115	101501	84650
APR-AUG	103085	107168	115	112529	93090
JAN-JUL	112729	116394	108	120965	107300

☒ [Water Supply Plot for COLUMBIA - THE DALLES DAM](#)

APR-SEP

Move the mouse over the desired "Forecast Period" to display a graph.

Overlay

☐ ESP10 ☐ ESP3 ☐ ESP0

Data Files

100 0 0

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT CONFERENCE CALL

Wednesday June 13, 2012 11:00am - 12:00pm

CONFERENCE CALL INFORMATION

Phone Number (877) 336-1274

Access Code 3871669

Security Code 5763

**We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone**

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnnw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Lower Monumental Transition from Spring to Summer Spill Operations Transition - Doug Baus, COE-NWD
 - a. [Draft Operation Transition](#)
3. Other
 - a. Set agenda and date for next meeting - **June 20, 2012**
 - b. [\[Calendar 2012\]](#)

*Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995*

Lower Monumental Dam Spring to Summer Spill Operation Transition

The 2012 Fish Operations Plan (FOP) states that summer spill operations at Lower Monumental Dam (LMN) will begin on approximately June 21. However, fish run timing and research schedules may require an earlier transition date to summer operations to ensure that research occurs during the bulk of the migration (FOP, page 9). Additionally, the NOAA Fisheries 2010 Supplemental Biological Opinion (2010 Supplemental BiOp) specifies that (RPA Table 2, footnote 6):

The actual start of summer spill at Snake River projects will be initiated when subyearling Chinook salmon exceed 50% of the collection for a 3-day period for each Snake River project anytime after June 1.

As of June 6, 2012, the proportion of subyearling Chinook salmon at LMN had exceeded the 50 percent threshold for 3 consecutive days.

A performance standard test of juvenile salmonid dam passage survival as required by the 2010 Supplemental BiOp is currently underway at LMN to estimate the survival of subyearling Chinook salmon passing LMN. Therefore, the Action Agencies (AAs) propose implementing the summer spill operation at LMN immediately to align the study dates and summer spill operation with the passage of as much of the subyearling Chinook run as possible.

The AAs convened a Studies Review Workgroup (SRWG) conference call on June 7 to discuss transitioning to summer spill at Lower Monumental Dam (as specified in the FOP, page 13). On the call, several SRWG members, including CRITFC, ID, NOAA, NPT, and OR disagreed with the 2010 Supplemental BiOp criteria stated above and recommended applying alternative criteria for transitioning from spring to summer spill at LMN (SRWG members add biological basis for deviating from transition criteria stated in the 2010 Supplemental BiOp here). The alternative criteria recommended are to transition to summer spill when:

- the daily average river flow is ≤ 85 kcfs at LMN
- and river flow is forecast (see forecast hyperlink below) to remain below 85 kcfs for 7 consecutive days at LMN, then transition to the summer spill operation at LMN

If the above criteria are not met by June 20, then summer spill would begin on June 21 at LMN as stated in the FOP. These criteria would only apply to the summer 2012 spring to summer spill transition at LMN, since this recommended alternative is different than transition criteria stated in the 2010 Supplemental BiOp.

Applying these recommended alternative criteria for making the spring to summer spill transition at LMN will affect the outcome of the summer performance standard test and may result in the mean spill level over the course of the study period exceeding the target spill operation of 17 kcfs by more than 5 kcfs.

<http://www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?id=LMNW1>

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

June 13, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Lower Monumental Transition from Spring to Summer Spill Operations Transition

Discussions about this topic began at TMT on 6/6 and continued through SRWG leading up to today's TMT conference call. Doug Baus, Corps, described the memo that was linked to today's agenda as an action agency pre-decisional document with a refined operations plan based on discussions held at SRWG. Three options were considered for transitioning Lower Monumental Dam (LMN) from spring to summer spill operations:

- Align summer operations with performance standard testing and fish run timing (subyearling Chinook) per guidance in the 2010 Supplemental BiOp as well as the Fish Operations Plan. These documents provide for adjustments in the initiation of summer spill based on subyearling Chinook run timing. Because there is a presence of fish and the study test has begun, begin summer operations immediately. The 2010 Supplemental BiOp states, "The actual start of summer spill at Snake River projects will be initiated when subyearling Chinook salmon exceed 50% of the collection for a 3-day period for each Snake River project anytime after June 1 (RPA Table 2 Footnote 6)." The 2012 Fish Operation Plan states, "Spring spill operations will continue through June 20. However, fish run timing and research schedules may require an earlier transition date to summer operations to assure that research occurs during the bulk of the migration. Such changes will be coordinated through TMT," as well as, "Summer spill operations approximately June 21 through August 31 (pg. 13)."
- Follow Fish Operations Plan guidance that says to spill to the gas cap until June 20 and transition on June 21 to summer spill operations (17 kcfs).
- Third option discussed at SRWG: Use alternative criteria to transition to summer spill when:
 - the daily average river flow is ≤ 85 kcfs at LMN
 - and river flow is forecast (see [forecast hyperlink below](#)) to remain below 85 kcfs for 7 consecutive days at LMN, then transition to the summer spill operation at LMN
 - If the above criteria are not met by June 20, then summer spill would begin on June 21 at LMN as stated in the FOP. These criteria would only apply to the summer 2012 spring to summer spill transition at LMN, since this recommended alternative is different than transition criteria stated in the 2010 Supplemental BiOp.

Some salmon managers clarified that they did not recommend the above third option, but said it was discussed at SRWG. The memo was put together by an action agency representative in response to the discussion at SRWG. The Corps offered that involuntary spill is ongoing and

they would begin the transition to summer spill operations as soon as flows would allow (possibly using the above third option criteria if there was regional consensus). Additionally, the action agencies indicated that LMN would be moved from position 6 to 8 on the spill priority list in order to spill in accordance with the 17 kcfs summer spill operation for performance standard testing. This last issue was not discussed any further.

TMT members were polled on their level of support for the third option described above:

- Oregon – Objects to any operation that transitions LMN to summer spill sooner than the June 21 trigger date described in the FOP, and will elevate this issue as needed.
- Idaho – Would not object to the third option
- Washington – Was not informed enough to state a position
- Montana – Not present for today's call
- CTUIR – Prefer the June 21 FOP option, but will not object to the third option
- Colville – Prefer June 21 FOP option, and objects to the third option
- NOAA – Can see the merits of all options, and would not object to third option
- USFWS – Prefers the June 21 FOP option, but will not object to the third option
- BPA – Supports the third option and transitioning to summer spill operations as soon as possible
- Reclamation – Supports the third option and Corps' decision
- Nez Perce – Was not in attendance for the meeting but provided the Corps with the following email response after the meeting, "...cessation of spill operations prior to June 20 is not advised. ... NPT would object to early cessation of spring spill for performance testing of summer spill."
- Corps – Hearing objections, needs to coordinate with internal policy and legal team and get back to the region with a decision, as soon as possible.

Next Steps –

As soon as possible, the Corps will make a decision and share it with the region via an email to TMT. If anyone objects to the decision, it can be elevated in the RIOG process by notifying their RIOG representative who may raise the issue to the Senior Hydro Team Chair, who would then coordinate a conference call of the Senior Hydro Team to develop a RIOG Policy Briefing Paper with the assistance of technical team members. All TMT members will brief their RIOG and Senior Hydro Team representatives on this issue and give them a heads up that a follow up meeting may be convened in the near future. This item will also be on the 6/20 TMT agenda.

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

June 13, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT conference call was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of Oregon, BPA, NOAA, USFWS, COE, BOR, the Colville Tribe, CRITFC/Umatilla Tribe, Idaho, Washington and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Lower Monumental Dam Summer Spill Operations

The purpose of today's meeting was to continue the regional dialogue regarding the transition at Lower Monumental Dam (LMN) from the spring spill operation of spilling to the 115/120% TDG gas cap 24 hours per day (currently 26 kcfs) to the summer spill operation of spilling 17 kcfs 24 hours per day. Today's TMT meeting continued a June 7 Studies Review Work Group (SRWG) discussion regarding the Corps' proposal to transition from the spring to summer spill operation to coincide with performance standard testing currently underway at LMN as specified in the Reasonable and Prudent Alternative (RPA) in NOAA Fisheries' 2010 Supplemental Biological Opinion (BiOp) and in the 2012 court-ordered Fish Operations Plan (FOP).

Today's discussion focused on the date the Action Agencies (AAs) will switch from the spring to the summer spill operation at LMN. There are differing opinions on the appropriate date to make the transition due to how the transition date is described in the BiOp vs. the FOP.

The BiOp states:

- "The actual start of summer spill at Snake River projects will be initiated when subyearling Chinook salmon exceed 50% of the collection for a 3-day period for each Snake River project anytime after June 1." (RPA No. 29, Table 2)

The FOP states:

- "Lower Snake River Projects: Spring spill operations will continue through June 20. However, fish run timing and research schedules may require an earlier transition to summer operations to assure that research occurs during the bulk of the migration. Such changes will be coordinated through TMT." (page 9)
- "Summer spill will begin on June 21 at Lower Granite, Little Goose, Lower Monumental and Ice Harbor dams..." (page 9)
- "Summer Spill Operations Approximately June 21 through August 31."

During the SRWG meeting on June 7, the AAs advocated for transitioning to summer spill operations at LMN immediately in accordance with the BiOp criteria, as subyearling Chinook salmon had exceeded 50% of the collection at LMN for 3 days and BiOp performance standard testing had begun. The AAs communicated their concern

that delaying the transition to summer spill operations would negatively impact their summer performance standard test of subyearling Chinook passage at LMN during the summer spill operation. The AAs interpret the FOP to allow for an earlier transition date to be coordinated to assure the test captures the bulk of the subyearling Chinook run, as intended in the BiOp.

Not all SRWG members shared the AA's perspective on the date LMN should transition to the summer spill operation. Some of the concerns expressed regarding making a change on approximately June 7 were: 1) a preference to wait until June 21 (as mentioned in the FOP) since current flows were not indicative of summer-like flow conditions, and 2) there needed for additional time to discuss this change with their respective agency representatives.

There was a lack of consensus among SRWG participants regarding the AA's desire to make the transition to the summer spill operation on June 7, in accordance with the BiOp criteria. Several SRWG participants felt more comfortable with making the change at a later date based on hydraulic triggers and forecast information similar to the criteria used to make the spillway weir crest height change at Little Goose Dam. This was intended to strike a balance between the gap in the transition date (June 7 vs. June 21) in order to satisfy the concerns of some SRWG participants. The following criteria were defined as a potential alternative trigger to initiate the transition to the summer spill operation at LMN (applicable to 2012 only).

