COLUMBIA RIVER REGIONAL FORUM

Technical Management Team
Annual Review of Lessons Learned: 2009

Friday, December 11, 2009
9:00 am - 3:30 pm PST
Portland Services Building
1120 SW Fifth Avenue, 2nd Floor
Conference Room C
Portland, Oregon 97205

AGENDA

Questions about the meeting may be referred to Robin Gumpert or Erin Halton at (503) 248-4703.

Purpose: To provide an opportunity for TMT members and other interested parties to step out of the regular meeting format and review the management decisions and operations of the 2009 season in order to learn lessons that can enhance choices and decision making for 2010.

The timing of agenda items are offered as a guide for the day. Depending on information presented and group dynamics it may compress or expand. Presenters are reminded that their presentations are meant to provide visual cues that spark reflection and discussion, as opposed to a full blown analysis of the issue.

1. **9:00 Welcome, get settled and introductions** - *Donna Silverberg, Facilitator*

2. **9:15 Conditions Review: What were the water, weather and fish conditions that existed throughout the year? How did this year compare to others? Is there something we can learn from this? Is there anything unique that bears sharing?**

   - Weather - *Kyle Dittmer, CRITFC*
     [Summary of Water Year 2009 Weather]
     [WINTER WEATHER 2009 - 2010 FORECAST]
     [Winter 2009 - 2010 Climate Forecast]
   - Water - *Steve Barton, COE*
     [2009 Water Year Runoff, Flow and Water Quality Summary]
   - Ocean Conditions Summary - *Bill Peterson and Bob Emmett, NMFS Science Center*
     [Ocean Conditions and Salmon Productivity]
   - Fish
     1. Juvenile summary - *Paul Wagner, NOAA*
     2. Adult summary - *Cindy LeFleur, WA*

3. [Spring Chinook Adult Migration Timing at Bonneville Dam] - *Brandon R. Chockley, Fish Passage Center*

- Sea Lions - *Robert Stansell, COE*
  [EVALUATION OF SEA LION PREDATION IN THE BONNEVILLE DAM TAILRACE]

- Lessons Learned from the 2009 Conditions Review?

10:30 Break

3. **10:45 <u>Reservoir Operations Review</u>: How effective were the proposed actions (SORs) at achieving desired results? What changes might be necessary to enhance results in the future? How did this year compare to others?**

- Libby Summer Operations - *Joel Fenolio, COE; Brian Marotz, MT*
  [Libby Operations 2009]
- Hungry Horse Operations - *John Roache, BOR*
  [Hungry Horse Operations 2009]
- Grand Coulee Operations - *John Roache, BOR*
  [Grand Coulee Operations 2009]
- Upper Snake Operations - *John Roache, BOR*
  [Upper Snake Flow Augmentation 2009]
- Canadian Operations and Impacts on Columbia River System - *Tony Norris, BPA*
- Dworshak Spring/Summer Operations - *Steve Hall, Walla Walla District COE and Dan Feil, Division, COE*
  [Dworshak Reservoir Regulation 2009]

- Lessons Learned from the 2009 Reservoir Operations Review? Is there more flexibility that TMT could utilize to improve in-season operations?

12:30 <u>Break for Lunch</u>

4. **1:00 <u>Review of Specific Operations</u>: What was learned about specific operations that were requested by TMT members or other regional entities? How effective were these operations in achieving the intended goal? Should they be continued or modified in future years? Why or why not?**

- Dworshak SOR - *Steve Hall, Walla Walla District COE*
  [Dworshak Transition to Refill]
- Juvenile Survival for 2009 - *Bill Muir, NMFS Science Center*
  [Survival of Migrating Salmonid Smolts in the Snake and Lower Columbia Rivers, 2009]
- Fall Chinook Survival for 2009 - *Jerry McCann, Fish Passage Center*
  [Hatchery Subyearling Survival Lower Granite to McNary Dam 1998 to 2009]
- Juvenile fish travel time, transport percentages, and Non-Detected Population: What has Changed? - *Bill Muir, NMFS Science Center*
- Chum Operations - *Paul Wagner, NOAA and Tony Norris, BPA*
  [Annual Review of Chum Spawning Operation]
- Libby 2008 end of December variable draft methodology and 2009 SOR - *Joel Fenolio, Seattle District COE*
  [Libby Dam End of December Variable Draft Target]
- Chief Joseph Spill Deflectors - *Amy Reese, Seattle District COE*
  [Chief Joseph Dam, Spillway Flow Deflector DRAFT Total Dissolved Gas Exchange Assessment]

- Lessons Learned from these specific operations?

5. **3:00 <u>Other Lessons Learned?</u>** Given the review of conditions, decisions and actions throughout the day, what

are the overarching lessons that could impact future work of the TMT? Are there themes that might need further discussion at a future TMT meeting or other regional work group?

6. **3:30 Adjourn**

NOTE: Lunch will be brought in for all participating in or attending the meeting. A $10 contribution is required. **RSVP as soon as possible - and no later than Friday, December 4. Your RSVP is required to guarantee enough food for everyone! To RSVP and to make special food requests (e.g. vegetarian) please email ehalton@cnnw.net or call 503-248-4703 and speak with Erin Halton.**

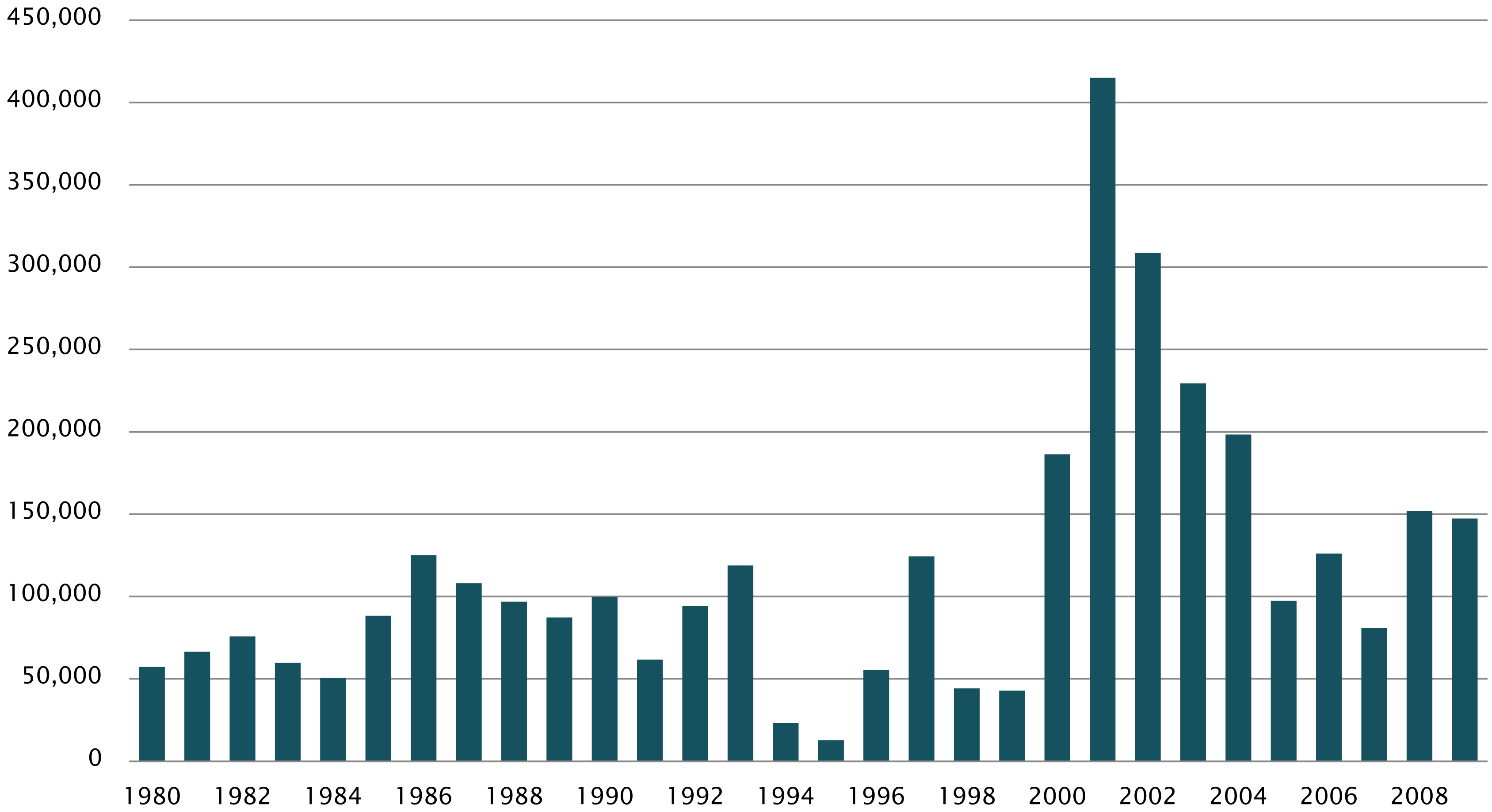
Thank you in advance for your thoughtful participation.

Columbia River Salmon and Steelhead Returns

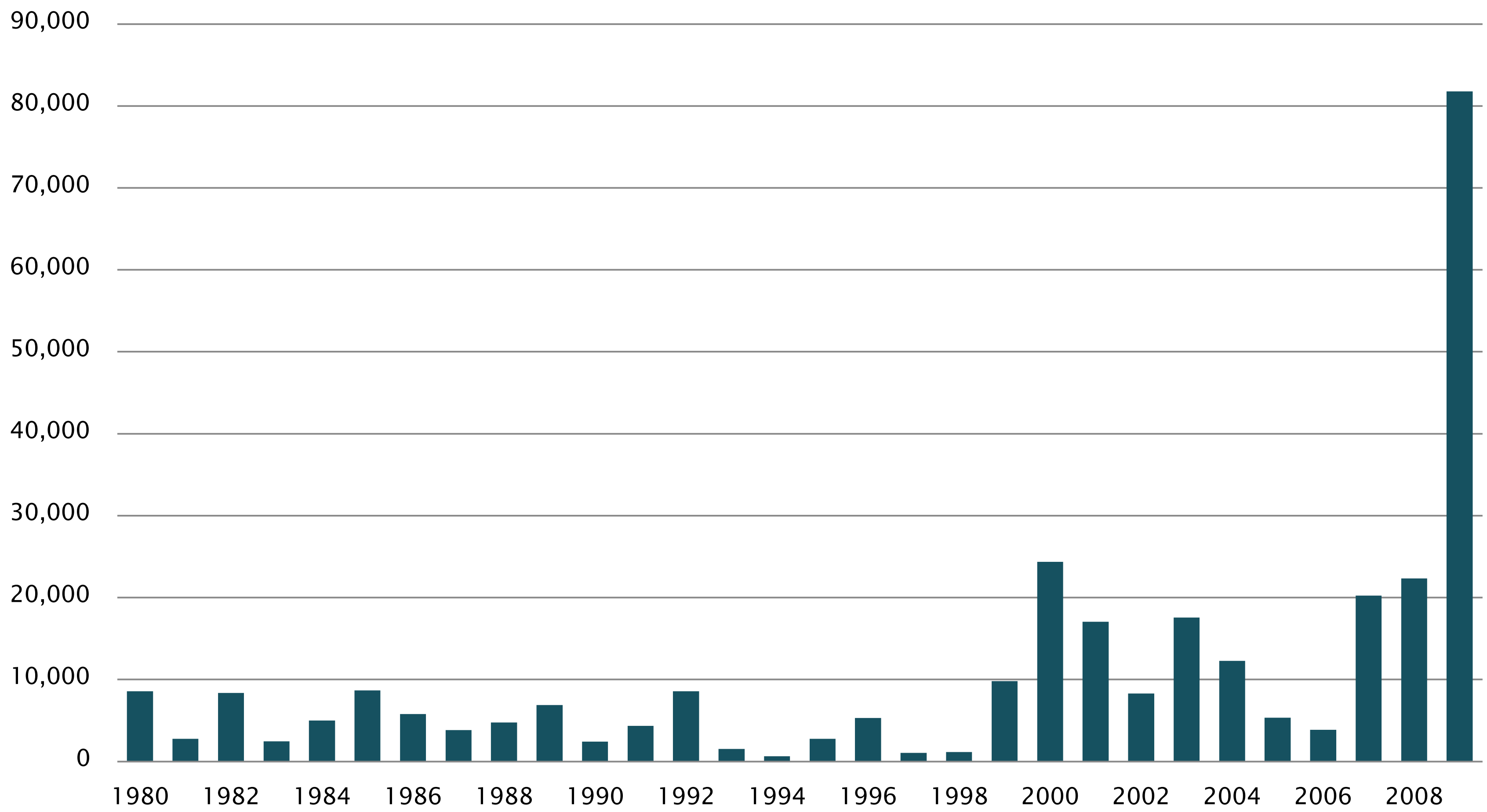
TMT – December 11, 2009

Cindy LeFleur
Washington Department of Fish and Wildlife

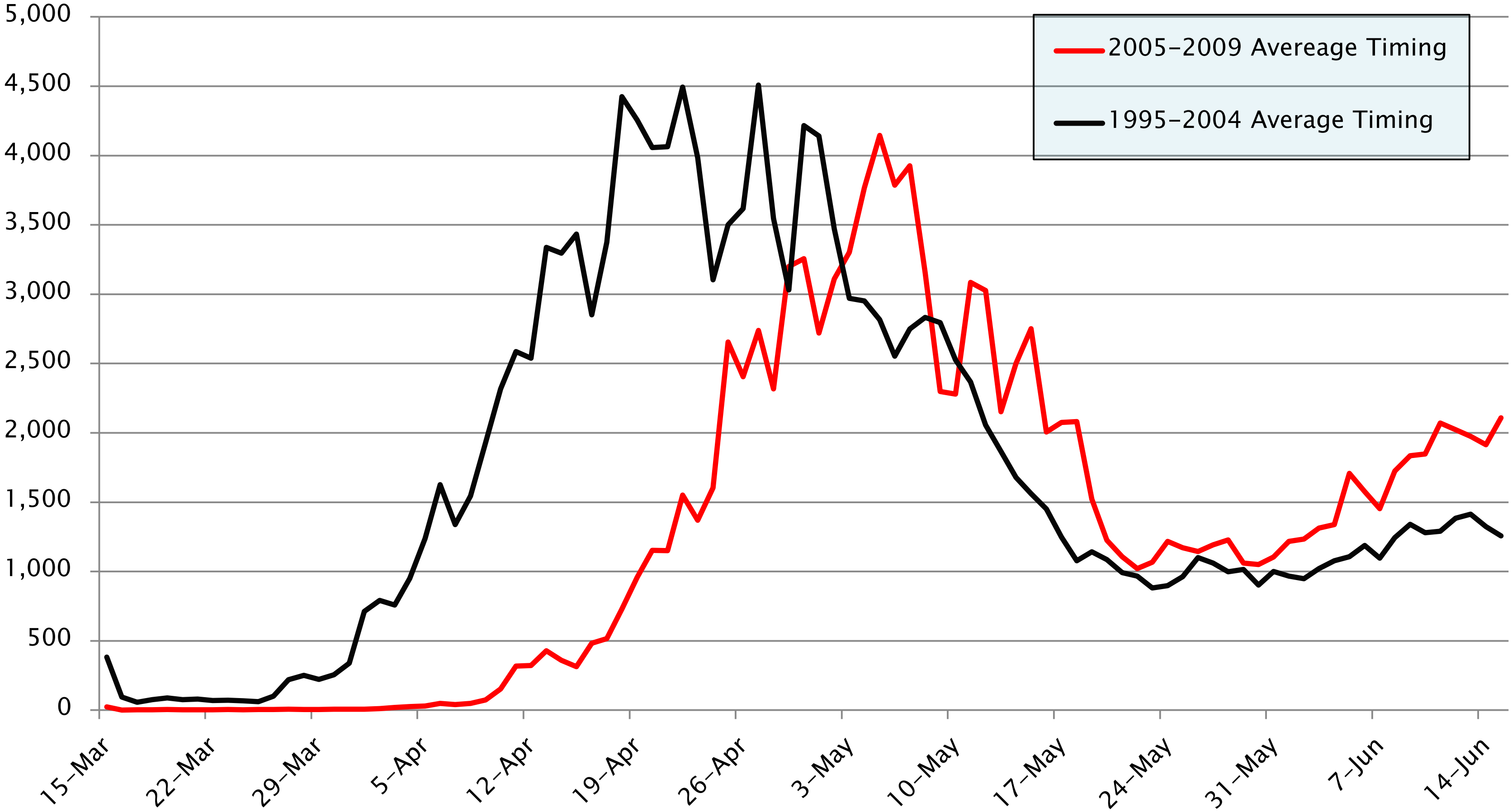
Bonneville Dam Counts of Adult Spring Chinook
March 15 – June 15



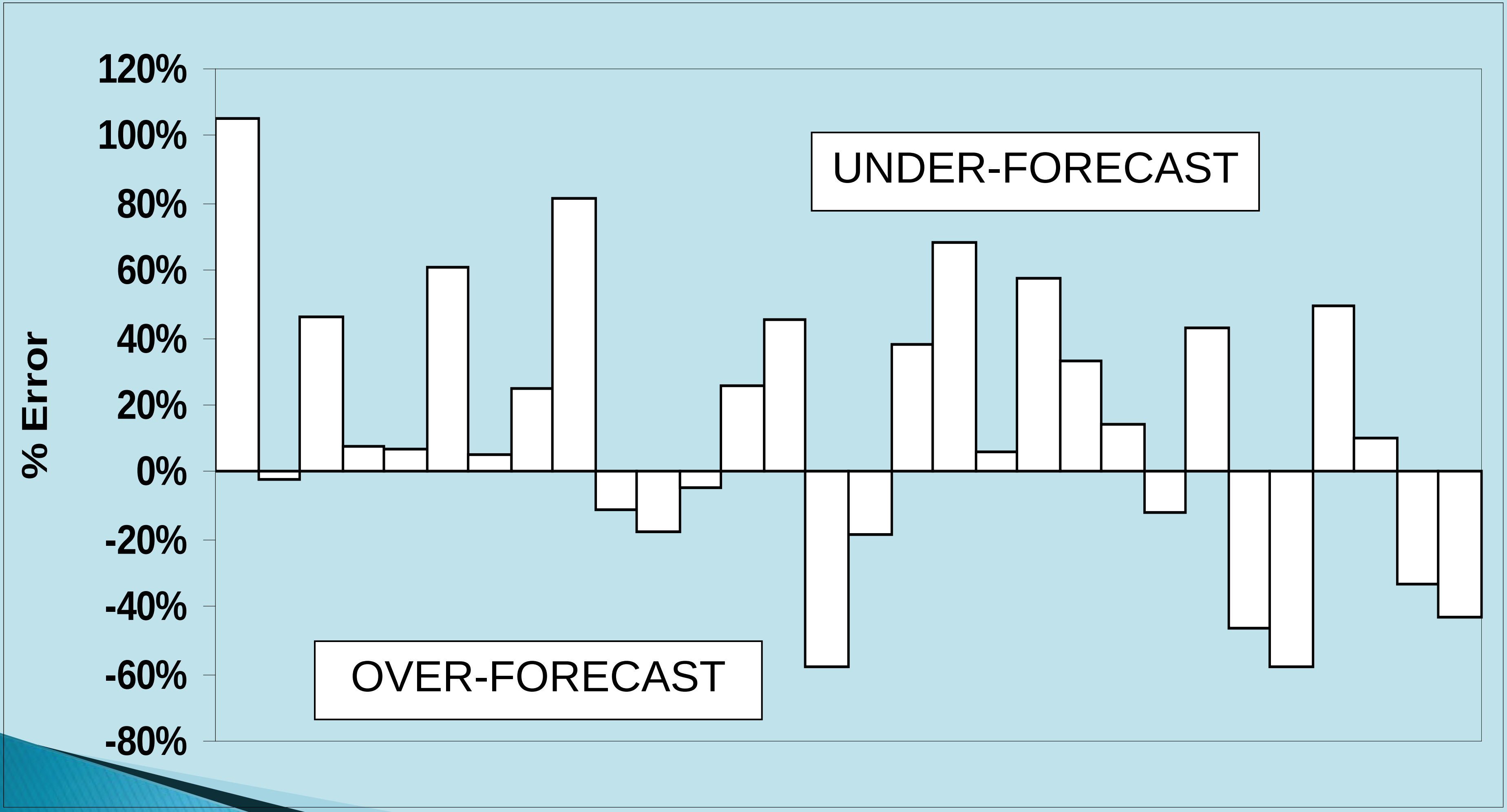
Bonneville Dam Counts of Jack Spring Chinook
March 15 – June 15



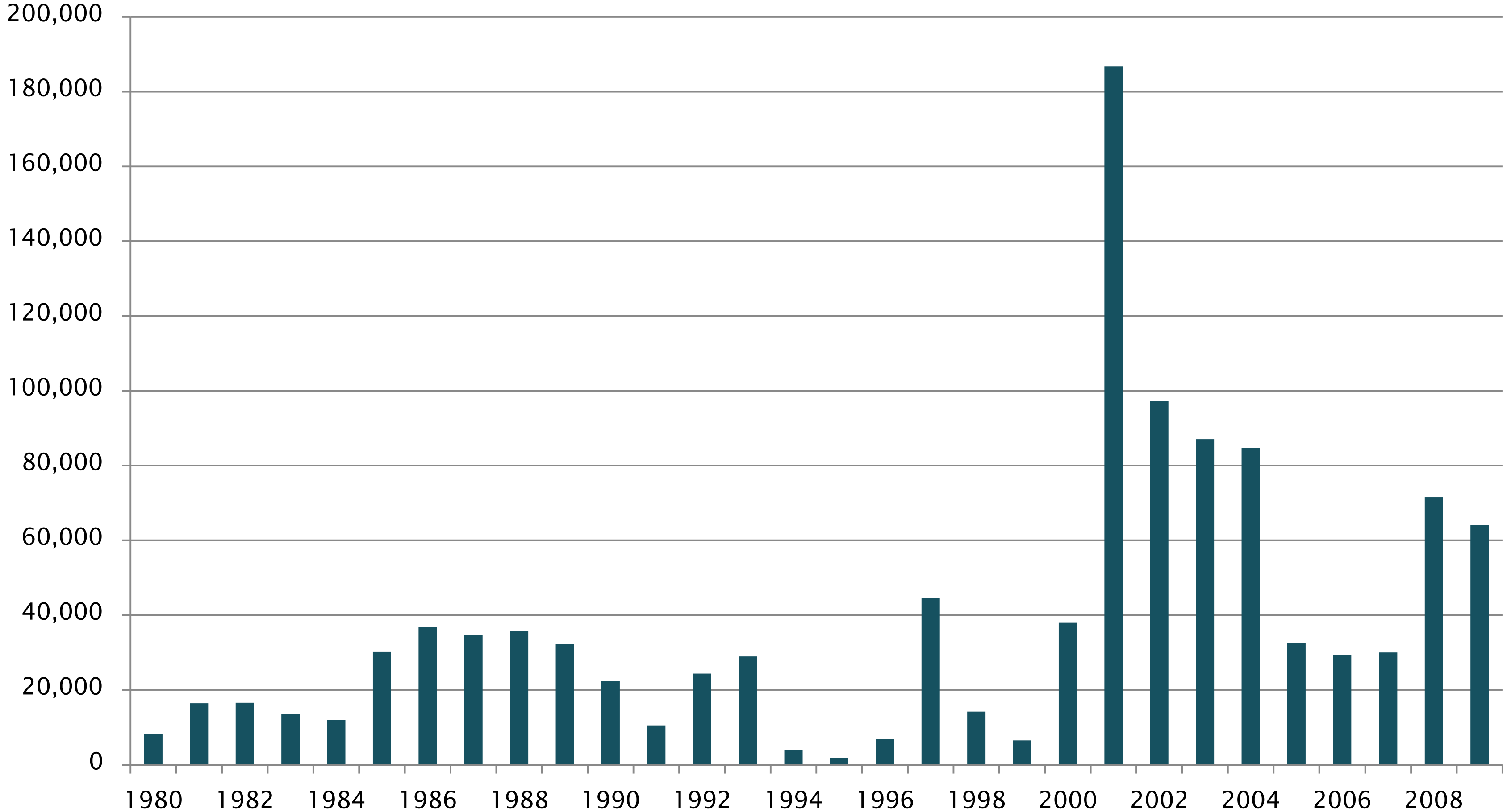
Run Timing of Spring Chinook at Bonneville Dam (March 15–June 15)



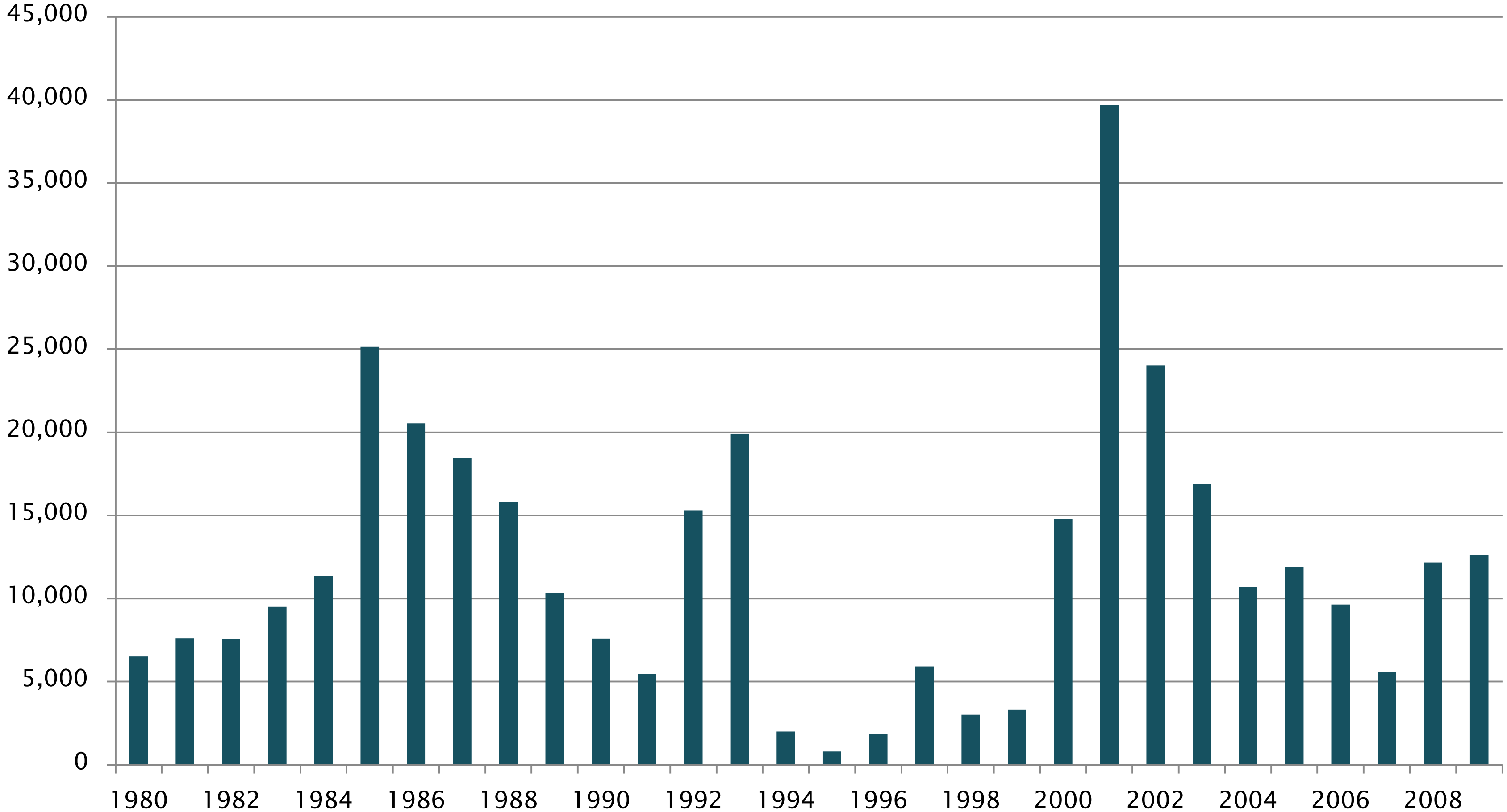
Error in Upriver Spring Chinook Forecast 1980–2009



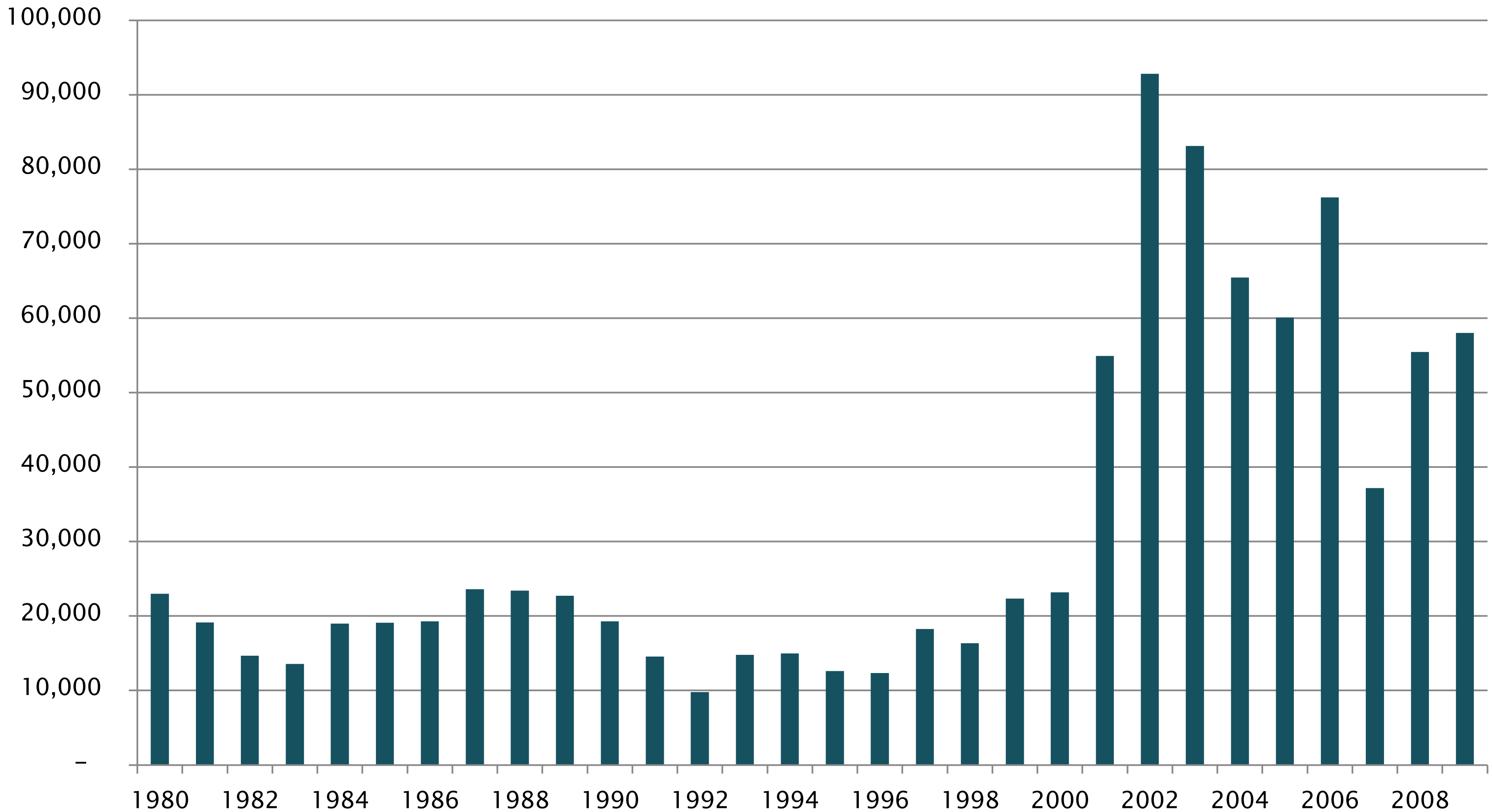
Lower Granite Dam Counts of Adult Spring/Summer Chinook



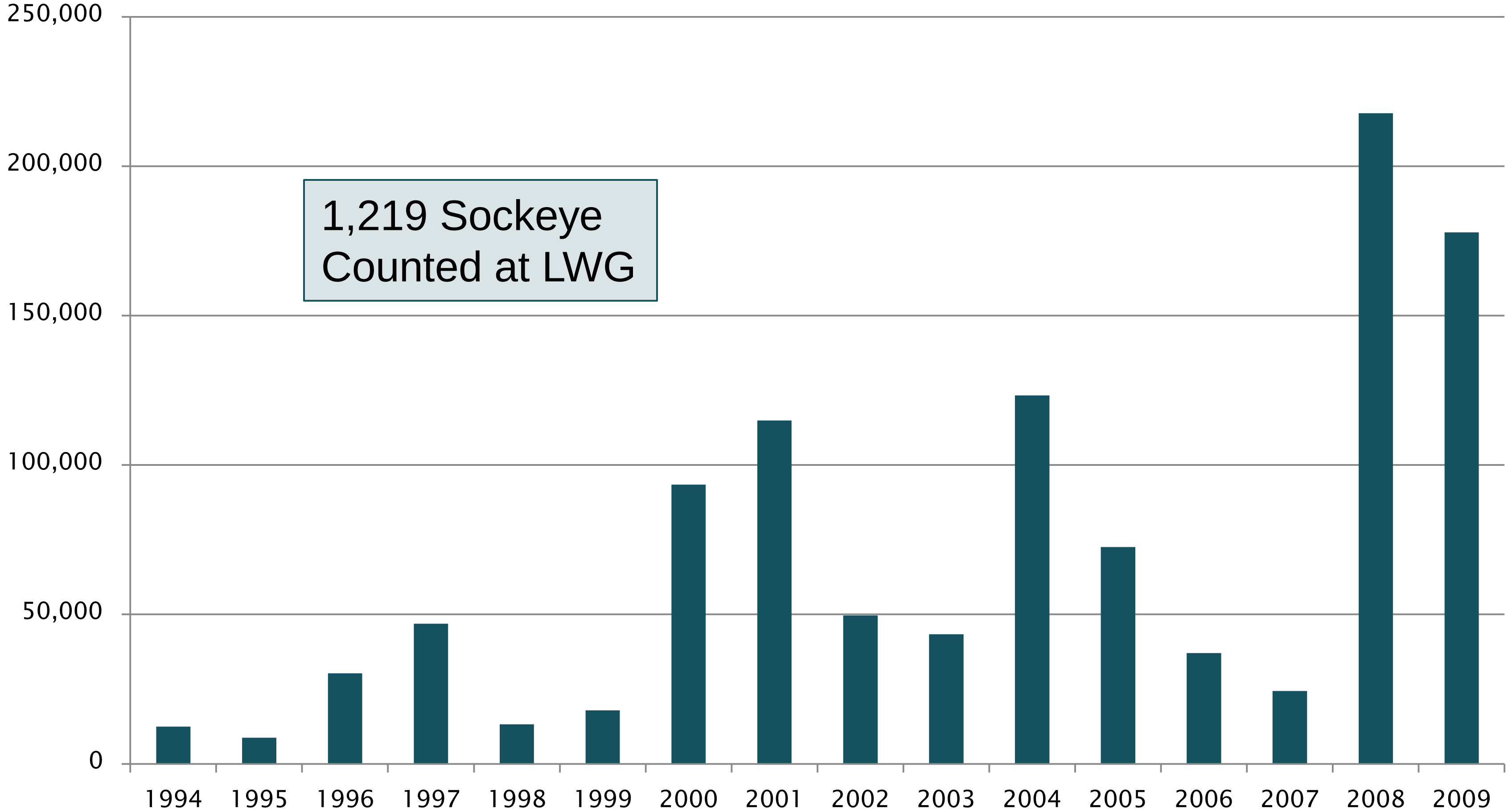
Rock Island Dam Counts of Adult Spring Chinook



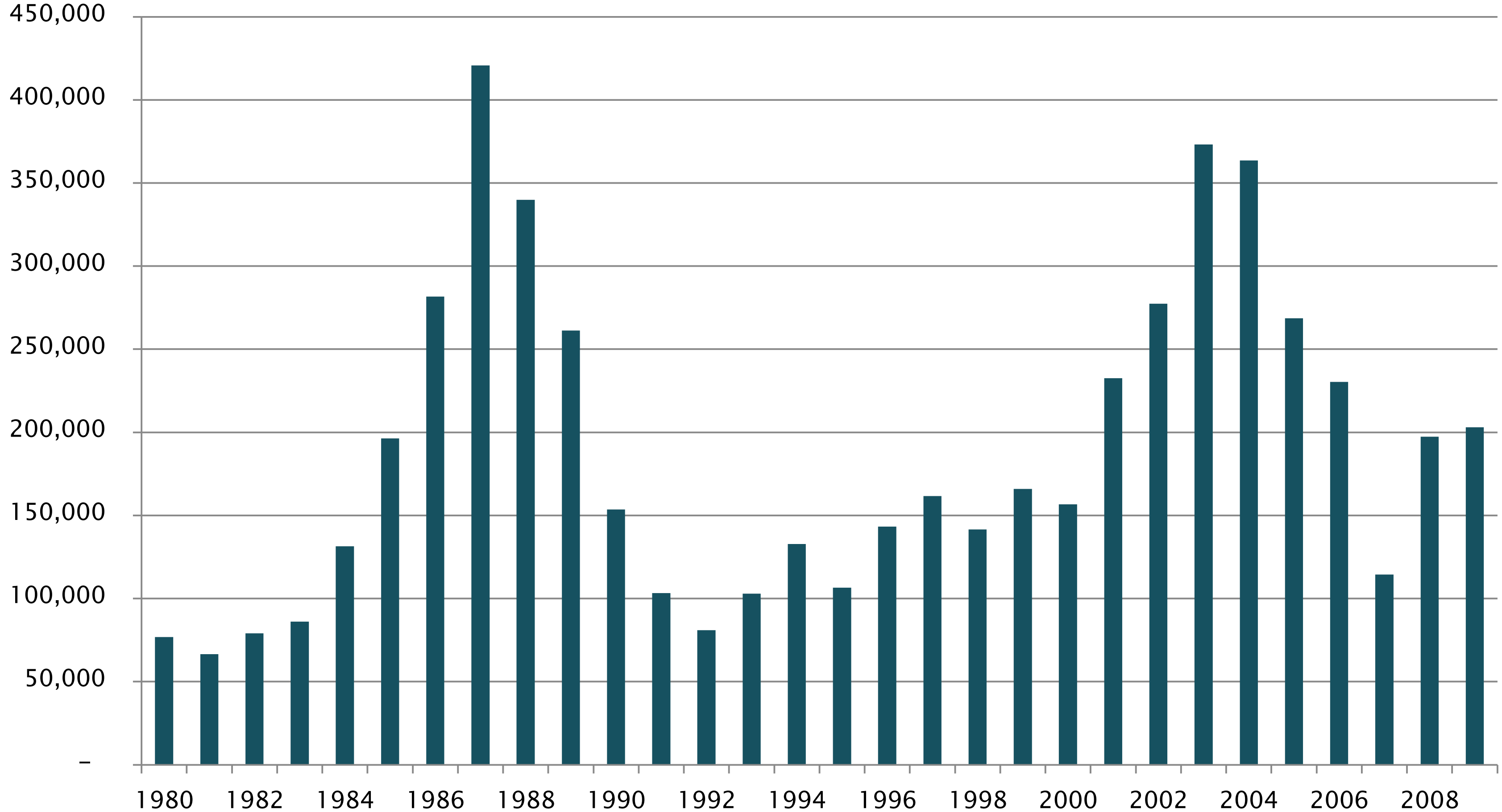
Summer Chinook Run Size
(Count period June 16 – July 31 at Bonneville Dam)