- Observed daily average inflow at LMN of less than 85 kcfs;
- and, forecasted inflows at LMN below 85 kcfs for 7 consecutive days.

This information was distributed to SRWG participants via email on June 11 and had been posted to today's TMT agenda to facilitate discussion.

Baus clarified that, as of today, the conditions at LMN had met the criteria defined by SRWG – the actual daily average inflow was <85 kcfs, and was forecasted to remain <85 kcfs for next 7 days. Further, the criteria defined in the BiOp have also been met - LMN subyearling Chinook salmon have been exceeding 50% of the collection for at least 3 days. Therefore, considering that criteria defined in the BiOp and by the SRWG has been satisfied, and that summer performance standard testing is currently underway and the AAs intent of the test is to assess the performance of subyearling Chinook passage at LMN at the summer spill operation of 17 kcfs, the AAs propose to transition to the summer spill operation at LMN as soon as involuntary spill conditions at LMN allow, possibly as soon as this evening. The AAs contend this proposal is consistent with language in the FOP that allows for an earlier transition to summer spill operations to be coordinated based on run timing of subyearling Chinook salmon, as called for in the BiOp.

Baus and Tony Norris, BPA, added that in order for the AAs to achieve the summer spill rate at LMN of 17 kcfs, the AAs would move LMN down on the spill priority list from position #6 to position #8 in order to provide better conditions for performance

standards testing. This would allow Lower Monumental to achieve a spill rate of 17 kcfs for testing at a flow rate consistent with summer operations.

The Oregon and Idaho representatives commented that their recollection of the SRWG call was that a COE employee had suggested the third alternative, not the Salmon Managers as identified in a recent email regarding the SRWG meeting. TMT members gave their views of the AA's proposal:

- **Oregon** objects to switching LMN from spring to summer spill prior to June 21. Making the change prior to June 21 would compromise the remainder of the spring migration. Oregon's preference is to operate within FOP guidelines, which call for spill at Snake River projects to the gas cap until the end of the day on June 20, followed by summer flows of 17 kcfs beginning on June 21. If the AAs decide to change LMN spill from spring to summer prior to June 21 despite Oregon's objection, Oregon would elevate to RIOG.
- **Idaho** agreed there is some uncertainty whether the BiOp or the FOP takes precedence in these sorts of situations. Considering that the alternative trigger defined by SRWG had been met, Idaho did not object to the proposed operation being implemented as soon as this evening if spill conditions allow.
- **CRITFC/Umatilla Tribe** would prefer to change spill on the date specified in the FOP, and believes the performance standard test is to test existing conditions rather than one specific spill operation. Did not object to the AA's proposed operation.
- The **Colville Tribe** objects to changing to the LMN summer spill operation prior to June 21. Would prefer to spill to the gas cap through June 20. Spring migrants are still in the river and need the water to pass.
- **NOAA** sees justification for both sides of this debate and did not object to the proposed operation.
- **USFWS** would prefer to use the June 21 criteria identified in the FOP for the start of summer operations, but did not object to the operation as proposed.
- **BPA** and **BOR** both support the proposal to start summer operations at Lower Monumental as soon as this evening if involuntary spill conditions allow.
- **Washington** attended today's meeting but did not express an opinion.
- **Nez Perce** objects to changing to the LMN summer spill operation prior to June 21 (Nez Perce did not attend the TMT meeting but this response was provided to the Corps via email after the TMT meeting on June 13).

In consideration of Oregon, Nez Perce, and Colville's objection to the AAs proposal to transition to the summer spill operation at LMN based on criteria defined in the BiOp and the FOP, as well as the SRWG alternative criteria, the COE will delay a decision on whether to implement the summer spill operation until additional policy and legal coordination is completed. The COE will inform TMT via email as soon as a decision has been reached.

Gumpert advised TMT members to brief their RIOG representatives as soon as possible on this issue in the event that the Senior Hydro Team chair, Ritchie Graves (NOAA Fisheries), contacts them to set up a RIOG meeting. One goal of that meeting would be to prepare a policy briefing paper documenting all perspectives on the issue.

3. Next TMT Meeting

The next TMT meeting will be held in person on June 20 at the COE NW Division office in Portland.

<i>Name</i>	<i>Affiliation</i>
Rick Kruger	Oregon
Scott Bettin	BPA
Tony Norris	BPA
Paul Wagner	NOAA
David Wills	USFWS
Doug Baus	COE
John Roache	BOR
Derek Fryer	COE
Sheri Sears	Colville
Margaret Filardo	FPC
Tom Lorz	CRITFC
Holly Krebs	Chelan PUD
Ruth Burris	PGE
XX	Thompson Reuters
Lisa Wright	COE
Laura Hamilton	COE
Barry Espenson	CBB
Russ Kiefer	Idaho
Richelle Beck	Grant PUD
Peter Richardson	Junsket
Charles Morrill	Washington

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday June 20, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 9963

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnmw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

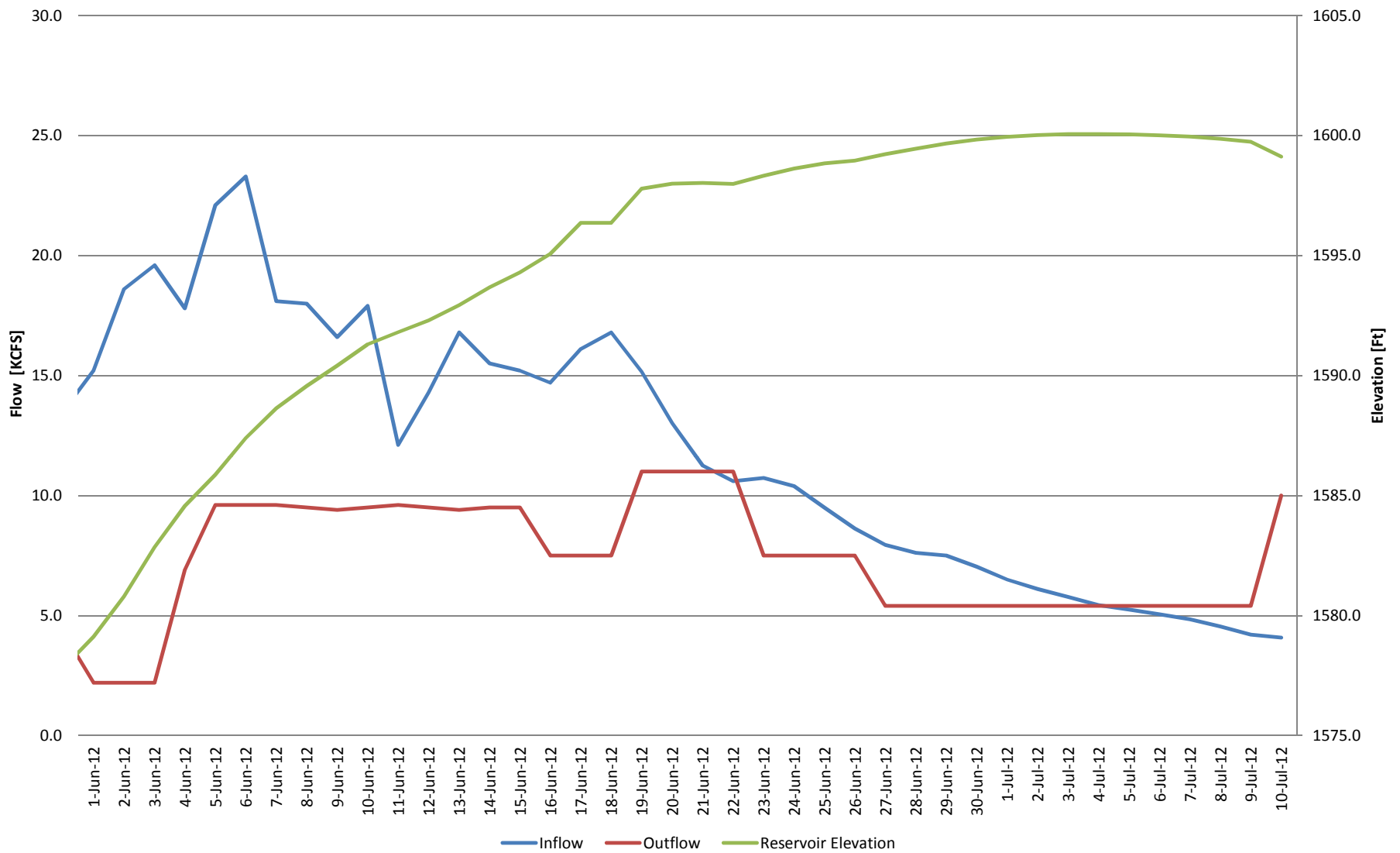
1. Welcome and Introductions
2. Review June 6 and 13 Meeting Minutes
3. Spill Priority List - Doug Baus, COE-NWD
 - a. [Updated](#)
4. Operation of the Lower Columbia Pools for the Summer 2012 Treaty Fishery - Tom Lorz, Umatilla; Doug Baus, COE-NWD
 - a. [SOR 2012-C1](#)
5. Grand Coulee Refill - John Roache, BOR

6. Upper Snake River Flow Augmentation - *John Roache, BOR*
7. Dworshak Operations - *Steve Hall, COE-NWW*
 - a. [Regulation - Final Refill](#)
8. Libby Operations - *Joel Fenolio, COE-NWS*
9. Operations Review
 - a. Reservoirs
 - b. Fish
 - c. Water Quality
 - d. Power System
10. Other
 - a. Set agenda and date for next meeting - **June 27, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995

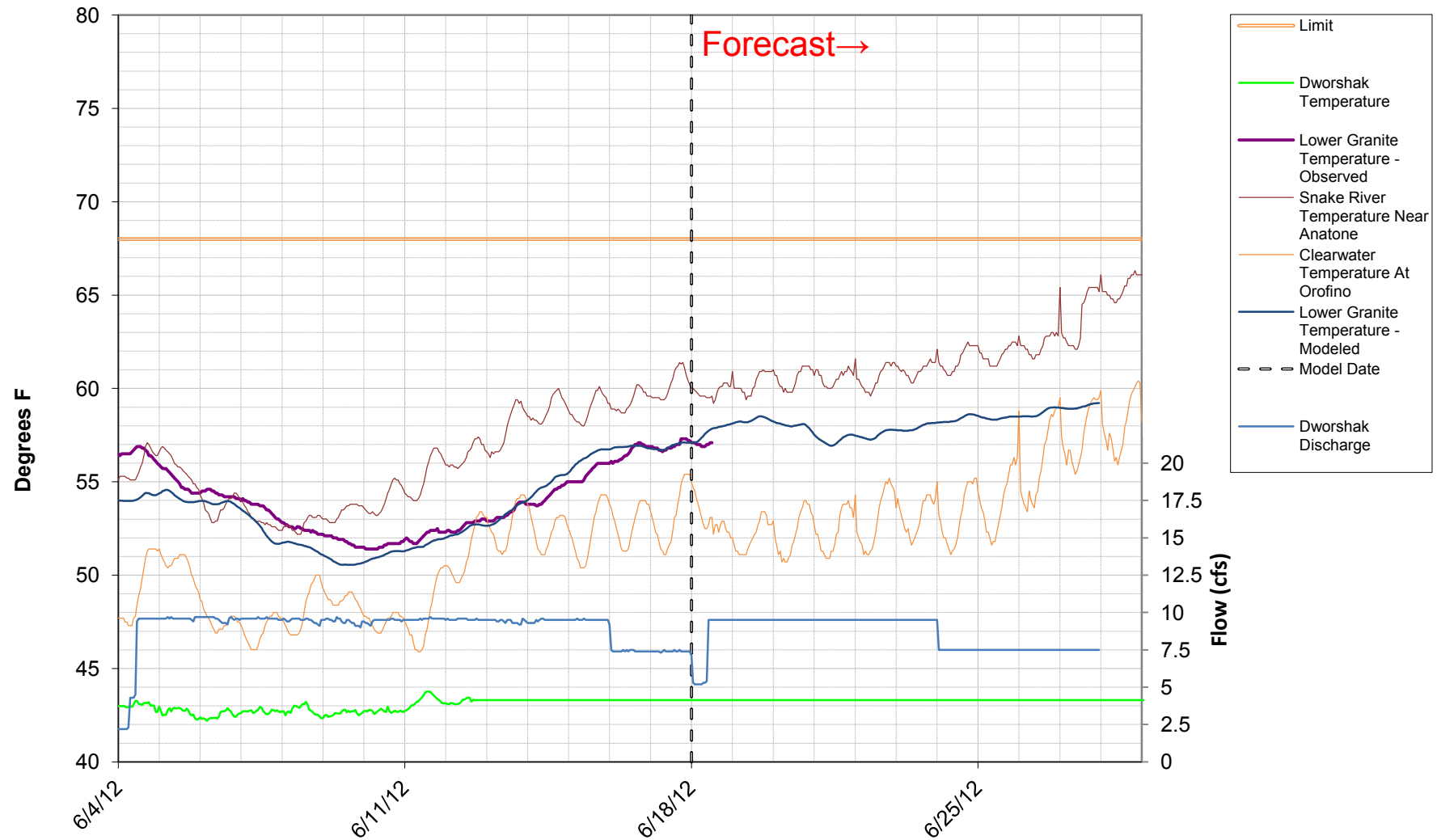
DWR Regulation - Final Refill

Inflow based on NWS-RFC forecast June 19th



Output from CEQUALUtility Pre-processor
w/ SILW from agrimet spreadsheet
9.5kcfs until 6/24 - 7.5kcfs after

Water Temperature Comparisons Model from 6/4/2012 to 6/29/2012 Observed Data to 6/18/2012



COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

June 20, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Review June 6 and June 13 Meeting Minutes

With no comments, both sets of Official Meeting Minutes and Facilitator's Notes were approved as final.

Spill Priority List

Doug Baus, Corps, reported that with the system transitioning in to Summer spill operations, the action agencies developed a spill priority list that would support their ability to do performance standard testing and manage system wide TDG. This version of the spill priority list was linked to the agenda item and viewed at the meeting. He provided more detail about the specific changes that were made, and turned to the salmon managers to hear their input. Paul Wagner, NOAA, on behalf of FPAC said the salmon managers provided an alternative list that they believed would better place the priority of excess spill at the location of fish passage during this Summer period. With that, Doug shared a revised spill priority list (not yet posted during this discussion) that tried to meet the recommendations of the salmon managers and the action agencies' need to meet performance standard testing. The one exception to the salmon managers' recommendation was that Lower Monumental was placed lower on the list to allow more flexibility to meet the conditions of the performance standard test, which had already been initiated at that project. There was also some discussion about the high flows in the system and likelihood that the action agencies would have to implement at least Level 1 of this spill priority list.

Action/Next Steps: TMT members were willing to accept the revised spill priority list described in today's meeting, and as such, the Corps planned to put this list in place immediately and through July 20 when performance standard testing ends. This updated list will be posted to today's TMT agenda and the order for Level 1 and Level 2 is as follows:

LEVEL 1 – FISH PASSAGE SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
01	LWG	120/115% ^a	41
02	IHR	120/115% ^a	92
03	LGS	120/115% ^a	35
04	BON	120/115% ^a	100
05	MCN	120/115% ^a	145
06	JDA	120/115% ^a	140
07	TDA	120/115% ^a	128
08	LMN	120/115% ^a	24
09	CHJ	110%	15
10	GCL	110%	5
11	DWR	110%	~ 3 (35%)

LEVEL 2 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
12	LWG	120%	55
13	IHR	120%	90
14	LGS	120%	52
15	BON	120%	190
16	MCN	120%	165
17	JDA	120%	142
18	TDA	120%	118
19	LMN	120%	72
20	CHJ	115%	70
21	GCL	115%	20
22	CHJ	120%	110
23	GCL	120%	25

The salmon managers thanked the Corps for the opportunity to provide feedback on the list, and the willingness to make adjustments to balance all needs. The Corps likewise appreciated receiving the salmon managers' input with enough lead time to coordinate the adjustments.

Lower Columbia Pool Operations for Summer Treaty Fishery

Tom Lorz, CRITFC/CTUIR, presented SOR 2012-C1 requesting special operations to support treaty fishing during the periods 6/18-6/21 and 6/25-6/28. As in the past, the Corps agreed to implement this operation to the extent possible. Tom will follow up in two weeks with a report and possibly new request for continuing the fishery.

Grand Coulee Refill

John Roache, Reclamation, reported that high flows are expected to continue through the first week of July, and so Grand Coulee was expected to reach refill sometime between the end of June and July 4th. The current project elevation was 1281.8'. John acknowledged that the high flows would most likely not allow the agency much flexibility this year to meet the interests of holiday recreationists who would like a lower reservoir elevation for beach access.

Upper Snake Flow Augmentation

John Roache also reported on Upper Snake flow augmentation, saying the full 487 kaf will be released this year: Releases above Milner began on 6/7 and will continue in to July, totaling approximately 207 kaf; releases out of Boise began on 6/5 and will continue in to July totaling approx. 42 kaf; the Payette releases will begin in late June and continue in to August, totaling approx. 160 kaf; and the rest, about 78 kaf, will come from natural flow.

Dworshak Operations

Steve Hall, Corps Walla Walla District, reported on final refill operations at Dworshak and shared inflow models going in to July. A 6/8 snow flight observed higher than expected, 8% remaining snow pack. Currently the project was releasing 11 kcfs and would ramp down to about 7.5 kcfs over the weekend; then further to about 5 kcfs through the week of 7/4, until the project is full. Summer augmentation discharges will begin around 7/10, depending on temperatures.

Steve also shared the latest temperature modeling runs and said Lower Granite temperatures, currently around 57° F (similar to recent years), should stay cool through the end of June so no need for temperature augmentation flows from Dworshak. The hatchery has asked the Corps to increase release temperatures out of Dworshak up to 45°, which the Corps will do as soon as flows subside enough for them to make the switch in to overshot mode at the project. They plan to run weekly temperature models.

Steve introduced temperature modeler Evan Heisman and said he has done a lot of work on modeling improvements. Steve also reported that repairs had been done to fix leaky turbines at the project, and so the Corps did not anticipate any issues this year. A more permanent fix is scheduled to begin in 2013/2014.

Libby Operations

Doug Baus, Corps, reported that Libby discharges were currently 31.2 kcfs and Libby discharges were being managed to within one foot of flood stage at Bonners Ferry. Robyn McKay, BPA, added that BPA had to back down 10 megawatts on 6/19 and 20 megawatts on 6/15-16 at Libby and Hungry Horse to address low load issues in Flathead Valley – emergencies were declared because they disrupted the sturgeon operation, but the total flow disruption at the projects was minimal. It was reported that preliminary data shows 7 sturgeon have moved above Bonners Ferry; crews will know more and be able to recover them once the flows recede.

Action: Doug Baus will ask Joel Fenolio, Seattle District Corps, to provide model runs for Libby Summer operations at the next TMT meeting. The plan is to target elevation 2449' by the end of August.

Operations Review

Reservoirs – John Roache reported on Reclamation projects. Grand Coulee was at elevation 1281.8 feet and filling. Hungry Horse was at elevation 3558.1 feet with 12.5 kcfs outflows and about 20 kcfs inflows – runoff and precipitation are high, with precipitation for June at 200% of normal. Lisa Wright reported on Corps projects. Libby was at elevation 2446.6 feet, with 65.4 kcfs inflows and 29.7 kcfs outflows. Albeni Falls was at elevation 2061.4 feet with 84.9 kcfs inflows and 88.7 kcfs outflows. Priest Rapids inflows were 241.5 kcfs. Dworshak elevation was

1597.7 feet, with 15.1 kcfs inflows and 11 kcfs outflows. Lower Granite inflows were 92.1 kcfs and Bonneville inflows were 355.4 kcfs.

Doug Baus reported that the special operation at Bonneville to minimize descaling of sockeye had concluded on 6/13. Also, as follow up to the 6/13 TMT conference call, he shared that summer spill operations at Lower Monumental would begin on 6/21 since agreement on an earlier start date was not reached..

Tom Lorz, CRITFC/CTUIR, reported that a large subyearling Chinook run is expected to reach Bonneville very soon and there is concern for descaling at Bonneville given the unique high flow conditions and fish screens remaining in at Bonneville. Tom requested that the action agencies implement the special operation provided for sockeye, now for subyearling Chinook, beginning tomorrow, 6/21, and continuing through Monday evening 6/25. The Corps responded there had been a wide range of variability in percent descaling and mortality in juveniles during previous operations limiting PH2 to the mid-point (50%) of the 1% of best efficiency operating range. Based on the wide range of variability in mortality and descaling rates it has been unclear that the effects of implementing the special operation at PH2 provided any benefit to juvenile sockeye that passed through PH2. Furthermore, this operational change request would be taking place during performance standard testing at Bonneville Dam. Implementing this change would modify PH2 and PH1 operations during performance standard testing and would be a significant change from the current Bonneville Dam operation as identified in the FPP. Accordingly, the AAs need additional regional coordination before implementing this change. That said, Doug indicated that FPOM discussed this issue at the last meeting and set up a special task group to continue work on this issue. Doug committed to completing additional coordination and following up with Lorz prior to the next TMT with the goal of having a path forward to address Tom's concern. Scott Bettin, BPA, added that Unit 11 was expected to come back on line tomorrow and this would give the project more capacity.