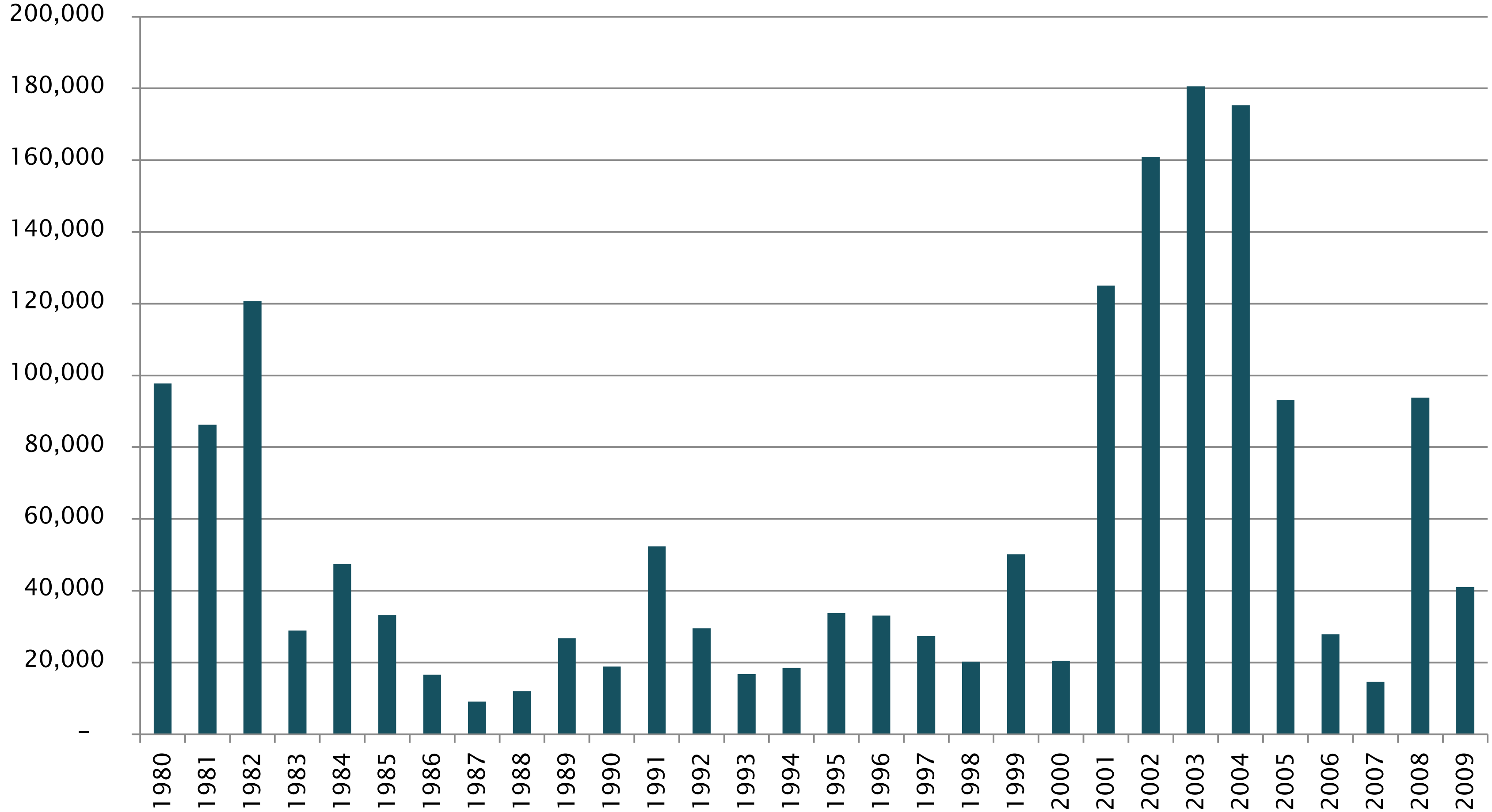
Bonneville Dam Counts of Sockeye



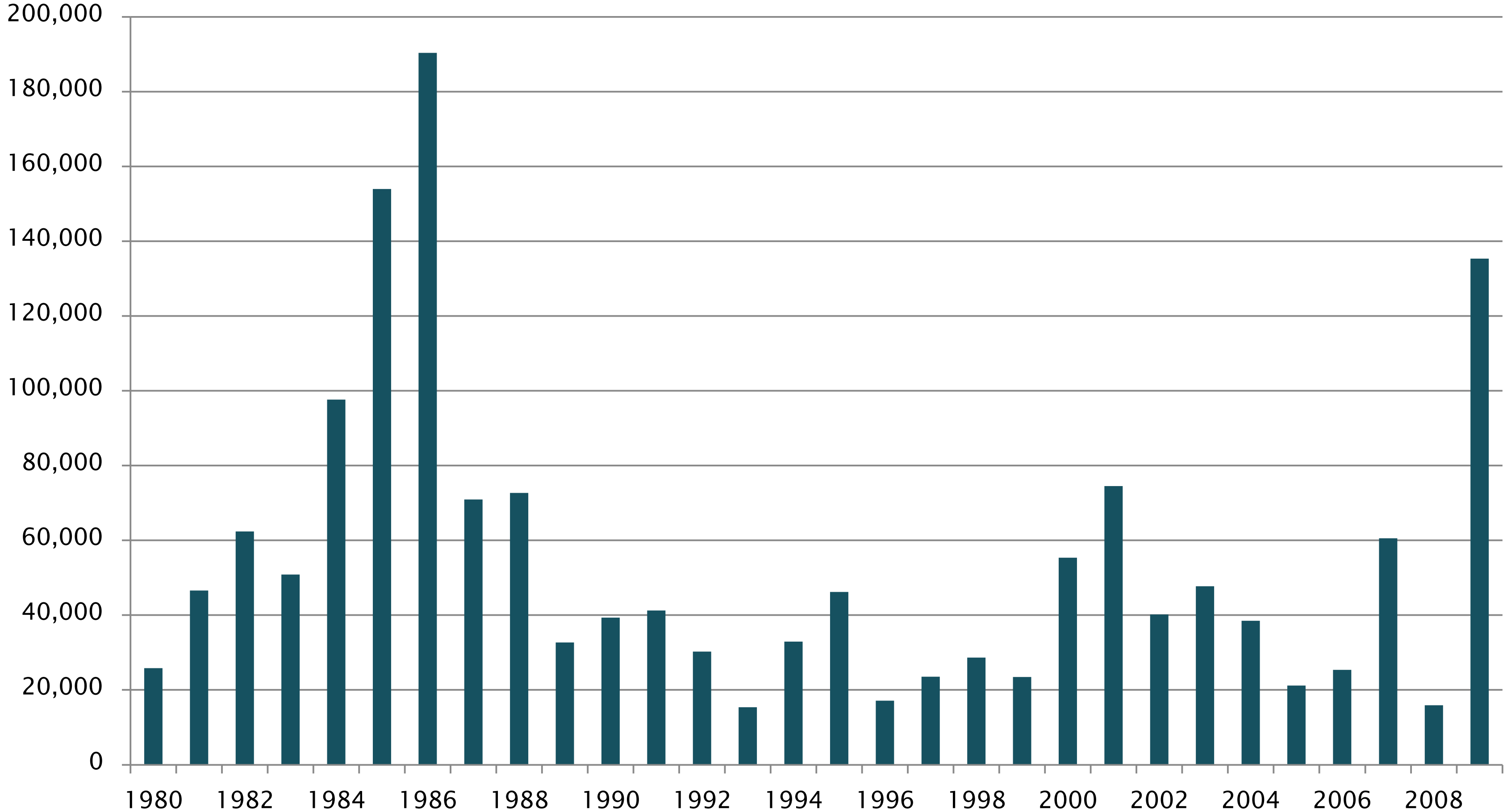
Upriver Bright Stock Adult Fall Chinook Returns



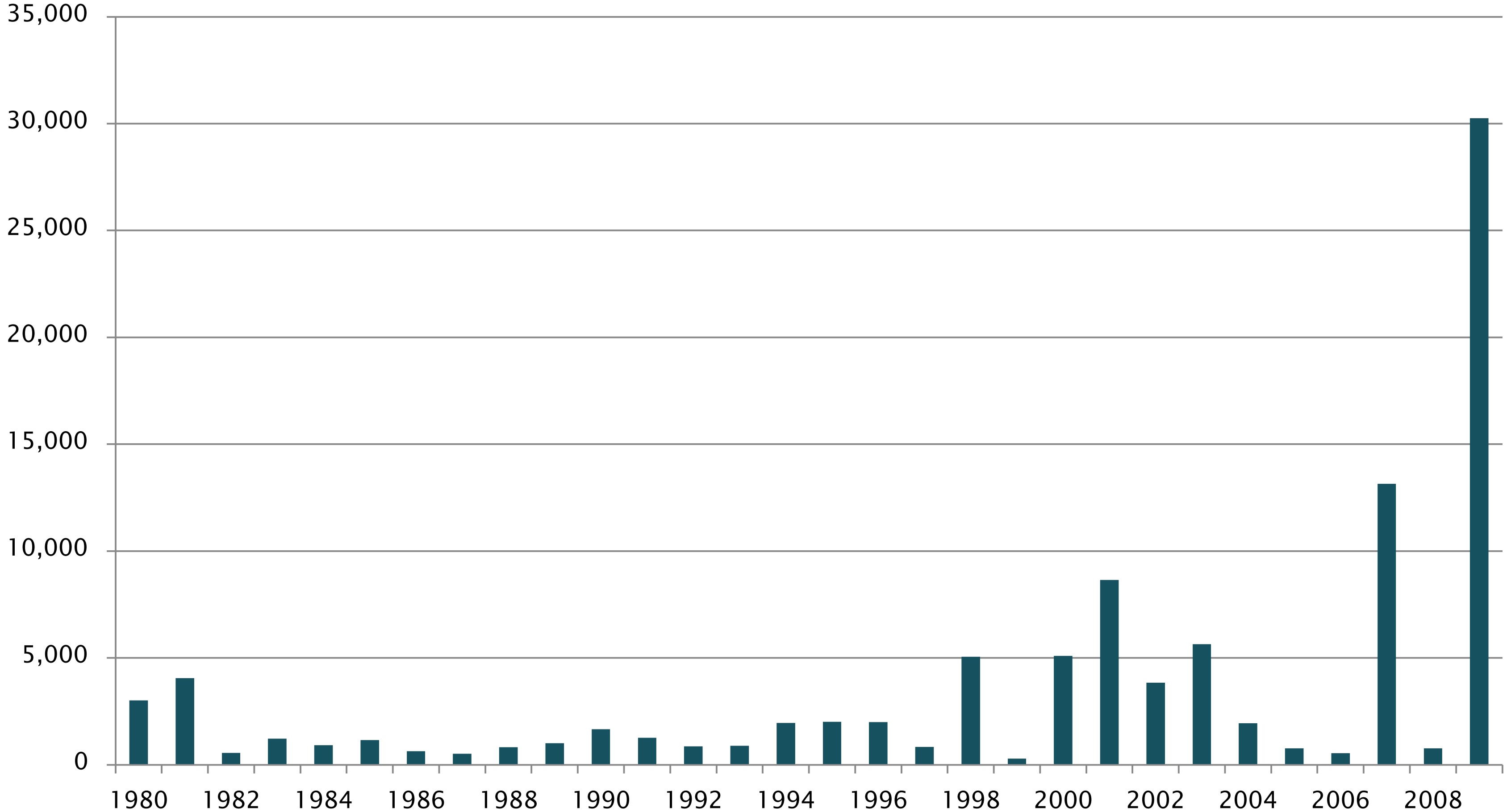
Bonneville Pool Hatchery Stock Adult Fall Chinook Returns



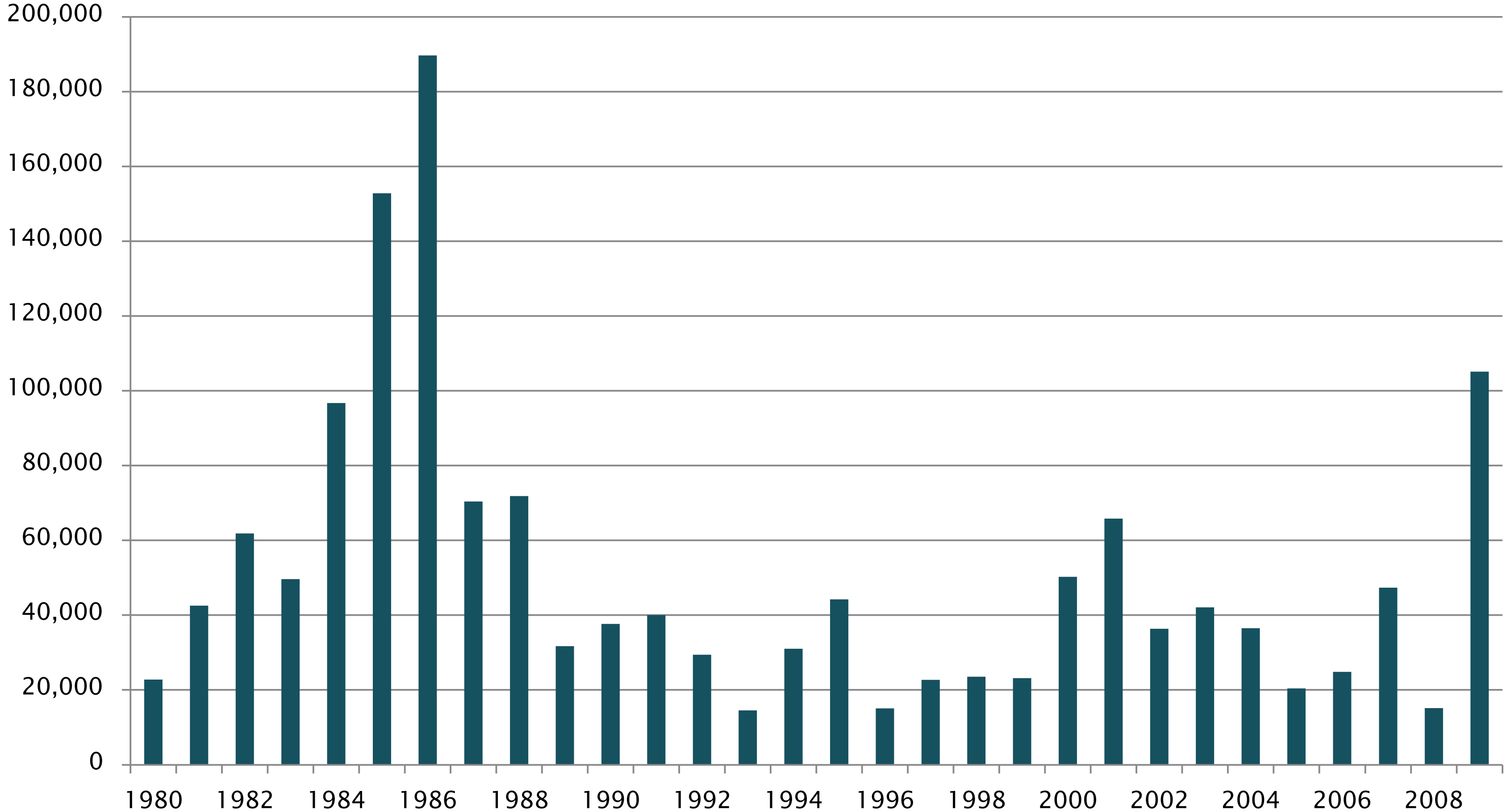
Bonneville Dam Counts of Jack Fall Chinook



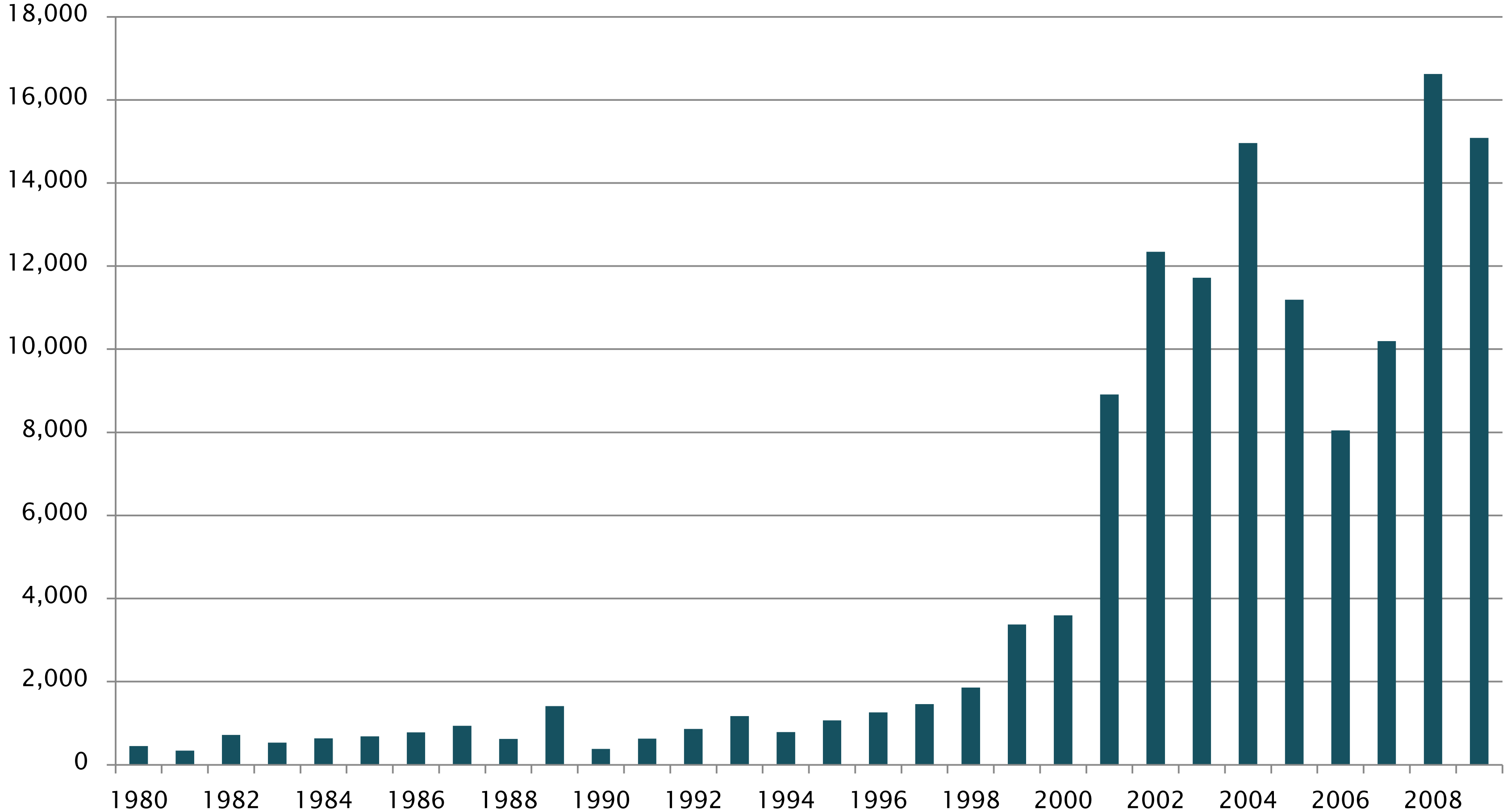
Bonneville Dam Counts of Tule Jack Fall Chinook (Spring Creek Hatchery)



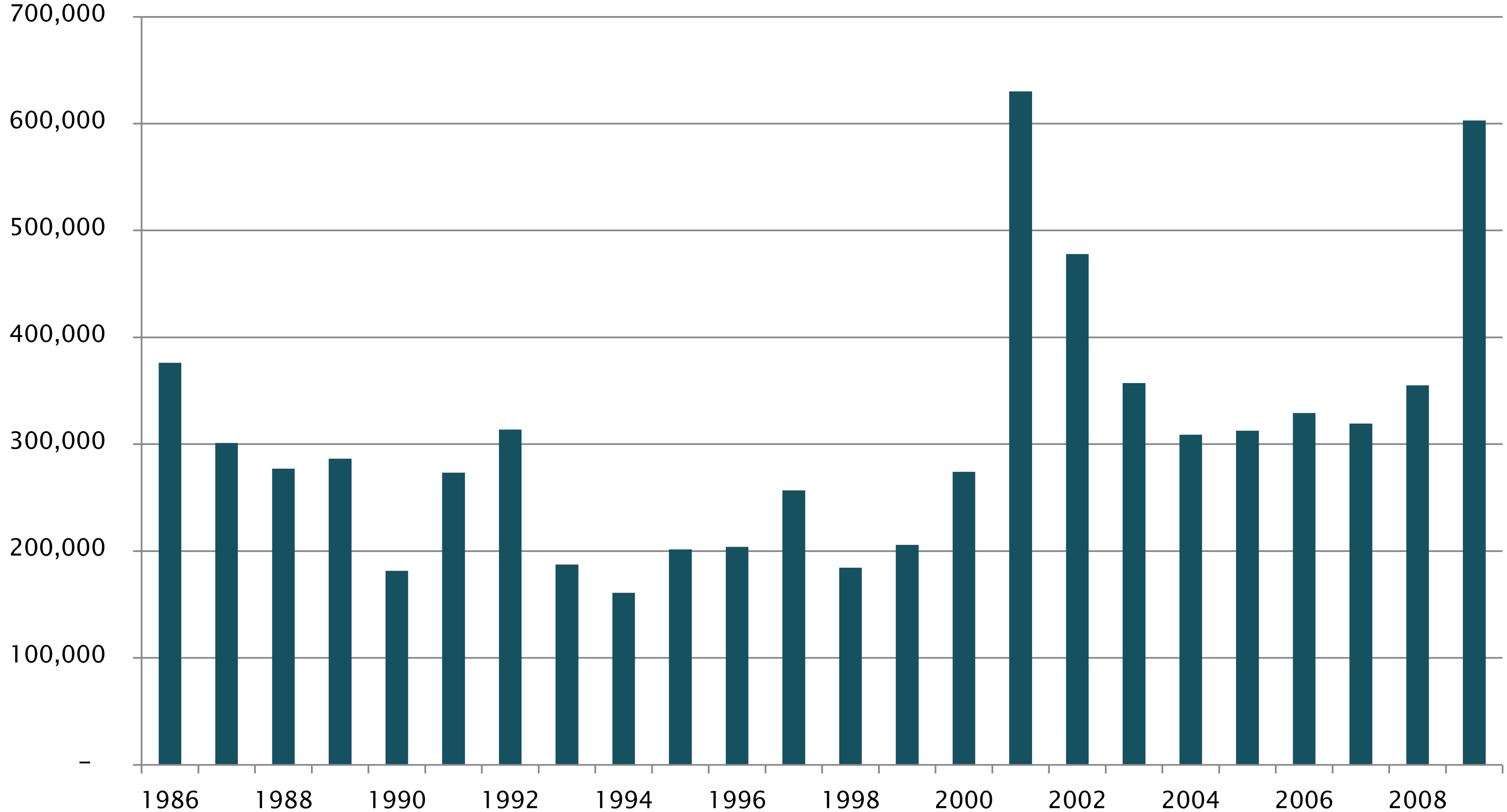
Bonneville Dam Counts of Bright Fall Chinook Jacks



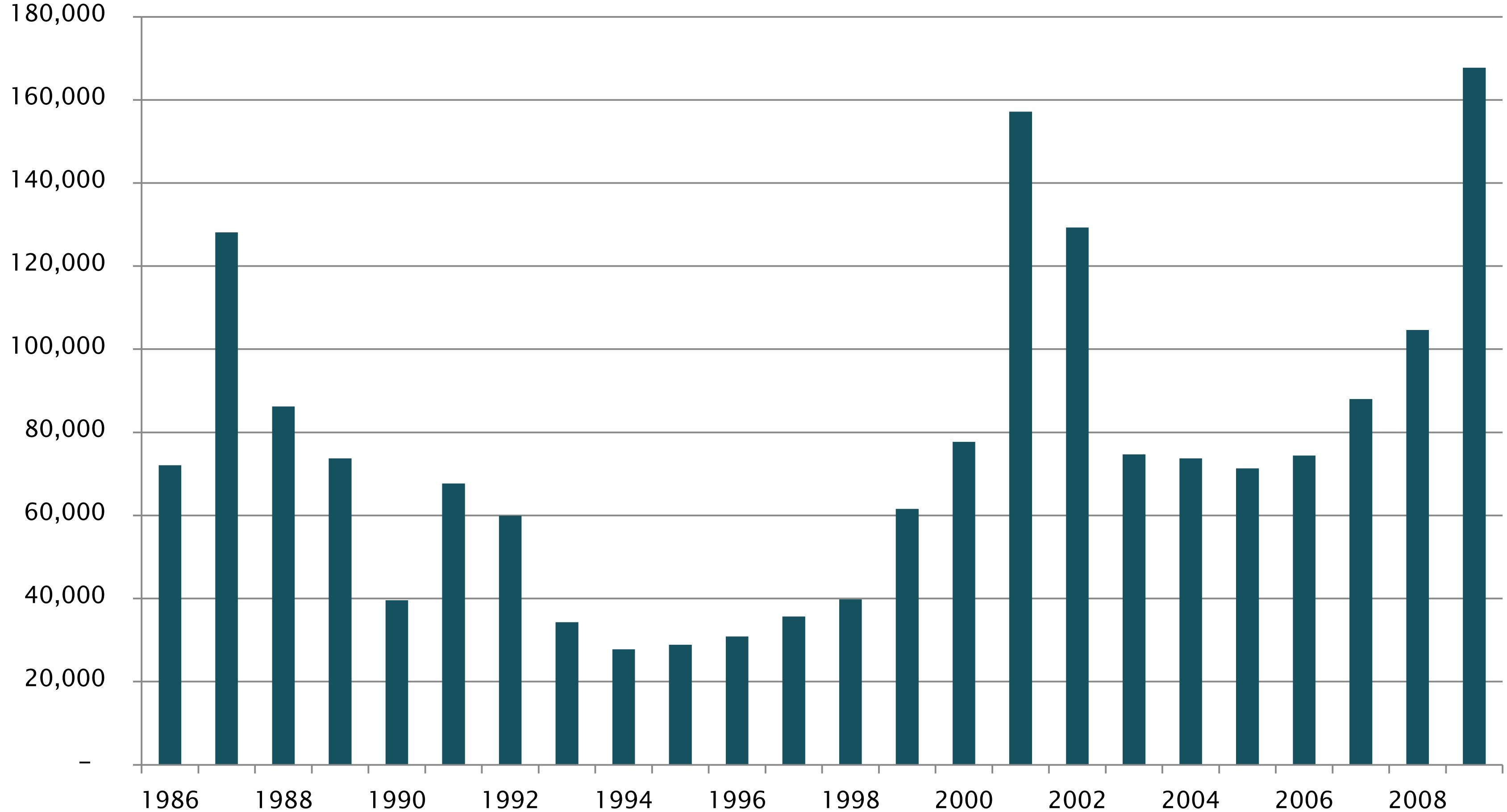
Lower Granite Dam Counts of Adult Fall Chinook



Bonneville Dam Counts of Summer Steelhead

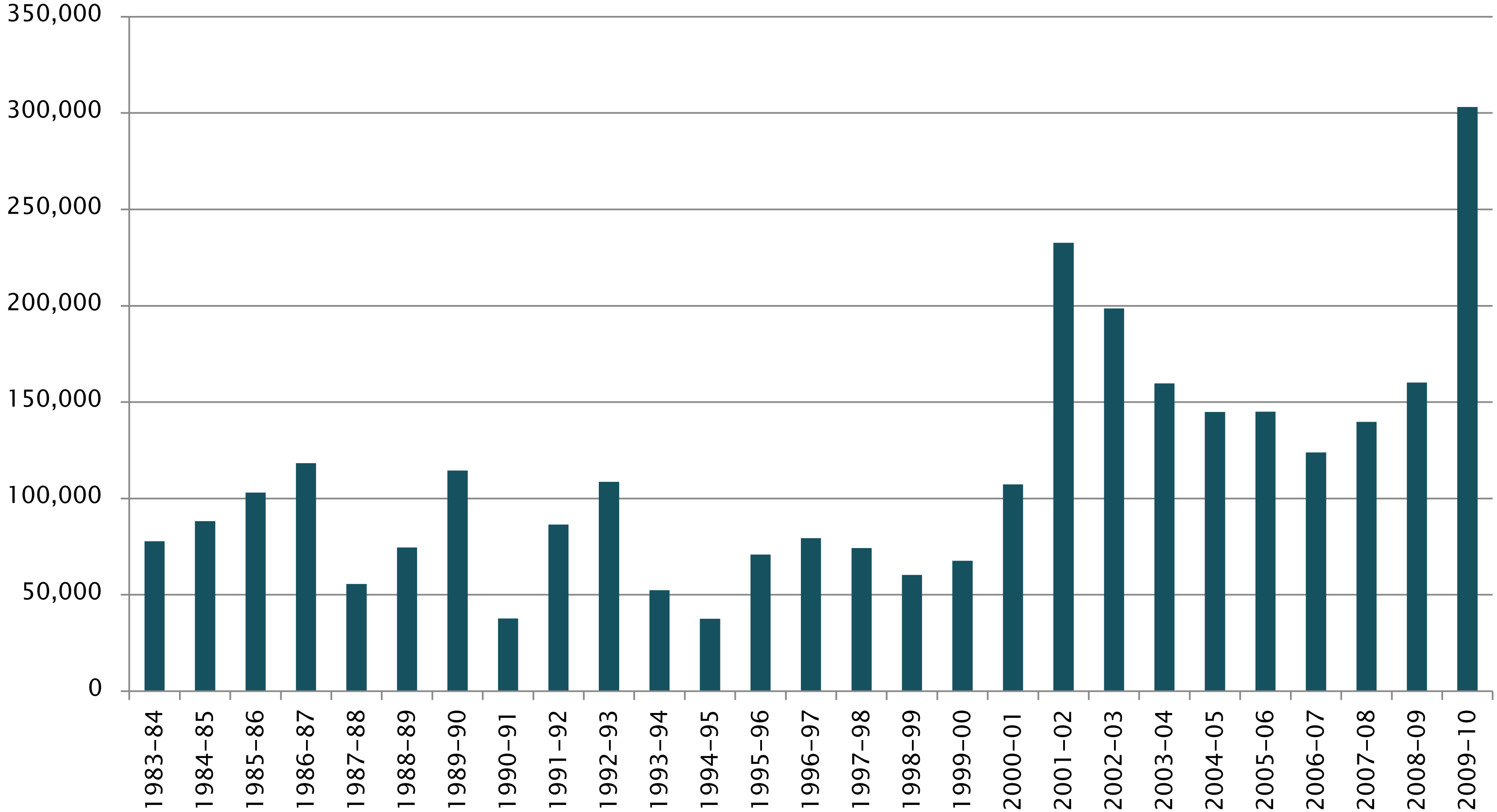


Bonneville Dam Counts of Wild Summer Steelhead



Lower Granite Dam Counts of Summer Steelhead

June 1 – November 5



Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

Michael L. Schneider
Coastal and Hydraulic Laboratory
U.S. Army Engineer Research and Development Center

and

Kent B. Easthouse
U.S. Army Corps of Engineers Seattle District

Chief Joseph Dam, Spillway Flow Deflector

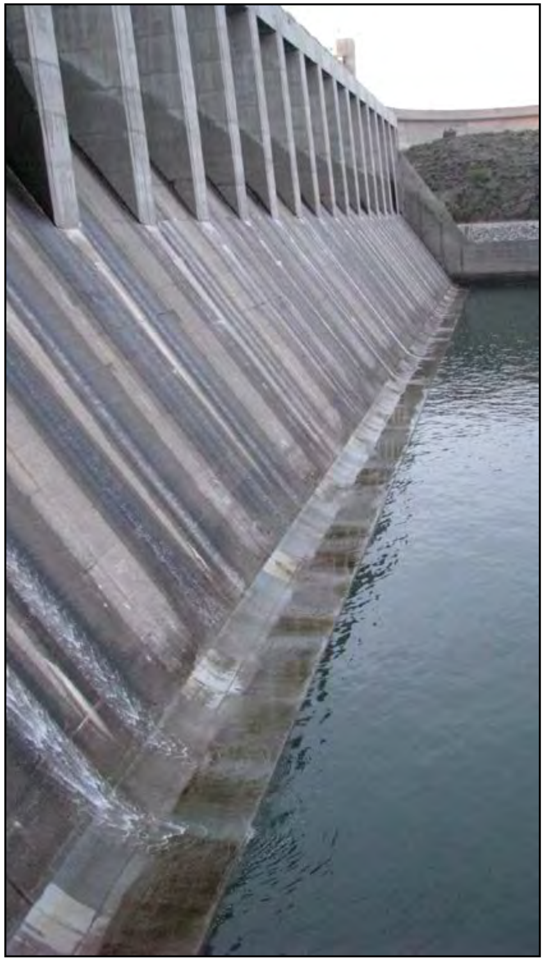
DRAFT Total Dissolved Gas Exchange Assessment

- Summary
  - TDG saturations greatly reduced with deflectors when compared to 1999 study
  - TDG saturations were greater for bulk spill pattern than for uniform spill pattern
  - Tailwater elevation impacted deflector performance and TDG reduction, with higher tailwater resulting in higher TDG saturations

Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

- Spillway flow deflectors added to all 19 spill bays
- Deflector design
  - Elevation 776 ft
  - 12.5 foot length with toe curve
- Maximum design discharge 175 kcfs
  - Skimming flow targeted
- Tailwater Elevation Impacts
  - Skimming vs. Plunging flow



Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

TDG exchange Spill Events

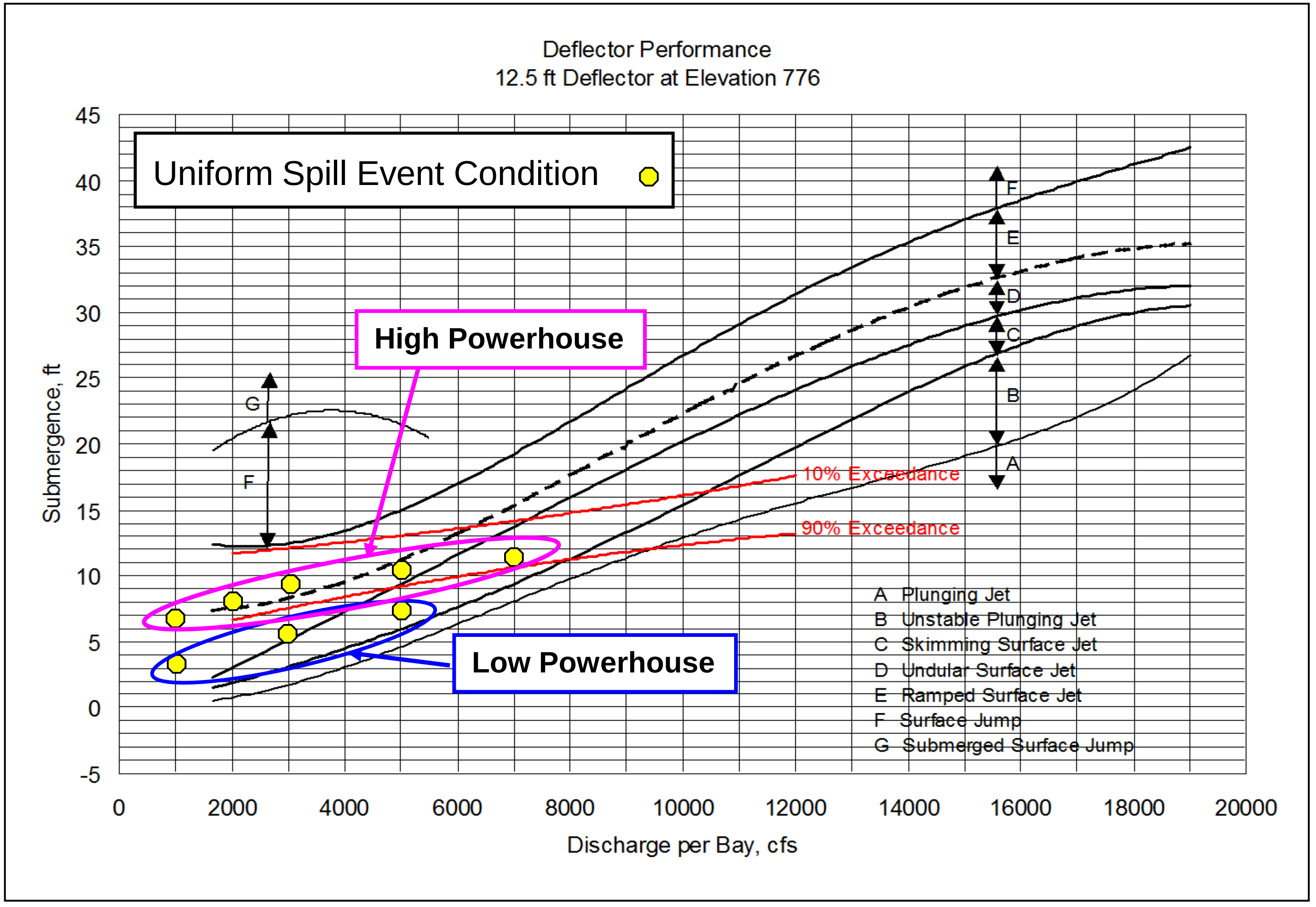
- Varied Spillway Flows 18 - 142 kcfs
- Consistent Duration of 3 hours
- Varied Deflector submergence
  - 3.6 to 11.1 ft
  - acceptable zone
- Uniform and Bulk Spill Pattern
- Varied Powerhouse Flow
  - 59 to 150 powerhouse flow
  - 77 to 226 kcfs total river flow

Chief Joseph Total Dissolved Gas Study Event Matrix, April 28-May 1, 2009 (12 Spill Events)			
Spill Flow (kcfs)	Powerhouse Flow (kcfs) and Spill Pattern		
	Uniform*	Uniform	Bulk
18	59	141	
37		150	150
58	59	145	145
98	62	95	106
142		82	84

*low powerhouse flow events.

Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

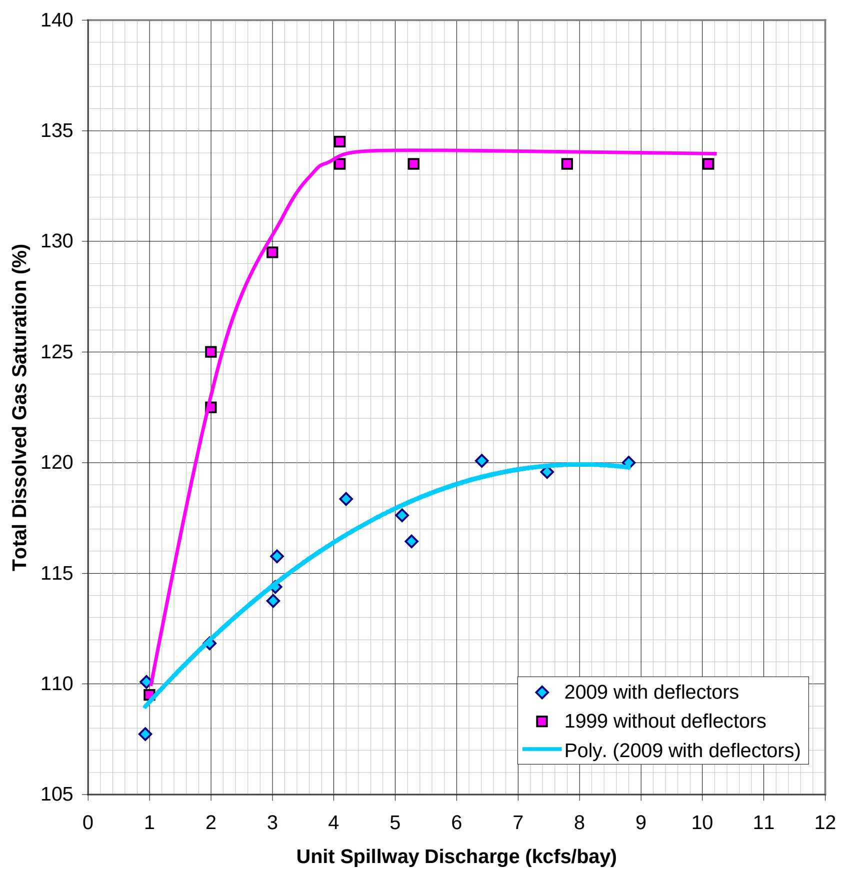


Deflector Performance Curve and submergence of deflectors during Uniform Events with low powerhouse and high powerhouse flows

Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

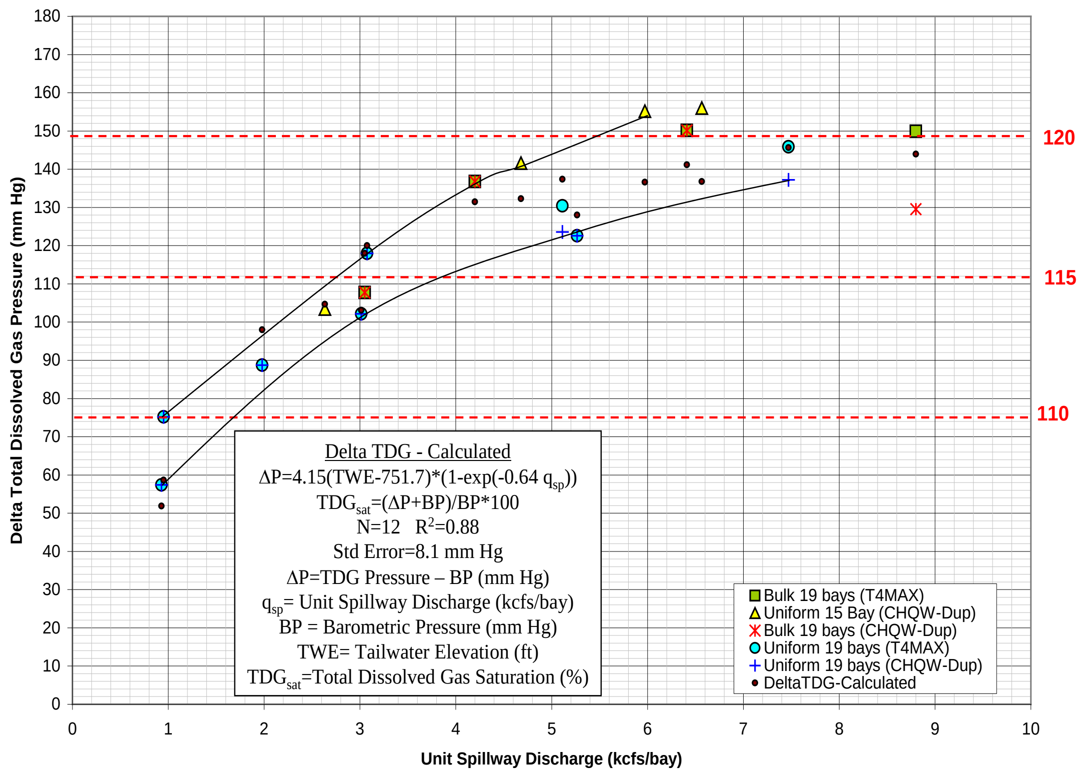
- TDG exchange results
  - Deflectors produce reduction in TDG generation
    - TDG Reduction up to16% saturation for comparable spill
    - Tripled spill capacity at 120%
  - Abrupt TDG response to spill reduced with deflectors
  - TDG saturation approached 120 percent
    - Peak levels were a function of flow conditions and location
  - Does not include data from actual spill in May



Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

- Regression Model TDG saturation
  - Local atmospheric pressure (mm Hg)
  - Specific discharge (kcfs/bay)
    - Weighted for bulk pattern
  - Effective tailwater depth (ft)
    - Function of Qtotal
    - Wells Pool Regulation
  - Limited number of events N=12
  - Limited range of independent variables
- Upper and lower bound curves



Recommended Caps

110	19kcfs	125	160kcfs
115	50kcfs	130	160kcfs (unknown)
120	100kcfs	135	160kcfs (unknown)

Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

- Tailwater FMS unreliable during study
- Time to equilibrium at TW FMS 60-90 minutes
- Higher TDG for duplicate sensor at FMS
- Maximum cross sectional TDG levels not at FMS for spill discharge of 98 kcfs and greater

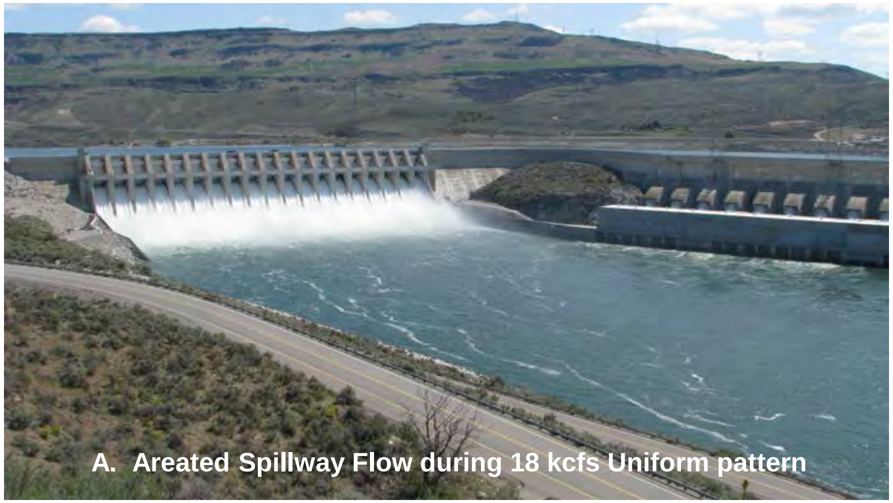
Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

- Visual Observations
  - Redirection of spill jet from vertical to horizontal orientation when encountering the deflector for all flows
  - Prominent zone of highly aerated flow extends well downstream of stilling basin
  - Return flow into stilling basin more evident for bulk spill pattern

A. Spill jet transition during 3 kcfs/bay

B. Spill jet transition during 7 kcfs/bay



A. Areated Spillway Flow during 18 kcfs Uniform pattern

B. Areated Spillway Flow during 58 kcfs uniform pattern..

C. Areated Spillway Flow during 98 kcfs uniform pattern.

D. Areated Spillway Flow during 142 kcfs uniform pattern.

Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

A. Bulking of spill and subsequent rooster tail trajectory.

B. Areated Spillway Flow during 58 kcfs event.

Chief Joseph Dam, Spillway Flow Deflector

DRAFT Total Dissolved Gas Exchange Assessment

Chief Joseph Dam 100 kcfs Uniform Spill Event, High Powerhouse Flow, May 1 2009

Chum Spawning Operation

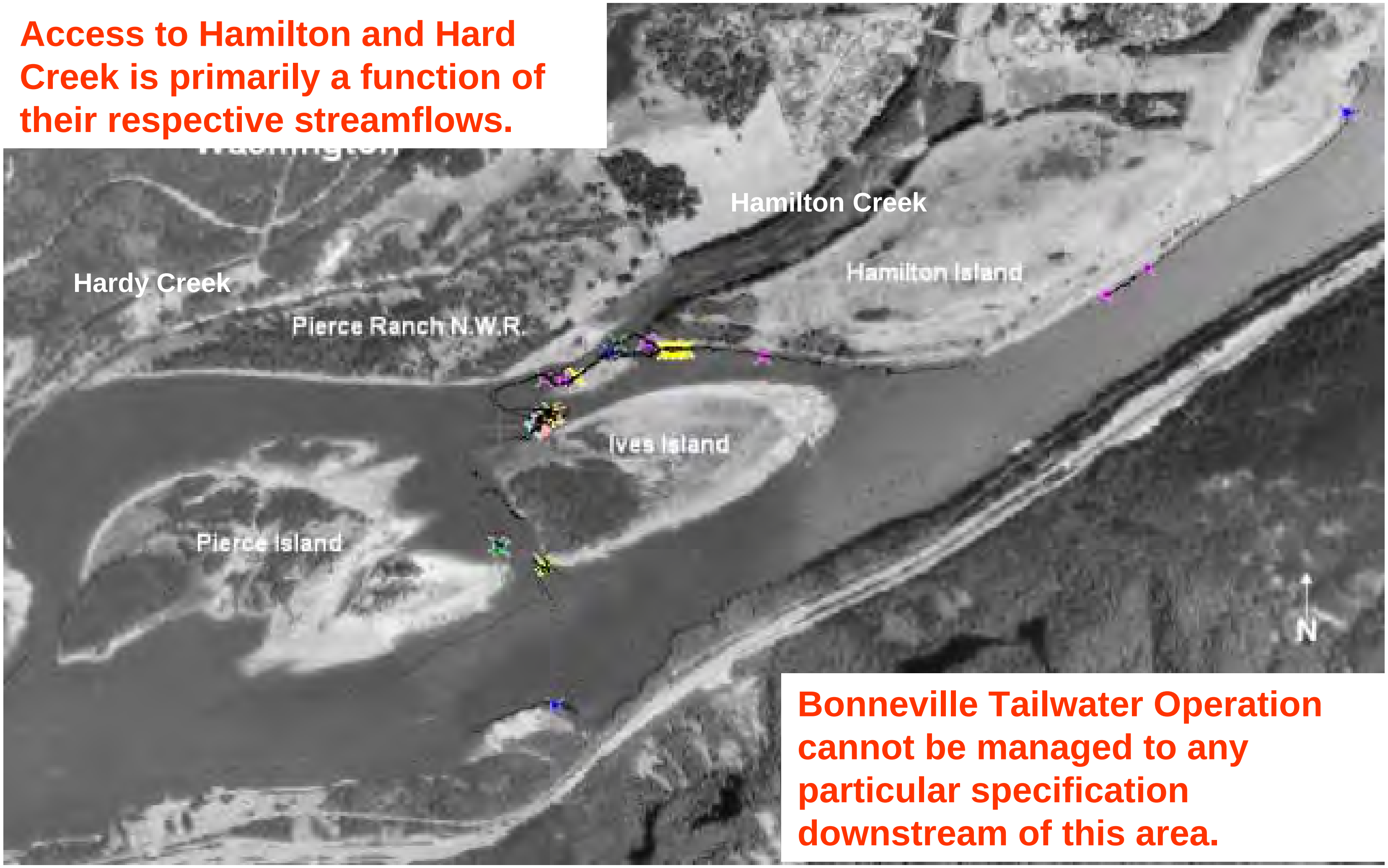
Daytime Tailwater Operation

Successful Maintenance of the Spawning Operation Depends on the Forecasted Effect and Interaction of Several Variables

- Streamflow forecasts
- Water surface influence from the tide
- Rate and volume of unmeasured streamflows into Bonneville Dam's Pool
- Bonneville Dam Project Operating Limits
- Operation of the Mid-Columbia dams and Brownlee dam.
- Water surface influence from streams flowing into the Columbia River downstream of Bonneville Dam
- Available storage at each project from GCL to BON.
- Power system needs

Chum Spawning Operation Effective Area

Access to Hamilton and Hard Creek is primarily a function of their respective streamflows.



Bonneville Tailwater Operation cannot be managed to any particular specification downstream of this area.

BONNEVILLE POWER ADMINISTRATION

Chum Spawning Operation Evolution

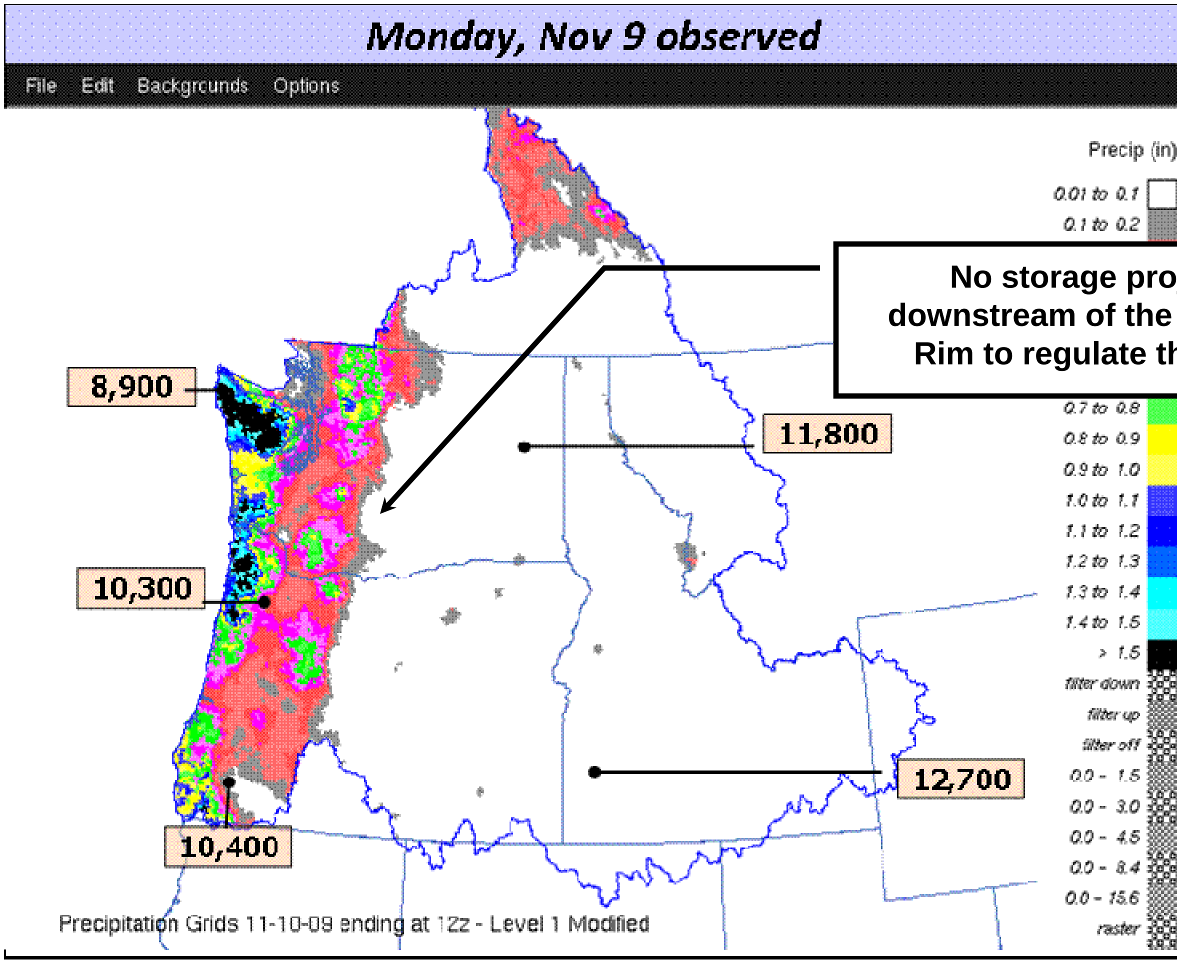
- **A flow objective of 125 kcfs at Bonneville Dam was the first criterion used to manage access to chum spawning habitat.**
- **A tailwater greater than 11.2' was identified as the critical element of the operation to provide access to sufficient spawning habitat.**
- **Spawning operation refined several times over the years as new information on chum behavior became available.**

Chum Spawning Operation Evolution

- **The spawning operation has also been refined over the years as we have learned how the tailwater operation is affected by natural hydrologic events and the operation of the FCRPS.**
  - A preference to manage to the 11.5 elevation target to limit future risk to spring flows.
  - Excess water must often be moved at night to maintain a stable daytime tailwater.
  - For events where the nighttime tailwater would exceed 18’ feet the preference is to increase the daytime tailwater to elevation 12.5 feet.

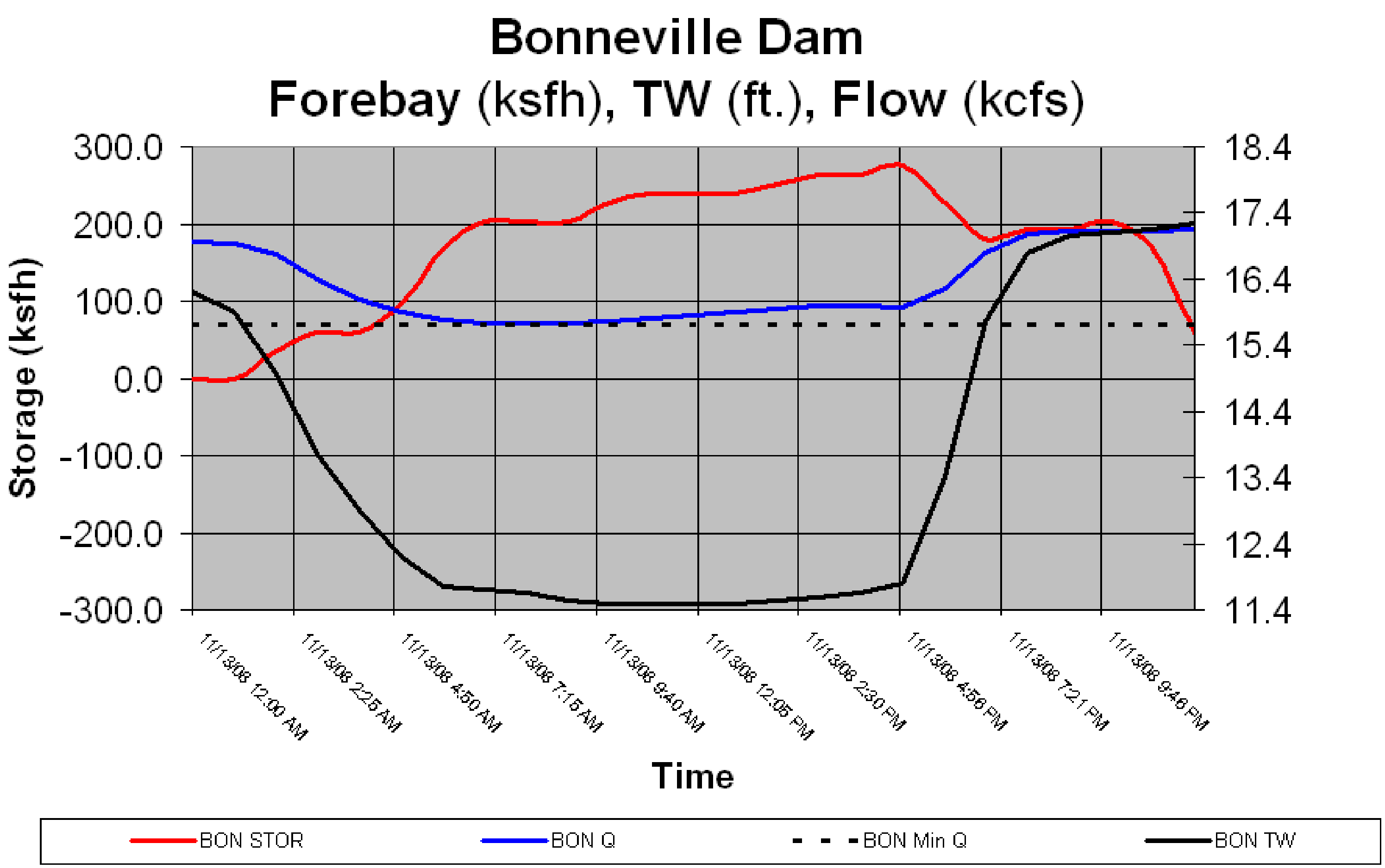
Daytime Tailwater Operation

West side precipitation events are common during November and December during the chum spawning operation.



Daytime Tailwater Operation

Bonneville Dam at minimum discharge can still exceed the TW range.



2009 Chum Spawning Operation Specifications

Provide a daytime tailwater elevation below Bonneville Dam within a range of 11.3 to 11.7 feet beginning the first week of November or when fish arrive.

If flows are too high to pass all excess water at night at a TW elevation <18' then increase the daytime elevation to 12.5 feet.

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
729 N.E. Oregon, Suite 200, Portland, Oregon 97232
Telephone (503) 238-0667
Fax (503) 235-4228
www.critfc.org

WINTER WEATHER 2009 - 2010 FORECAST
TMT End-of-Year Review Meeting; December 11th, 2009

Kyle Dittmer, *Hydrologist- Meteorologist*, CRITFC Hydro Program

Climate prediction tools used:

1. Australian Bureau of Meteorology—ENSO guide (http://www.bom.gov.au/climate/enso).
2. Assumes 12 La Nina (60%) years, 6 ENSO-neutral (30%) years and 2 El Niño (10%) years.
3. Analog (or surrogate) Water Years include **15** sunspot minima years (out of 20 years).
4. Analog Water Years (October 1 to September 30): 1943, 1944, 1949, 1953, 1954, 1964, 1965, 1975, 1976, 1985, 1986, 1990, 1993, 1996, 1997, 2002, 2006, 2007, 2008, and 2009.
5. Multivariable ENSO Index: (http://www.cdc.noaa.gov/people/klaus.wolter/MEI)
6. Sea Surface Temperature departure forecasts: (http://www.cpc.ncep.noaa.gov/products/people/wwang/cfs_fcst/images/glbSSTMonMask.gif)
7. Sunspot data: (http://solarscience.msfc.nasa.gov/images/ssn_predict_l.gif). Dr. Landscheidt's Solar Model: (http://www.john-daly.com/theodor/new-enso.htm)

Winter 2009 - 2010 Climate Forecast for Portland:

Month:	Temperature (mean monthly):	"Hedge"	Precipitation (% normal):	"Hedge"
November	Near Normal (-1.8 to + 1.8 degF)	-0.3	Above Normal (110 - 130%)	115%
December	Near Normal (-1.8 to + 1.8 degF)	-0.8	Near Normal (90 - 110%)	98%
January	Near Normal (-1.8 to + 1.8 degF)	0.4	Above Normal (110 - 130%)	111%
February	Near Normal (-1.8 to + 1.8 degF)	-0.8	Below Normal (70 - 90%)	86%
March	Near Normal (-1.8 to + 1.8 degF)	-0.6	Below Normal (70 - 90%)	88%

Snow (% probability): November 40%, December 80%, January 90%, February 75%, March 75%.
Snow (inch): Nov. 0.3 (+/- 0.9), Dec. 2.2 (+/- 4.8), Jan. 3.0 (+/- 3.4), Feb. 2.0 (+/- 3.8), March 0.2.

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Water Supply Forecast (Columbia River at The Dalles), January - July 2010, Million-Acre-Feet:

CRITFC (MEI method), updated Dec. 9, 2009: **94.4 MAF** or 88% of normal.
CRITFC (Hydro-climate method), updated Oct. 13, 2009: **106.8 MAF** or 100% of normal.
CIG's VIC Hydro model (modified), updated Nov. 29, 2009: **98.7 MAF** or 92% of normal.
NOAA-NWS-NWRFC (ESP method), updated Dec. 8, 2009: **90.0 MAF** or 84% of normal.

VERIFICATION: Winter 2008 – 2009, CRITFC Climate Forecast vs. Observed Data for Portland:

Month:	Temperature (mean monthly):	"Hedge"	**Observed**	Precipitation (% normal):	"Hedge"	**Observed**
November	Near Normal (-1.8 to + 1.8 degF)	-0.7	**3.4**	Above Normal (110 - 130%)	114%	**74%**
December	Near Normal (-1.8 to + 1.8 degF)	-0.8	**-2.7**	Near Normal (90 - 110%)	97%	**47%**
January	Near Normal (-1.8 to + 1.8 degF)	-0.3	**0.1**	Near Normal (90 - 110%)	102%	**89%**
February	Near Normal (-1.8 to + 1.8 degF)	-0.5	**-1.8**	Near Normal (90 - 110%)	95%	**33%**
March	Near Normal (-1.8 to + 1.8 F)	0	**-1.9**	Below Normal (70 - 90%)	85%	**91%**
	average:	-0.5	**-0.6**	average:	99%	**67%**

WY 2009 Water Supply Forecast (Columbia River at The Dalles):

CRITFC (Kyle Dittmer's) MEI prediction: 105.9 MAF (99% of normal).
CIG (UW) prediction: 102.6 MAF (96% of normal).
NOAA-NWS-NWRFC prediction: 103.4 MAF (96% of normal).

The observed, unregulated runoff was 90.2 MAF (January – July).
The best preseason 2008-09 forecast goes to the UW's CIG. ☺

2009 Water Year Runoff, Flow and Water Quality Summary

Technical Management Team
2009 Year End Review
December 11, 2009

- Runoff
- Flow Objectives
- Total Dissolved Gas (TDG) Monitoring
- Questions/Discussion

OBSERVED 2006 – 2009 RUNOFF

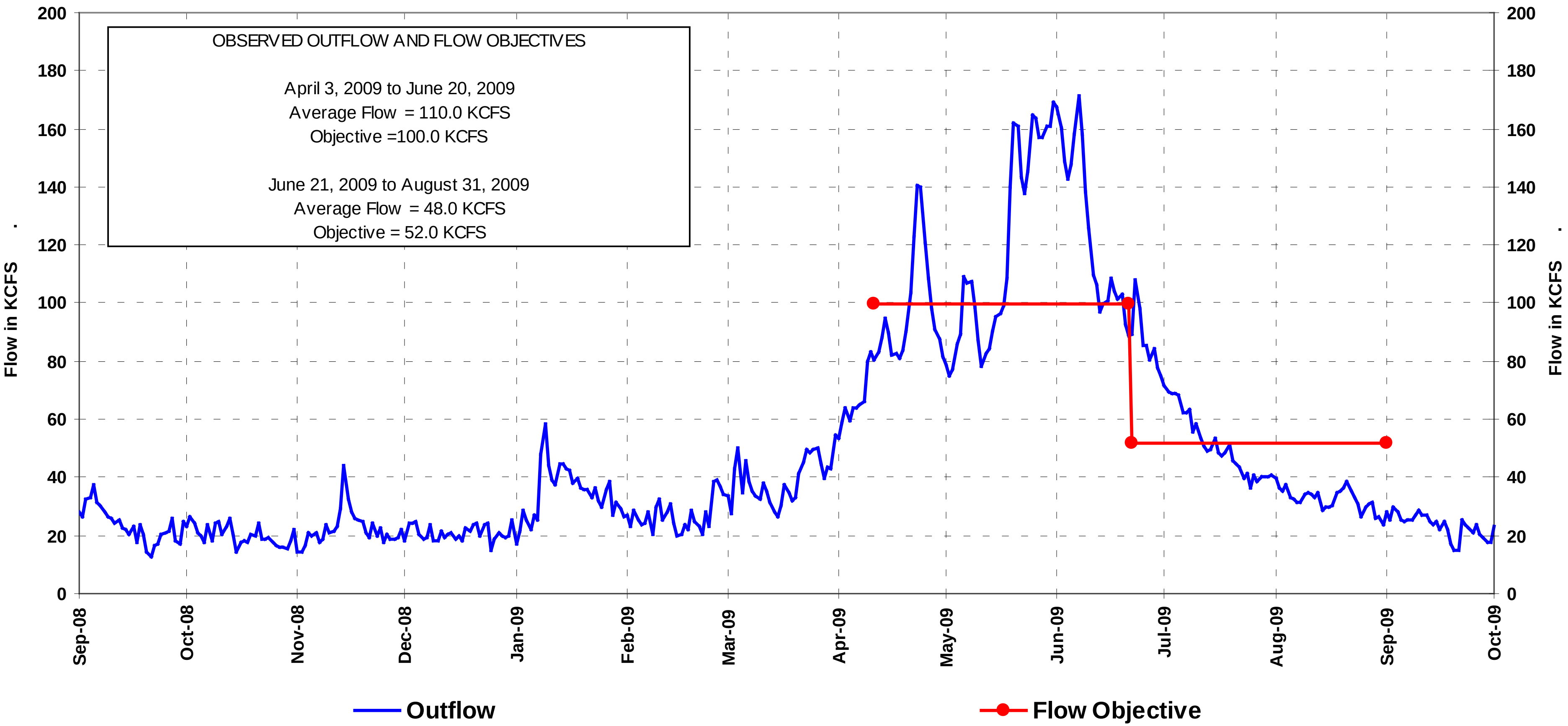
(MILLIONS OF ACRE FEET)

	JAN-JUL 06		JAN-JUL 07		JAN-JUL 08		JAN-JUL09	
PROJECT	**OBS**	**%**	**OBS**	**%**	**OBS**	**%**	**OBS**	**%**
HUNGRY HORSE	2.4	106	1.9	86	2.5	113	2.0	90
LIBBY	6.9	110	7.3	115	5.5	87	4.4	69
ALBENI FALLS	16.2	106	13.1	86	16.1	106	13.9	91
GRAND COULEE	66.9	106	63.9	102	59.6	95	49.7	79
DWORSHAK	3.5	99	2.7	77	3.8	108	3.3	94
LOWER GRANITE	32.2	107	18.9	63	27.5	92	28.9	96
THE DALLES	114.7	107	95.7	89	99.2	92	90.2	84

	APR-AUG 06		APR-AUG 07		APR-AUG 08		APR-AUG09	
PROJECT	**OBS**	**%**	**OBS**	**%**	**OBS**	**%**	**OBS**	**%**
HUNGRY HORSE	2.1	104	1.6	77	2.5	119	1.9	91
LIBBY	6.6	106	6.8	109	5.5	89	4.4	71
ALBENI FALLS	13.9	104	10.1	76	15.3	114	12.5	94
GRAND COULEE	61.2	101	57.4	95	59.7	99	48.2	80
DWORSHAK	2.7	100	1.8	67	3.6	131	2.6	96
LOWER GRANITE	25.6	112	13.5	59	22.8	106	24.3	106
THE DALLES	97.5	105	78.9	85	93.2	100	80.8	87

US Army Corps of Engineers

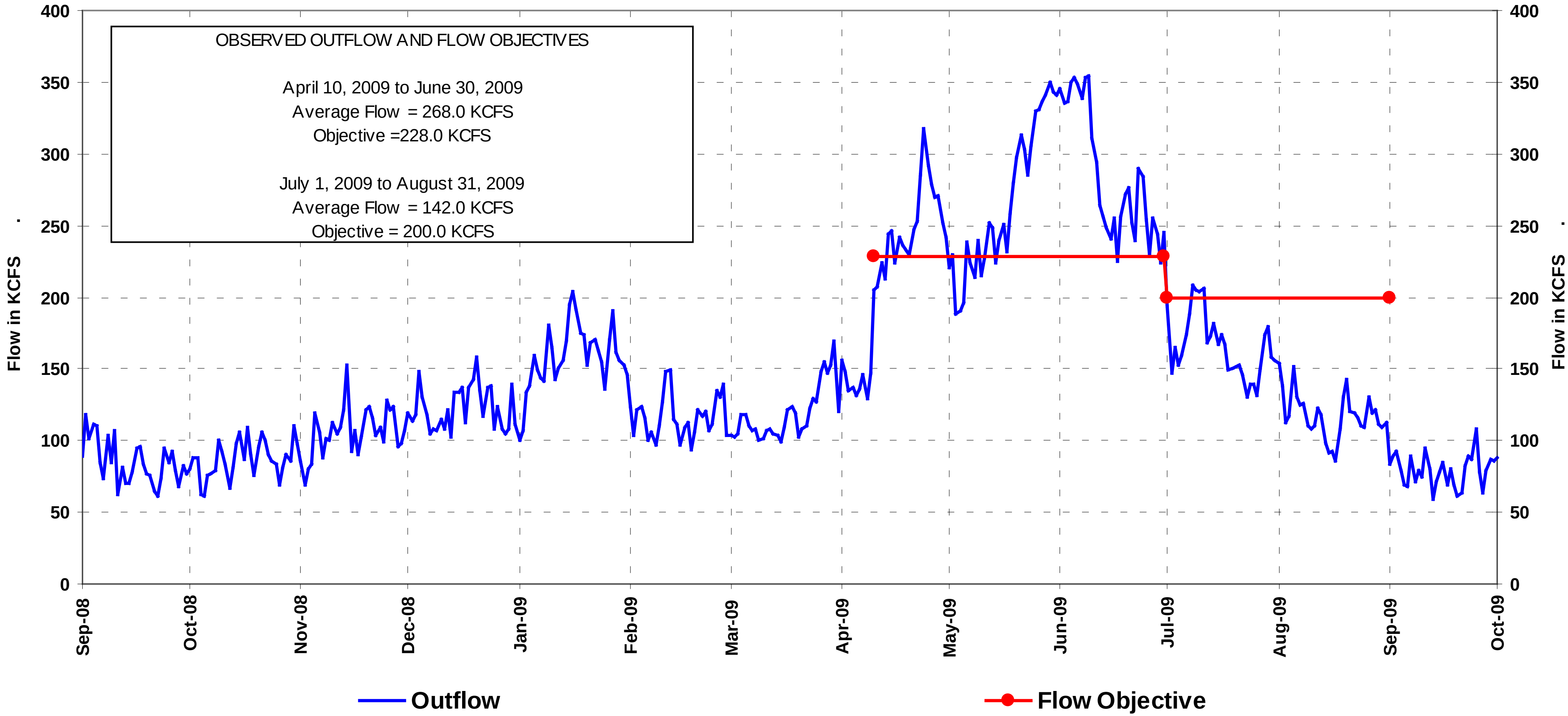
Lower Granite Flow Objectives



Building Strong

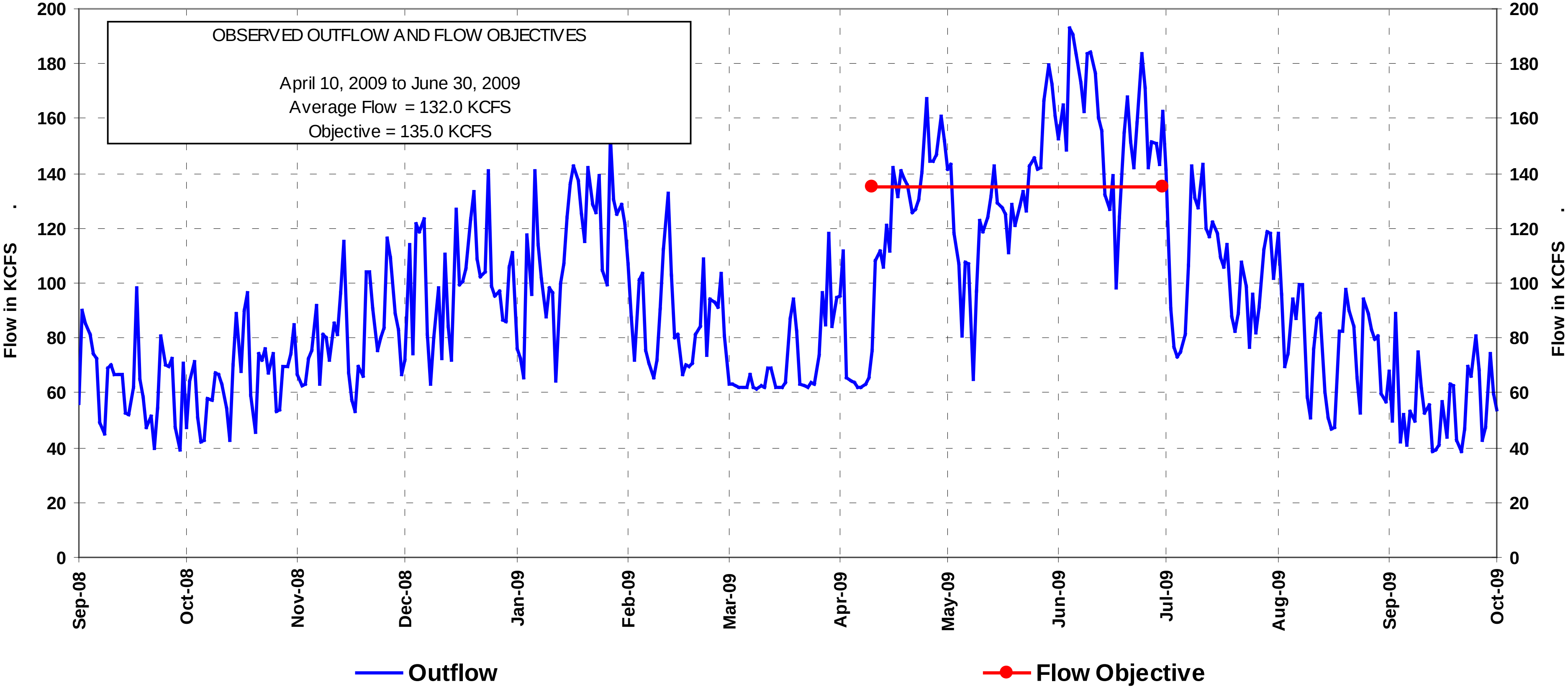
US Army Corps of Engineers

McNary Flow Objectives



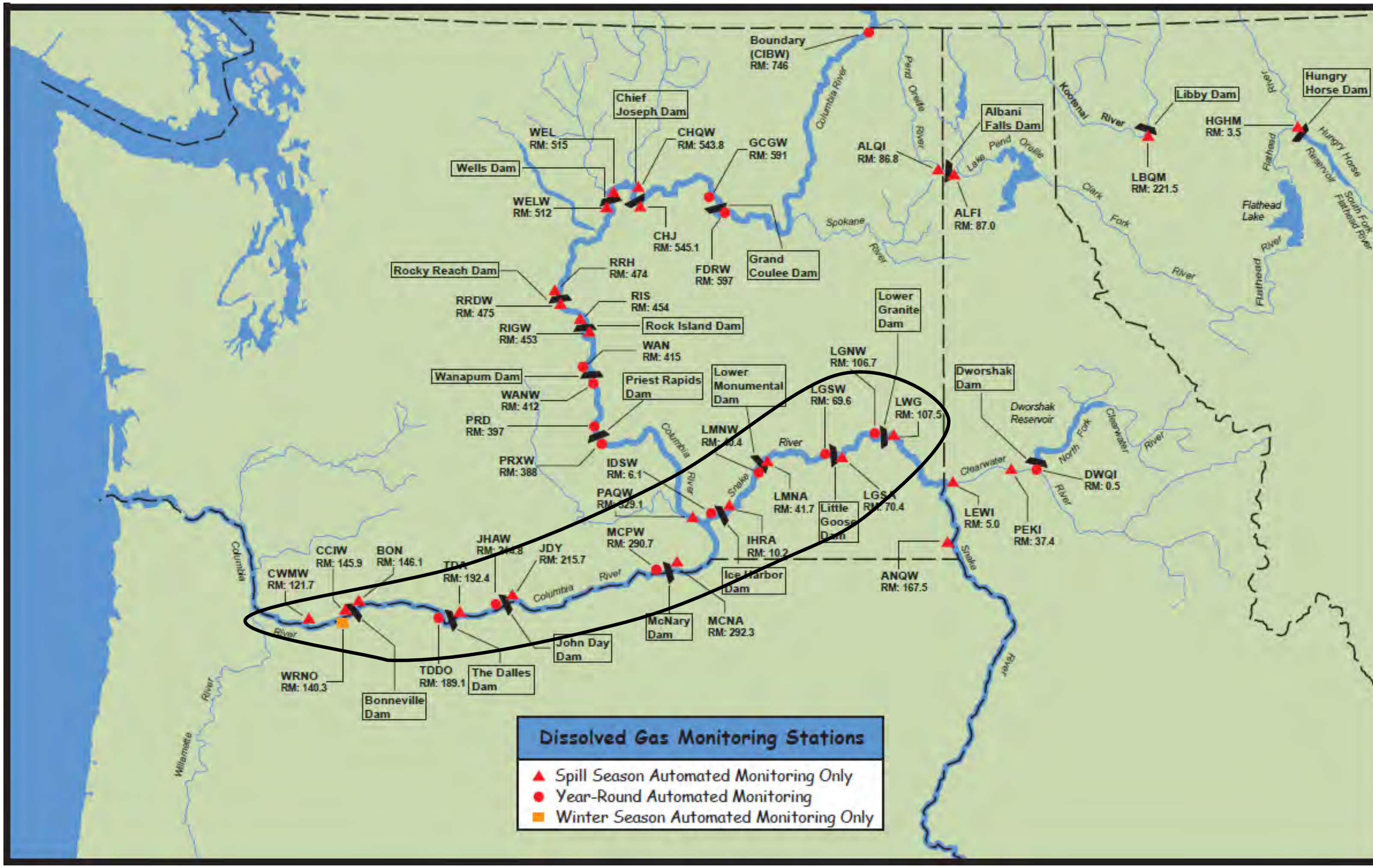
Building Strong

Priest Rapids Flow Objective



US Army Corps of Engineers

TDG Monitoring



Building Strong

Changes in the state TDG standards

- Both Oregon and Washington removed the Camas Washougal gage from their TDG waivers.
- Oregon no longer requires forebay gages to assess TDG levels on the Columbia river
- Washington requires that the highest 12 hours used to calculate the daily TDG average be consecutive

TDG Exceedance Types

Type 1 Condition	**TDG levels exceed the TDG standard due to exceeding powerhouse capacity at run-of-river projects resulting in spill above the BiOp fish spill levels. This condition type includes:**
• High runoff flows and flood control efforts. • BPA load requirements are lower than actual powerhouse capacity. • Involuntary spill at Mid Columbia or lower Snake river dams resulting in high TDG levels entering the lower Columbia River.	
Type 1a Condition	**Planned and unplanned outages of hydro power equipment including generation unit, intertie line, or powerhouse outages.**
Type 2 Exceedance	**TDG exceedances due to the operation or mechanical failure of non-generating equipment. This exceedance type includes:**
• Flow deflectors unable to function for TDG abatement with tailwater elevations above 19 - 26 feet at Bonneville Dam. • Spill gates stuck in open position or inadvertently left open. • Increased spill in a bulk spill operation to pass debris. • Communication errors, such as teletype were transmitted but change was not timely made or misinterpretation of intent of teletype by Project operator.	
Type 2a Exceedance	**Malfunctioning FMS gauge, resulting in fewer TDG or temperature measurements when setting TDG spill caps.**
Type 3 Exceedance	**TDG exceedances due to uncertainties when using best professional judgment, SYSTDG model and forecasts. This exceedance type includes:**
• Uncertainties when using best professional judgment to apply the spill guidance criteria, e.g., travel time, degassing, and spill patterns. • Uncertainties when using the SYSTDG model to predict the effects of various hydro system operations, temperature, degassing, and travel time. • Uncertainties when using forecasts for flows, temperature and wind. • Unanticipated sharp rise in water temperature (a 1.5 degree F. or greater change in a day). • Bulk spill pattern being used which generated more TDG than expected.	