Fish – Paul Wagner, NOAA, reported on the fish. Adult summer Chinook were passing about 2,200/day at Bonneville, with a total 38,000 so far. This lined up with the 10-year average. Jacks counts, on the other hand, were falling short by about ½ of the 10 year average so far. Sockeye numbers were very high, totaling 96,000 at Bonneville. Steelhead numbers were picking up. On the Snake, 6,847 spring Chinook were counted passing Lower Granite, and this was close to the 10-year average. Jack counts were low. Russ Kiefer, Idaho, reported that 4 PIT-tagged sockeye from Stanley Basin were counted at Lower Granite. Lamprey adult counts were 5,461 at Bonneville, well ahead of 2011 counts. FPAC received a report that there were issues with the adult lamprey counts and only those observed through the observation window were being counted, so the actual is probably higher than the observed total.

Juvenile yearling Chinook counts were low, but subyearling numbers were high – ranging from 17,000 to 40,000 at the Lower Snake projects; about 30,000 at McNary and 19,000 at Bonneville.

Water quality – Scott English, Corps, reported that TDG was high but manageable in the system and also said the tailwater gauge at Bonneville was back on line. If desired, Scott said he would prepare a presentation for TMT on the problem and solutions to the failed water quality gauge.

Power system – Nothing more to report.

TMT Schedule

June 27 Agenda items include –

- Libby Summer Operations – model runs
- Bonneville Operations Report
- Treaty Fishery Update
- Dworshak Operations – temperature modeling
- Water quality gauge report
- Other?

July 11 Agenda items include –

- July Final Water Supply Forecasts
- Dworshak Operations
- Libby Operations
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

June 20, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of Montana, BPA, COE, Idaho, NOAA, CRITFC/Umatilla Tribe, BOR, Salish-Kootenai Tribes, Washington, the Colville Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review June 6 and 13 Meeting Minutes

The facilitator's notes and official minutes for June 6 and 13 were approved as final.

3. Spill Priority List

On June 18, the COE posted to the TMT website a preliminary draft of the spill priority list that reflects the transition from spring spill to summer operations and is consistent with performance testing, Baus reported. The Action Agencies aim is to deemphasize spill in excess of summer spill rates as defined in the 2012 Fish Operations Plan (FOP) that arise during lack of load conditions at projects where performance testing is taking place.

Paul Wagner, NOAA, suggested a direct comparison of the changes from spring to summer spill priorities by comparing the draft list posted to today's TMT agenda with the list for spring posted to the April 11 agenda, which he considered an effective prioritization of involuntary spill at projects.

Level 1 (up to the 120/115% TDG cap at fish passage projects) spill priority order, per the draft list posted today, has Lower Granite and Ice Harbor in positions #1 and #2, respectively, which is the same as in spring since both projects do not have performance standard testing in spring or summer this year, Baus said. Those two projects are followed by Little Goose, McNary, John Day, The Dalles, Bonneville, Lower Monumental, Chief Joseph, Grand Coulee and Dworshak in that order. Lower Monumental is lower on the list than it was in spring due to performance testing now underway. The summer draft list adds Dworshak and Grand Coulee up to 110% TDG (neither project has state TDG waivers). For the sake of system wide TDG management, Level 2 summer spill for lack of load conditions includes Chief Joseph and Grand Coulee at the 115% and 120% TDG levels.

Wagner said the Salmon Managers would prefer to move Lower Monumental up from position #8 to #4 at Level 1 spill, and Bonneville up to position #5 at Level 1 spill. Level 2 spill priorities for lack of load would remain the same as in the Action Agency proposal, except the Salmon Managers would move Chief Joseph and Grand Coulee to the bottom of the list. The rationale behind this recommendation is to spill first up to TDG state standards at projects where the spill could provide fish benefits before spilling exceeding the state TDG standards at projects with no fish passage.

Baus then showed TMT a revised draft spill priority list, which incorporated feedback received yesterday from FPAC after they reviewed the Corps' draft. The revised list had not yet been posted to the TMT agenda as of this meeting and will be posted there this afternoon.

For Level 1 spill, FPAC had recommended the following order: Lower Granite, Ice Harbor, Little Goose, Lower Monumental, Bonneville, McNary, John Day and The Dalles up to the 120/115% TDG caps (in the tailrace and forebay of the next downstream project, respectively), and ending with Chief Joseph, Grand Coulee and Dworshak up to the 110% TDG cap. In the revised list, the Action Agencies have adopted the recommendations for Level 1 spill with the exception of Lower Monumental, which remains in position #8 to increase the likelihood of achieving a successful summer performance test which is already currently underway. The Action Agencies also adopted the recommendation to place Chief Joseph and Grand Coulee at the bottom of the Level 2 list. It was clarified that the two dams would both spill to 115% TDG in a stepwise approach before either spills to 120% TDG. The revised order of priority for Level 2 spill is as follows: Lower Granite, Ice Harbor, Little Goose, Bonneville, McNary, John Day, The Dalles, Lower Monumental, Chief Joseph, Grand Coulee and Dworshak.

Russ Kiefer, Idaho, questioned why the summer performance test at Lower Monumental would be considered higher priority than testing at other projects. Tom Lorz, CRITFC/Umatilla, commented that the performance test at Lower Monumental should represent a range of operations that might reasonably occur over the next 5-10 years, not a special operation for performance testing. Wagner commented that the amount of inflows coming is likely to make the position of Lower Monumental in Level 1 a moot point, as all projects on the list will likely have to spill up to this level due to the high flows.

Kiefer proposed moving Lower Monumental up to position #4 for Level 1 spill and leaving it at position #8 for Level 2 spill. Baus replied that testing time has already been lost at Lower Monumental due to involuntary spill, and the COE is making best efforts to put spill at other projects where there may be more flexibility. The placement of Lower Monumental at the bottom of the list for Level 1 spill reflects the fact that the summer spill treatment has not yet been attainable there, and performance testing is scheduled to end July 20.

CRITFC/Umatilla was willing to accept the spill priority list as revised by the Action Agencies in response to Salmon Manager recommendations. **Idaho** was likewise willing to accept the revised list. The Action Agencies will implement that list later today.

4. Operation of the Lower Columbia Pools for Summer 2012 Treaty Fishery

Tom Lorz, CRITFC, presented SOR 2012-C1, linked to this item on today's agenda. The SOR, presented on June 14, calls for two treaty fisheries:

- 6 am, June 18 – 6 pm, June 21
- 6 am, June 25 – 6 pm, June 28

The SOR calls for Bonneville, John Day and The Dalles pools to be managed within a 1.5-foot band during these hours. Baus reported that the COE has already provided guidance to the projects to implement the operation as requested.

Lorz will report back to TMT on planning for any further fisheries and will provide catch data when it is available.

5. Grand Coulee Refill

John Roache, BOR, reported. Typically the BOR manages flows so that beaches are available at Lake Roosevelt over the July 4 weekend, but high inflows this year mean that Grand Coulee is expected to fill around July 4. The current reservoir elevation is 1281.8 feet, and the project is slowly filling.

6. Upper Snake River Flow Augmentation

The BOR expects to provide 487 KAF of flow augmentation from the upper Snake River this year, Roache reported. Augmentation flows began June 7 and are expected to continue until mid July. Estimated volumes are as follows:

207 KAF – Upper Snake River above Milner
42 KAF – Boise basin
160 KAF – Payette basin
+78 KAF – natural flows
487 KAF – total flow augmentation

7. Dworshak Operations

Steve Hall, COE, reported on Dworshak final refill preparations. Two slides attached to today's agenda depicting inflow and temperature conditions at Dworshak. Inflows over the past few days have been substantial. The first slide depicts flow and elevation projections through July. On June 14, a snow flight

found about 8% snow covered area, which means there is less snow in the basin than expected. With the reservoir 2 feet from full now, inflows are expected to decline. Current outflows are 11 kcfs, expected to drop to 7.5 kcfs this weekend due to lower inflows. After that, releases will drop down to 5 kcfs until the reservoir is topped off at 1600 feet elevation, probably through July 4. Summer flow augmentation will begin around July 10 depending on temperatures.

Currently Lower Granite temperatures are around 57 degrees F, with the reservoir expected to remain cool through the end of June. Dworshak temperatures are currently around 43 degrees F. Next week's model run will include the July 4 holiday and is not expected to involve a need for temperature augmentation. As soon as possible, the COE will raise Dworshak reservoir temperatures to 45 F in response to a request from the Dworshak hatchery.

Kiefer asked about Lower Granite temperatures. Hall replied that temperature model runs indicate that conditions this year will be similar to the past few years. No special turbine operations are envisioned. Last year's repair of the leaking head seal at Dworshak was apparently successful. The head cover seal on the unit still needs to be rebuilt, but that repair will be scheduled a few years out (2013 or 2014) between September and March, when fish are not migrating.

Hall said current projections show 2012 will be a relatively high inflow year, but not as high as 2010. Similar years are 1959 and 1991. With Lower Granite tailwater currently at 57 degrees F and slowly warming, it will be a good 10 days before it approaches 65 degrees F, triggering temperature augmentation flows. The COE will provide updated temperature model runs for each TMT meeting throughout the remainder of fish passage season.

8. Libby Operations

Libby is currently releasing 31.2 kcfs, managing Bonner's Ferry within a foot of flood stage, Baus reported. Robyn MacKay, BPA, reported on recent transmission emergencies in the Flat Head Valley. The area has been experiencing higher generation than load especially during light load hours at night. This means generation at Libby, Hungry Horse or both dams must be cut back. Last night, Flat Head Valley generation was reduced by 10 MW. On June 15-16, generation was reduced by 20 MW, which is equivalent to about 0.5 kcfs at each project. Transmission emergencies were declared in light of the sturgeon spill operation at Libby.

MacKay said load and generation imbalances will continue to be a problem, primarily at night, until flows decline or loads pick up for warmer weather. The sturgeon operation has had its ups and downs as a result of the power emergencies and flood stage management at Bonner's Ferry. Scott Bettin, BPA, reported that 7 sturgeon, 4 of them females, have moved to the area above

Bonner's Ferry. High flows have made the area inaccessible for data collection. When flows go down, USFWS and Idaho will report on the sturgeon operation.

Jim Litchfield, Montana, asked about the status of summer operations at Libby in light of high inflows. The RFC water supply forecast is about a MAF higher than the official COE forecast for Libby, Karl Kanbergs, COE, replied. Recent storms in the area have added volume to the high flows.

9. Operations Review

a. Reservoirs. Grand Coulee is at elevation 1281.8 feet, expected to fill after June 30. Hungry Horse is at elevation 3558.1 feet, with outflows of 12.5 kcfs which are expected to continue. Precipitation in the Flat Head Valley was 220% of normal in the first 20 days of June. Inflows at Hungry Horse are now around 20 kcfs. Roache will notify TMT via email if the "glory hole" is pressed into service to handle the high volume.

Libby is at elevation 2446.6 feet, with inflows of 65.4 kcfs and releases of 29.7 kcfs. Albeni Falls is at elevation 2061.4 feet with inflows of 84.9 kcfs and releases of 88.7 kcfs. Dworshak is at elevation 1597.7 with inflows of 15.1 kcfs and releases of 11 kcfs. Priest Rapids inflows are 241.5 kcfs. Lower Granite inflows are 92.1 kcfs. Bonneville inflows are 355.4 kcfs.

The change to summer spill operations at Lower Monumental will begin on June 21 as identified in the Fish Operations Plan, Baus said. The operation for juvenile sockeye passage at Bonneville ended on June 13.

Lorz reported that 7.8 million subyearlings are expected to arrive at Bonneville next week. Because high flows have been forcing turbine operations toward the upper end of the 1% of best efficiency operating range, and it's unusual to have fish screens in place when flows are this high, he recommended that the sockeye operation to cap powerhouse 2 units to the mid-point (50%) of the 1% range be implemented immediately for a duration of one week.

In light of differing opinions in the region on the implications of that operation on juveniles, adults and water quality, as well as performance testing underway at Bonneville, Baus said the Action Agencies are not prepared to implement the request for a special Bonneville operation for juvenile passage. Bettin reported that Bonneville unit 11 is returning to service tomorrow, which will help alleviate passage problems. The current rate of juvenile descaling is 4-5% compared to an expected rate of 1-2%, so descaling is higher than it should be, Wagner said. Mortality is not an issue.

The Action Agencies will review available data and coordinate further with the region regarding the operation of Bonneville powerhouse 2 at the mid-point and powerhouse 1 at open geometry.

b. Fish. Adults: Summer chinook have been arriving at Bonneville at the rate of 2200 per day, with a total season count of 38,000 which is good, Wagner reported. However summer chinook jack counts are only 50% of the 10 year average. The causes behind the lack of jack returns in spring and summer are unknown. Sockeye have been arriving at the rate of 19,000 per day with a total season count of 96,000 to date, which is phenomenal – 400% of the 10 year average. Snake River steelhead passage is increasing. Lower Granite spring chinook counts are at 6,847 to date, which is close to the 10 year average.

Juveniles: Yearling chinook passage is on the wane, while subyearling passage is active – 17,000 per day at Lower Granite and Little Goose, 40,000 per day at Lower Monumental, 19,000 per day at Bonneville, and 30,000 per day at McNary. The next few weeks are prime time for subyearling passage.

Adult lamprey passage has been noteworthy, with 5,400 to date arriving at Bonneville – about double last year's total adult lamprey count. Lorz will get clarification on whether that's just lamprey observed through the fish ladder windows or using more sophisticated methods.

c. Water Quality. Scott English, COE, reported that systemwide TDG levels have been high but manageable. Bonneville and McNary have posed the greatest challenges. The previously inundated water quality monitoring station in the Bonneville tailrace has been restored to service. English will give TMT a presentation on the latest findings regarding TDG management in the Bonneville tailrace. He reported that performance testing of summer operations at Bonneville began on June 16 with 95 kcfs constant flows, dropping to 85 kcfs flows during daytime. The gas cap at Bonneville is now 121 kcfs at night, but spill levels reached 189 kcfs yesterday, Laura Hamilton, COE, reported.

d. Power System. As reported under Libby operations today, there have been transmission problems in the Flat Head Valley.

6. Next TMT Meeting

There will be a TMT conference call on July 11 to focus on temperature management at Dworshak. The next regular TMT meeting will be July 18. That agenda will include updates on Bonneville operations, Columbia treaty fisheries, Libby operations, Dworshak temperature management, and a presentation on water quality management in the Bonneville tailrace.

Name	Affiliation
Jim Litchfield	Montana
Robyn MacKay	BPA
Doug Baus	COE
Russ Kiefer	Idaho
Paul Wagner	NOAA

Scott Reed	BPA
Scott Bettin	BPA
Kim Johnson	COE
Steve Barton	BPA
Steve Hall	COE Walla Walla
Kevin Heitstuman	COE Walla Walla
Karl Kanbergs	COE
Laura Hamilton	COE
Lisa Wright	COE
Dan Feil	COE
Tom Lorz	CRITFC/Umatilla

Phone:

John Roache	BOR
Stu Leavitt	Salish Kootenai
Dan Folz	Snohomish
Russ George	WMC
Barry Espenson	CBB
Jay Finch	Chelan
Don Tinker	SCL
Bruce McKay	hydro consultant
Richelle Beck	Grant PUD
Holly Krebs	Chelan
Denny Rohr	DRA
Cindy LeFleur	Washington
Sheri Sears	Colville
Shane Scott	PPC



COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION

729 NE Oregon, Suite 200, Portland, Oregon 97232

Telephone 503 238 0667

Fax 503 235 4228

SYSTEM OPERATIONAL REQUEST: 2012 C-1

TO:	Brigadier General McMahon	COE-NWD
	James D. Barton	COE-NWD-NP-Water Management
	Karl Kanbergs, Douglas Baus	COE-NWD-NP-WM-RCC
	D. Feil, R. Peters, D. Ponganis	COE-NWD-PDD (Fish Management Office)
	Col. Steven R. Miles	COE-Portland District
	JR Inglis/Paul Cloutier	COE-Portland District/NWD (Tribal Liaison)
	Karl Wirkus	USBR- PNW Regional Director
	Steven J. Wright	BPA Administrator
	Steve Oliver, Greg Delwiche	BPA-PG-5
	Scott Bettin, Tony Norris	BPA-Operations Planning-PGPO
	Stan Speaks, Keith Hatch	BIA, Northwest Regional Office

FROM: Babtist Paul Lumley, *Executive Director*

DATE: June 14, 2012

SUBJECT: **Operation of the Lower Columbia Pools for the Summer 2012 Treaty Fishery**

The Columbia River Inter-Tribal Fish Commission, on behalf of its members, the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Nation, requests the following reservoir operations in "Zone 6" (Bonneville to McNary dams) during the summer 2012 Treaty fishery. This effort supports the 2012 ceremonial, subsistence, and commercial Treaty fishery times as established by the tribes and the Columbia River Compact.

SPECIFICATIONS: Implement the following pool operations as a hard system constraint, as follows:

June 18, 2012, 6 am, Monday, through 6 pm, June 21, 2012, Thursday.

June 25, 2012, 6 am, Monday, through 6 pm, June 28, 2012, Thursday.

Bonneville: Operate the pool within a 1.5 foot band during the treaty fishing period.

The Dalles (Celilo): Operate the pool within a 1.5 foot band during the treaty fishing period

John Day: Operate the pool within a 1.5 foot band during the treaty fishing period.

JUSTIFICATION:

The 2012 summer treaty fishing season is of critical importance to CRITFC's member tribes. The escapement of an estimated of **80,400** (Columbia at Bonneville Dam) adult summer Upper Columbia Chinook and **460,000** sockeye will create harvest opportunities for tribal fishers who will exercise their treaty rights by participating in this harvest using platform and gillnet fishing methods. This harvest will provide for the cultural, religious, and economic needs of the treaty tribes.

CRITFC will sponsor net flights each week to count the nets in each Zone 6 pool. The survey data will be shared with COE-RCC staff by early afternoon of the flight day.

Achieving good river conditions through managed river operations during the treaty fishery have been the basis of past litigation that have been supported by federal courts and are consistent with the trust and fiduciary responsibilities that the federal operators have with respect to CRITFC's member tribes. Good river conditions during the treaty fishery are also consistent with the spirit of the 10-year Memorandum of Agreements signed by tribal and Corps, BPA, and BOR officials.

In past meetings with Corps officials, tribal fishers have explained that a pool fluctuation of more than 1.5 foot disrupts tribal fishery operations. Specific problems include: (1) increased local currents that sweep debris into fishing nets, (2) rapid 1-2 hour drops in water level will lead to entanglement of nets or change local currents that affect fishing success, (3) boat access problems, and (4) nets torn from their anchors if pools are raised after nets are set. Nets and gear are costly to replace and may become "ghost nets" that continue to catch fish and may negatively affect fish populations outside of the treaty fishing period.

Any delays or disruptions to tribal fishing operations caused by the excessive pool fluctuations in Zone 6 can negatively impact tribal incomes, food resources and cultural practices. Much of the tribal fishers' annual income and food is generated during the brief treaty fishing season. The fishers have expressed to Corps officials that the loss of fishing opportunity during the extremely limited treaty fishery period cannot be replaced.

If this SOR cannot be accommodated, CRITFC requests a verbal response with an explanation from the federal operators by COB, Friday June 15, 2012. Thank you for considering this request. Please contact Kyle Dittmer or Stuart Ellis should you have any questions at (503) 238-0667.

cc: Tribal staffs and attorneys

DRAFT SUMMER SPILL PRIORITY LIST

Prepared 6/15/12

For use from 0001 hours June 21 through 2400 hours July 20 to prioritize spill at projects with no summer performance standard test (LWG and IHR). A new spill priority list may be coordinated after all performance standard testing for 2012 is complete.