TDG Exceedances

April-August, 1999-2009

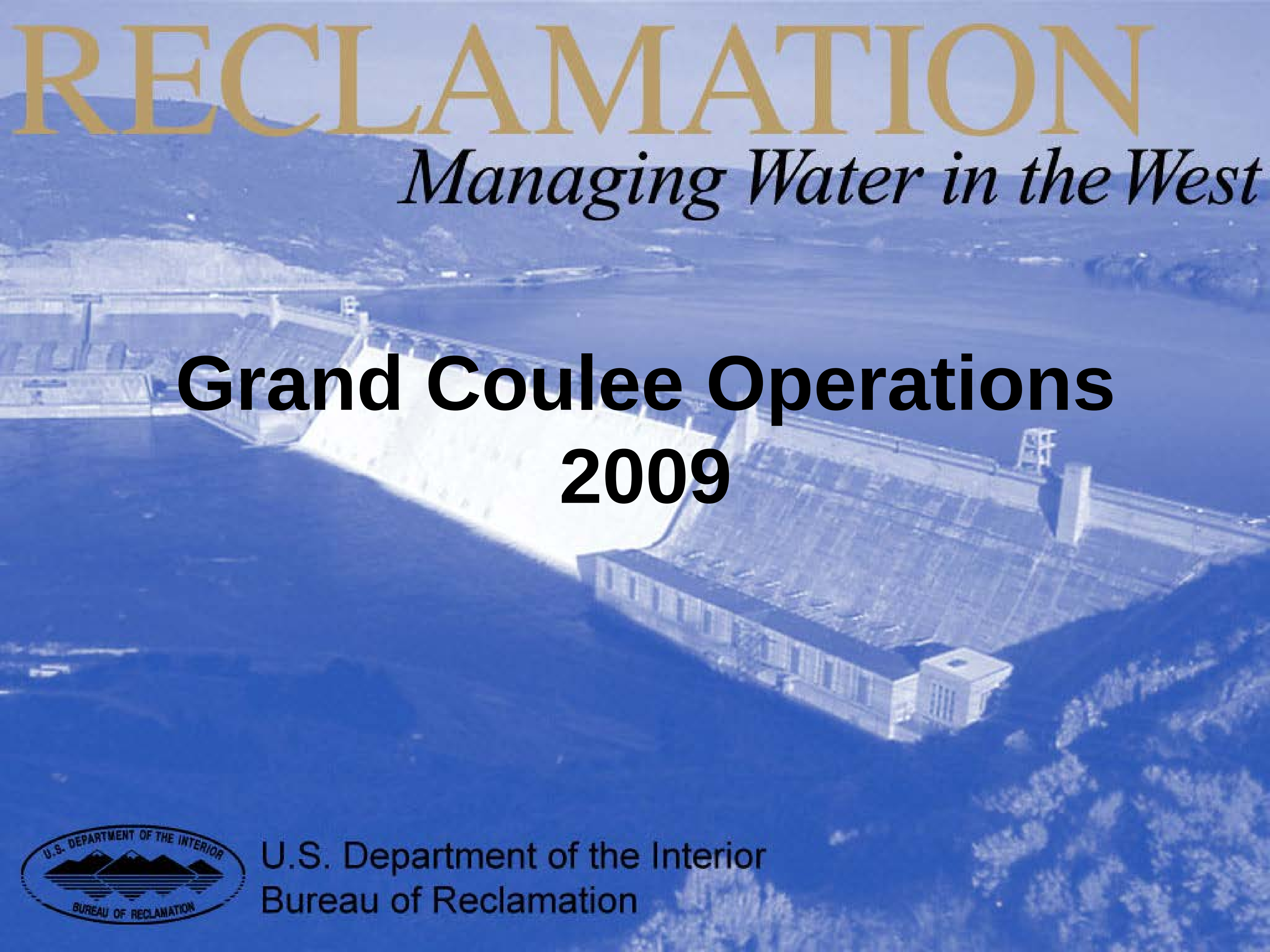
AVERAGE HIGH 12 HR %TDG EXCEEDANCES AT FMS FROM 1999 - 2009												
Water Quality Gages	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**	**1999**	**11 year**
	Qty.	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Qty.**	**Avg**
Lower Granite Forebay	0	0	0	0	0	0	0	0	5	2	0	1
Lower Granite Tailwater	15	35	0	28	0	0	15	17	0	4	15	13
Little Goose Forebay	19	34	0	24	0	3	10	17	0	2	39	15
Little Goose Tailwater	0	23	0	19	0	0	6	6	0	9	6	7
Lower Monumental FB	26	54	11	56	6	1	19	49	0	28	44	29
Lower Monumental TW	21	32	7	29	7	1	10	6	0	12	26	15
Ice Harbor Forebay	44	55	31	51	3	4	35	24	0	34	44	33
Ice Harbor Tailwater	25	31	0	22	3	2	4	6	0	4	12	11
McNary Forebay - WA	4	21	6	31	8	10	24	43	1	14	22	18
McNary Forebay - OR	--	--	--	--	11	23	32	45	5	22	19	16
McNary Tailwater	5	28	1	32	1	7	12	31	0	17	50	18
John Day Forebay	9	14	0	20	2	0	10	11	0	1	8	8
John Day Tailwater	7	17	3	38	3	0	0	29	0	12	43	15
The Dalles Forebay	11	17	8	40	6	5	11	18	0	5	1	12
The Dalles Tailwater	0	2	0	10	0	0	4	11	0	5	5	4
Bonneville Forebay	32	27	3	51	3	1	17	30	0	14	19	20
Cascade Island *	24	57	0	61	0	---	---	---	---	---	---	36
Warrendale	--	--	--	--	---	0	1	19	0	6	2	3
Camas/Washougal	66	68	29	63	16	14	33	65	2	58	51	47
Total Number of Exceedances	**308**	**515**	**99**	**575**	**69**	**71**	**243**	**427**	**13**	**249**	**406**	**270**

TDG Exceedances By Type

FOR 2003 - 2009 SPILL SEASONS									
7 Year Average	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**TYPE #**	**DEFINITION**
175	191	422	6	486	29	7	86	**1**	TDG levels exceed the TDG standard due to exceeding powerhouse capacity at run-of-river projects resulting in spill above the BiOp fish spill levels.
7	1	1	1	45	0	0	0	**1a**	Planned and unplanned outages of hydro power equipment including generation unit, intertie line, or powerhouse outages.
7	1	11	0	14	1	6	17	**2**	TDG exceedances due to the operation or mechanical failure of non-generating equipment.
6	17	10	0	1	1	6	7	**2a**	Malfunctioning FMS gauge, resulting in fewer TDG or temperature measurements for setting TDG spill caps.
85	98	81	93	75	39	48	159	**3**	TDG exceedances due to uncertainties when using best professional judgment, SYSTDG model and forecasts.
280	**308**	**525**	**100**	**621**	**70**	**67**	**269**		**Totals**

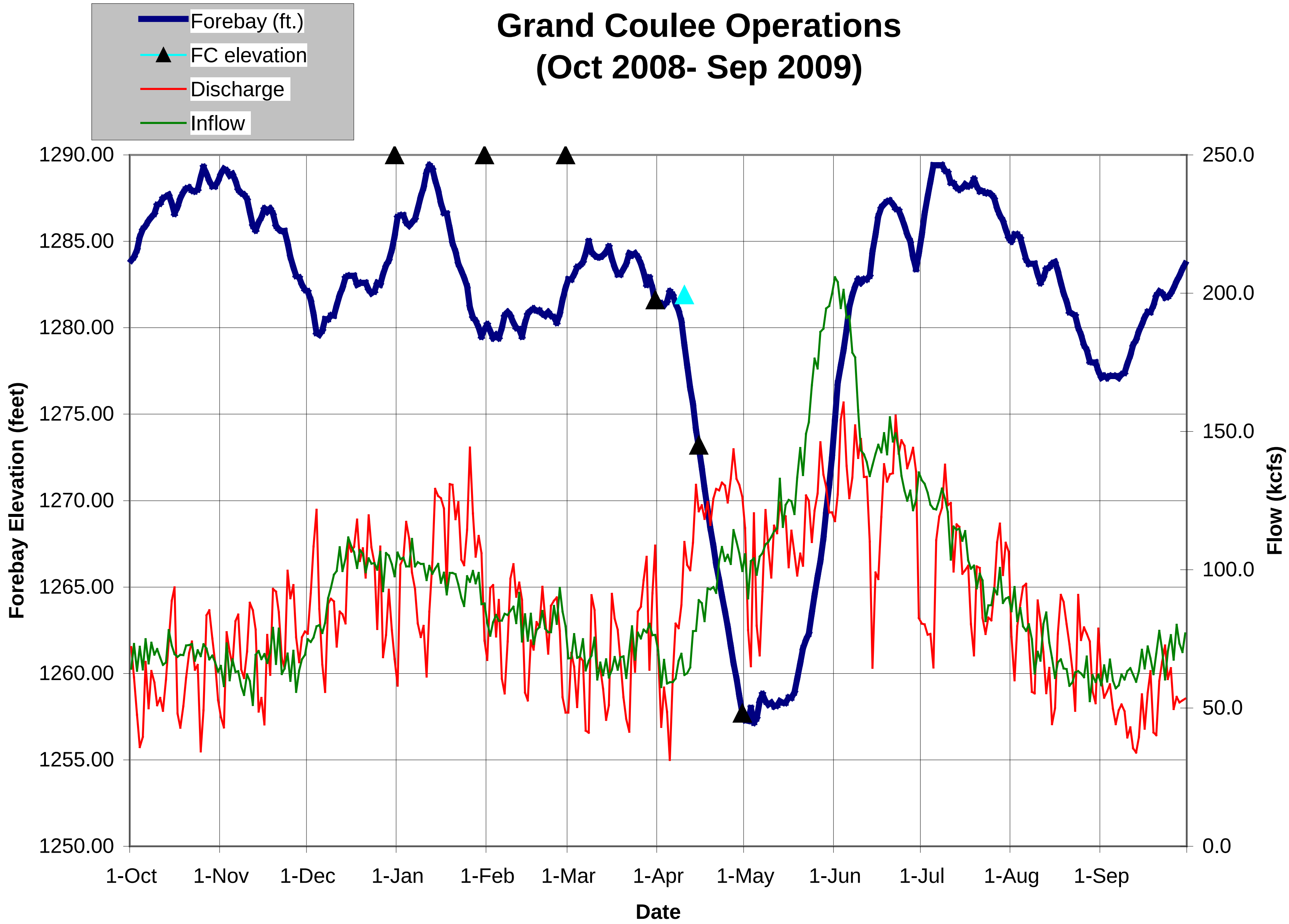
Temperature Exceedances

Location	2009	2008	2007	2006	2005
	Number of days	Number of days	Number of days	Number of days	Number of days
LBQM	0	0	0	0	0
ALFI	54	42	29	70	50
ALQI	54	38	64	70	---
CHJ	0	0	0	0	0
CHQW	0	0	0	0	0
ANQW	76	49	78	76	65
DWQI	0	0	0	0	0
PEKI	0	0	0	0	0
LEWI	0	0	0	0	0
LWG	3	0	1	5	53
LGNW	0	0	1	8	0
LGSA	25	7	35	51	20
LGSW	18	6	34	48	20
LMNA	36	13	58	59	40
LMNW	31	14	59	59	44
IHRA	61	32	66	68	56
IDSW	62	36	68	69	60
PAQW	38	12	28	38	27
MCNA	60	27	63	59	49
MCPW	65	29	65	61	50
JDY	60	39	72	68	55
JHAW	70	41	72	68	55
TDA	63	34	69	67	56
TDDO	70	38	69	67	56
BON	62	27	65	64	56
CCIW	65	27	65	65	55
CWMW	65	34	66	65	58
Total	**1,038**	**545**	**1,127**	**1,205**	**925**



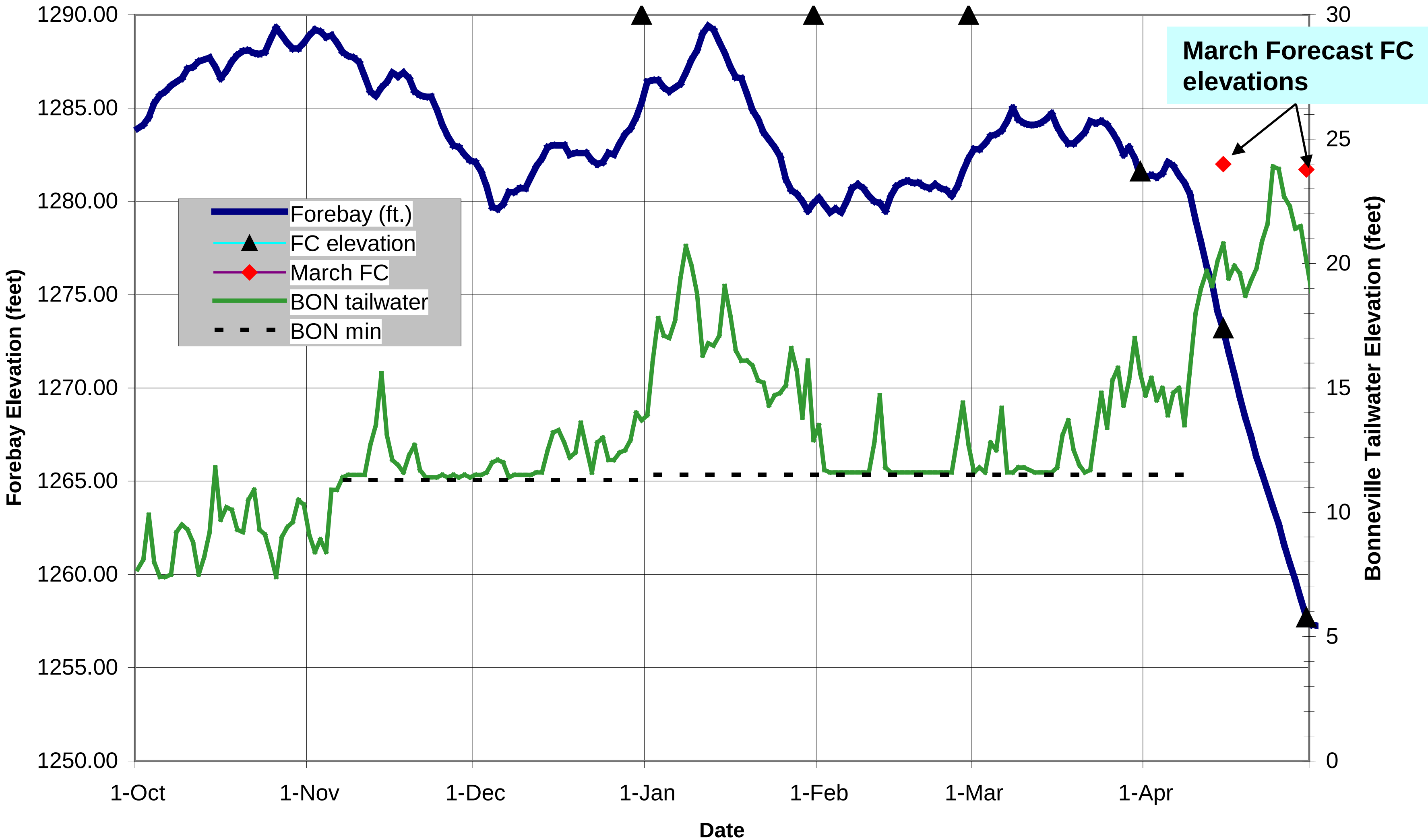
Grand Coulee Operations 2009

U.S. Department of the Interior
Bureau of Reclamation



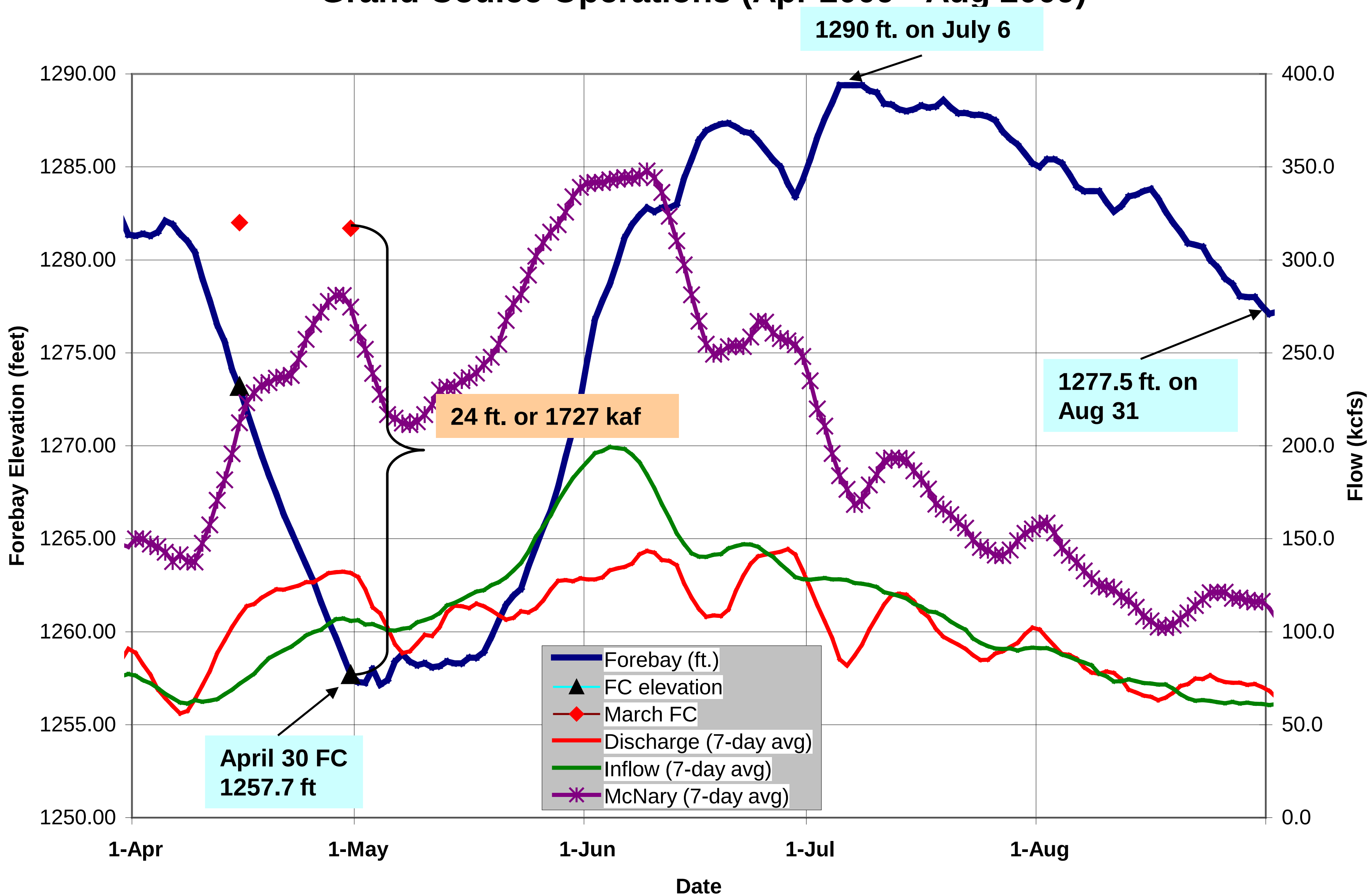
RECLAMATION

Grand Coulee Operations
(Oct 2008- Apr 2009)



RECLAMATION

Grand Coulee Operations (Apr 2009 - Aug 2009)



Hatchery Subyearling Survival Lower Granite to McNary Dam 1998 to 2009

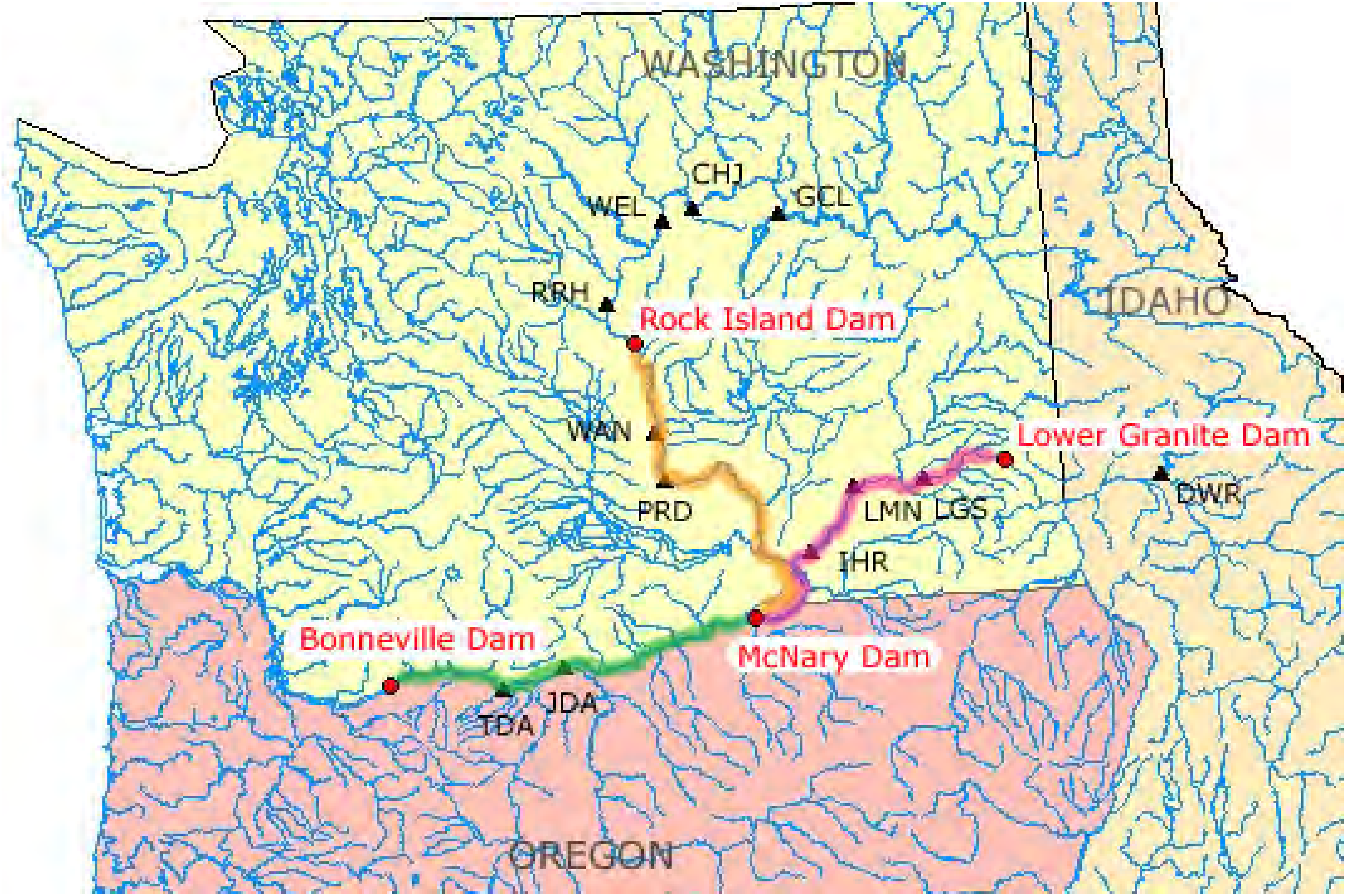
(preliminary results)

Fish Passage Center

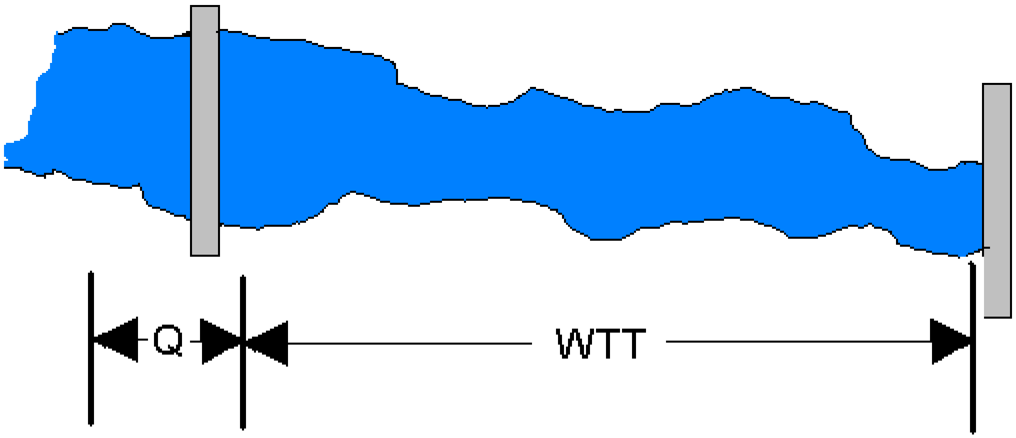
Overview

- PIT-tagged Hatchery Subyearling Chinook passing LGR dam during two-week blocks from May 20 to July 15 each year--from release sites ('GRAND1','SNAKE3','SNAKE4','LUGUAF','NPTH','NLVP‘)
- Estimate Survival and Travel Time for blocks
- Assign average environmental variables during passage such as Flow, Spill, Temperature and Water Transit Time
- Show bivariate plots of Reach Survival and environmental variables.

Lower Granite to McNary Dam Reach

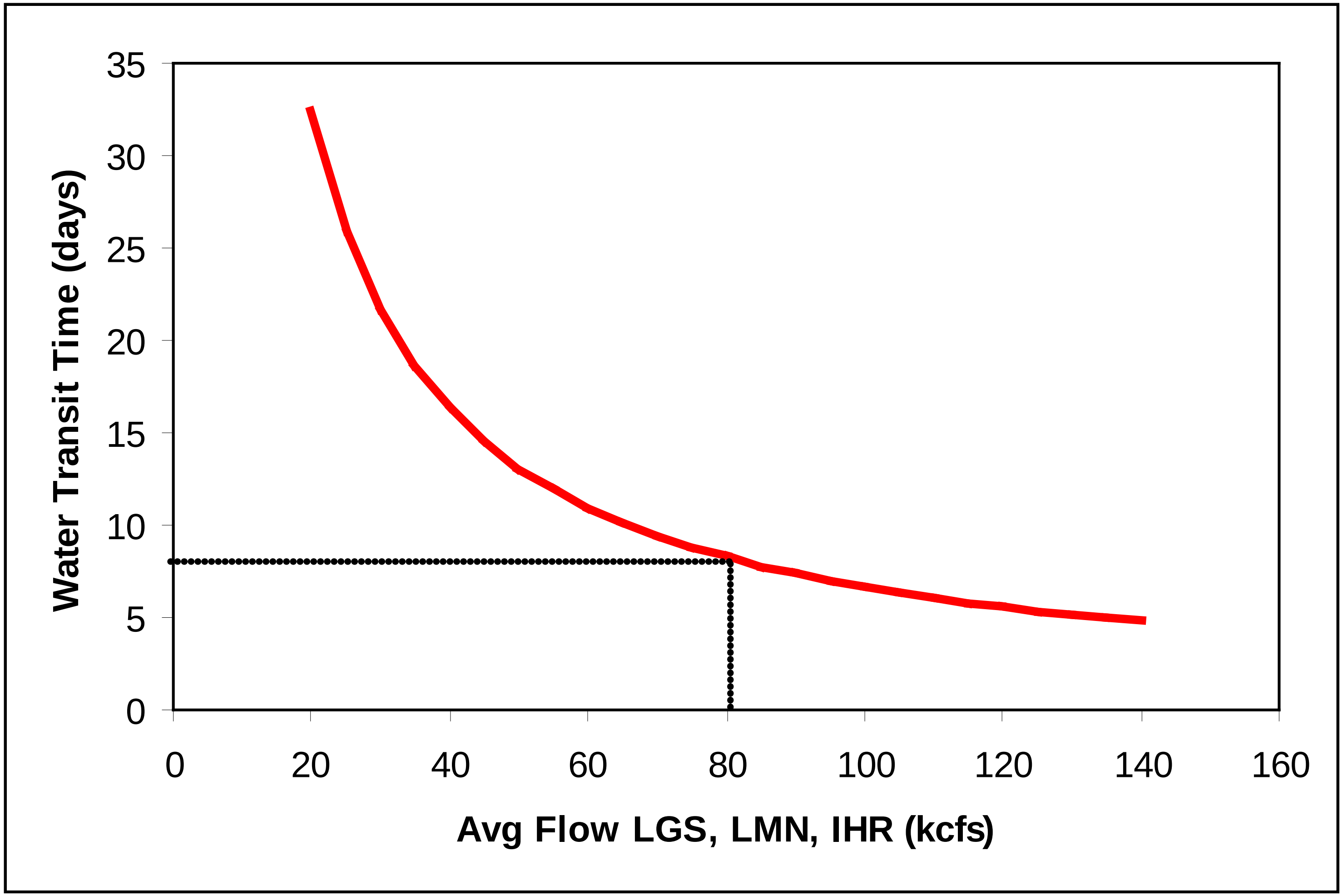


Water Transit Time

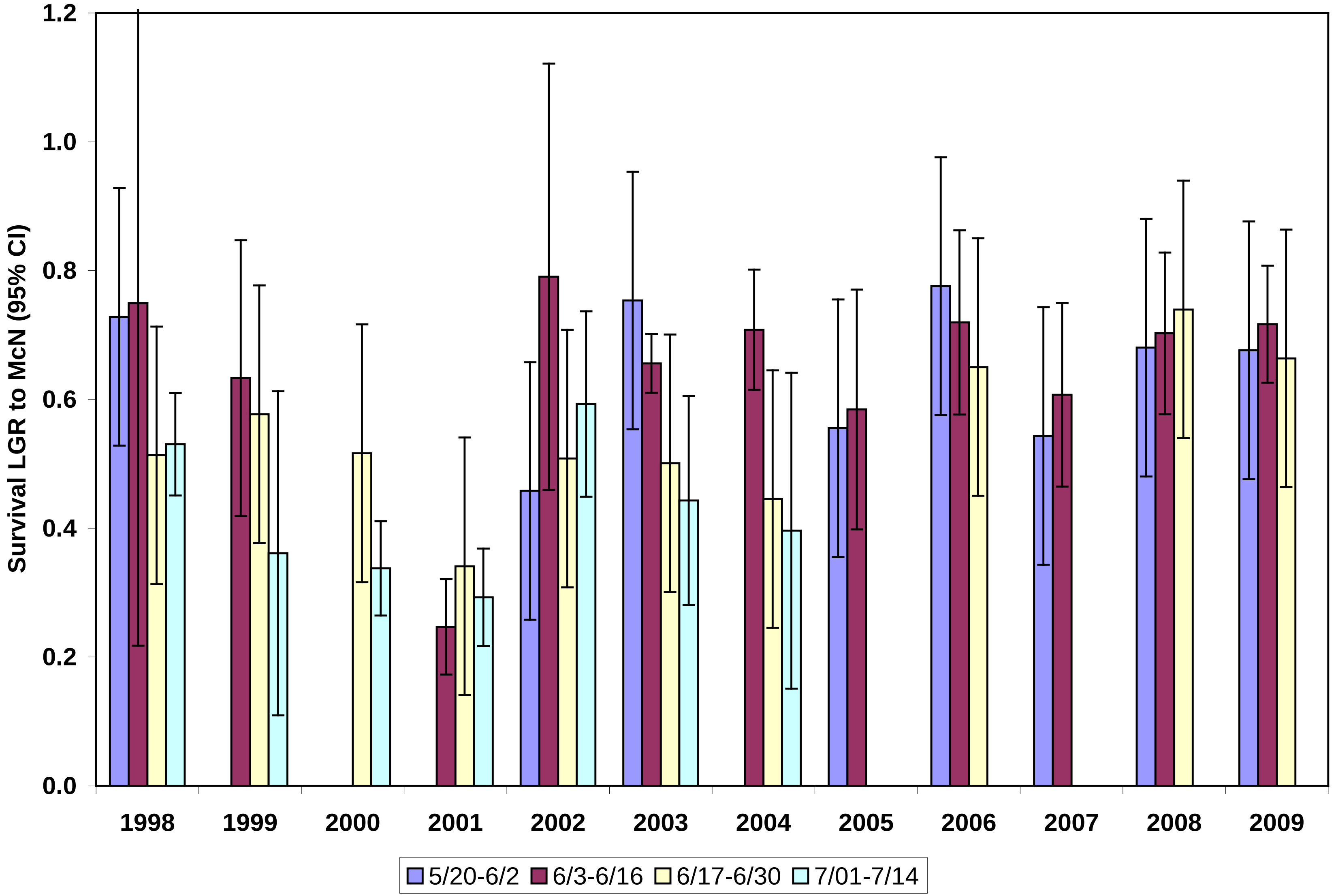


- WTT--Avg Time for Water Particle to Transit Reservoir
- Q -- discharge at dam

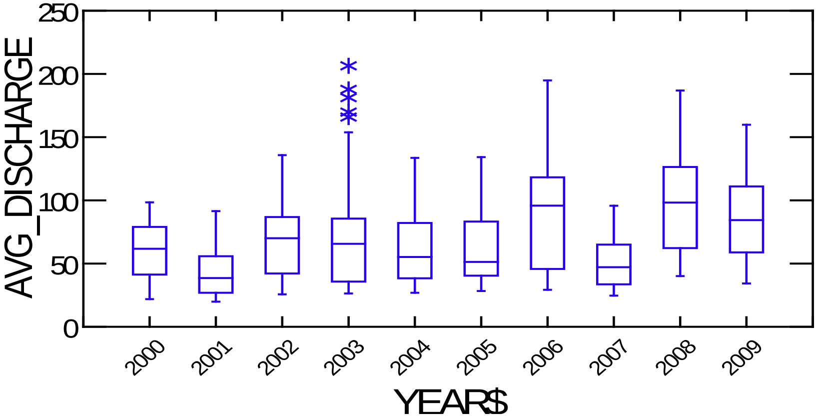
Converting Flows to Water Transit Time



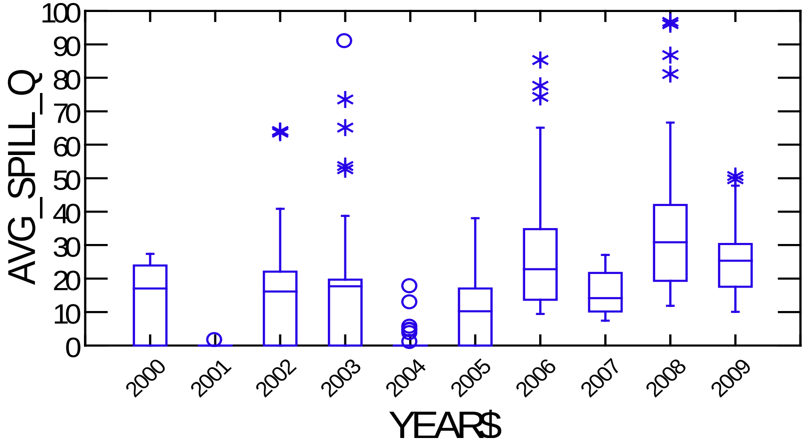
Survival for Hatchery Subyearling Chinook LGR to McN 1998 to 2009 with 95% CI's



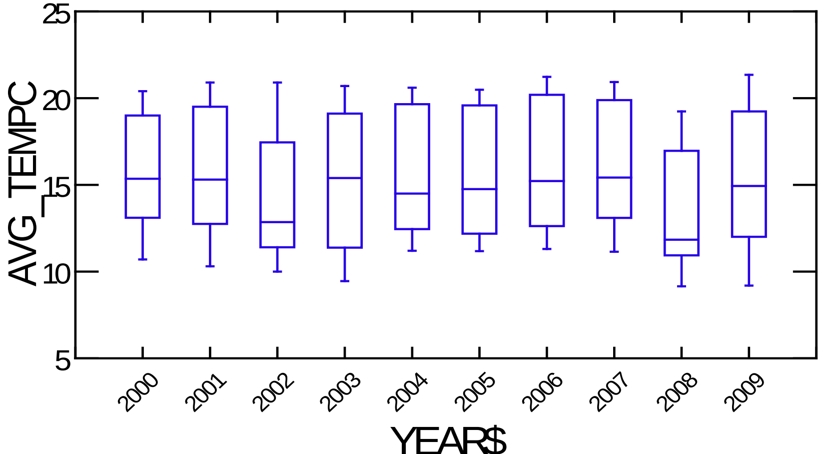
Comparison of Environmental conditions at LGS



Flows in 2009 were lower than 2008 and 2006 but relatively high compared to other years

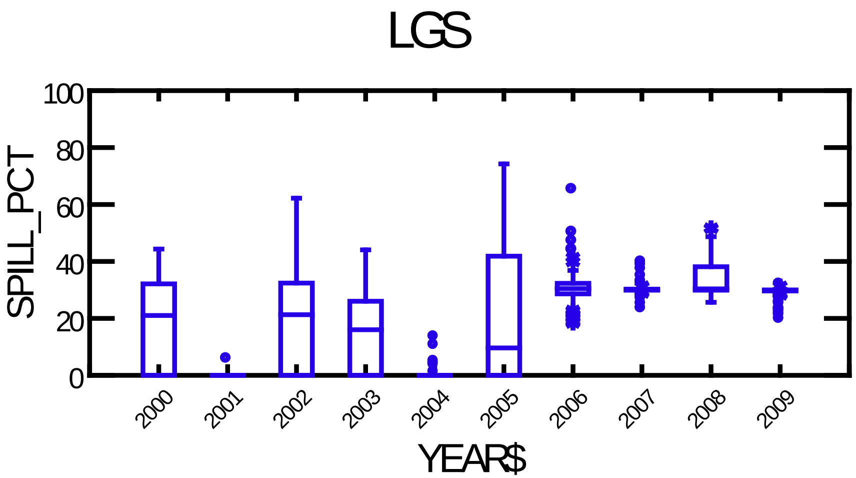


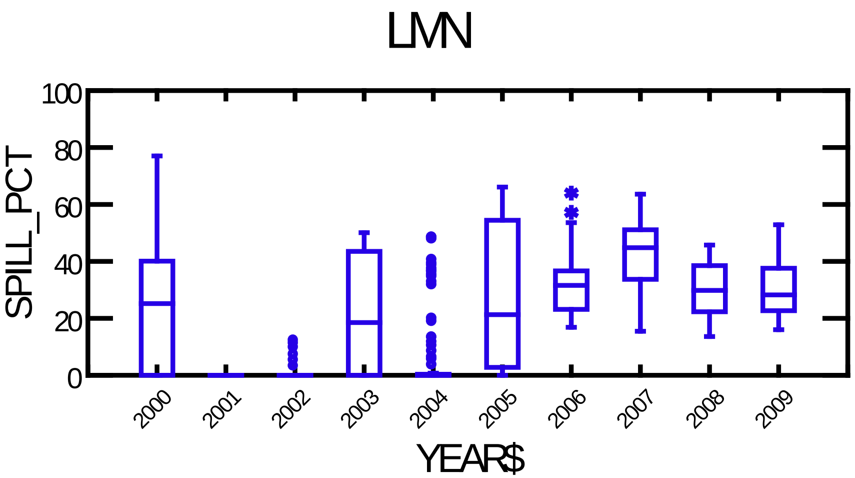
Avg spill volumes were high in 2009 similar to other years since 2005

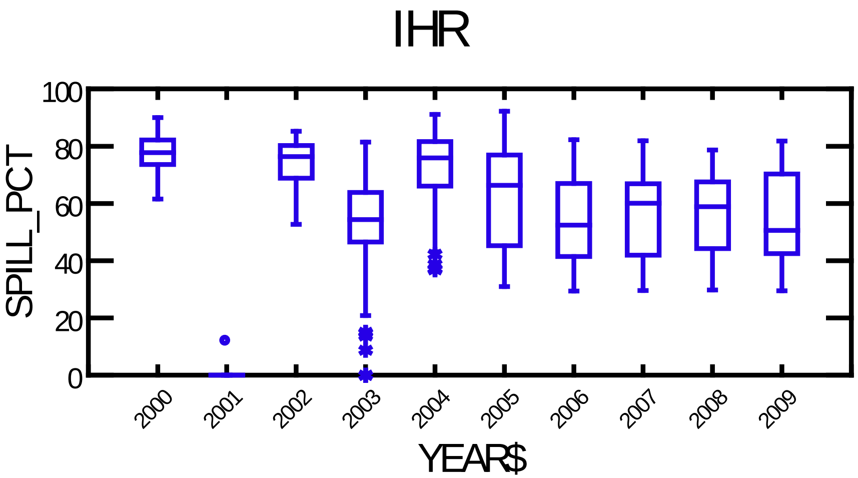


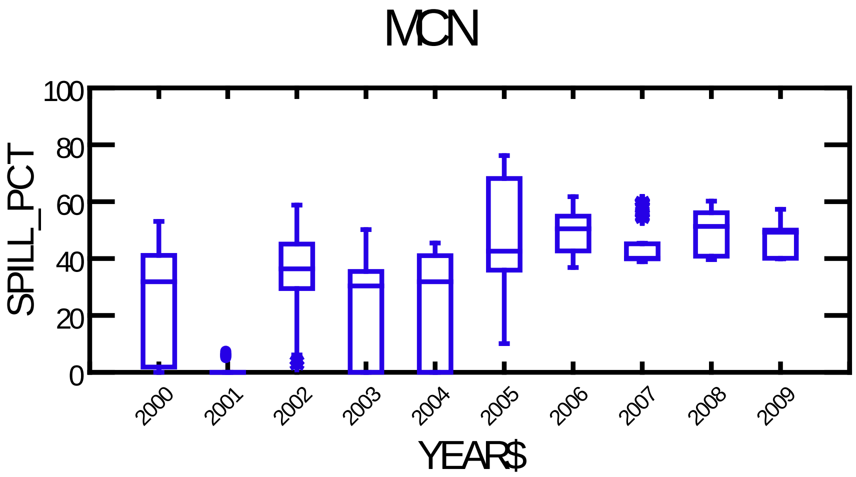
Temperatures were similar to other years-- except for cool temps in 2008