LEVEL 0 – FOP Summer Spill Rates (<i>priority order does not apply</i>)		
PRIORITY ORDER	PROJECT	FOP Summer Spill Rate
n/a	LWG (no test)	18 kcfs
n/a	LGS	30%
n/a	LMN	17 kcfs
n/a	IHR (no test)	June 21-July 13: 30% vs. 45 kcfs day/TDG cap night July 13-Aug 31: 45 kcfs day/TDG cap night
n/a	MCN	50%
n/a	JDA	July 1-July 20: 30% vs. 40% July 20-Aug 31: 30%
n/a	TDA	40%
n/a	BON	June 16-July 20: 85 kcfs day/ 121 kcfs night vs. 95 kcfs July 21-Aug 31: 75 kcfs day/TDG cap night

If necessary to spill in excess of the FOP summer spill rates due to lack of load, the Action Agencies will incrementally increase spill at projects in the following priority order. The Spill Priority List is intended to manage TDG levels on a system-wide basis while prioritizing extra spill in a manner that provides the most benefit to fish passage without negatively impacting ongoing BiOp performance testing. *The order of the eight fish passage projects will be adaptively managed in-season based on feedback and recommendations from the Salmon Managers through TMT.*

LEVEL 1 – FISH PASSAGE SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
01	LWG	120/115% ^a	41
02	IHR	120/115% ^a	92
03	LGS	120/115% ^a	35
04	MCN	120/115% ^a	145
05	JDA	120/115% ^a	140
06	TDA	120/115% ^a	128
07	BON	120/115% ^a	100
08	LMN	120/115% ^a	24
09	CHJ	110%	15
10	GCL	110%	5
11	DWR	110%	35% ~ 3

a. Fish passage spill cap = 120% TDG in the tailrace OR 115% in the forebay of the next downstream project.

LEVEL 2 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
12	CHJ	115%	70
13	GCL	115%	20
14	LWG	120%	55
15	IHR	120%	90
16	CHJ	120%	110
17	GCL	120%	25
18	LGS	120%	52
19	MCN	120%	190
20	JDA	120%	165
21	TDA	120%	142
22	BON	120%	118
23	LMN	120%	72

LEVEL 3 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
24	LWG	122%	60
25	IHR	122%	95
26	LGS	122%	59
27	MCN	122%	225
28	JDA	122%	178
29	TDA	122%	155
30	BON	122%	130
31	LMN	122%	75
32	CHJ	122%	150
33	GCL	122%	50

LEVEL 4 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
34	LWG	125%	70
35	IHR	125%	110
36	LGS	125%	82
37	MCN	125%	230
38	JDA	125%	190
39	TDA	125%	269
40	BON	125%	170
41	LMN	125%	80
42	CHJ	125%	190
43	GCL	125%	75

LEVEL 5 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
44	LWG	127%	85
45	IHR	127%	124
46	LGS	127%	95
47	MCN	127%	280
48	JDA	127%	206
49	TDA	127%	294
50	BON	127%	234
51	LMN	127%	120
52	CHJ	127%	190
53	GCL	127%	93

LEVEL 6 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
53	LWG	130%	90
54	IHR	130%	145
55	LGS	130%	125
56	MCN	130%	321
57	JDA	130%	250
58	TDA	130%	360
59	BON	130%	250
60	LMN	130%	180
61	CHJ	130%	190
62	GCL	130%	120

LEVEL 7 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
63	LWG	135%	200
64	IHR	135%	240
65	LGS	135%	177
66	MCN	135%	375
67	JDA	135%	300
68	TDA	135%	400
69	BON	135%	300
70	LMN	135%	250
71	CHJ	135%	190
72	GCL	135%	130

SUMMER SPILL PRIORITY LIST

6/20/12

As coordinated at the TMT meeting on June 20, the below Summer Spill Priority List will take effect on June 20 to prioritize spill at projects with no summer performance standard test (LWG and IHR). A new spill priority list may be coordinated after all performance standard testing for 2012 is complete.

If necessary to spill in excess of the FOP summer spill rates due to lack of load, the Action Agencies will incrementally increase spill at projects in the following priority order. The Spill Priority List is intended to manage TDG levels on a system-wide basis while prioritizing extra spill in a manner that provides the most benefit to fish passage without negatively impacting ongoing BiOp performance testing.

FOP Summer Spill Rates (priority order does not apply)		
PRIORITY ORDER	PROJECT	FOP Summer Spill Rate
n/a	LWG (no test)	18 kcfs
n/a	LGS	30%
n/a	LMN	17 kcfs
n/a	IHR (no test)	June 21-July 13: 30% vs. 45 kcfs day/TDG cap night July 13-Aug 31: 45 kcfs day/TDG cap night
n/a	MCN	50%
n/a	JDA	July 1-July 20: 30% vs. 40% July 20-Aug 31: 30%
n/a	TDA	40%
n/a	BON	June 16-July 20: 85 kcfs day/ 121 kcfs night vs. 95 kcfs July 21-Aug 31: 75 kcfs day/TDG cap night

LEVEL 1 – FISH PASSAGE SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFs)
01	LWG	120/115% ^a	41
02	IHR	120/115% ^a	92
03	LGS	120/115% ^a	35
04	BON	120/115% ^a	100
05	MCN	120/115% ^a	145
06	JDA	120/115% ^a	140
07	TDA	120/115% ^a	128
08	LMN	120/115% ^a	24
09	CHJ	110%	15
10	GCL	110%	5
11	DWR	110%	~ 3 (35%)

a. Fish passage spill cap = 120% TDG in the tailrace OR 115% in the forebay of the next downstream project.

LEVEL 2 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
12	LWG	120%	55
13	IHR	120%	90
14	LGS	120%	52
15	BON	120%	190
16	MCN	120%	165
17	JDA	120%	142
18	TDA	120%	118
19	LMN	120%	72
20	CHJ	115%	70
21	GCL	115%	20
22	CHJ	120%	110
23	GCL	120%	25

LEVEL 3 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
24	LWG	122%	60
25	IHR	122%	95
26	LGS	122%	59
27	BON	122%	130
28	MCN	122%	225
29	JDA	122%	178
30	TDA	122%	155
31	LMN	122%	75
32	CHJ	122%	150
33	GCL	122%	50

LEVELS 4-7 (125%, 127%, 130%, and 135% TDG, respectively) LACK OF LOAD SPILL CAP: Same project Priority Order as in Level 3.

COLUMBIA RIVER TECHNICAL MANAGEMENT TEAM

June 20, 2012

Facilitator's Summary

Facilitator: Robin Gumpert

The following notes are a summary of issues that are intended to point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members.

Review June 6 and June 13 Meeting Minutes

With no comments, both sets of Official Meeting Minutes and Facilitator's Notes were approved as final.

Spill Priority List

Doug Baus, Corps, reported that with the system transitioning in to Summer spill operations, the action agencies developed a spill priority list that would support their ability to do performance standard testing and manage system wide TDG. This version of the spill priority list was linked to the agenda item and viewed at the meeting. He provided more detail about the specific changes that were made, and turned to the salmon managers to hear their input. Paul Wagner, NOAA, on behalf of FPAC said the salmon managers provided an alternative list that they believed would better place the priority of excess spill at the location of fish passage during this Summer period. With that, Doug shared a revised spill priority list (not yet posted during this discussion) that tried to meet the recommendations of the salmon managers and the action agencies' need to meet performance standard testing. The one exception to the salmon managers' recommendation was that Lower Monumental was placed lower on the list to allow more flexibility to meet the conditions of the performance standard test, which had already been initiated at that project. There was also some discussion about the high flows in the system and likelihood that the action agencies would have to implement at least Level 1 of this spill priority list.

Action/Next Steps: TMT members were willing to accept the revised spill priority list described in today's meeting, and as such, the Corps planned to put this list in place immediately and through July 20 when performance standard testing ends. This updated list will be posted to today's TMT agenda and the order for Level 1 and Level 2 is as follows:

LEVEL 1 – FISH PASSAGE SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
01	LWG	120/115% ^a	41
02	IHR	120/115% ^a	92
03	LGS	120/115% ^a	35
04	BON	120/115% ^a	100
05	MCN	120/115% ^a	145
06	JDA	120/115% ^a	140
07	TDA	120/115% ^a	128
08	LMN	120/115% ^a	24
09	CHJ	110%	15
10	GCL	110%	5
11	DWR	110%	~ 3 (35%)

LEVEL 2 – LACK OF LOAD SPILL CAP			
PRIORITY ORDER	PROJECT	SPILL UP TO (% TDG):	SPILL CAP ESTIMATE (KCFS)
12	LWG	120%	55
13	IHR	120%	90
14	LGS	120%	52
15	BON	120%	190
16	MCN	120%	165
17	JDA	120%	142
18	TDA	120%	118
19	LMN	120%	72
20	CHJ	115%	70
21	GCL	115%	20
22	CHJ	120%	110
23	GCL	120%	25

The salmon managers thanked the Corps for the opportunity to provide feedback on the list, and the willingness to make adjustments to balance all needs. The Corps likewise appreciated receiving the salmon managers' input with enough lead time to coordinate the adjustments.

Lower Columbia Pool Operations for Summer Treaty Fishery

Tom Lorz, CRITFC/CTUIR, presented SOR 2012-C1 requesting special operations to support treaty fishing during the periods 6/18-6/21 and 6/25-6/28. As in the past, the Corps agreed to implement this operation to the extent possible. Tom will follow up in two weeks with a report and possibly new request for continuing the fishery.

Grand Coulee Refill

John Roache, Reclamation, reported that high flows are expected to continue through the first week of July, and so Grand Coulee was expected to reach refill sometime between the end of June and July 4th. The current project elevation was 1281.8'. John acknowledged that the high flows would most likely not allow the agency much flexibility this year to meet the interests of holiday recreationists who would like a lower reservoir elevation for beach access.

Upper Snake Flow Augmentation

John Roache also reported on Upper Snake flow augmentation, saying the full 487 kaf will be released this year. Releases above Milner began on 6/7 and will continue in to July, totaling approximately 207 kaf; releases out of Boise began on 6/5 and will continue in to July totaling approx. 42 kaf; the Payette releases will begin in late June and continue in to August, totaling approx. 160 kaf; and the rest, about 78 kaf, will come from natural flow.

Dworshak Operations

Steve Hall, Corps Walla Walla District, reported on final refill operations at Dworshak and shared inflow models going in to July. A 6/8 snow flight observed higher than expected, 8% remaining snow pack. Currently the project was releasing 11 kcfs and would ramp down to about 7.5 kcfs over the weekend; then further to about 5 kcfs through the week of 7/4, until the project is full. Summer augmentation discharges will begin around 7/10, depending on temperatures.

Steve also shared the latest temperature modeling runs and said Lower Granite temperatures, currently around 57° F (similar to recent years), should stay cool through the end of June so no need for temperature augmentation flows from Dworshak. The hatchery has asked the Corps to increase release temperatures out of Dworshak up to 45°, which the Corps will do as soon as flows subside enough for them to make the switch in to overshoot mode at the project. They plan to run weekly temperature models.

Steve introduced temperature modeler Evan Heisman and said he has done a lot of work on modeling improvements. Steve also reported that repairs had been done to fix leaky turbines at the project, and so the Corps did not anticipate any issues this year. A more permanent fix is scheduled to begin in 2013/2014.

Libby Operations

Doug Baus, Corps, reported that Libby discharges were currently 31.2 kcfs and Libby discharges were being managed to within one foot of flood stage at Bonners Ferry. Robyn McKay, BPA, added that BPA had to back down 10 megawatts on 6/19 and 20 megawatts on 6/15-16 at Libby and Hungry Horse to address low load issues in Flathead Valley – emergencies were declared because they disrupted the sturgeon operation, but the total flow disruption at the projects was minimal. It was reported that preliminary data shows 7 sturgeon have moved above Bonners Ferry; crews will know more and be able to recover them once the flows recede.

Action: Doug Baus will ask Joel Fenolio, Seattle District Corps, to provide model runs for Libby Summer operations at the next TMT meeting. The plan is to target elevation 2449' by the end of August.

Operations Review

Reservoirs – John Roache reported on Reclamation projects. Grand Coulee was at elevation 1281.8 feet and filling. Hungry Horse was at elevation 3558.1 feet with 12.5 kcfs outflows and about 20 kcfs inflows – runoff and precipitation are high, with precipitation for June at 200% of normal. Lisa Wright reported on Corps projects. Libby was at elevation 2446.6 feet, with 65.4 kcfs inflows and 29.7 kcfs outflows. Albeni Falls was at elevation 2061.4 feet with 84.9 kcfs inflows and 88.7 kcfs outflows. Priest Rapids inflows were 241.5 kcfs. Dworshak elevation was

1597.7 feet, with 15.1 kcfs inflows and 11 kcfs outflows. Lower Granite inflows were 92.1 kcfs and Bonneville inflows were 355.4 kcfs.

Doug Baus reported that the special operation at Bonneville to minimize descaling of sockeye had concluded on 6/13. Also, as follow up to the 6/13 TMT conference call, he shared that summer spill operations at Lower Monumental would begin on 6/21 since agreement on an earlier start date was not reached..

Tom Lorz, CRITFC/CTUIR, reported that a large subyearling Chinook run is expected to reach Bonneville very soon and there is concern for descaling at Bonneville given the unique high flow conditions and fish screens remaining in at Bonneville. Tom requested that the action agencies implement the special operation provided for sockeye, now for subyearling Chinook, beginning tomorrow, 6/21, and continuing through Monday evening 6/25. The Corps responded there had been a wide range of variability in percent descaling and mortality in juveniles during previous operations limiting PH2 to the mid-point (50%) of the 1% of best efficiency operating range. Based on the wide range of variability in mortality and descaling rates it has been unclear that the effects of implementing the special operation at PH2 provided any benefit to juvenile sockeye that passed through PH2. Furthermore, this operational change request would be taking place during performance standard testing at Bonneville Dam. Implementing this change would modify PH2 and PH1 operations during performance standard testing and would be a significant change from the current Bonneville Dam operation as identified in the FPP. Accordingly, the AAs need additional regional coordination before implementing this change. That said, Doug indicated that FPOM discussed this issue at the last meeting and set up a special task group to continue work on this issue. Doug committed to completing additional coordination and following up with Lorz prior to the next TMT with the goal of having a path forward to address Tom's concern. Scott Bettin, BPA, added that Unit 11 was expected to come back on line tomorrow and this would give the project more capacity.

Fish – Paul Wagner, NOAA, reported on the fish. Adult summer Chinook were passing about 2,200/day at Bonneville, with a total 38,000 so far. This lined up with the 10-year average. Jacks counts, on the other hand, were falling short by about ½ of the 10 year average so far. Sockeye numbers were very high, totaling 96,000 at Bonneville. Steelhead numbers were picking up. On the Snake, from 3/1 to 6/17, 66,366 spring Chinook had passed Lower Granite, and this was close to the 10-year average. Jack counts were low. Russ Kiefer, Idaho, reported that 4 PIT-tagged sockeye from Stanley Basin were counted at Bonneville. Lamprey adult counts were 5,461 at Bonneville, well ahead of 2011 counts. FPAC received a report that there were issues with the adult lamprey counts and only those observed through the observation window were being counted, so the actual is probably higher than the observed total.

Juvenile yearling Chinook counts were low, but subyearling numbers were high – ranging from 17,000 to 40,000 at the Lower Snake projects; about 30,000 at McNary and 19,000 at Bonneville.

Water quality – Scott English, Corps, reported that TDG was high but manageable in the system and also said the tailwater gauge at Bonneville was back on line. If desired, Scott said he would prepare a presentation for TMT on the problem and solutions to the failed water quality gauge.

Power system – Nothing more to report.

TMT Schedule

June 27 Agenda items include –

- Libby Summer Operations – model runs
- Bonneville Operations Report
- Treaty Fishery Update
- Dworshak Operations – temperature modeling
- Water quality gauge report
- Other?

July 11 Agenda items include –

- July Final Water Supply Forecasts
- Dworshak Operations
- Libby Operations
- Other?

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM – OFFICIAL MINUTES

June 20, 2012

Notes: Pat Vivian

1. Introduction

Today's TMT meeting was chaired by Doug Baus, COE, and facilitated by Robin Gumpert, DS Consulting. Representatives of Montana, BPA, COE, Idaho, NOAA, CRITFC/Umatilla Tribe, BOR, Salish-Kootenai Tribes, Washington, the Colville Tribe and others attended. This summary is an official record of the proceedings, not a verbatim transcript.

2. Review June 6 and 13 Meeting Minutes

The facilitator's notes and official minutes for June 6 and 13 were approved as final.

3. Spill Priority List

On June 18, the COE posted to the TMT website a preliminary draft of the spill priority list that reflects the transition from spring spill to summer operations and is consistent with performance testing, Baus reported. The Action Agencies aim is to deemphasize spill in excess of summer spill rates as defined in the 2012 Fish Operations Plan (FOP) that arise during lack of load conditions at projects where performance testing is taking place.

Paul Wagner, NOAA, suggested a direct comparison of the changes from spring to summer spill priorities by comparing the draft list posted to today's TMT agenda with the list for spring posted to the April 11 agenda, which he considered an effective prioritization of involuntary spill at projects.

Level 1 (up to the 120/115% TDG cap at fish passage projects) spill priority order, per the draft list posted today, has Lower Granite and Ice Harbor in positions #1 and #2, respectively, which is the same as in spring since both projects do not have performance standard testing in spring or summer this year, Baus said. Those two projects are followed by Little Goose, McNary, John Day, The Dalles, Bonneville, Lower Monumental, Chief Joseph, Grand Coulee and Dworshak in that order. Lower Monumental is lower on the list than it was in spring due to performance testing now underway. The summer draft list adds Dworshak and Grand Coulee up to 110% TDG (neither project has state TDG waivers). For the sake of system wide TDG management, Level 2 summer spill for lack of load conditions includes Chief Joseph and Grand Coulee at the 115% and 120% TDG levels.

Wagner said the Salmon Managers would prefer to move Lower Monumental up from position #8 to #4 at Level 1 spill, and Bonneville up to position #5 at Level 1 spill. Level 2 spill priorities for lack of load would remain the same as in the Action Agency proposal, except the Salmon Managers would move Chief Joseph and Grand Coulee to the bottom of the list. The rationale behind this recommendation is to spill first up to TDG state standards at projects where the spill could provide fish benefits before spilling exceeding the state TDG standards at projects with no fish passage.

Baus then showed TMT a revised draft spill priority list, which incorporated feedback received yesterday from FPAC after they reviewed the Corps' draft. The revised list had not yet been posted to the TMT agenda as of this meeting and will be posted there this afternoon.

For Level 1 spill, FPAC had recommended the following order: Lower Granite, Ice Harbor, Little Goose, Lower Monumental, Bonneville, McNary, John Day and The Dalles up to the 120/115% TDG caps (in the tailrace and forebay of the next downstream project, respectively), and ending with Chief Joseph, Grand Coulee and Dworshak up to the 110% TDG cap. In the revised list, the Action Agencies have adopted the recommendations for Level 1 spill with the exception of Lower Monumental, which remains in position #8 to increase the likelihood of achieving a successful summer performance test which is already currently underway. The Action Agencies also adopted the recommendation to place Chief Joseph and Grand Coulee at the bottom of the Level 2 list. It was clarified that the two dams would both spill to 115% TDG in a stepwise approach before either spills to 120% TDG. The revised order of priority for Level 2 spill is as follows: Lower Granite, Ice Harbor, Little Goose, Bonneville, McNary, John Day, The Dalles, Lower Monumental, Chief Joseph, Grand Coulee and Dworshak.

Russ Kiefer, Idaho, questioned why the summer performance test at Lower Monumental would be considered higher priority than testing at other projects. Tom Lorz, CRITFC/Umatilla, commented that the performance test at Lower Monumental should represent a range of operations that might reasonably occur over the next 5-10 years, not a special operation for performance testing. Wagner commented that the amount of inflows coming is likely to make the position of Lower Monumental in Level 1 a moot point, as all projects on the list will likely have to spill up to this level due to the high flows.

Kiefer proposed moving Lower Monumental up to position #4 for Level 1 spill and leaving it at position #8 for Level 2 spill. Baus replied that testing time has already been lost at Lower Monumental due to involuntary spill, and the COE is making best efforts to put spill at other projects where there may be more flexibility. The placement of Lower Monumental at the bottom of the list for Level 1 spill reflects the fact that the summer spill treatment has not yet been attainable there, and performance testing is scheduled to end July 20.

CRITFC/Umatilla was willing to accept the spill priority list as revised by the Action Agencies in response to Salmon Manager recommendations. **Idaho** was likewise willing to accept the revised list. The Action Agencies will implement that list later today.

4. Operation of the Lower Columbia Pools for Summer 2012 Treaty Fishery

Tom Lorz, CRITFC, presented SOR 2012-C1, linked to this item on today's agenda. The SOR, presented on June 14, calls for two treaty fisheries:

- 6 am, June 18 – 6 pm, June 21
- 6 am, June 25 – 6 pm, June 28

The SOR calls for Bonneville, John Day and The Dalles pools to be managed within a 1.5-foot band during these hours. Baus reported that the COE has already provided guidance to the projects to implement the operation as requested.

Lorz will report back to TMT on planning for any further fisheries and will provide catch data when it is available.

5. Grand Coulee Refill

John Roache, BOR, reported. Typically the BOR manages flows so that beaches are available at Lake Roosevelt over the July 4 weekend, but high inflows this year mean that Grand Coulee is expected to fill around July 4. The current reservoir elevation is 1281.8 feet, and the project is slowly filling.