Spill Percent by site May to July

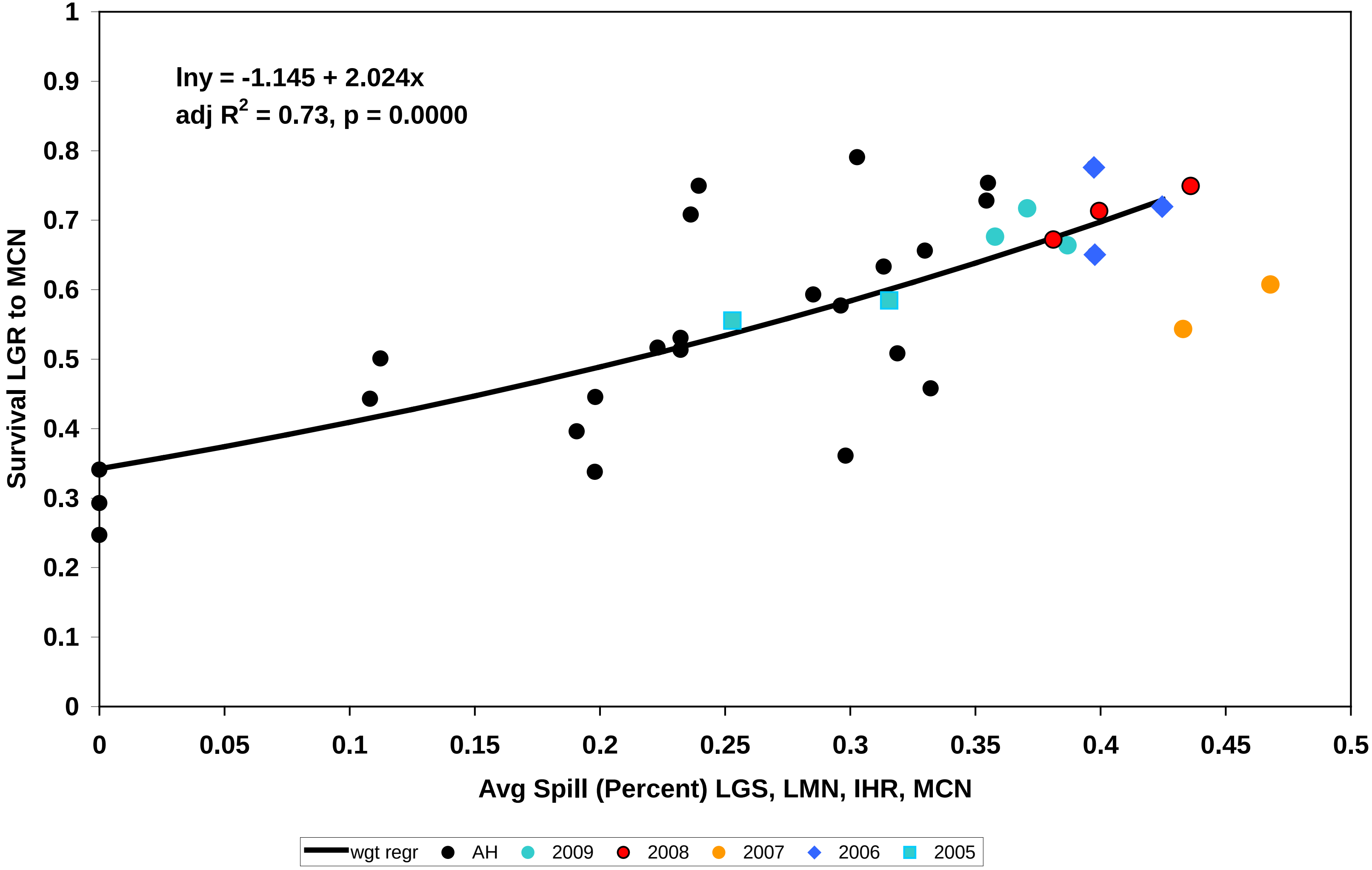




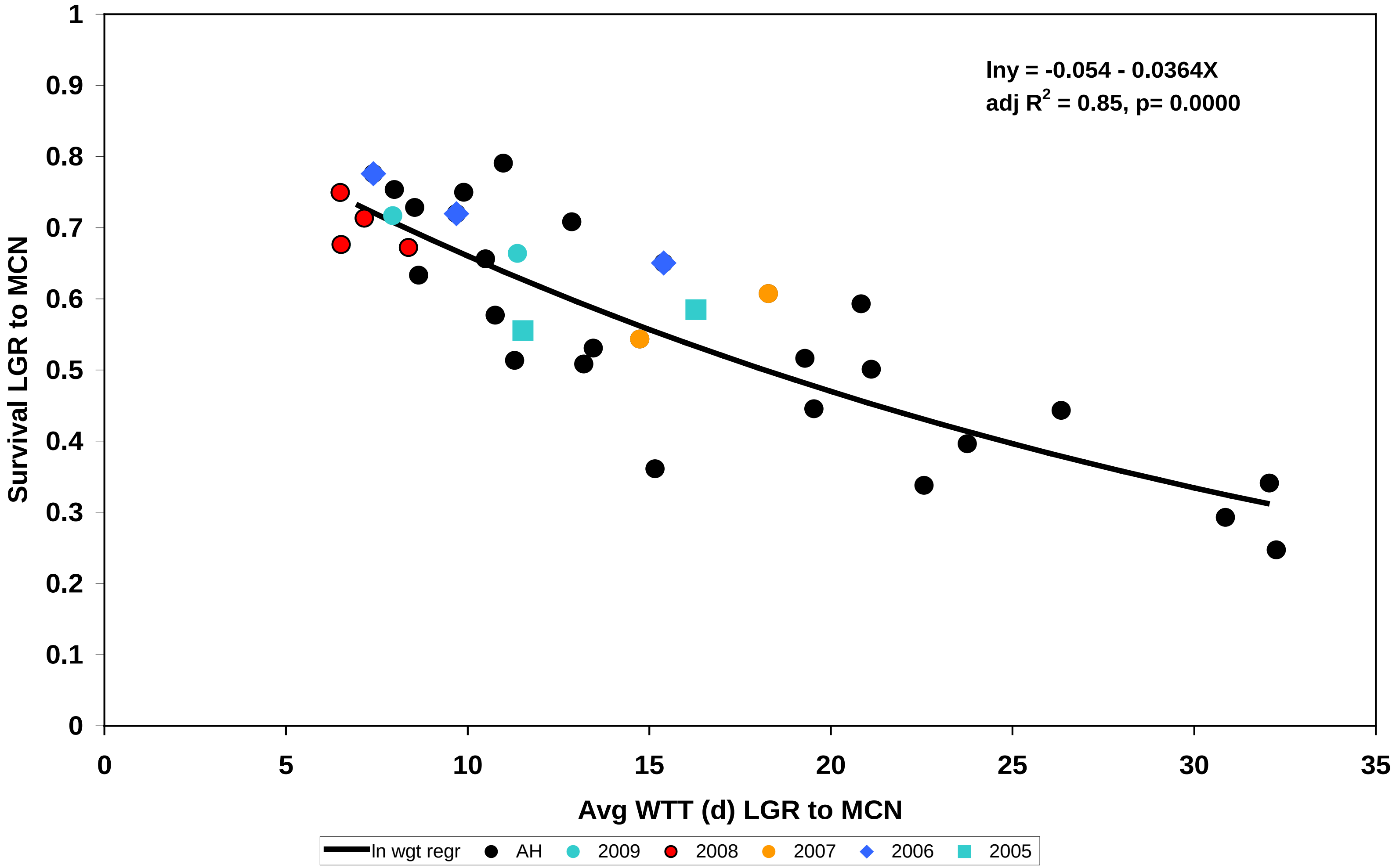




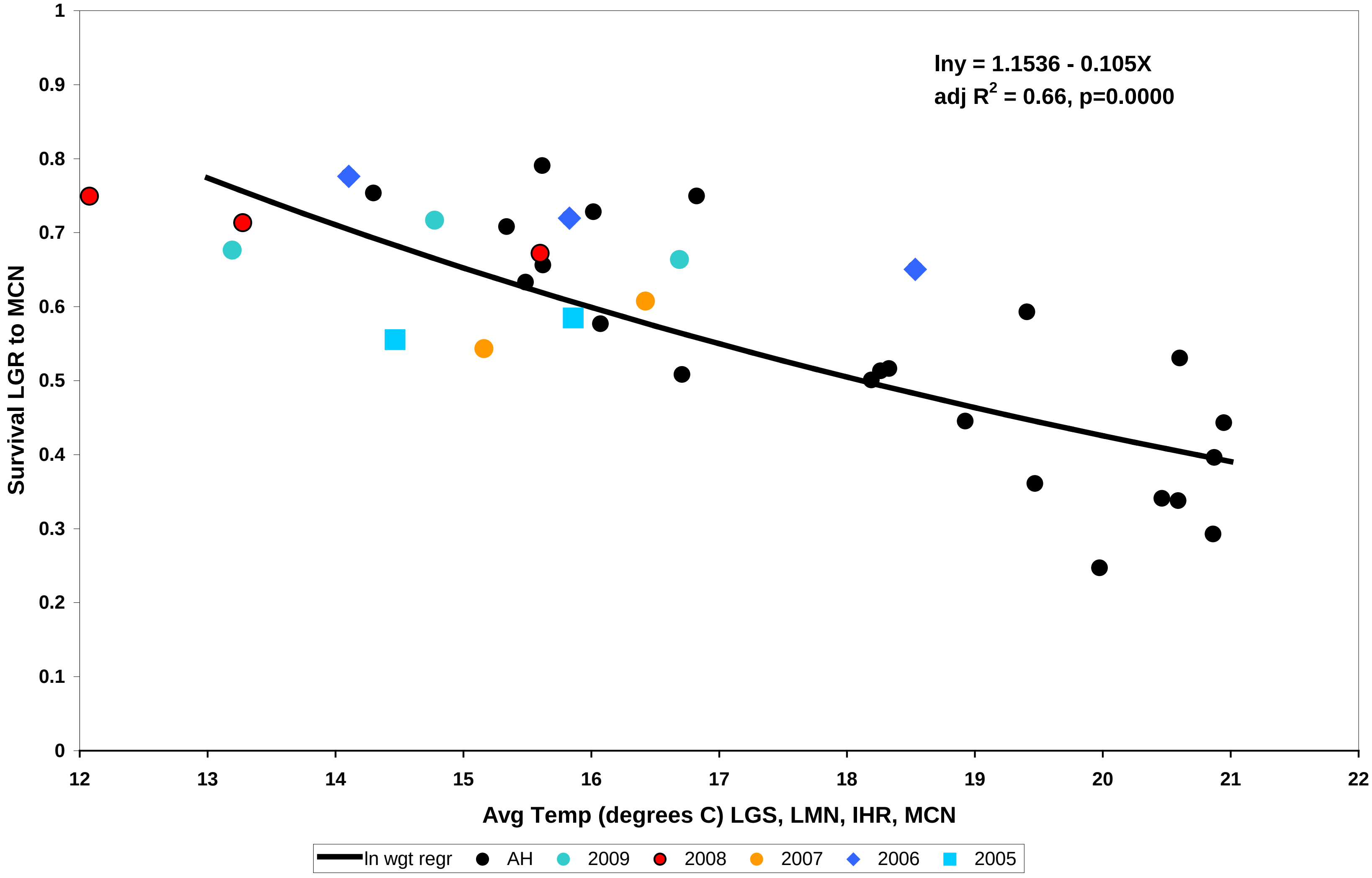
Hatchery Subyearling Chinook Survival vs Avg Spill Pct LGS, LMN, IHR, McN



Hatchery Subyearling Chinook Survival vs sum WTT LGS, LMN, IHR, McN



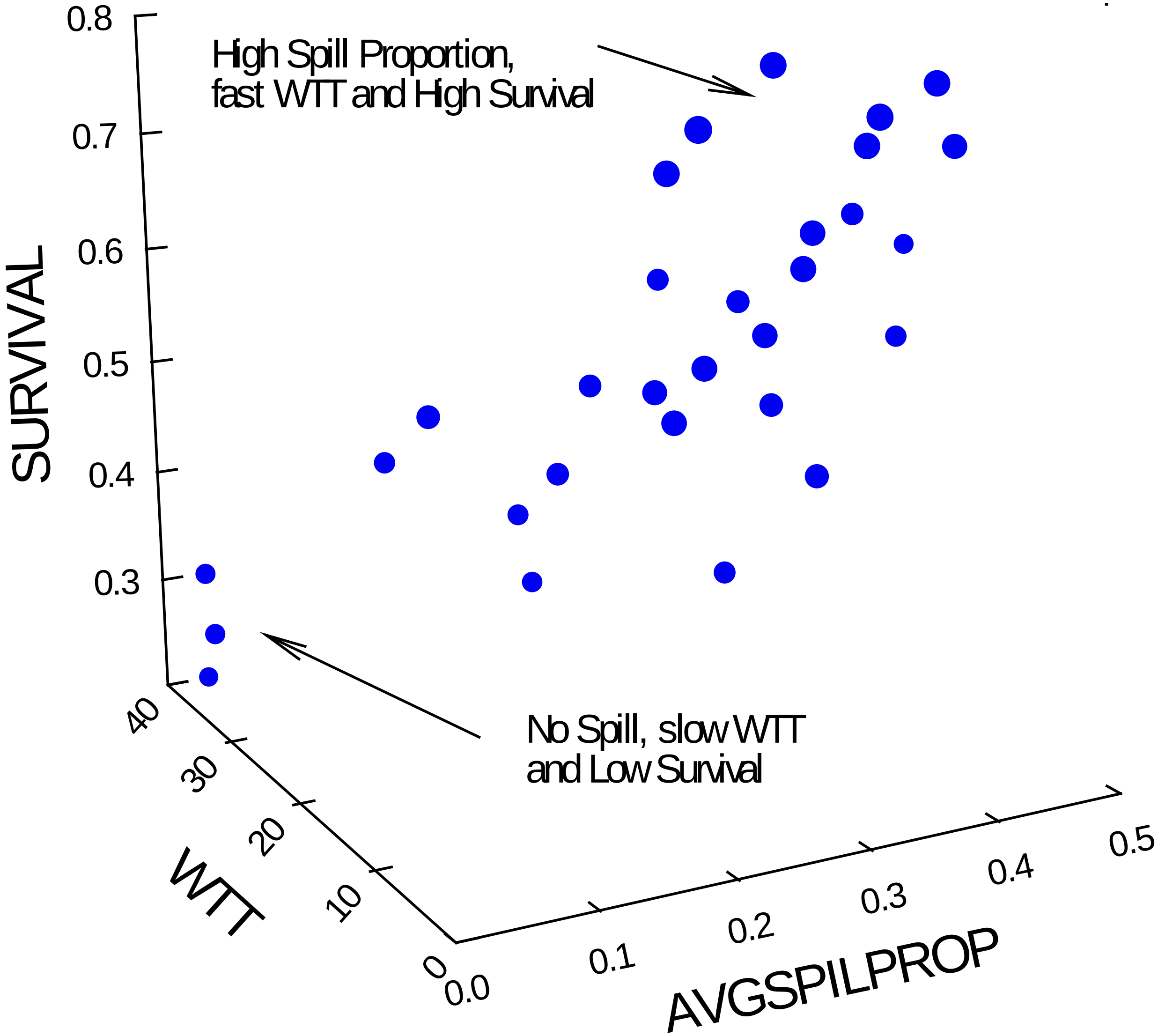
Hatchery Subyearling Chinook Survival vs Avg Temp LGS, LMN, IHR, McN



Pearson Correlation Matrix

	REL_GRP	AV_SPIL_PROP	WTT	FISHTT	SURVIVAL
REL_GRP	1				
AV_SPIL_PROP	-0.46548	1			
WTT	0.51856	-0.91248	1		
FISHTT	0.214	-0.74899	0.85072	1	
SURVIVAL	-0.54942	0.86314	-0.91942	-0.8094	1

Hatchery Subyearling Chinook Survival vs WTT and Spill Proportion



Probability of being transported

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
P(T)	0.93	0.96	0.93	0.90	0.97	0.81	0.52(H) 0. 56(W)	0.42 (H)	0.52 (H) 0.43 (W)	0.51 (H) 0.45 (W)

Conclusions

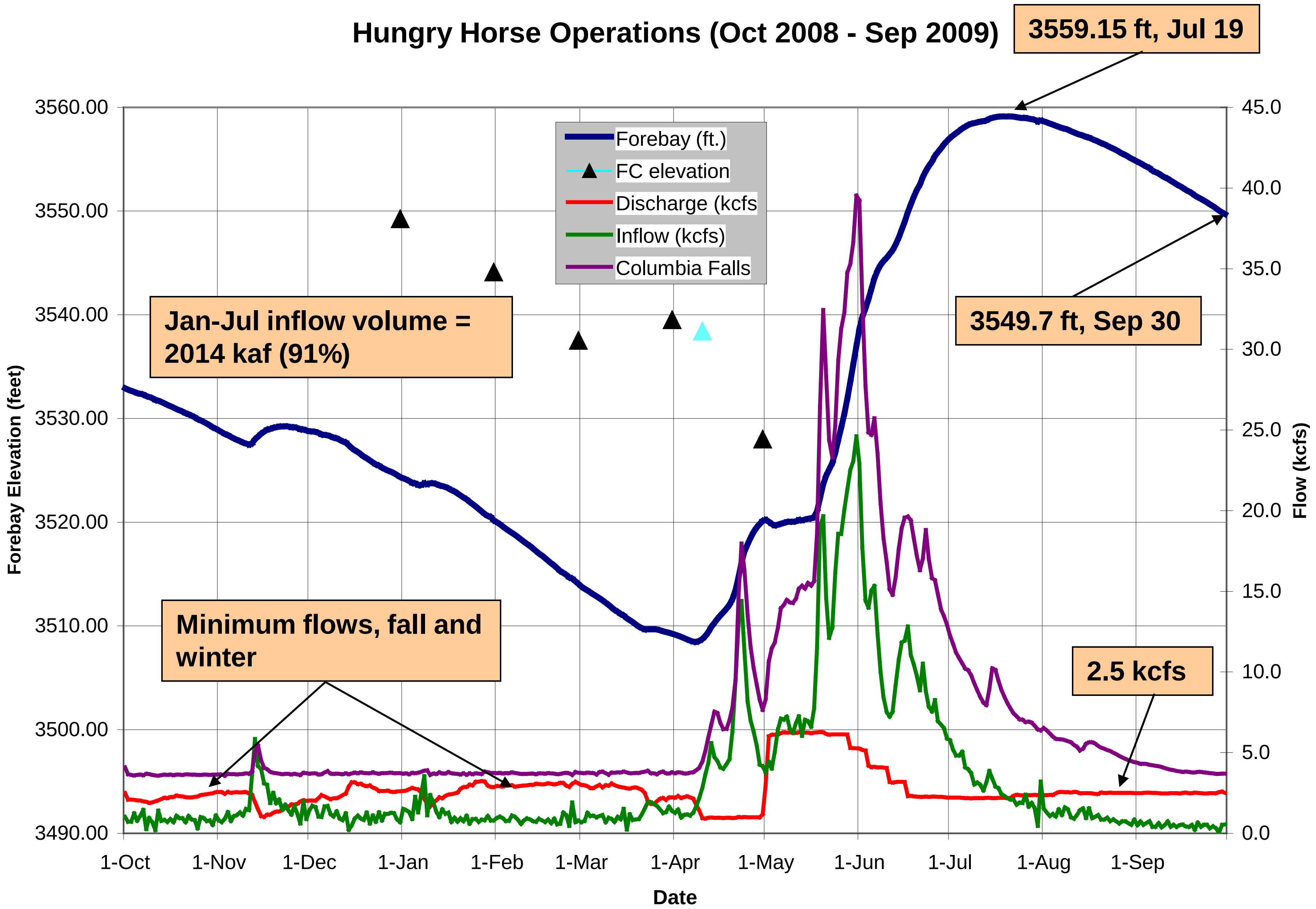
- For actively migrating subyearling Chinook, increased spill and decreased water transit time (higher flows) improve survival, while higher temperatures decrease survival
- Survivals were relatively high in 2009 because of high flows through June and above average spill while temperatures were near average for period of years analyzed

RECLAMATION

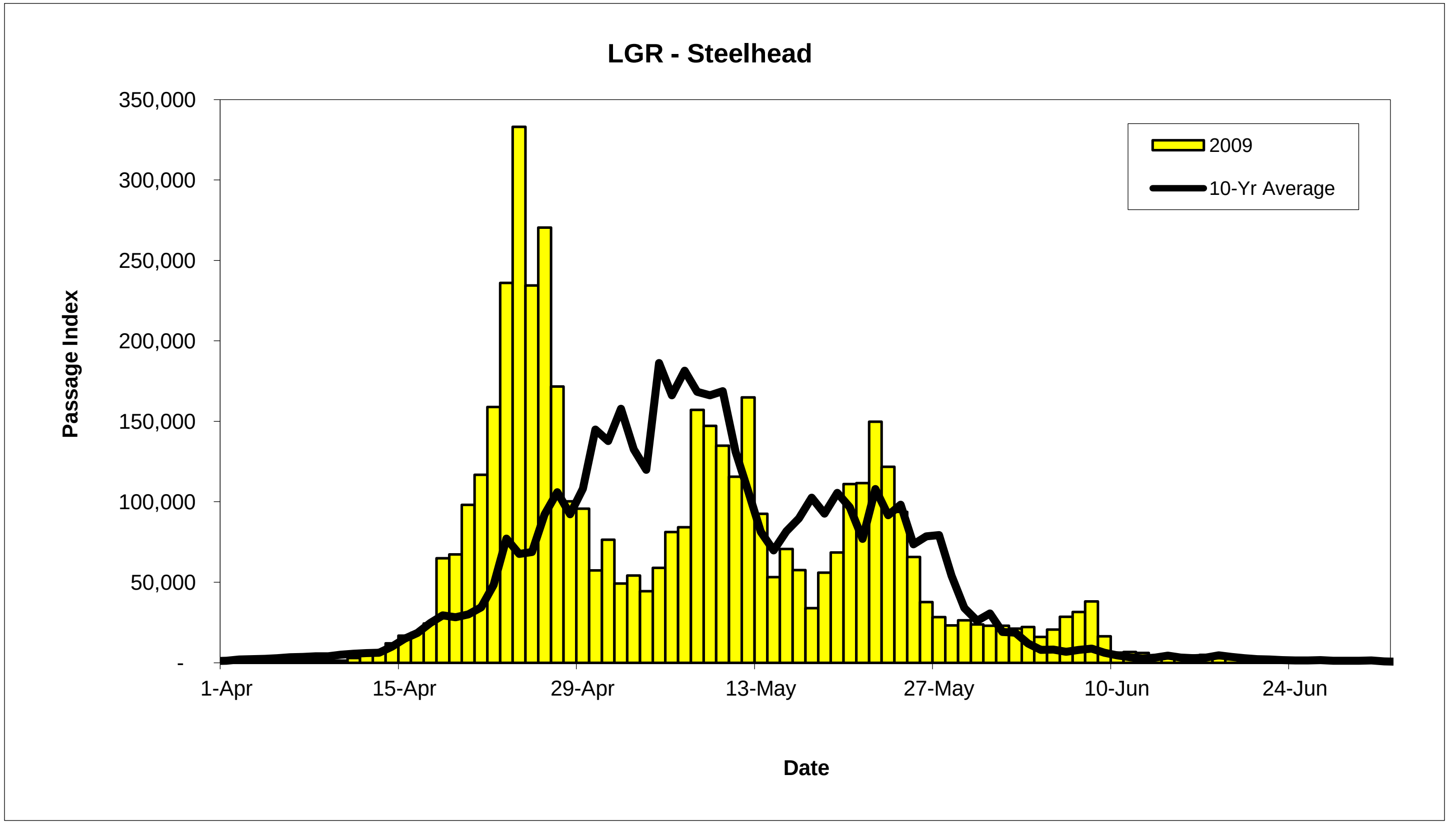
Managing Water in the West

Hungry Horse Operations 2009

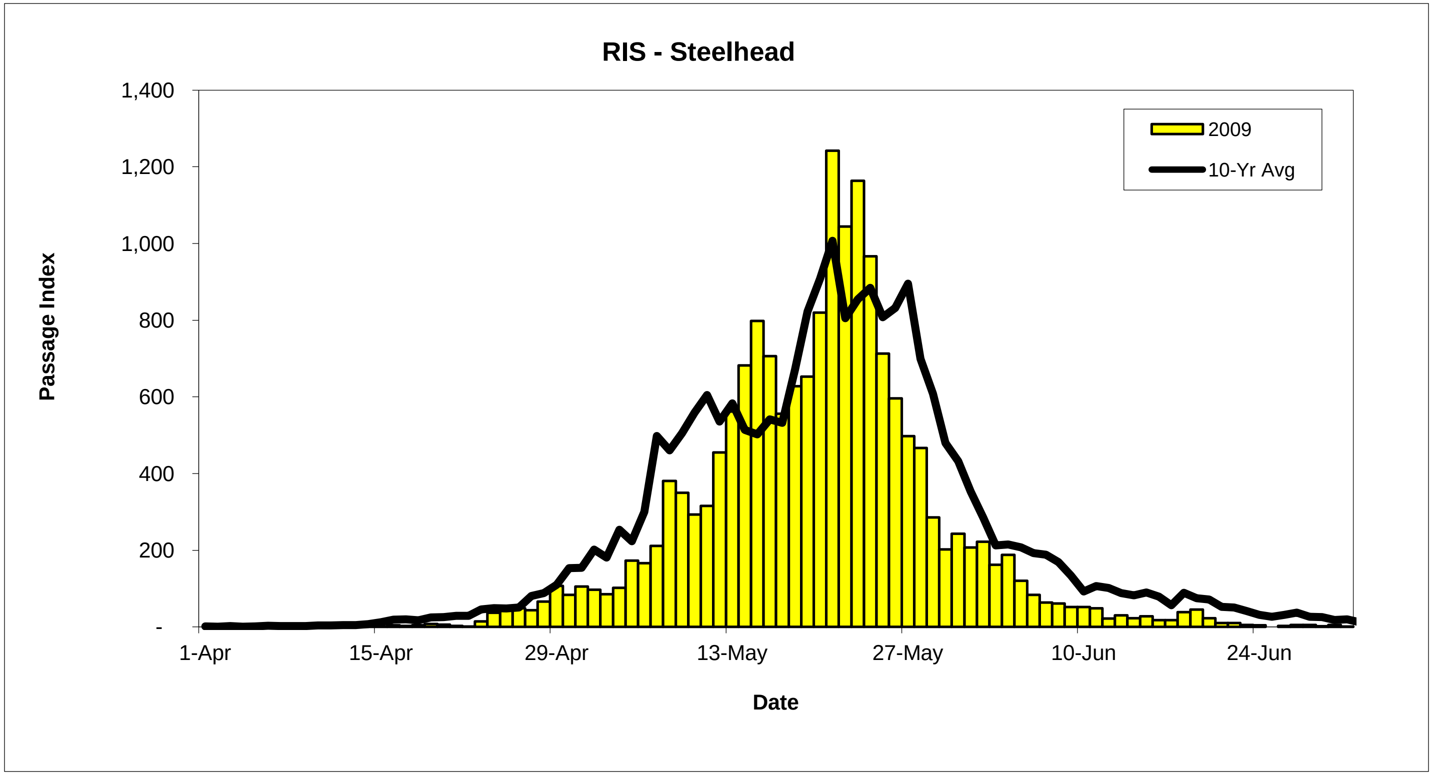
U.S. Department of the Interior
Bureau of Reclamation


Hungry Horse Operations (Oct 2008 - Sep 2009)
3559.15 ft, Jul 19
Forebay (ft.)
FC elevation
Discharge (kcfs
Inflow (kcfs)
Columbia Falls
Jan-Jul inflow volume = 2014 kaf (91%)
3549.7 ft, Sep 30
Minimum flows, fall and winter
2.5 kcfs
Forebay Elevation (feet)
Flow (kcfs)
Date
3560.00
3550.00
3540.00
3530.00
3520.00
3510.00
3500.00
3490.00
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1-Oct
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep

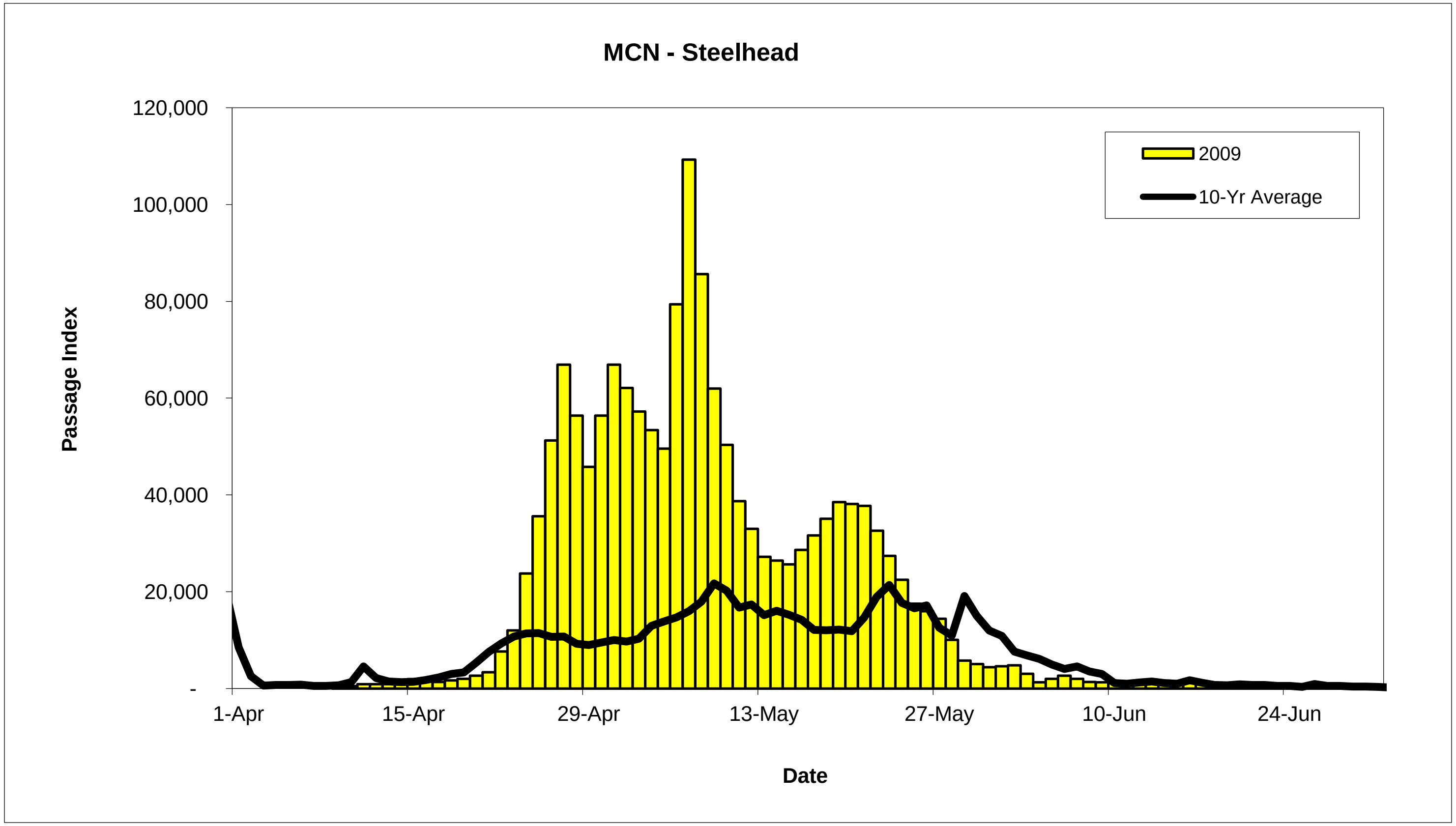
Lower Granite Steelhead



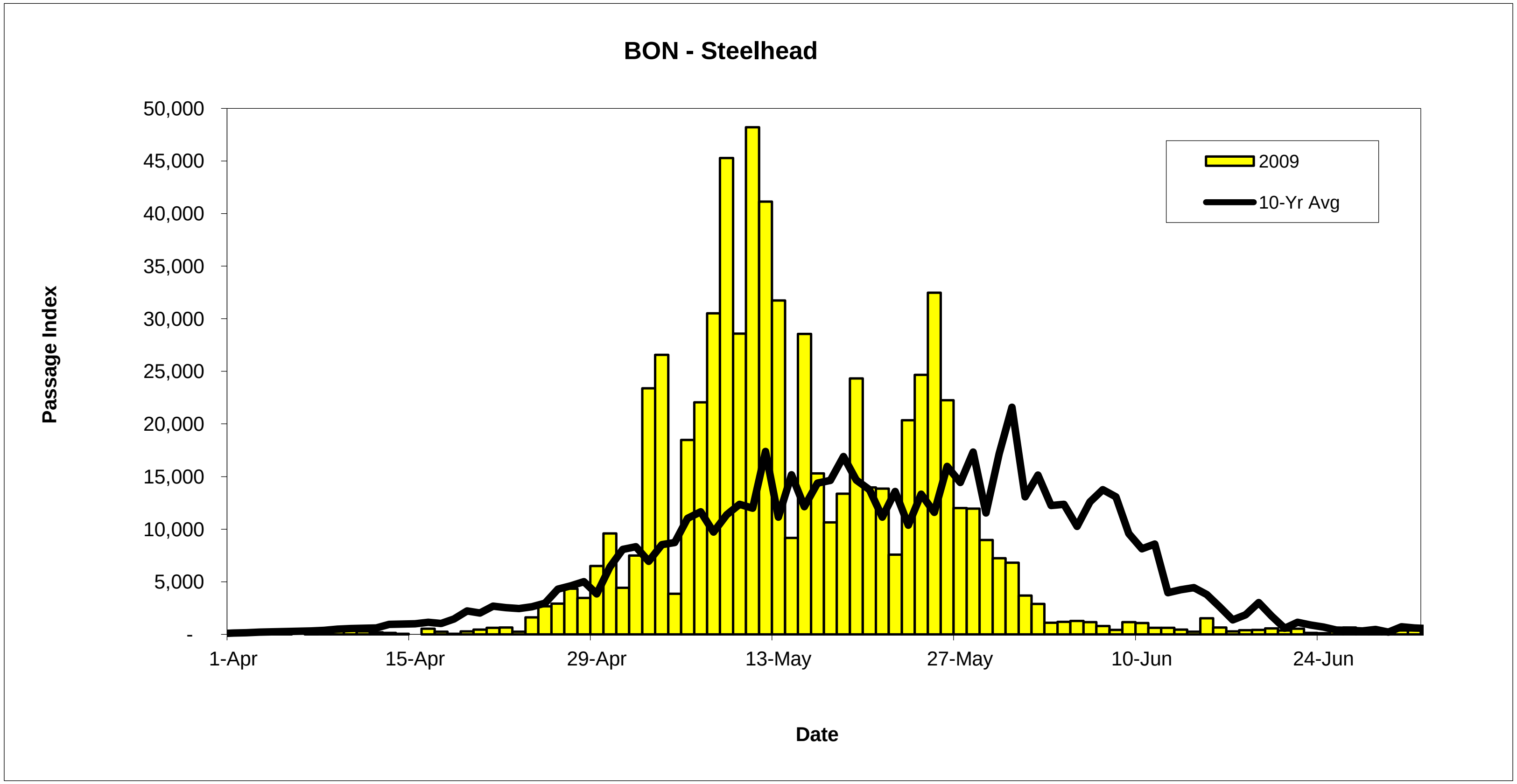
Rock Island Steelhead



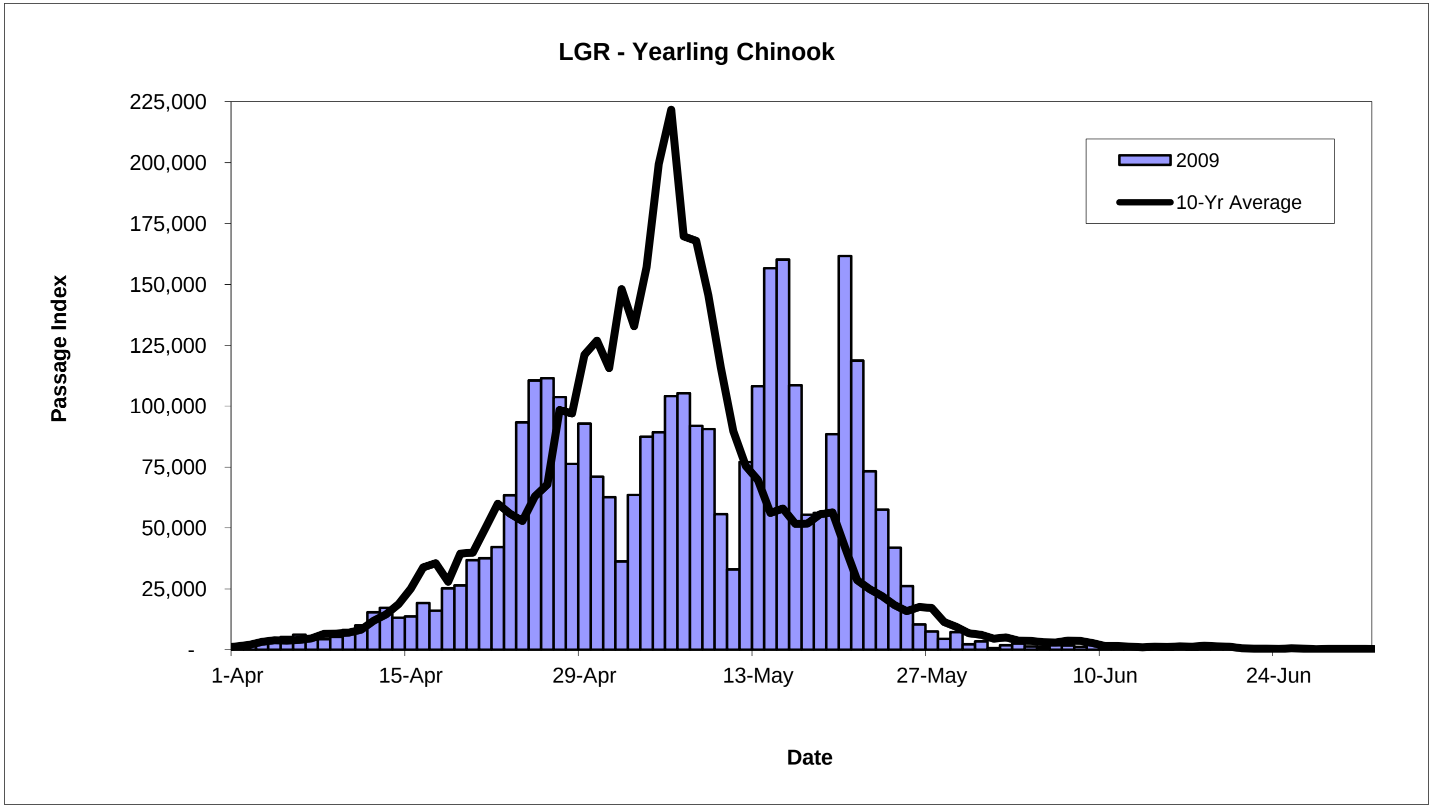
McNary Steelhead



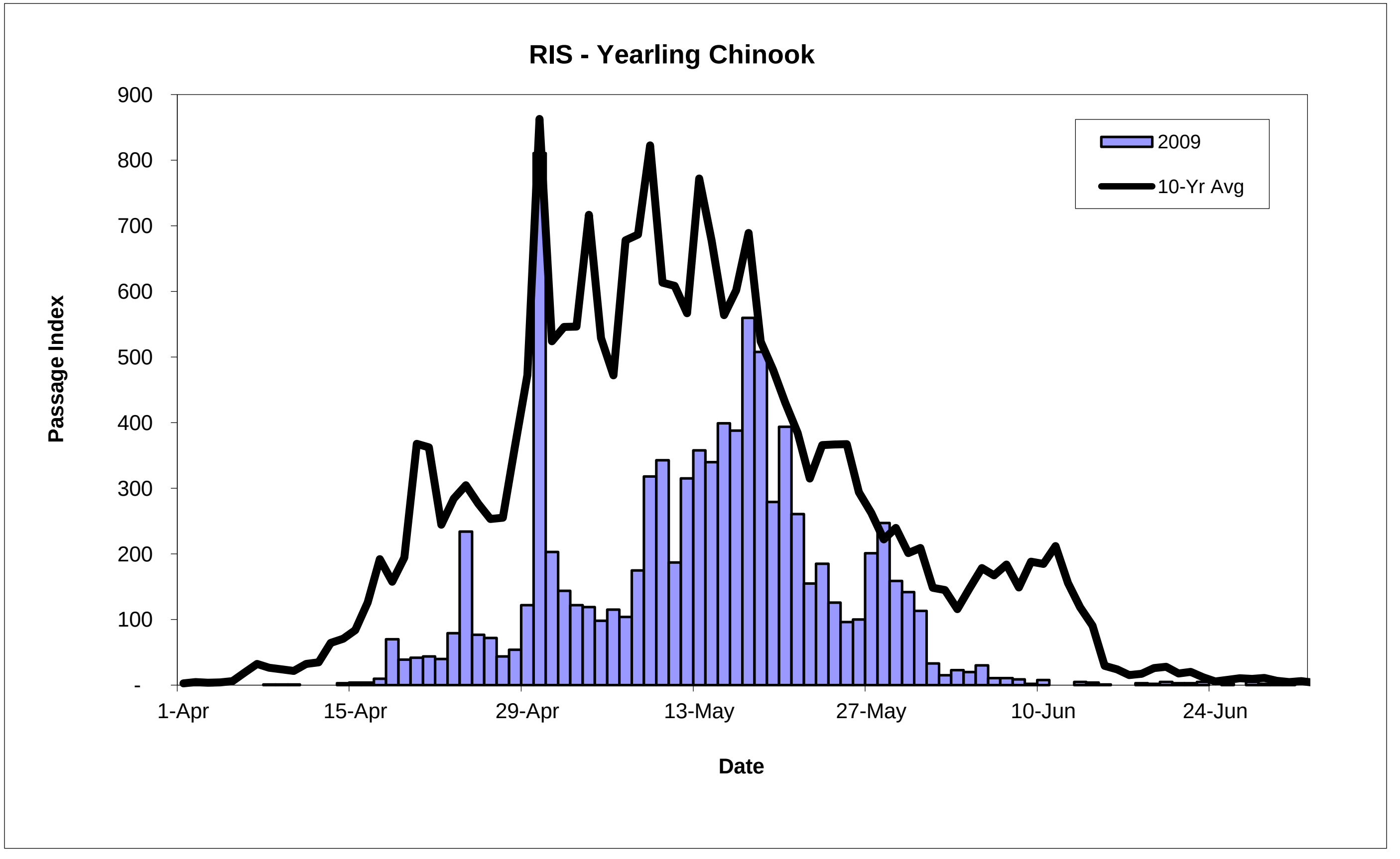
Bonneville Steelhead



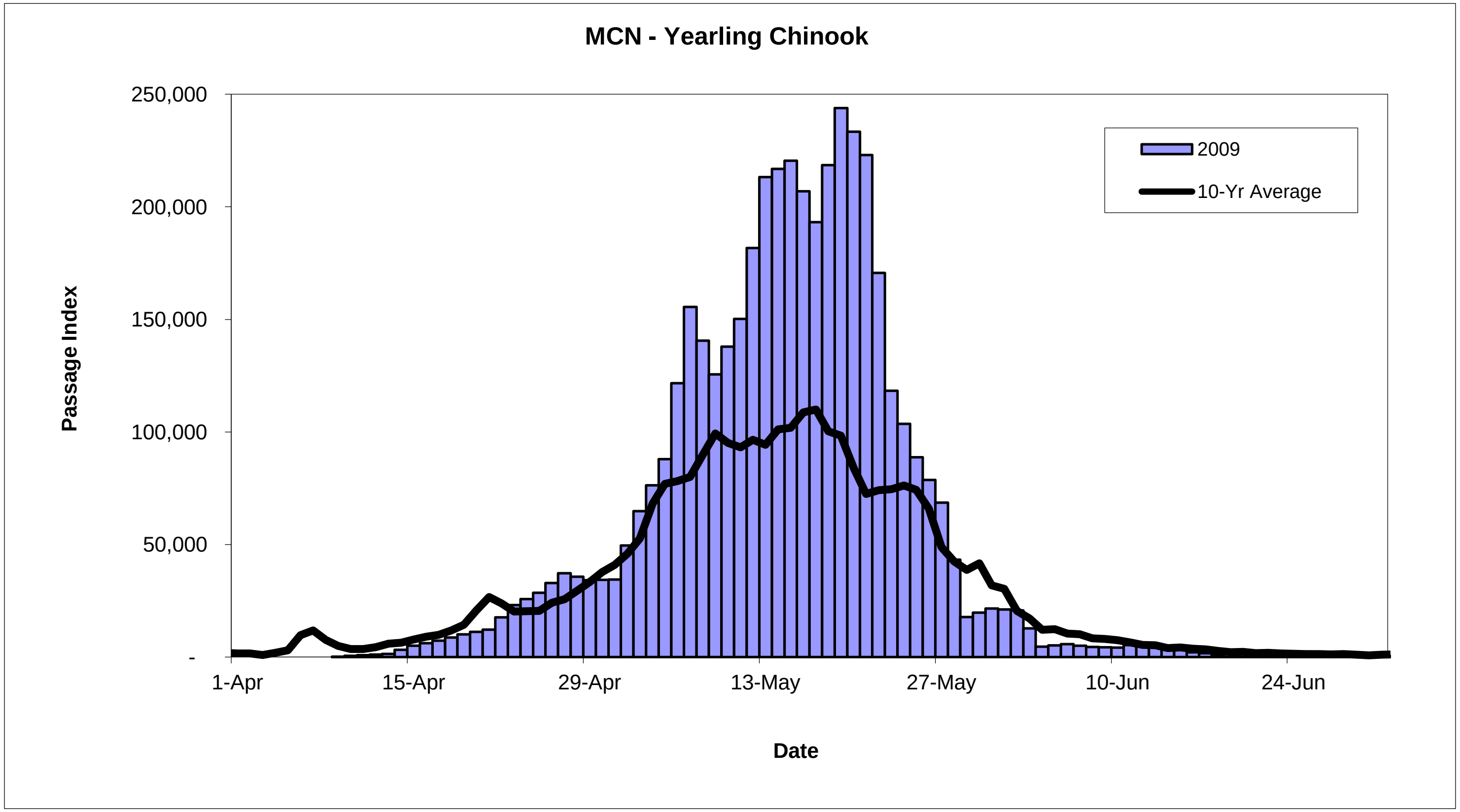
Lower Granite Yearling Chinook



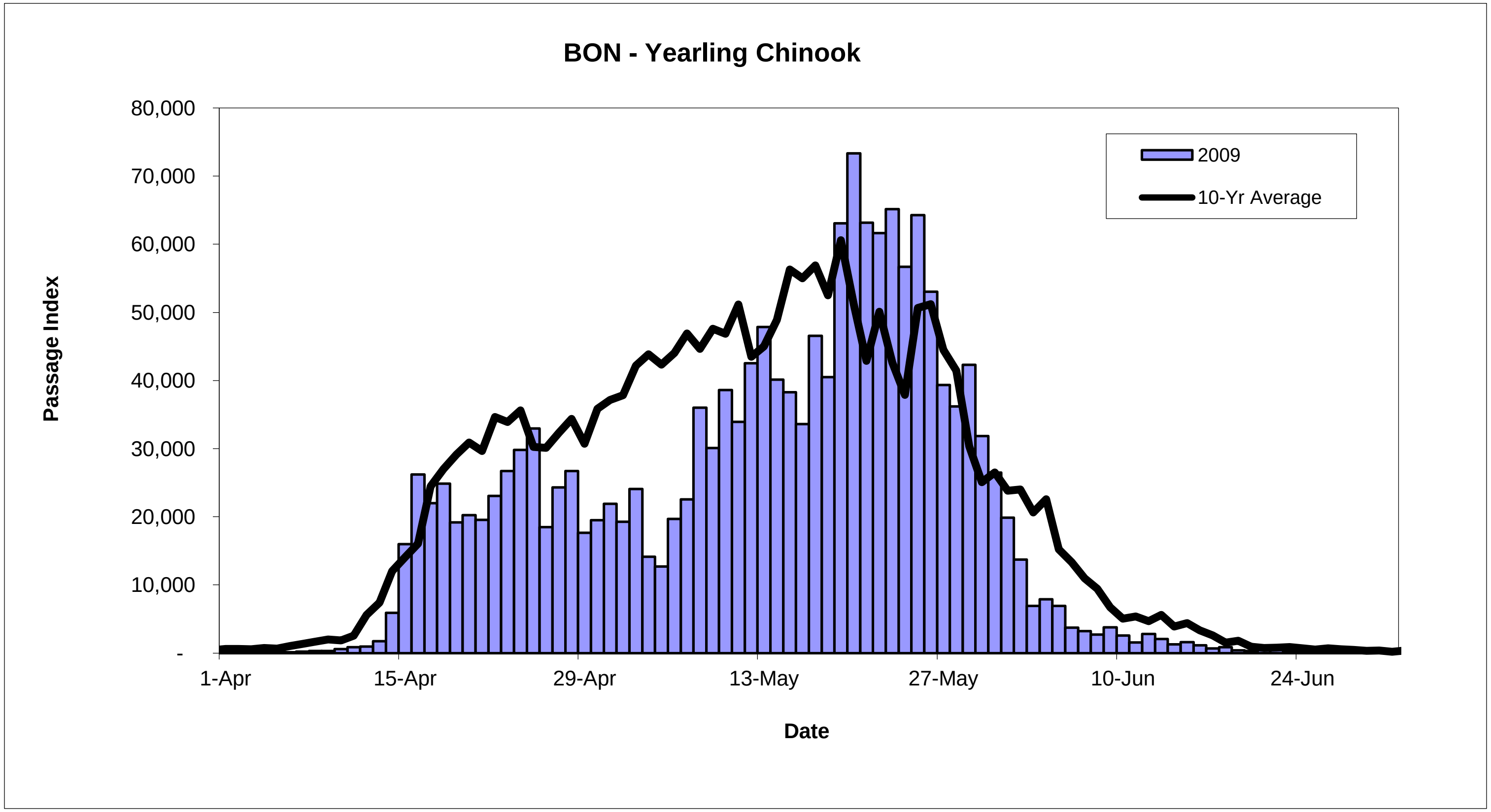
Rock Island Yearling Chinook



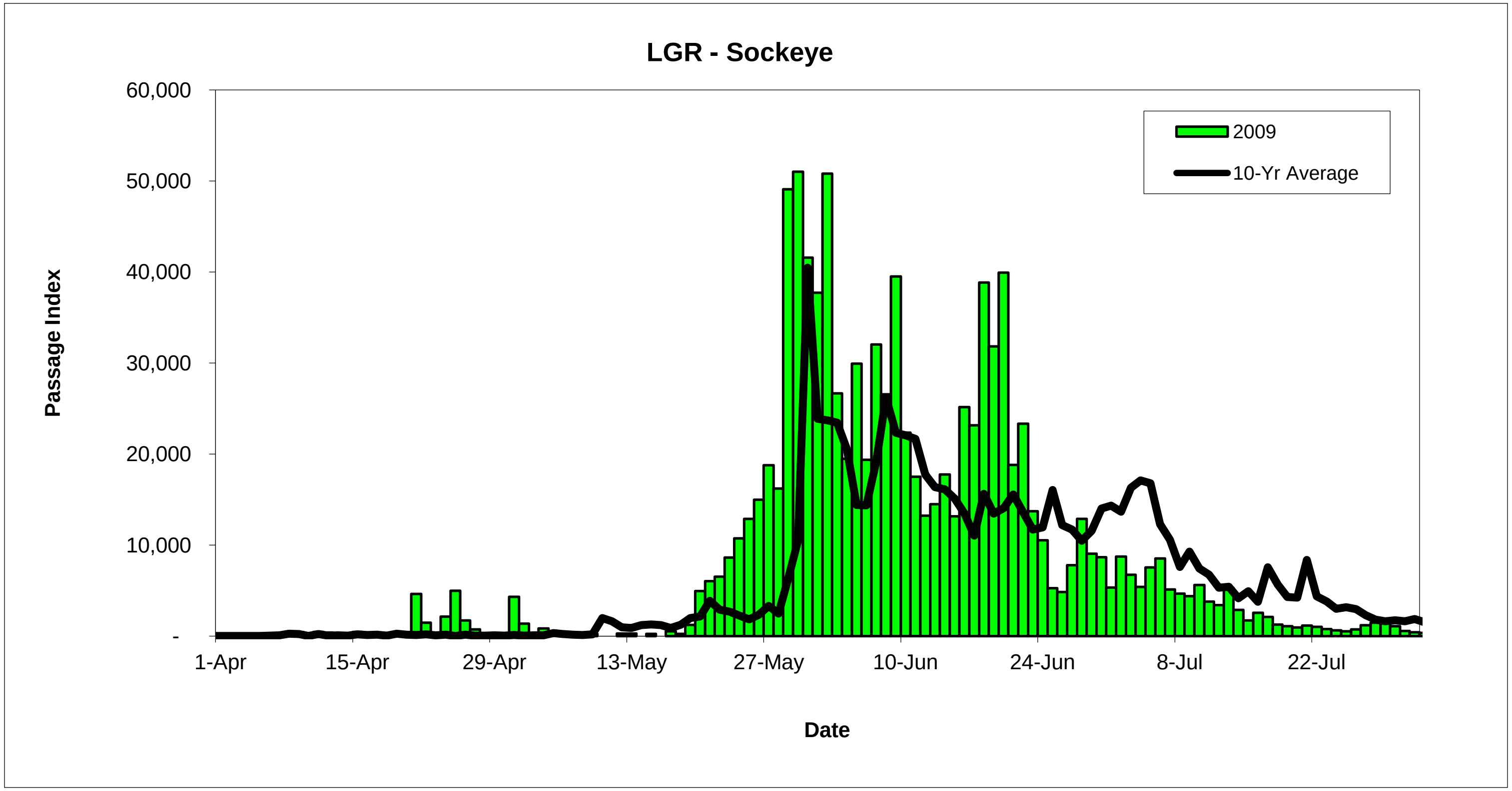
McNary Yearling Chinook



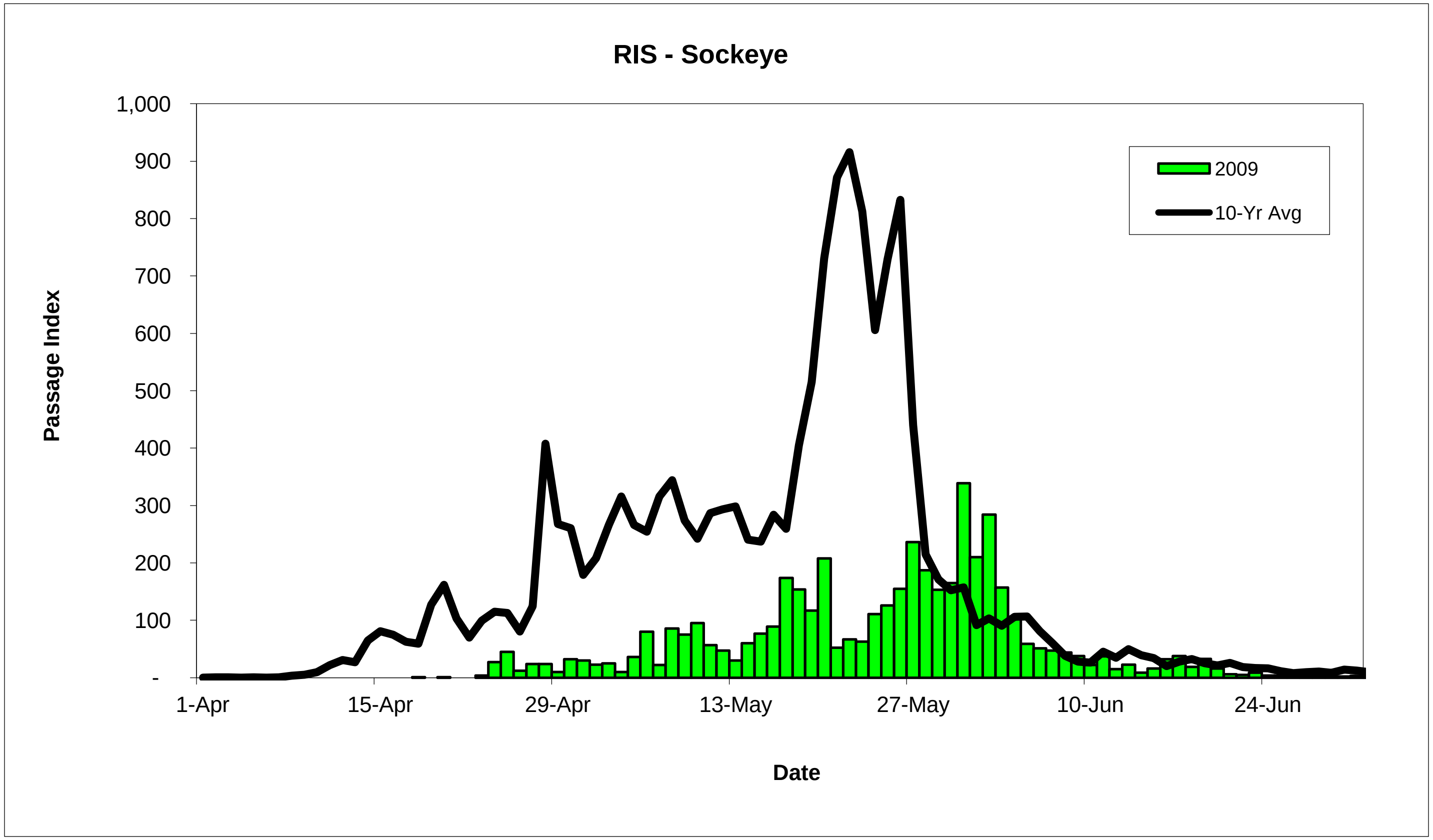
Bonneville Yearling Chinook



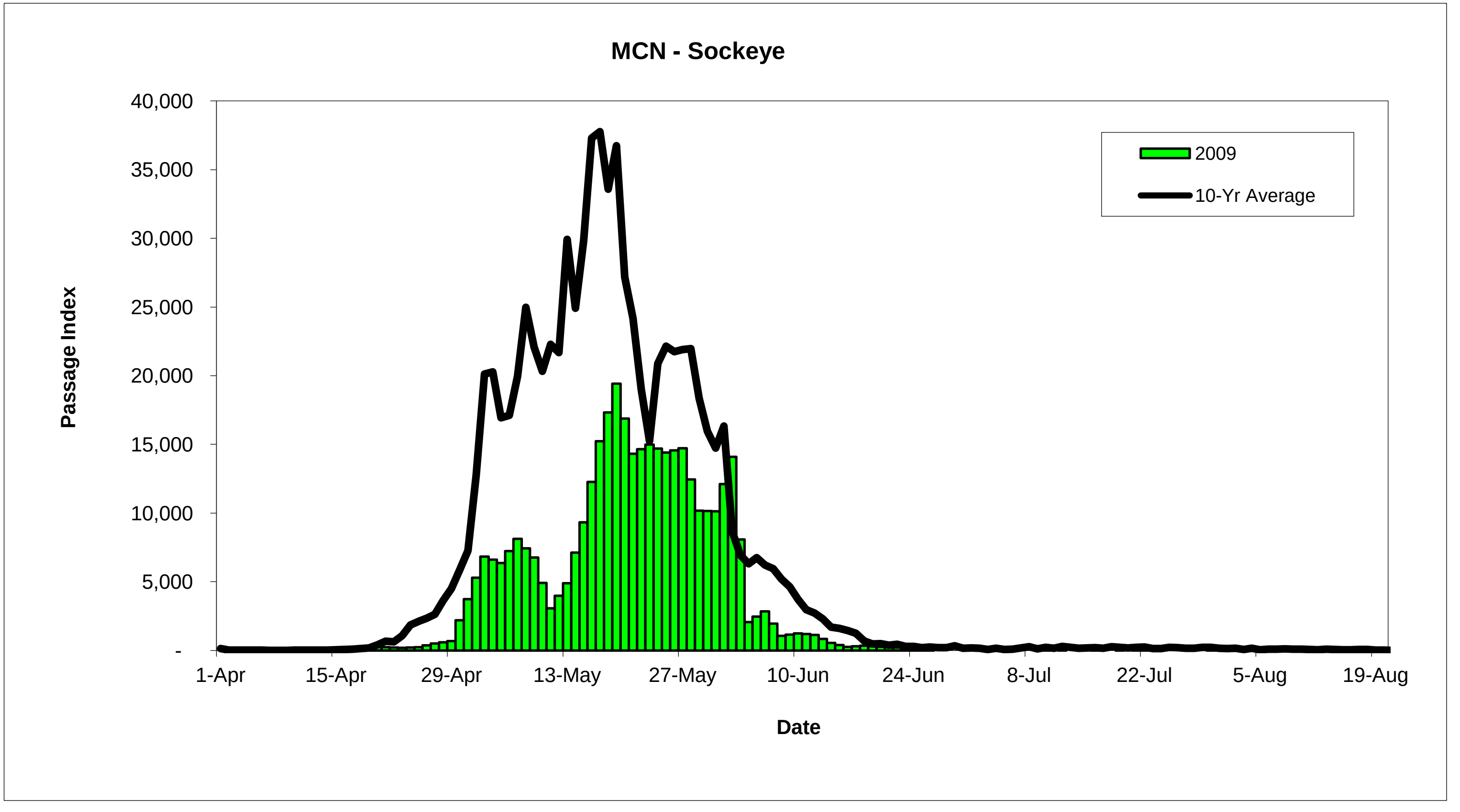
Lower Granite Sockeye



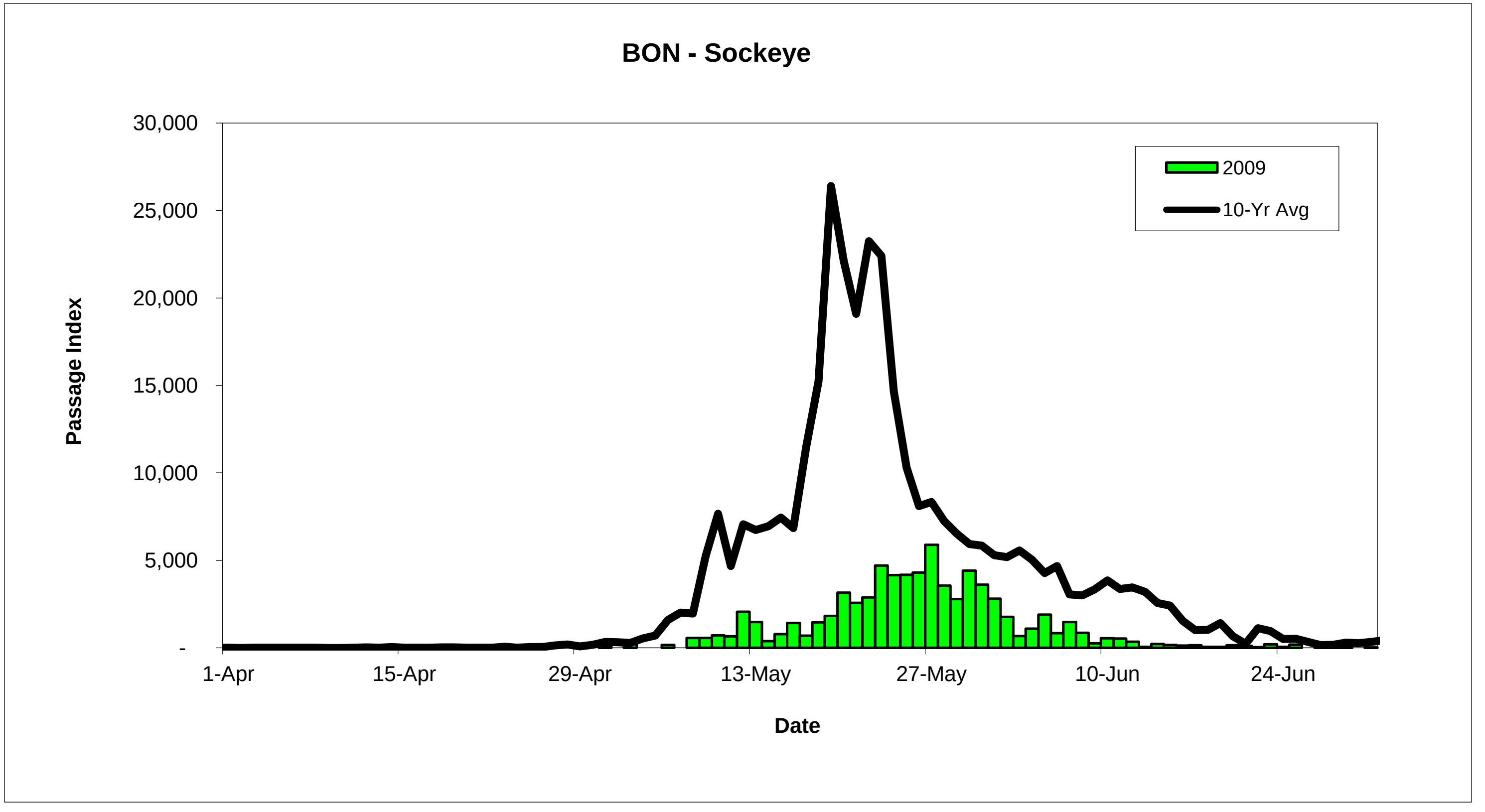
Rock Island Sockeye



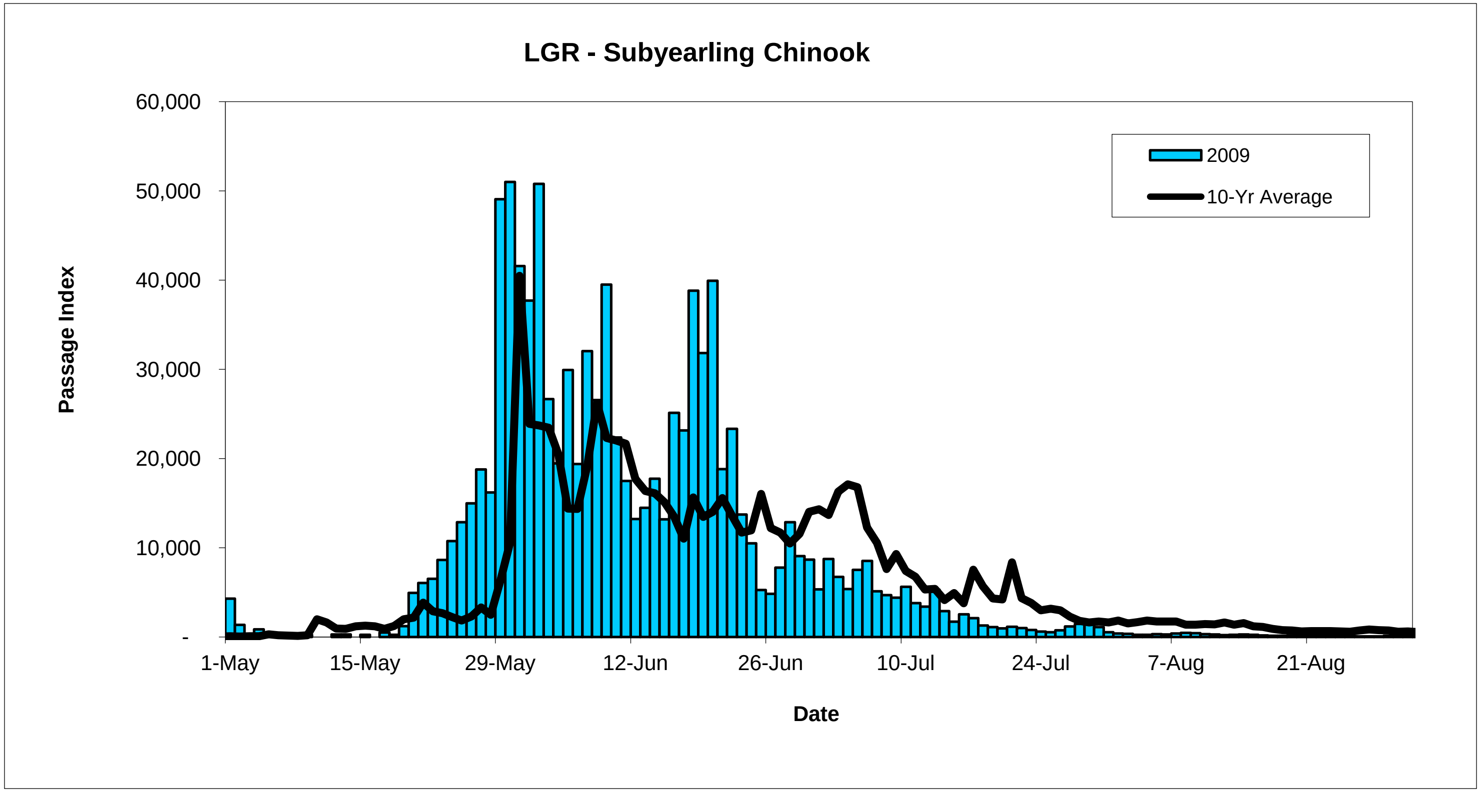
McNary Sockeye



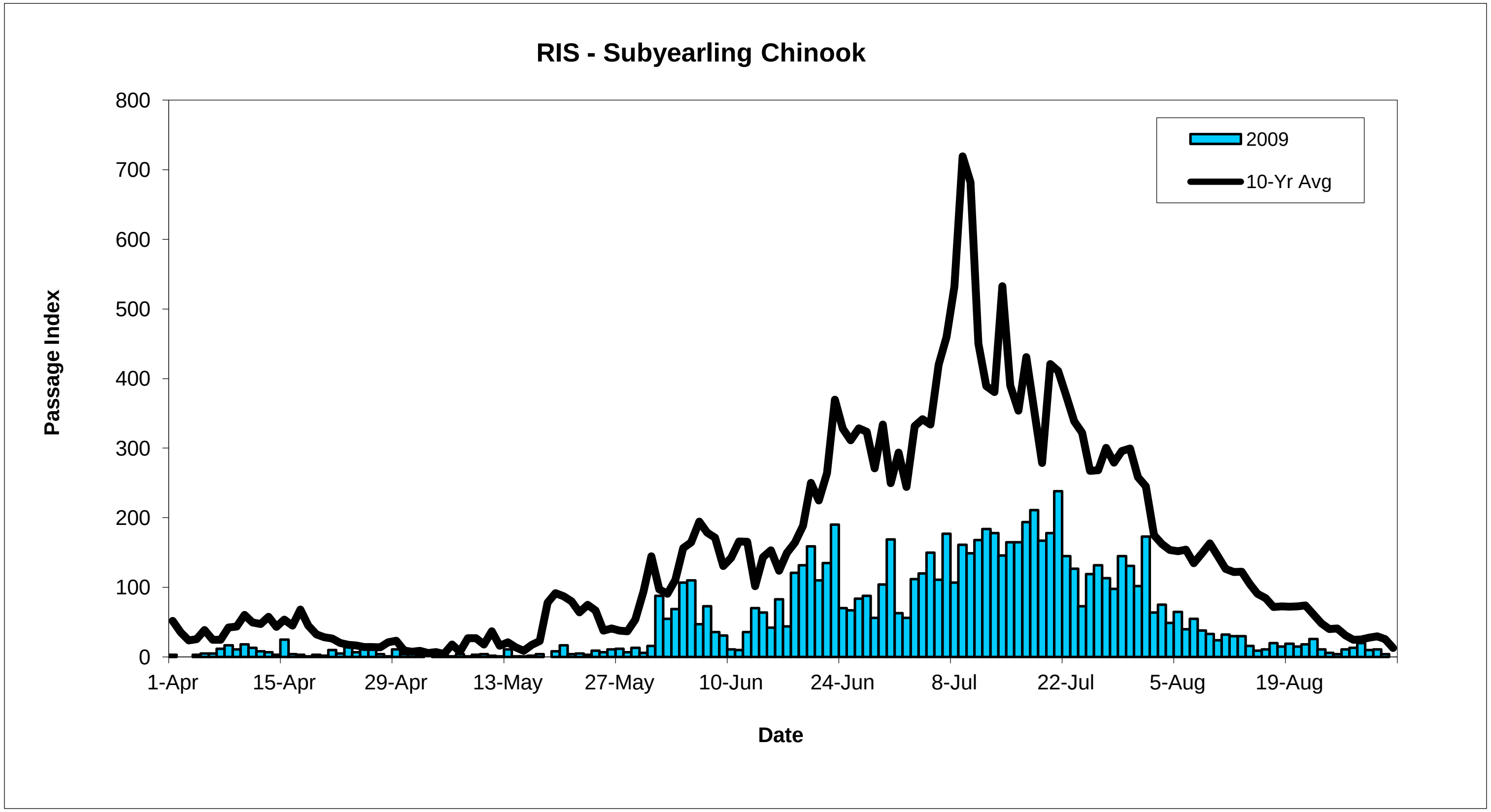
Bonneville Sockeye



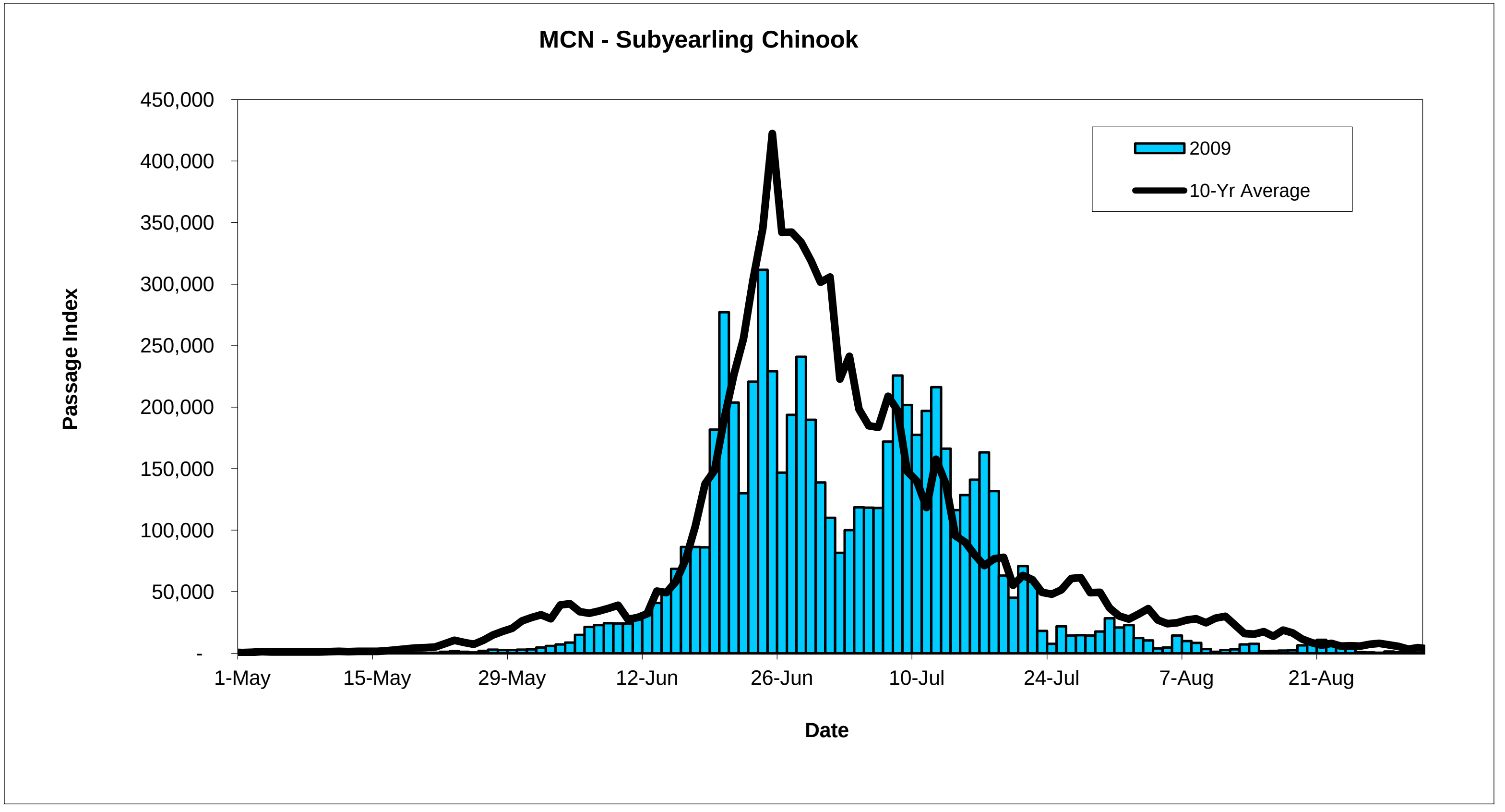
Lower Granite Subyearling Chinook



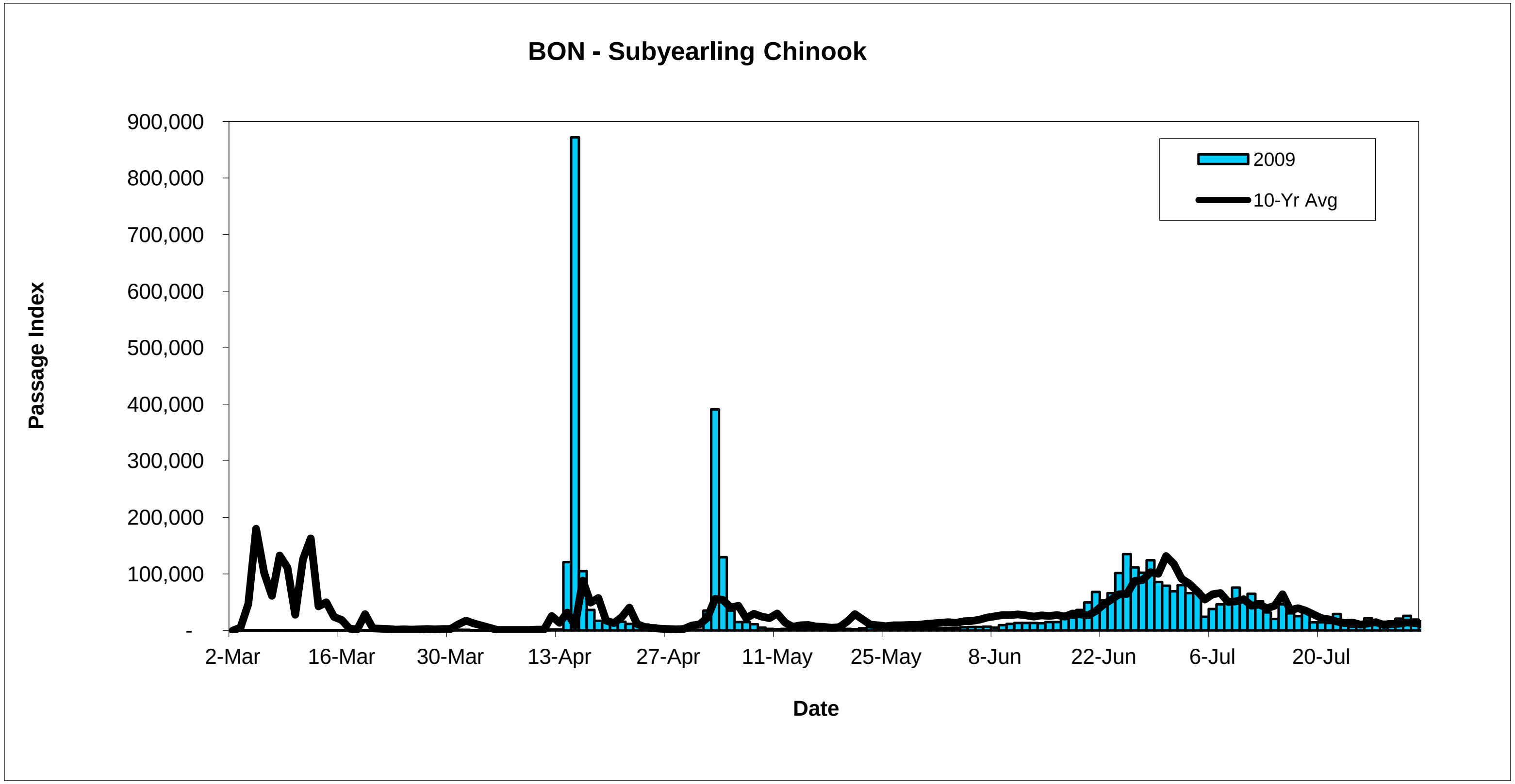
Rock Island Subyearling Chinook



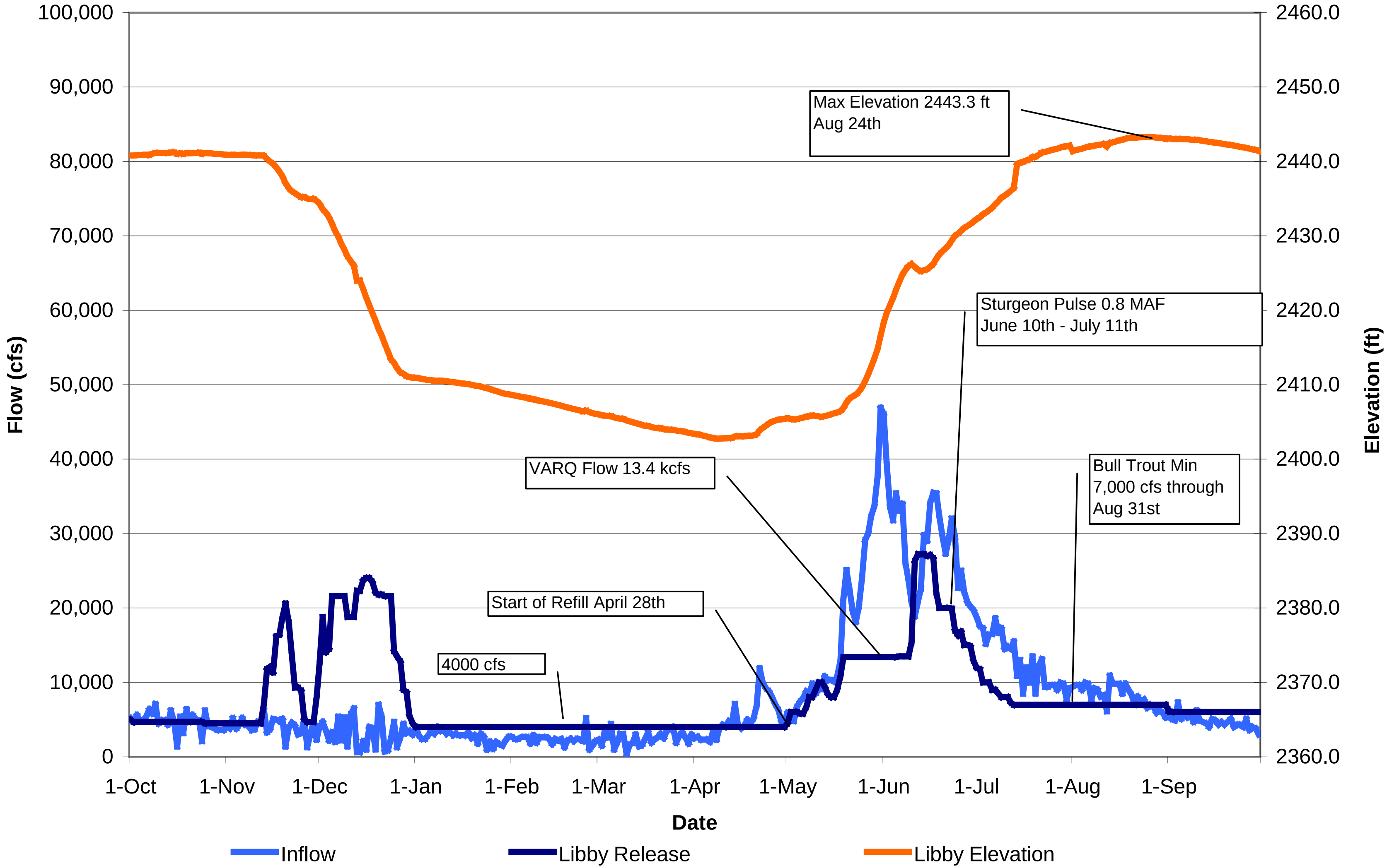
McNary Subyearling Chinook



Bonneville Subyearling Chinook



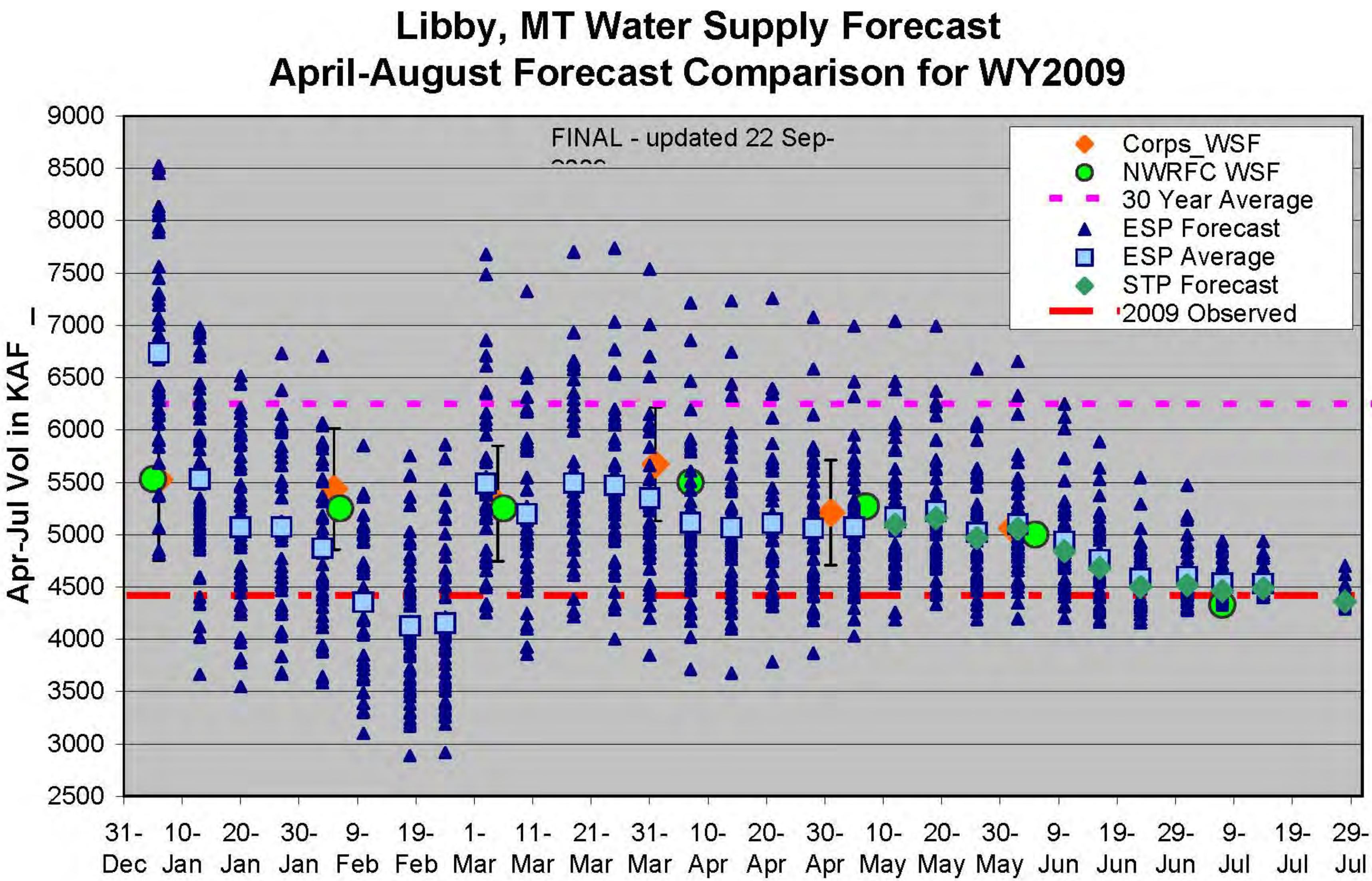
Libby Reservoir Operations for Water Year 2009



Libby Operations – 2009

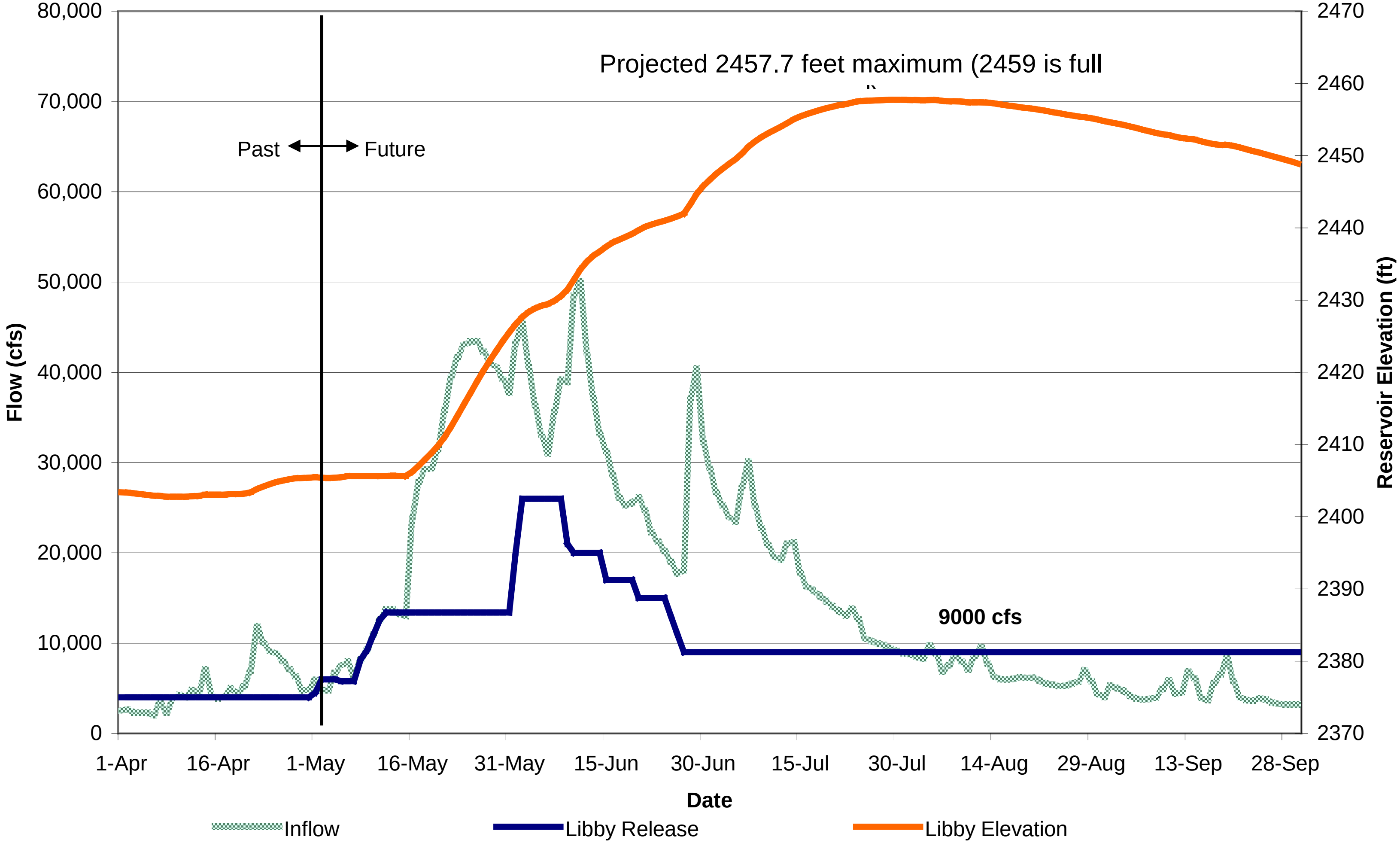
- The May WSF for 2009 was 5,208 KAF which is 82% of average.
- The actual inflow volume for April – August was 4,334 KAF which is 68% of average.
- June precipitation was only 60% of average.
- June is a month susceptible to monsoonal storms that are prevalent in the Rocky Mountains during late-spring and early summer.
- Reservoir inflows from January through the start of refill were 60% of normal and averaged 3,100 cfs.