6. Upper Snake River Flow Augmentation

The BOR expects to provide 487 KAF of flow augmentation from the upper Snake River this year, Roache reported. Augmentation flows began June 7 and are expected to continue until mid July. Estimated volumes are as follows:

207 KAF – Upper Snake River above Milner
42 KAF – Boise basin
160 KAF – Payette basin
+78 KAF – natural flows
487 KAF – total flow augmentation

7. Dworshak Operations

Steve Hall, COE, reported on Dworshak final refill preparations. Two slides attached to today's agenda depicting inflow and temperature conditions at Dworshak. Inflows over the past few days have been substantial. The first slide depicts flow and elevation projections through July. On June 14, a snow flight

found about 8% snow covered area, which means there is less snow in the basin than expected. With the reservoir 2 feet from full now, inflows are expected to decline. Current outflows are 11 kcfs, expected to drop to 7.5 kcfs this weekend due to lower inflows. After that, releases will drop down to 5 kcfs until the reservoir is topped off at 1600 feet elevation, probably through July 4. Summer flow augmentation will begin around July 10 depending on temperatures.

Currently Lower Granite temperatures are around 57 degrees F, with the reservoir expected to remain cool through the end of June. Dworshak temperatures are currently around 43 degrees F. Next week's model run will include the July 4 holiday and is not expected to involve a need for temperature augmentation. As soon as possible, the COE will raise Dworshak reservoir temperatures to 45 F in response to a request from the Dworshak hatchery.

Kiefer asked about Lower Granite temperatures. Hall replied that temperature model runs indicate that conditions this year will be similar to the past few years. No special turbine operations are envisioned. Last year's repair of the leaking head seal at Dworshak was apparently successful. The head cover seal on the unit still needs to be rebuilt, but that repair will be scheduled a few years out (2013 or 2014) between September and March, when fish are not migrating.

Hall said current projections show 2012 will be a relatively high inflow year, but not as high as 2010. Similar years are 1959 and 1991. With Lower Granite tailwater currently at 57 degrees F and slowly warming, it will be a good 10 days before it approaches 65 degrees F, triggering temperature augmentation flows. The COE will provide updated temperature model runs for each TMT meeting throughout the remainder of fish passage season.

8. Libby Operations

Libby is currently releasing 31.2 kcfs, managing Bonner's Ferry within a foot of flood stage, Baus reported. Robyn MacKay, BPA, reported on recent transmission emergencies in the Flat Head Valley. The area has been experiencing higher generation than load especially during light load hours at night. This means generation at Libby, Hungry Horse or both dams must be cut back. Last night, Flat Head Valley generation was reduced by 10 MW. On June 15-16, generation was reduced by 20 MW, which is equivalent to about 0.5 kcfs at each project. Transmission emergencies were declared in light of the sturgeon spill operation at Libby.

MacKay said load and generation imbalances will continue to be a problem, primarily at night, until flows decline or loads pick up for warmer weather. The sturgeon operation has had its ups and downs as a result of the power emergencies and flood stage management at Bonner's Ferry. Scott Bettin, BPA, reported that 7 sturgeon, 4 of them females, have moved to the area above

Bonner's Ferry. High flows have made the area inaccessible for data collection. When flows go down, USFWS and Idaho will report on the sturgeon operation.

Jim Litchfield, Montana, asked about the status of summer operations at Libby in light of high inflows. The RFC water supply forecast is about a MAF higher than the official COE forecast for Libby, Karl Kanbergs, COE, replied. Recent storms in the area have added volume to the high flows.

9. Operations Review

a. Reservoirs. Grand Coulee is at elevation 1281.8 feet, expected to fill after June 30. Hungry Horse is at elevation 3558.1 feet, with outflows of 12.5 kcfs which are expected to continue. Precipitation in the Flat Head Valley was 220% of normal in the first 20 days of June. Inflows at Hungry Horse are now around 20 kcfs. Roache will notify TMT via email if the "glory hole" is pressed into service to handle the high volume.

Libby is at elevation 2446.6 feet, with inflows of 65.4 kcfs and releases of 29.7 kcfs. Albeni Falls is at elevation 2061.4 feet with inflows of 84.9 kcfs and releases of 88.7 kcfs. Dworshak is at elevation 1597.7 with inflows of 15.1 kcfs and releases of 11 kcfs. Priest Rapids inflows are 241.5 kcfs. Lower Granite inflows are 92.1 kcfs. Bonneville inflows are 355.4 kcfs.

The change to summer spill operations at Lower Monumental will begin on June 21 as identified in the Fish Operations Plan, Baus said. The operation for juvenile sockeye passage at Bonneville ended on June 13.

Lorz reported that 7.8 million subyearlings are expected to arrive at Bonneville next week. Because high flows have been forcing turbine operations toward the upper end of the 1% of best efficiency operating range, and it's unusual to have fish screens in place when flows are this high, he recommended that the sockeye operation to cap powerhouse 2 units to the mid-point (50%) of the 1% range be implemented immediately for a duration of one week.

In light of differing opinions in the region on the implications of that operation on juveniles, adults and water quality, as well as performance testing underway at Bonneville, Baus said the Action Agencies are not prepared to implement the request for a special Bonneville operation for juvenile passage. Bettin reported that Bonneville unit 11 is returning to service tomorrow, which will help alleviate passage problems. The current rate of juvenile descaling is 4-5% compared to an expected rate of 1-2%, so descaling is higher than it should be, Wagner said. Mortality is not an issue.

The Action Agencies will review available data and coordinate further with the region regarding the operation of Bonneville powerhouse 2 at the mid-point and powerhouse 1 at open geometry.

b. Fish. Adults: Summer chinook have been arriving at Bonneville at the rate of 2200 per day, with a total season count of 38,000 which is good, Wagner reported. However summer chinook jack counts are only 50% of the 10 year average. The causes behind the lack of jack returns in spring and summer are unknown. Sockeye have been arriving at the rate of 19,000 per day with a total season count of 96,000 to date, which is phenomenal – 400% of the 10 year average. Snake River steelhead passage is increasing. From 3/1 to 6/17, 66,366 spring Chinook had passed Lower Granite, which is close to the 10 year average.

Juveniles: Yearling chinook passage is on the wane, while subyearling passage is active – 17,000 per day at Lower Granite and Little Goose, 40,000 per day at Lower Monumental, 19,000 per day at Bonneville, and 30,000 per day at McNary. The next few weeks are prime time for subyearling passage.

Adult lamprey passage has been noteworthy, with 5,400 to date arriving at Bonneville – about double last year's total adult lamprey count. Lorz will get clarification on whether that's just lamprey observed through the fish ladder windows or using more sophisticated methods.

c. Water Quality. Scott English, COE, reported that systemwide TDG levels have been high but manageable. Bonneville and McNary have posed the greatest challenges. The previously inundated water quality monitoring station in the Bonneville tailrace has been restored to service. English will give TMT a presentation on the latest findings regarding TDG management in the Bonneville tailrace. He reported that performance testing of summer operations at Bonneville began on June 16 with 95 kcfs constant flows, dropping to 85 kcfs flows during daytime. The gas cap at Bonneville is now 121 kcfs at night, but spill levels reached 189 kcfs yesterday, Laura Hamilton, COE, reported.

d. Power System. As reported under Libby operations today, there have been transmission problems in the Flat Head Valley.

6. Next TMT Meeting

There will be a TMT conference call on July 11 to focus on temperature management at Dworshak. The next regular TMT meeting will be July 18. That agenda will include updates on Bonneville operations, Columbia treaty fisheries, Libby operations, Dworshak temperature management, and a presentation on water quality management in the Bonneville tailrace.

Name	Affiliation
Jim Litchfield	Montana
Robyn MacKay	BPA
Doug Baus	COE
Russ Kiefer	Idaho
Paul Wagner	NOAA

Scott Reed	BPA
Scott Bettin	BPA
Kim Johnson	COE
Steve Barton	BPA
Steve Hall	COE Walla Walla
Kevin Heitstuman	COE Walla Walla
Karl Kanbergs	COE
Laura Hamilton	COE
Lisa Wright	COE
Dan Feil	COE
Tom Lorz	CRITFC/Umatilla

Phone:

John Roache	BOR
Stu Leavitt	Salish Kootenai
Dan Folz	Snohomish
Russ George	WMC
Barry Espenson	CBB
Jay Finch	Chelan
Don Tinker	SCL
Bruce McKay	hydro consultant
Richelle Beck	Grant PUD
Holly Krebs	Chelan
Denny Rohr	DRA
Cindy LeFleur	Washington
Sheri Sears	Colville
Shane Scott	PPC

TECHNICAL MANAGEMENT TEAM

BOR: John Roache / Mary Mellema / Pat McGrane	BPA: Tony Norris / Scott Bettin / Robyn MacKay
NOAA-F: Paul Wagner / Richard Dominique	USFWS: David Wills / Steve Haeseker
OR: Rick Kruger	ID: Russ Kiefer / Pete Hassemer
WDFW: Cindy LeFleur / Charles Morrill	MT: Jim Litchfield / Brian Marotz
Kootenai: Sue Ireland / Billy Barquin	Spokane: Deanne Pavlik-Kunkel / Andy Miller
Colville: Sheri Sears / Steve Smith	Nez Perce: Dave Statler
Umatilla: Tom Lorz (CRITFC)	
COE: Doug Baus / Karl Kanbergs	

TMT MEETING

Wednesday June 27, 2012 9:00am - 12:00pm

1125 N.W. Couch Street, Suite 500, Columbia Room
Portland, Oregon 97209-4142
Map Quest [\[Directions\]](#)

TMT MEETING
Phone Number (877) 336-1274
Access Code 3871669
Security Code 9937

We have had disruptions on the phone because people are not hitting 'mute' after dial in.
Please MUTE your Phone

*All members are encouraged to call Robin Gumpert with any issues or concerns they would like to see addressed.
Please e-mail her at rgumpert@cnmw.net or call her at (503) 248-4703.*

Note: Members of the public are encouraged to refer to the Official Meeting Minutes and the TMT agenda links for information re: discussions and decisions made at TMT. Operational decisions that are made outside a TMT meeting will be reported on at the next scheduled meeting and/or linked to the agenda item of the meeting at which it was discussed, as soon as is reasonably possible.

AGENDA

1. Welcome and Introductions
2. Review June 20 Meeting Minutes
3. Treaty Fishing - Tom Lorz, CRITFC
4. Dworshak Operations - Steve Hall, COE-NWW
5. Operations Review
 - a. Reservoirs
 - b. Fish
 - c. Water Quality

- d. Power System
- 6. Other
 - a. Set agenda and date for next meeting - **July 11, 2012**
 - b. [\[Calendar 2012\]](#)

Questions about the meeting may be referred to:
[Doug Baus](#) at (503) 808-3995