- Similar low flow occurred in other neighboring basins (Mica, Duncan)



Libby, MT Water Supply Forecast
April-August Forecast Comparison for WY2009
FINAL - updated 22 Sep-
Corps_WSF
NWRFC WSF
30 Year Average
ESP Forecast
ESP Average
STP Forecast
2009 Observed
Apr-Jul Vol in KAF
9000
8500
8000
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
31-Dec
10-Jan
20-Jan
30-Jan
9-Feb
19-Feb
1-Mar
11-Mar
21-Mar
31-Mar
10-Apr
20-Apr
30-Apr
10-May
20-May
30-May
9-Jun
19-Jun
29-Jun
9-Jul
19-Jul
29-Jul

Libby Reservoir April 1, 2009 - Sept. 30, 2009
Assumed April-Aug. Forecast Volume equal to current WSF
Assumed draft to 2,449 ft. by Sept. 30th



Libby Operations – 2009

- The timing of the sturgeon pulse also affected Libby Dam refill.
- The regional team of biologists has been requesting a later sturgeon pulse start date than previous years.
- A later start date means less of an overlap of the higher refill flow (VARQ flow) and the sturgeon pulse.
- This ultimately results in a higher volume of water being released during refill than if the sturgeon pulse were started earlier. This results in Libby Dam releasing higher flows during the time when the project may be ramping down to a lower summer flow, reducing flexibility to lower flows to increase chance of refill.

Libby Operations – 2009

- The May WSF sets the May VARQ flow, the final sturgeon volume, and the bull trout flow.
- The VARQ flow was 3,800 cfs higher in May and 3,600 cfs higher in June than it would have been if the forecast was accurate.
- The sturgeon volume was 800 KAF, when it would have been zero.
- Finally, the bull trout flows actually provided were 7,000 cfs when they would have instead been 6,000 cfs.
- Had the WSFs been accurate, the peak reservoir elevation could have been as much as 10 feet higher.

Available Flexibility

Recommendations to Improve Refill

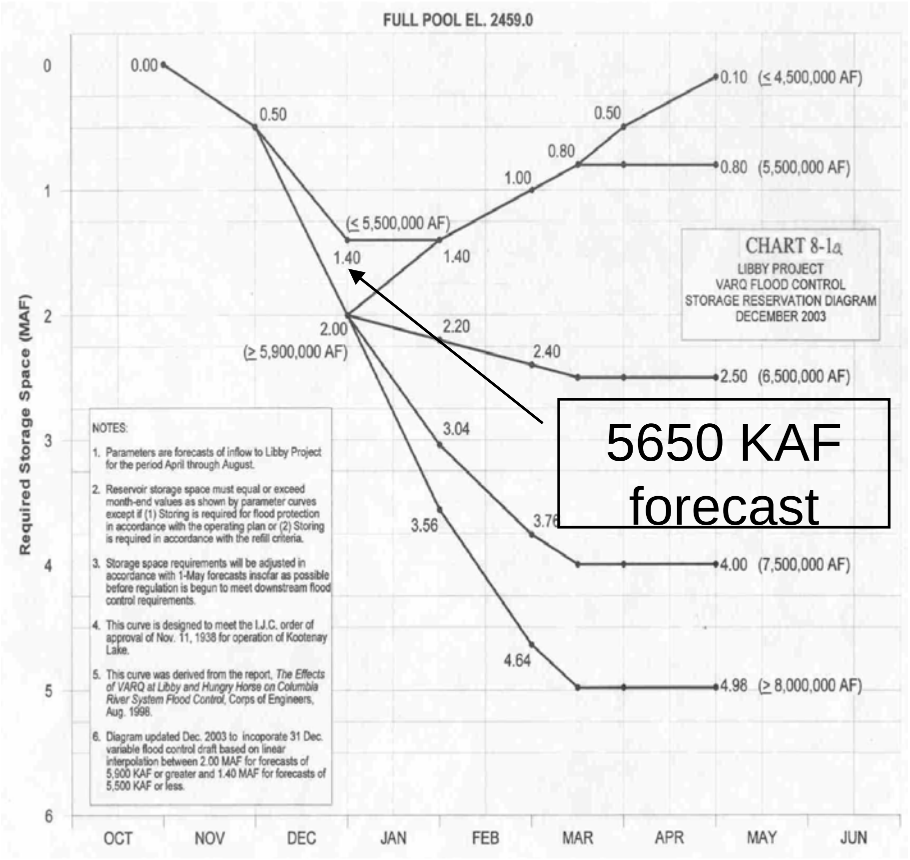
- Within the operational flexibility that exists that is consistent with the project's authorized purposes and operational considerations:
  - Employ the deviation request process (CENWD Reg No. 1110-2-6)
  - Through the TMT process, employ adaptive management when implementing the Biological Opinion(s) to better achieve refill, when possible.
  - Review the performance of Libby Dam official Water Supply Forecast (WSF) and suggest possible improvements.

Libby Dam End of December Variable Draft target

- The draft target is a function of the 1 December forecast for the inflow volume from 1 Apr – 31 Aug
  - If the forecast is >= 5900 KAF target 2411 ft (2.0 MAF of Space)
  - If the forecast is <= 5500 KAF target 2426.7 ft (relax to 1.4 MAF or 600 KAF)
  - If the forecast is between 5500 KAF and 5900 KAF relax draft by interpolating between 600 and 0 kaf

Example

- If the forecast is 5650 KAF
- 5650 KAF interpolated results in a Space of 1.625 MAF
- Which translates to a reservoir elevation of 2420.8 ft

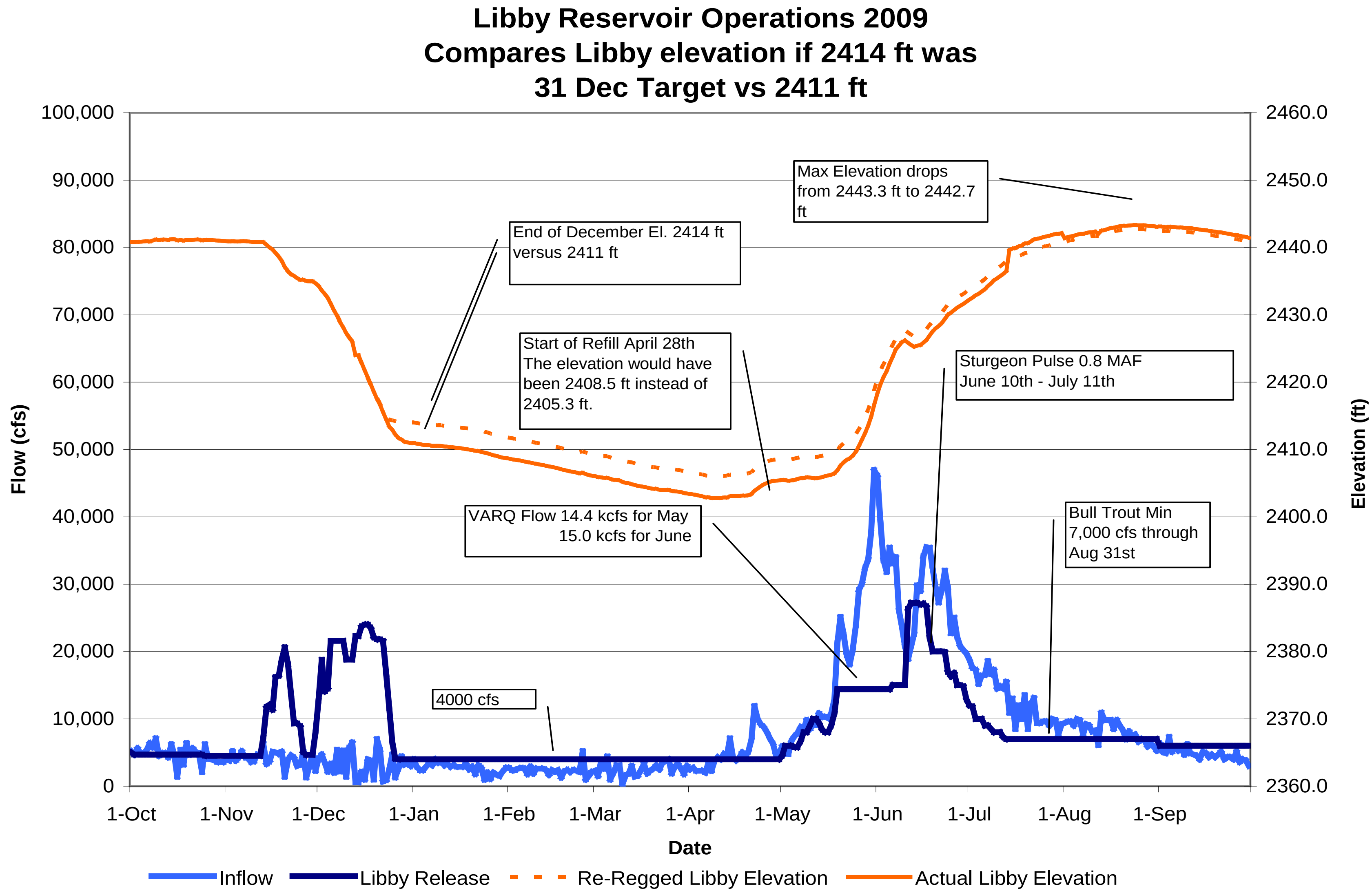


What happened last December?

- 1 Dec forecast is 5937 KAF, 94% of average from a 30 year period of record.
- The Water Management Plan said: *"The end of December elevation is a straight line sliding scale between elevation 2426 feet and 2411 feet when the forecast is between 88% and 95%"*. (Percentages are from a 70 year POR)
- It nows says: *"when the forecast is between 5500 and 5900 KAF."*

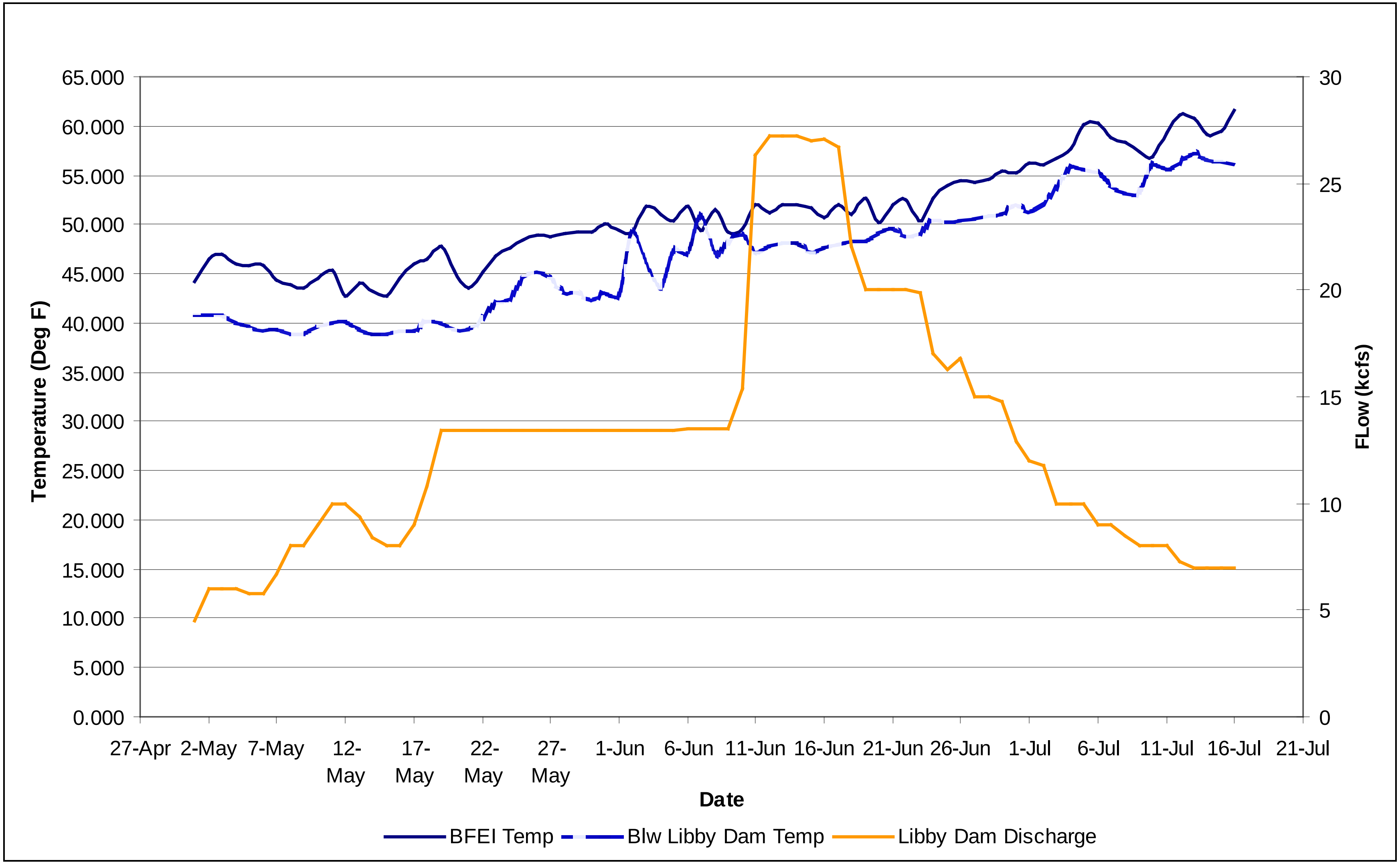
What would have happened if…

- .. the forecast was 94% of the 70 year average or 5823 KAF?
- The end of December target would have been 1.884 MAF of space or an elevation of 2414 ft. A 116 KAF relaxation.


Libby Reservoir Operations 2009
Compares Libby elevation if 2414 ft was
31 Dec Target vs 2411 ft
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
2460.0
2450.0
2440.0
2430.0
2420.0
2410.0
2400.0
2390.0
2380.0
2370.0
2360.0
Flow (cfs)
Elevation (ft)
Max Elevation drops from 2443.3 ft to 2442.7 ft
End of December El. 2414 ft versus 2411 ft
Start of Refill April 28th The elevation would have been 2408.5 ft instead of 2405.3 ft.
Sturgeon Pulse 0.8 MAF June 10th - July 11th
VARQ Flow 14.4 kcfs for May 15.0 kcfs for June
Bull Trout Min 7,000 cfs through Aug 31st
4000 cfs
1-Oct
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
Date
Inflow
Libby Release
Re-Regged Libby Elevation
Actual Libby Elevation

2009 SOR

- Sturgeon Pulse – Tier 2 Year 0.8 MAF
  - Temperature Trigger not to drop Kootenai River temperature 1.5° C with a Flow of 20-25 kcfs
  - Hold Powerhouse for 7 days
  - Decrease to 20 kcfs for 5 days
  - 17 kcfs for 5 days
  - 15 kcfs for 5 days


65.000
60.000
55.000
50.000
45.000
40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0.000
Temperature (Deg F)
30
25
20
15
10
5
0
FLow (kcfs)
27-Apr
2-May
7-May
12-May
17-May
22-May
27-May
1-Jun
6-Jun
11-Jun
16-Jun
21-Jun
26-Jun
1-Jul
6-Jul
11-Jul
16-Jul
21-Jul
Date
BFEI Temp
Blw Libby Dam Temp
Libby Dam Discharge

Dworshak Reservoir Regulation

Stephen Hall P.E., Reservoir Regulation

Walla Walla District USACE

Dworshak Operations Review

- Operating Objectives
- Water Supply Forecast
- Flood Control Space Shift to Grand Coulee
- Transition to Refill & SOR (Afternoon presentation)
- Final Refill
- Summer Temperature Operations
- Unit 3 Head-seal Repair

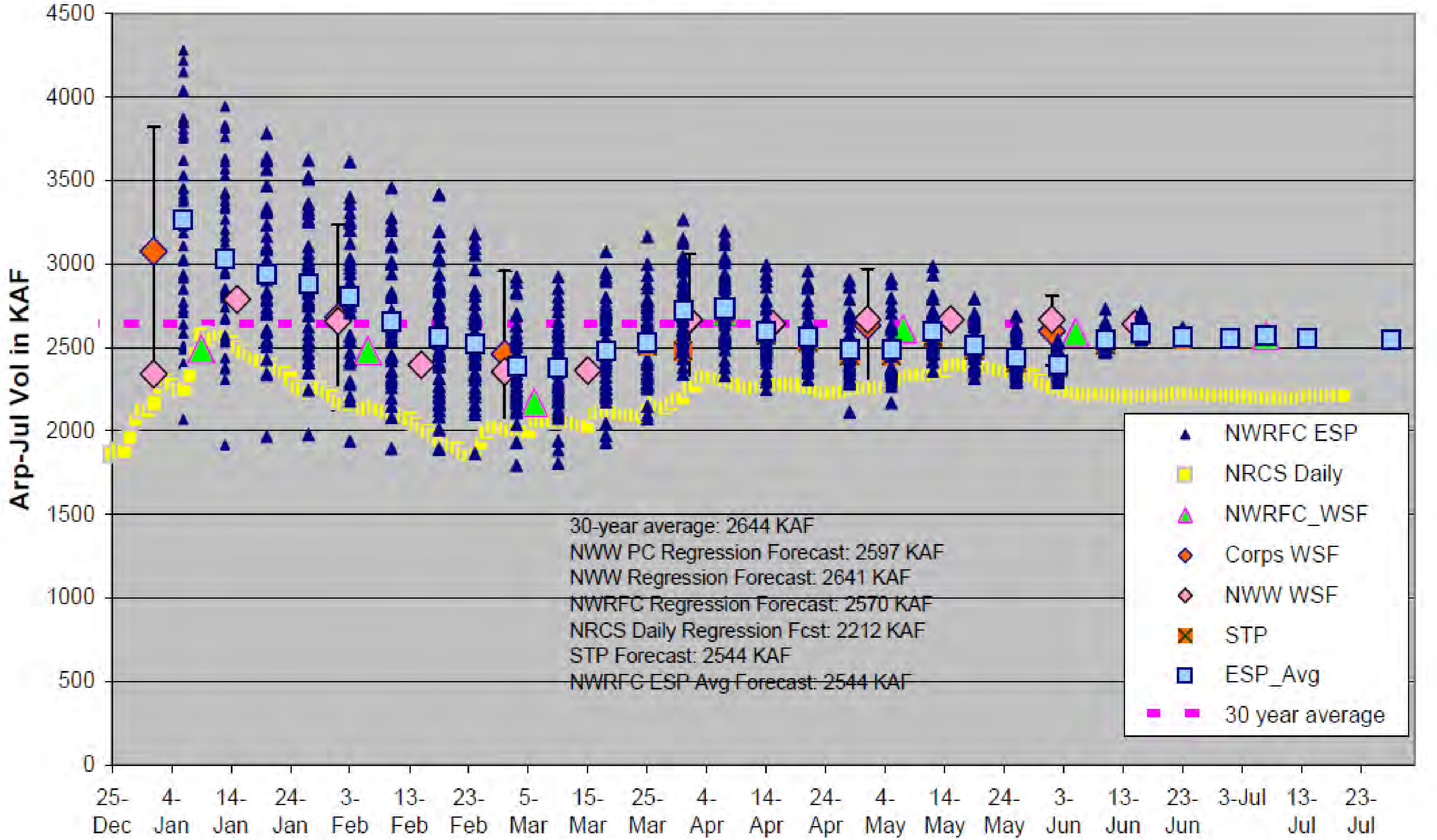
Operating Objectives

- Standard Flood Control with maximum shift of flood control space to Grand-Coulee.
- Operate to upper flood control rule curve on about April 10th to increase flows for spring flow management.
- Provide minimum flows while meeting 110% TDG Idaho water quality standard.
- Refill by about June 30th.
- Draft reservoir to 1535 by August 31st and 1520 by September 30th for temp and flow augmentation.
- Regulate discharges and temperatures to maintain Lower Granite tailwater temperatures at or below 68° F.
- Maximize discharge for salmon flow augmentation while meeting 110% total dissolved gas standard.

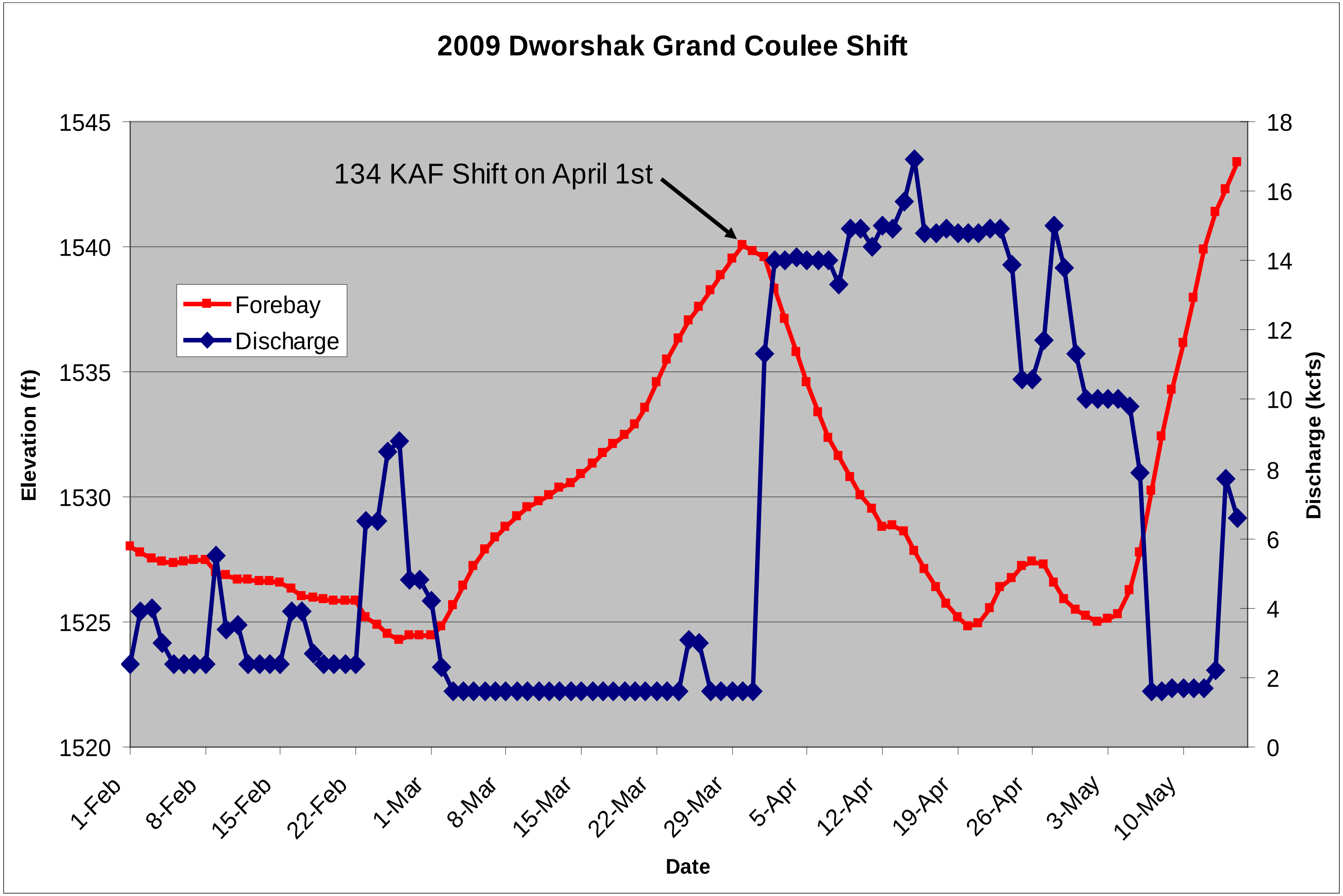
US Army Corps of Engineers
Walla Walla District

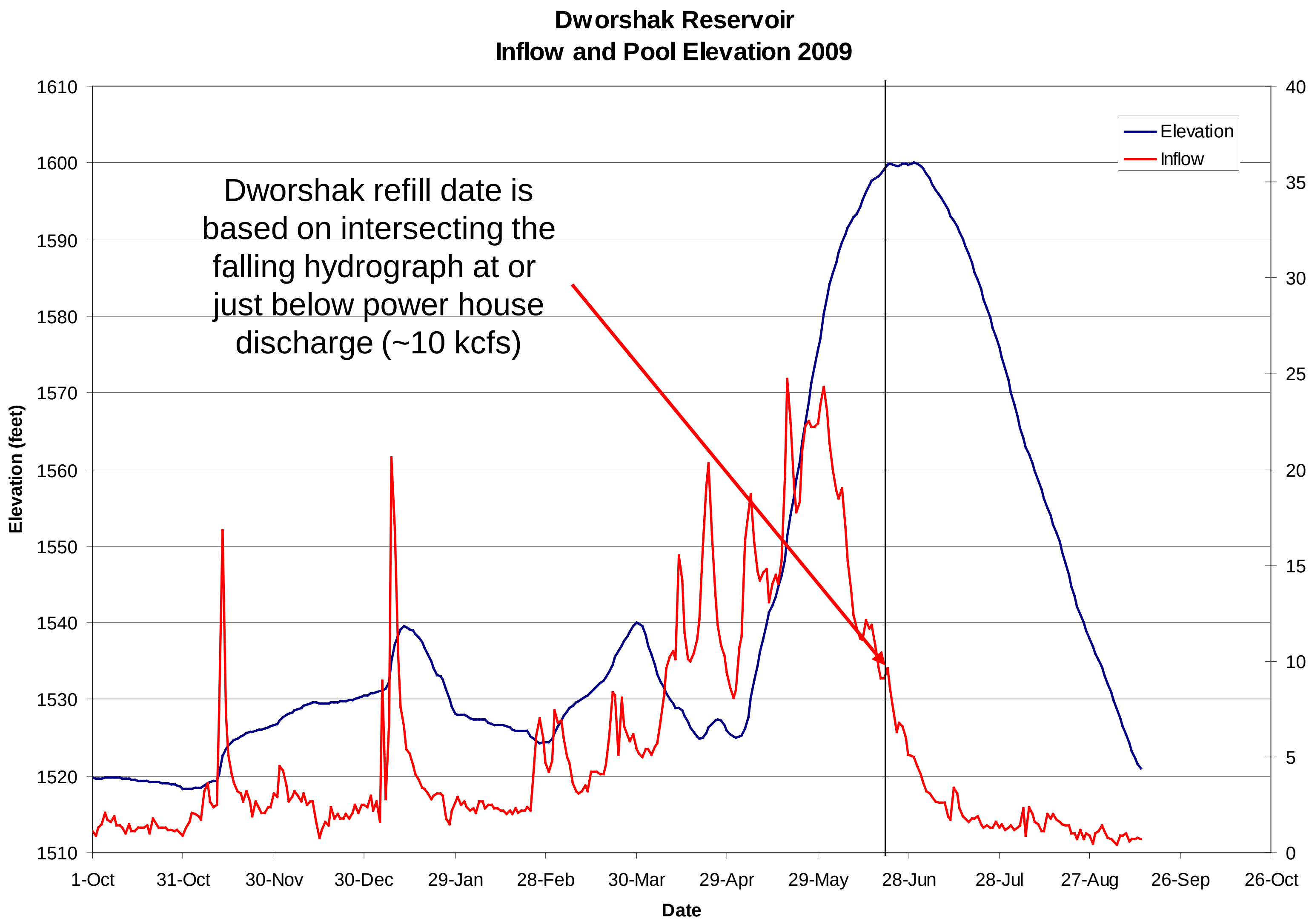
Dworshak, ID April-July Inflow Volume Forecast Comparison

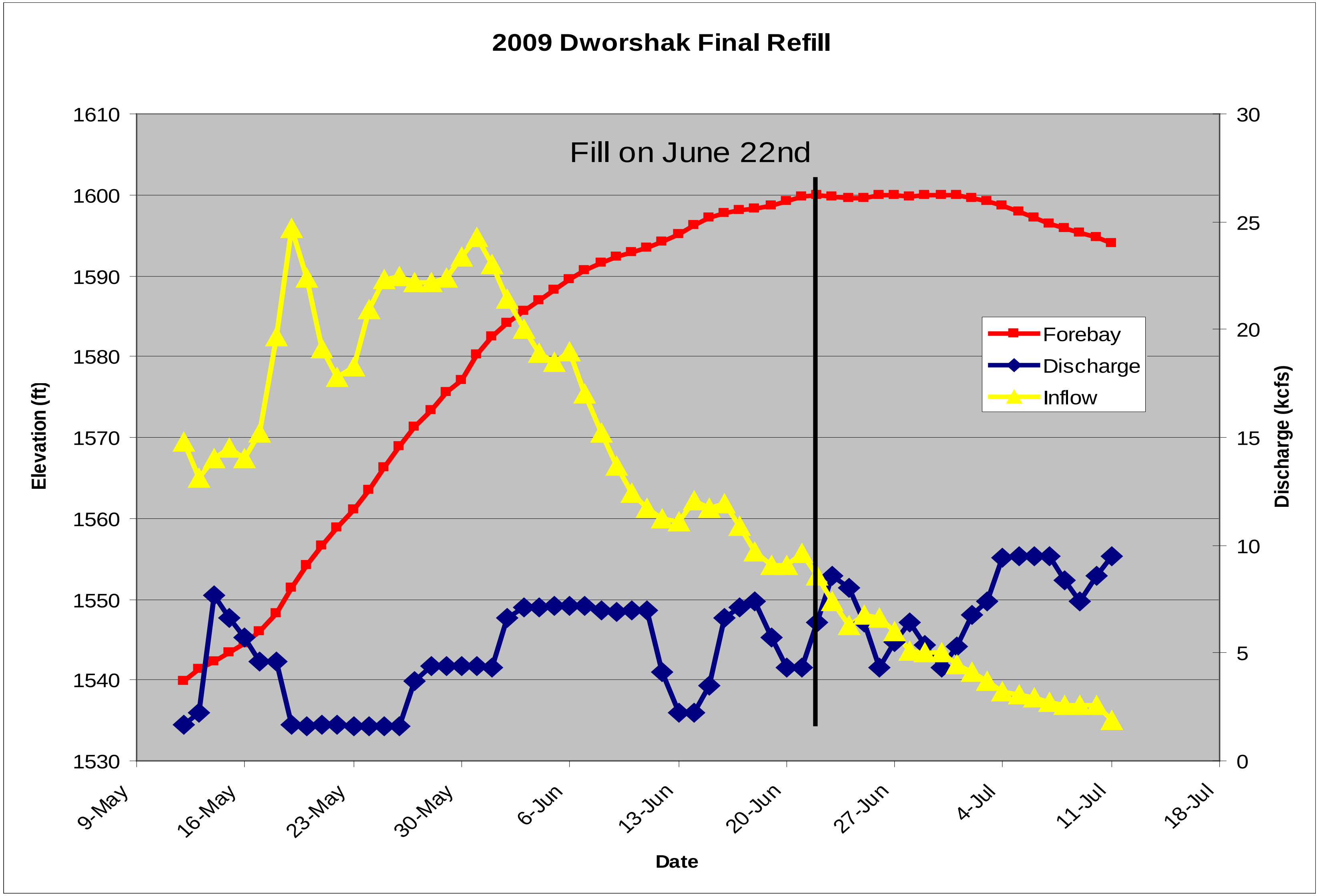
updated 28-Jul-2009



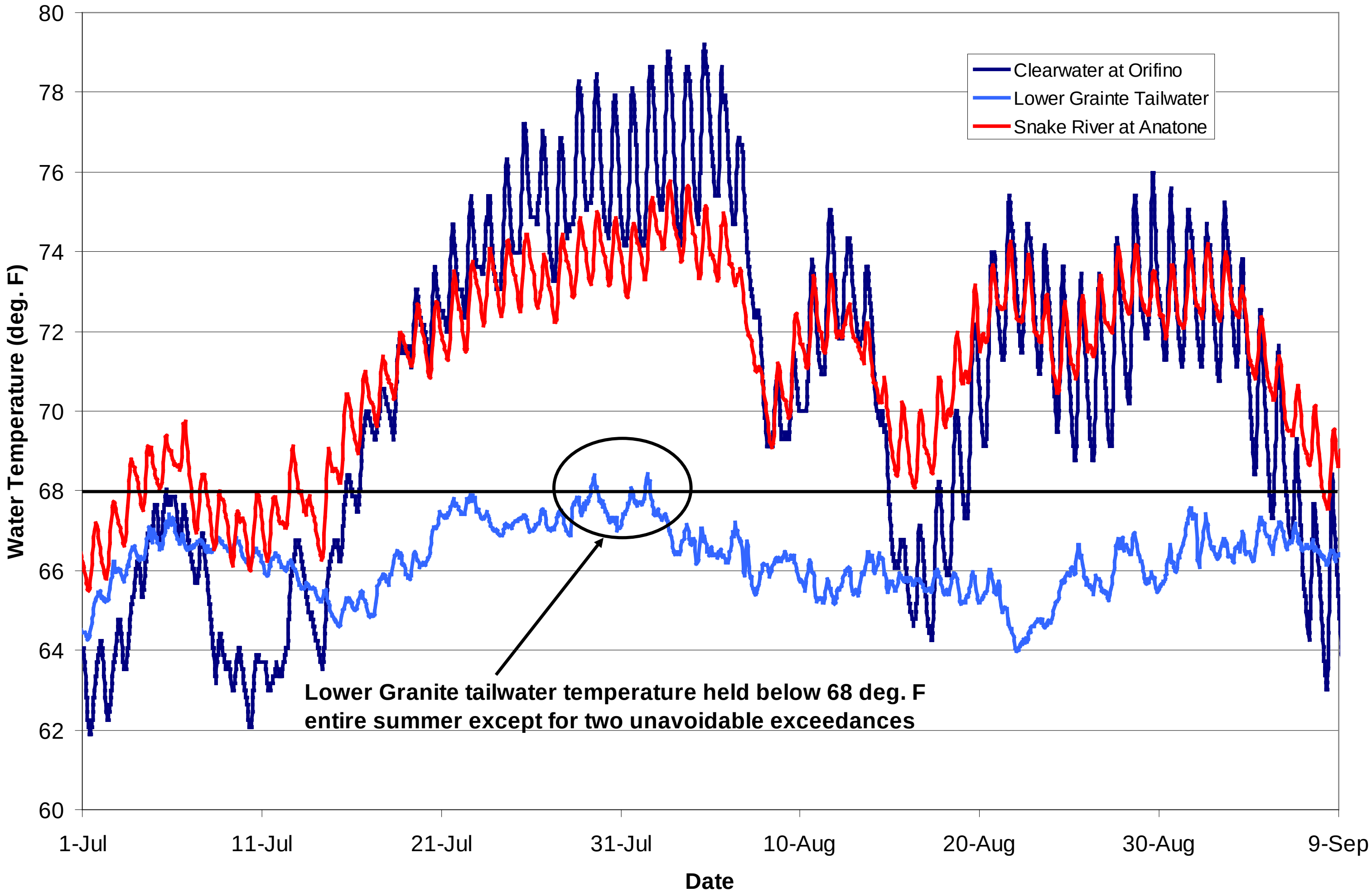
US Army Corps of Engineers
Walla Walla District




Dworshak Reservoir
Inflow and Pool Elevation 2009
Dworshak refill date is based on intersecting the falling hydrograph at or just below power house discharge (~10 kcfs)
Elevation
Inflow
Elevation (feet)
1610
1600
1590
1580
1570
1560
1550
1540
1530
1520
1510
40
35
30
25
20
15
10
5
0
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
28-Feb
30-Mar
29-Apr
29-May
28-Jun
28-Jul
27-Aug
26-Sep
26-Oct
Date


2009 Dworshak Final Refill
Fill on June 22nd
Elevation (ft)
Discharge (kcfs)
Date
Forebay
Discharge
Inflow
1610
1600
1590
1580
1570
1560
1550
1540
1530
30
25
20
15
10
5
0
9-May
16-May
23-May
30-May
6-Jun
13-Jun
20-Jun
27-Jun
4-Jul
11-Jul
18-Jul

Dworshak Temperature Augmentation



Dworshak SOR # 2009-02
Transition to Refill

Stephen Hall P.E., Reservoir Regulation

Walla Walla District USACE

SOR #2009-02

Requested full power-house discharge from Dworshak from May 12^{th} 2009 to May 17^{th} 2009 as needed to achieve 100 kcfs flow at Lower Granite Dam.

The COE response was a compromise between requested SOR flows and minimum discharge for a higher probability of refill.

Time Line of TMT Meetings

- April 8th TMT Meeting – April 1st forecast = 99% normal (2.66 MAF), estimated discharge during refill = 5 to 6 kcfs. Discharging maximum amount (110% TDG) for flood control based on Grand Coulee Flood control shift and increasing water supply forecast

- April 22nd TMT Meeting – Initiated discussion on transition to refill with two options. Salmon Managers requested maximum discharge through the end of April. COE accepted the Salmon Manager request.

- April 29th TMT Meeting – Based on a decline in National Weather Service Ensamble Streamflow Prediction forecasted volume (2.4 MAF) COE expressed concern regarding refill. The Flood Control Refill Curve (FCRC) was intersected on April 18th. FCRC provides 95% chance of refill by 30 June. Salmon Managers request maximum discharge through April 30th then a reduction to full powerhouse (10.6 kcfs) through May 6th. COE accepted the Salmon Manager request.

Time Line of TMT Meetings cont.

- May 5th RCC Communication with Salmon Managers – COE reduced discharge from 10.6 kcfs to 7.5 kcfs per agreement with Salmon Managers with a further plan to make further reductions on May 6th.

- May 6th TMT Meeting – COE expressed increasing concern with refill flexibility (little remaining volume above minimum discharge). Based on ESP and other data, with Salmon Manager agreement, COE reduced to minimum discharge on May 6th.

- May 12th @ 15:23 SOR sent to Reservoir Control Center (RCC) by Salmon Managers

- May 13th TMT Meeting – COE present ESP refill information, explained the significant departure from FCRC curve, and historical analysis of similar years/conditions to express significant concern regarding refill based on the SOR. COE decided to implement a compromise operation resulting in a gradual reduction in discharge over the next 5 days.

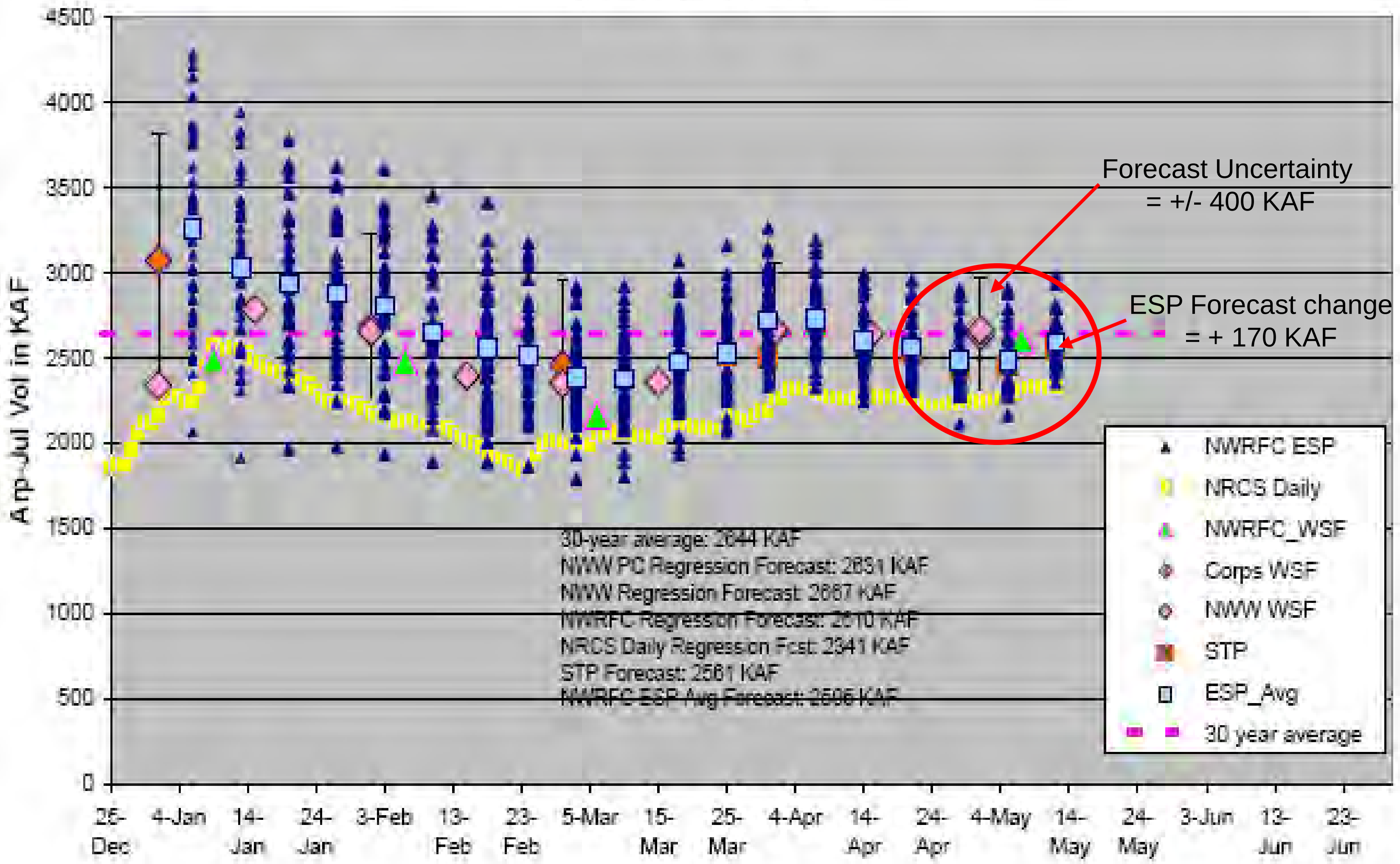
The next few slides are the information presented at TMT including:

Water Supply Forecast

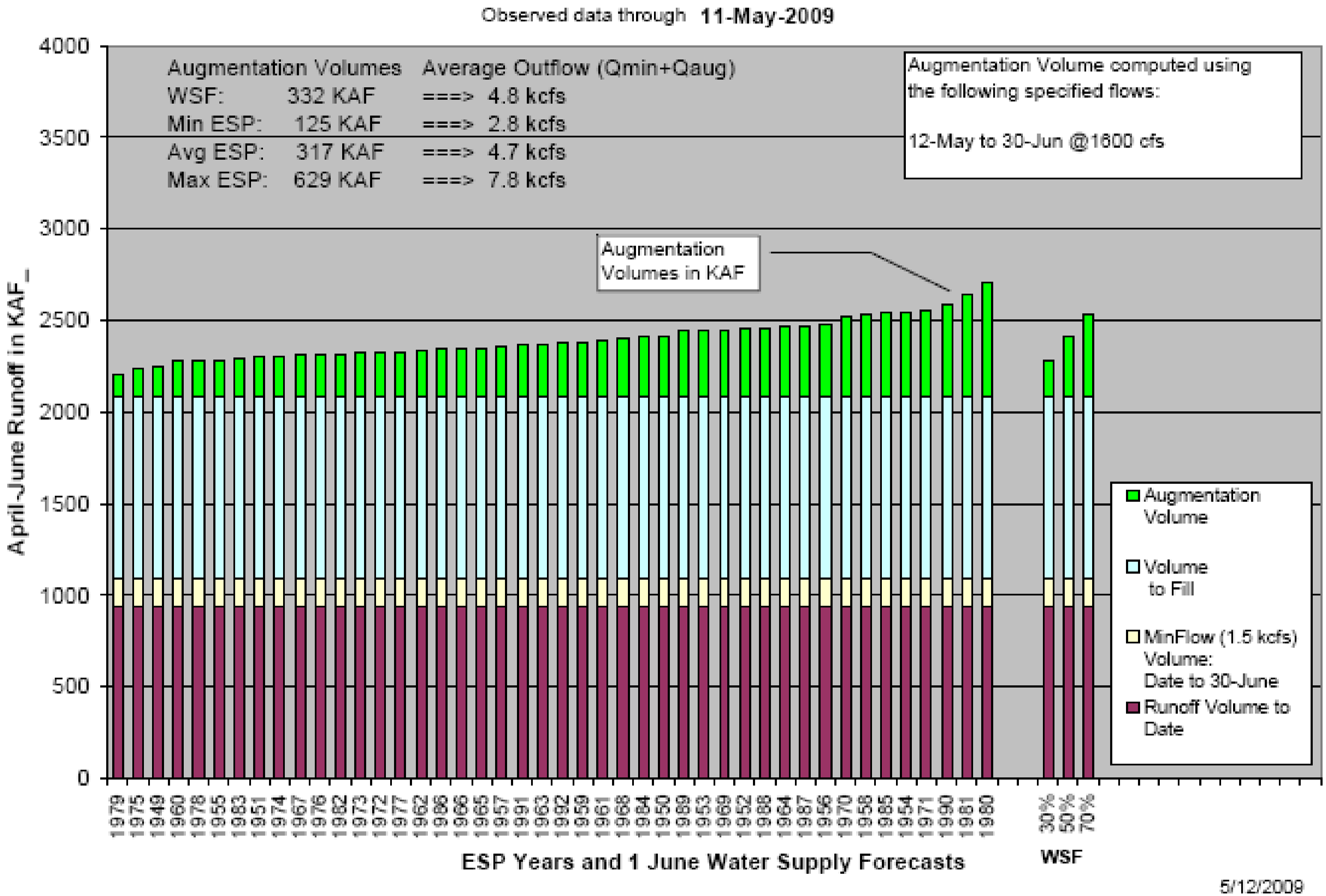
ESP Traces with refill volumes

Dworshak, ID April-July Inflow Volume Forecast Comparison

updated 12-May-2009

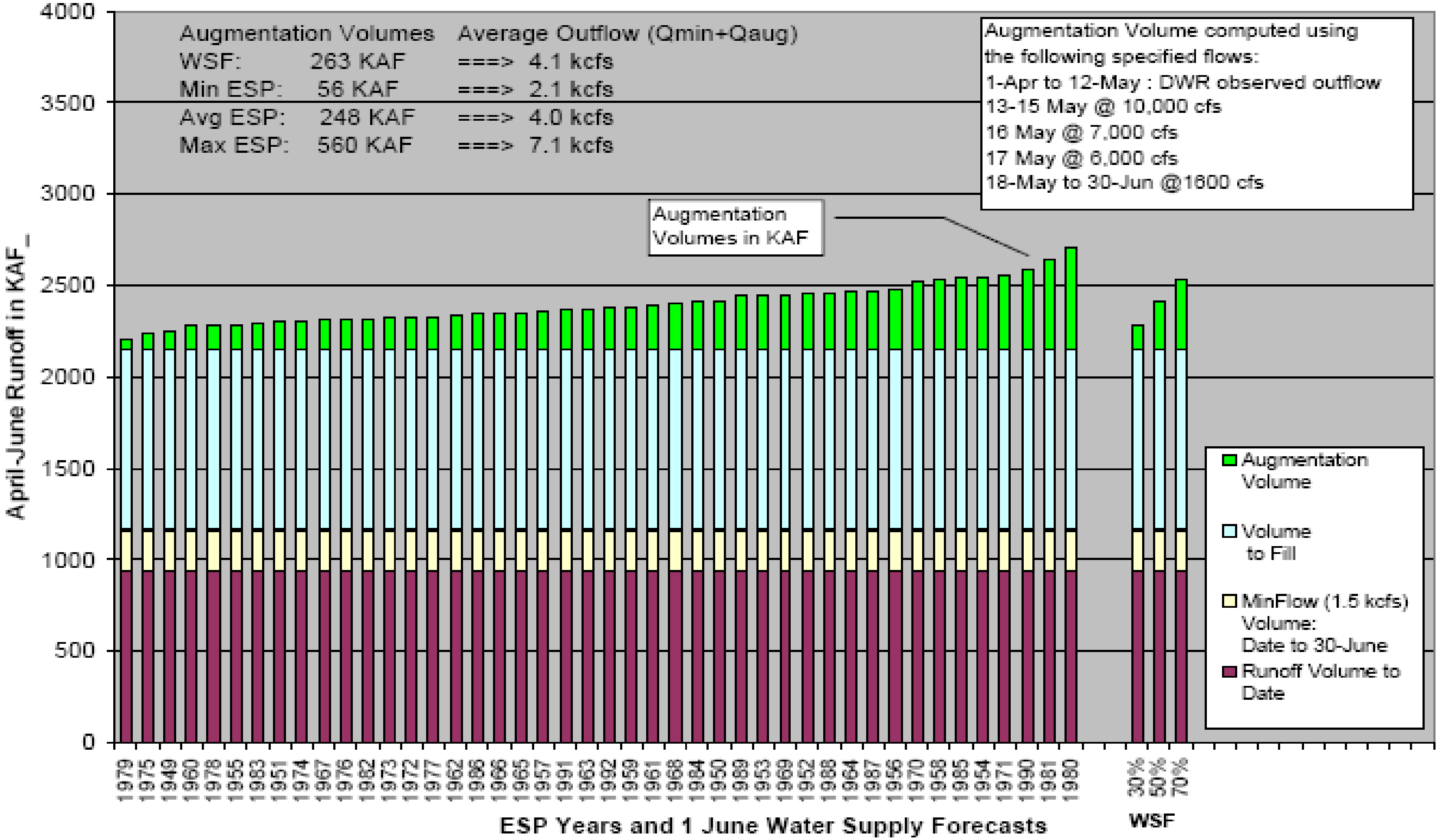


Dworshak Augmentation Volumes
ESP inflows and 01-May Water Supply Forecast



Dworshak Augmentation Volumes
ESP inflows and 01-May Water Supply Forecast

Observed data through **11-May-2009**



5/12/2009

COE Decision was based on:

- Fish Needs – described in SOR
- Risk to Refill
  - ESP Trace information
  - Flood Control Refill Curve computations
  - Historical Analysis – 4 of 12 similar years would not refill
  - Water supply forecast uncertainty

Lessons from SOR & JTS Memo

- Balance between refill and spring augmentation is difficult, especially with high uncertainty in future events.
- Raises valid question "If we could go back in time, would we do anything different based on what we did know or could have known?"
- We cannot use 20-20 hind sight (observed runoff) to question real-time decisions.
- We need to communicate forecast AND the uncertainty associated with the forecast


Pacific herring (*Clupea pallasi*)


Chinook salmon

Ocean conditions and salmon productivity

Bob Emmett and Bill Peterson
NOAA Fisheries
Hatfield Marine Science Center
Newport Oregon

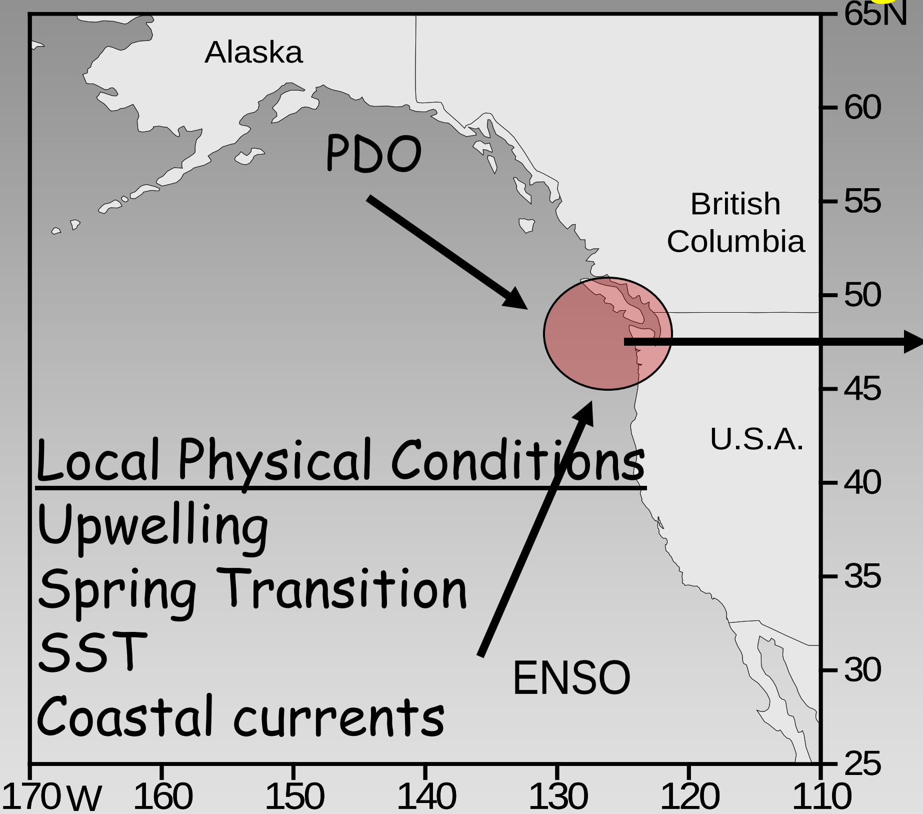
- See www.nwfsc.noaa.gov, "Ocean Index Tools"

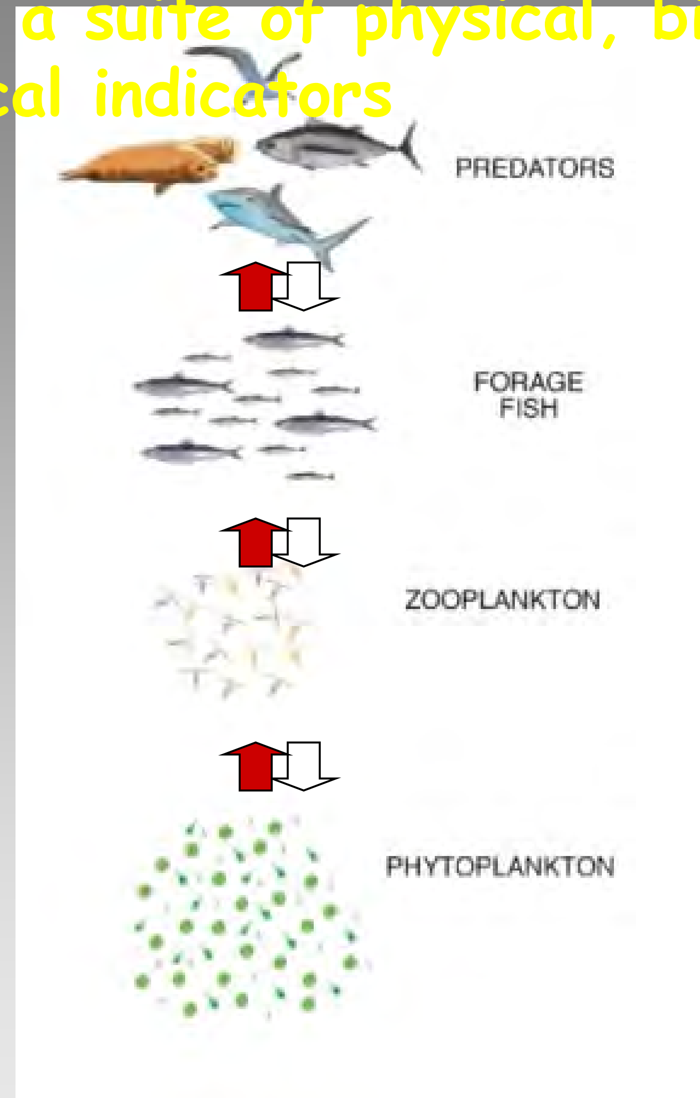
NWFSC and Climate change, marine ecosystems and salmon?

- Long-tem observations at sea: fish, birds, oceanography, zooplankton, etc.
- Experiments in the laboratory on living animals
- Computer models Oregon State University, Georgia Tech and Princeton Univ.
- Producing forecasts available on our web-page
- Timing of ocean entry
- Role of fatty acids in food webs
- Estuary/ocean survival relationships
- Much more..

We are contributing to salmon management by studying the ocean phase of their life history and by developing management advice based on a suite of physical, biological and ecological indicators

Large scale forces acting at the local scale can influence biological process important for salmon



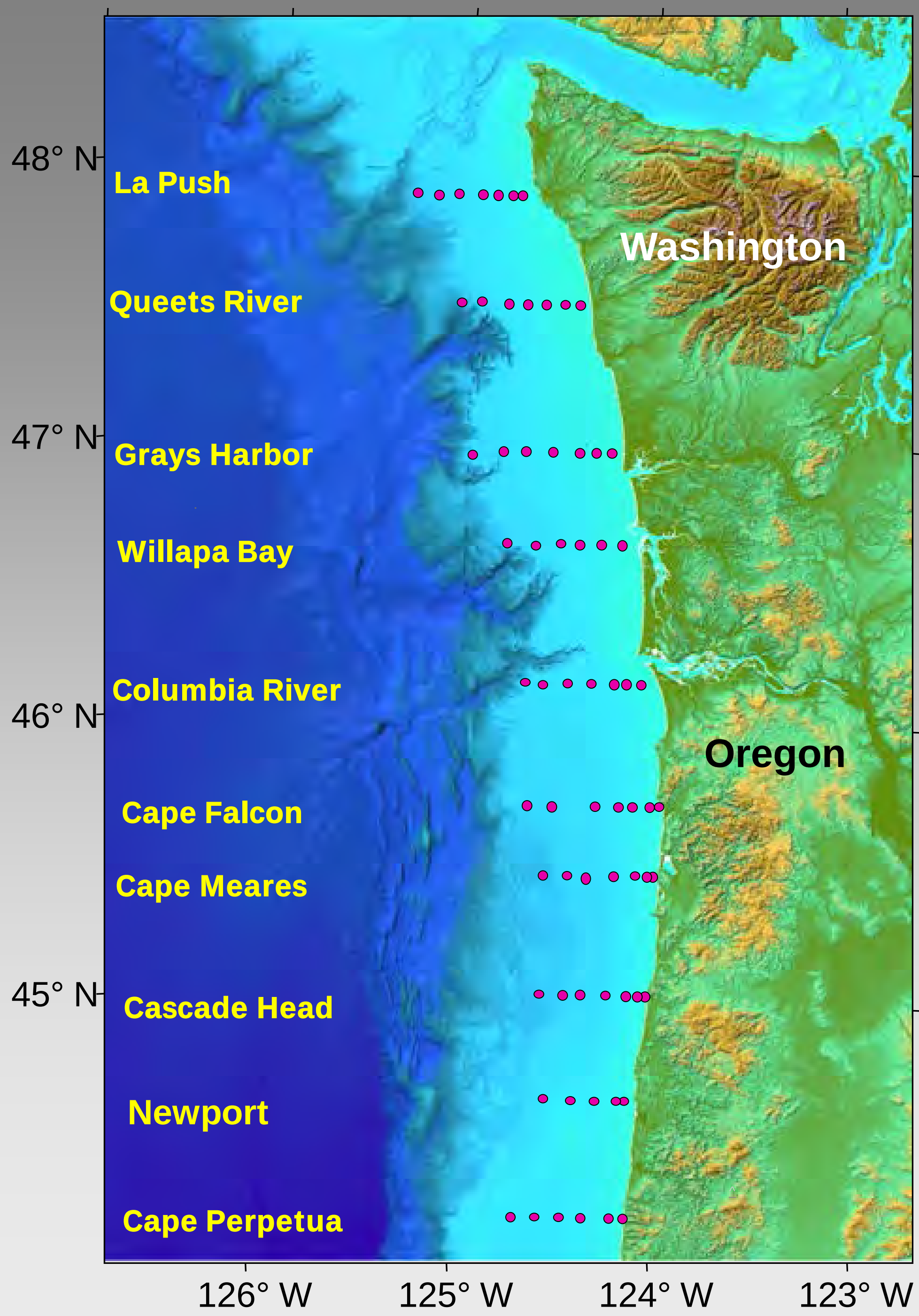


Approach

1. Develop time series
2. Relate to salmon through simple bivariate analyses

Local Biological Conditions

Observations



- Newport Line biweekly (zooplankton) sampling since 1996 (14 years)

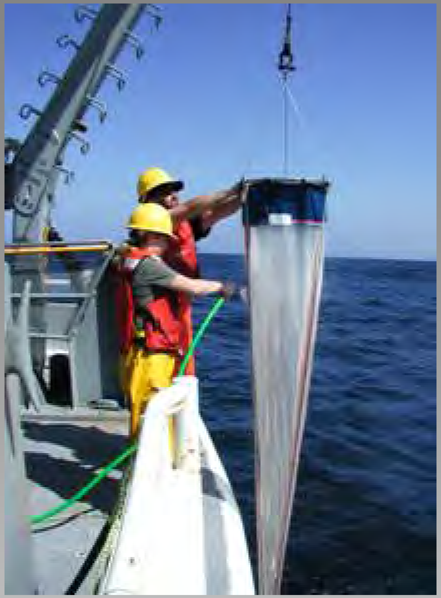
- Columbia River and Willapa Bay (surface trawl) every two weeks from May-August

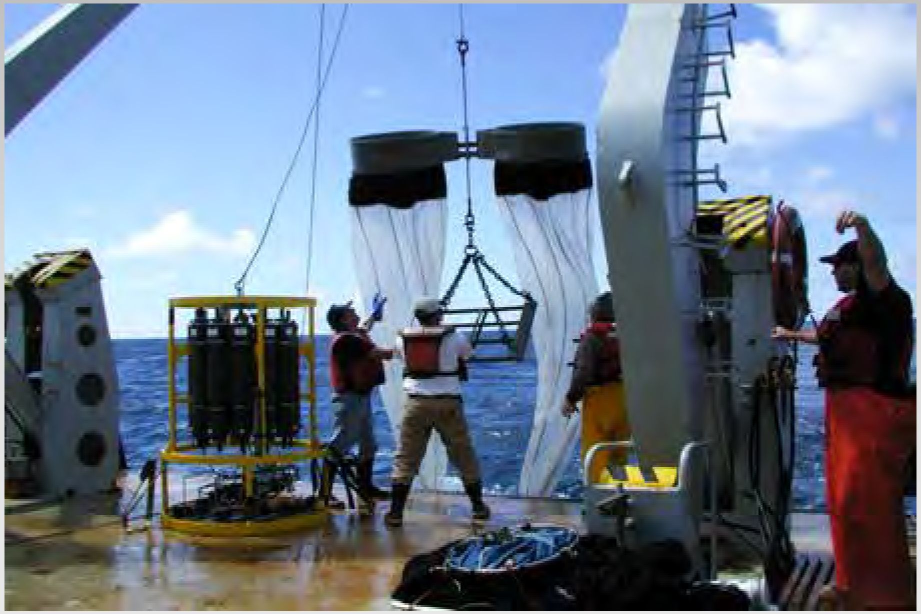
- Juvenile salmon sampling in May*, June and September since 1998 (12 years)

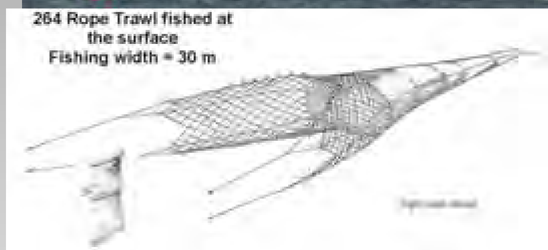
- Historical data:
  - hydrography, 1960s;
  - plankton, 1969-1973; 1983, 1990-1992
  - juvenile salmon, 1981-1985

Sampling methods

- Copepods with 0.5 m diameter 200 μm mesh net towed vertically from 100 m
- Krill with 70 cm 333 μm mesh net towed obliquely





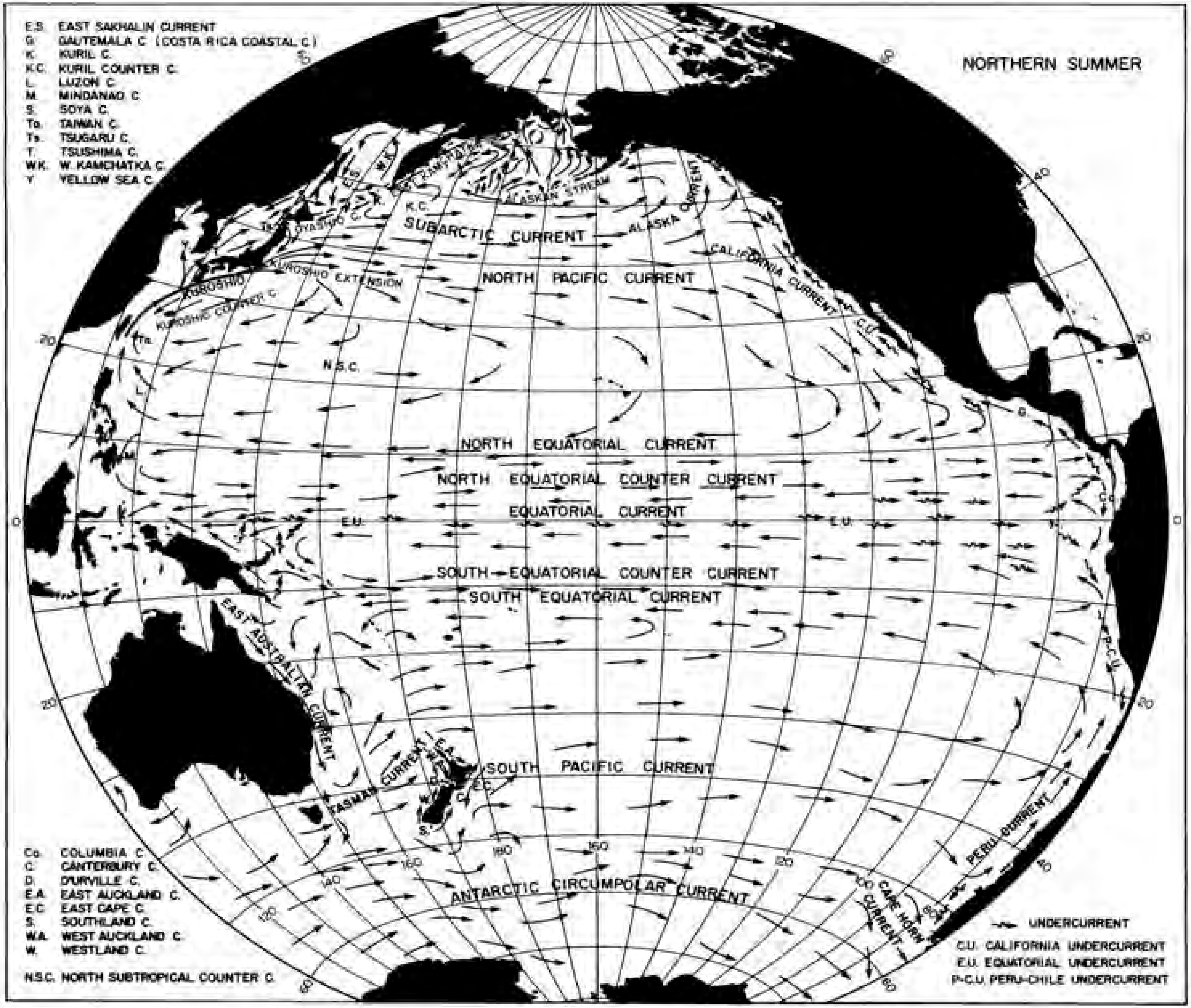

264 Rope Trawl fished at
the surface
Fishing width = 30 m

Four factors affect plankton, food chains, pelagic fish and the growth and survival of salmon in the northern California Current

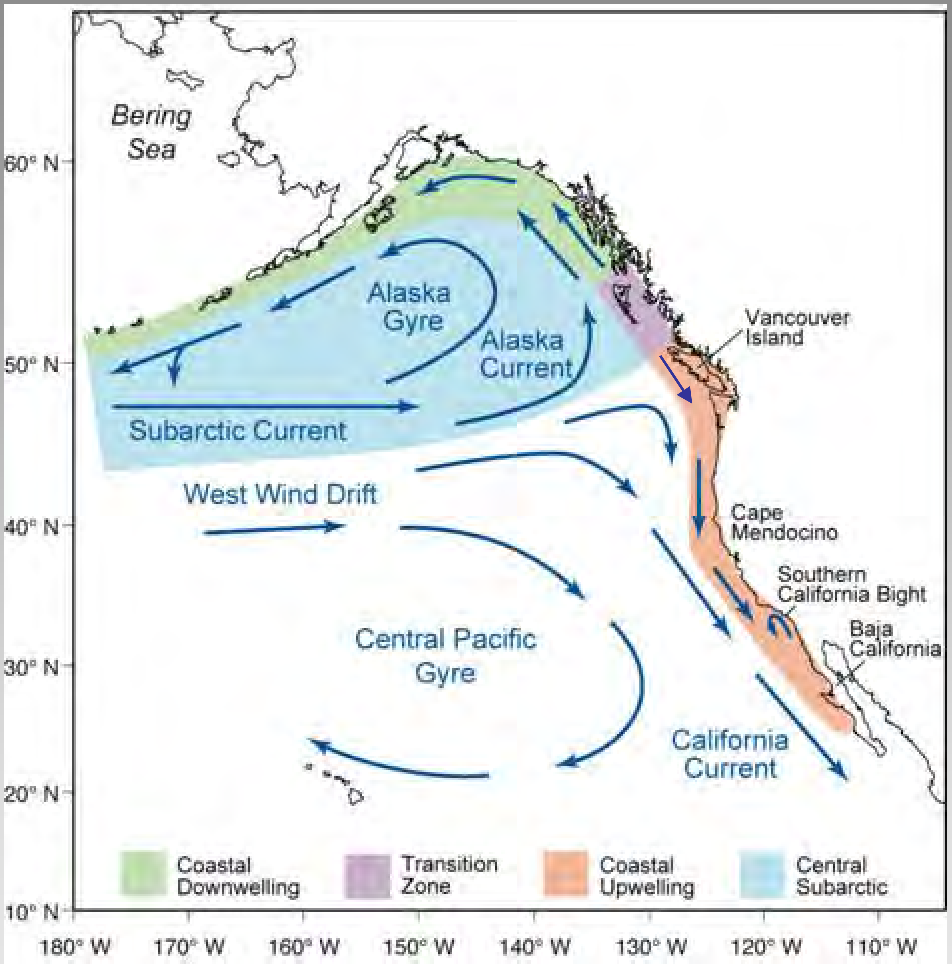
- Source waters: variations and their causes largely unknown
- Upwelling varies in terms of date of onset, length of season, and strength of winds
- Seasonal reversals in currents related to when upwelling/downwelling seasons begin
- Phase of the PDO – used to be decadal now more like semi-decadal

Much of our info is on the web at:
http://www.nwfsc.noaa.gov
"Ocean Index Tools"

Oceanography 101

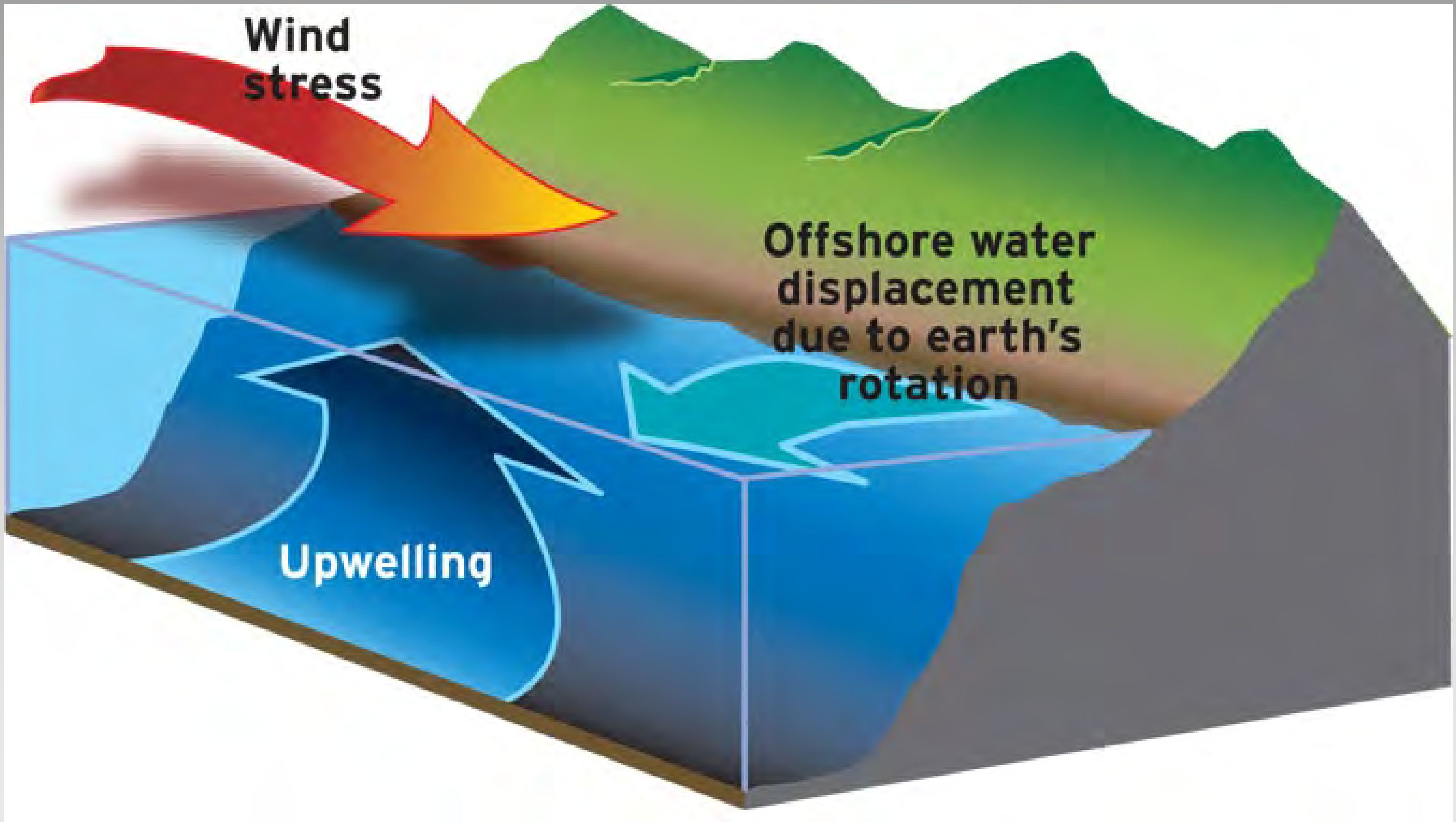


Circulation off the Pacific Northwest



Subarctic Current brings cold water and northern species to the N. California Current;
The West Wind Drift brings subtropical water and subtropical species to the N. California Current

Local winds drive currents and cause upwelling along the coasts of Washington, Oregon and California



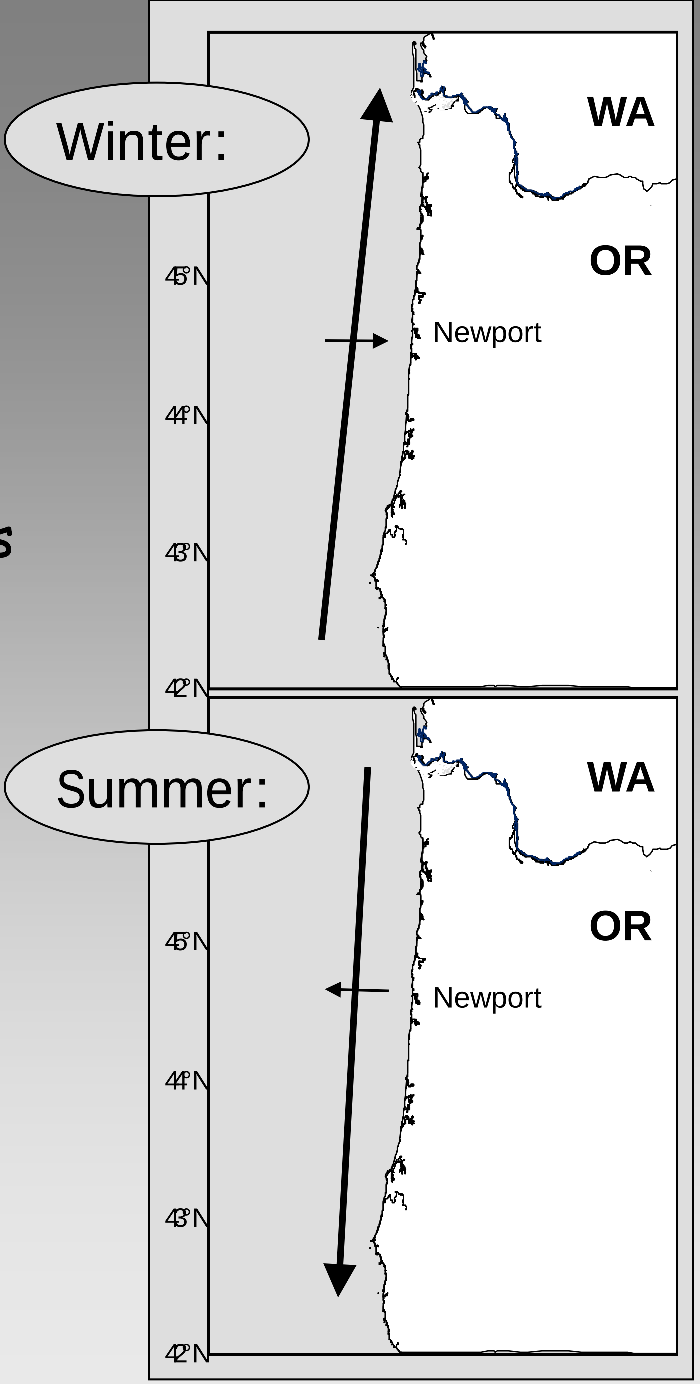
Winds and current structure off coastal Oregon:

- Winter:
  - Winds from the South
  - Downwelling
  - Poleward-flowing Davidson Current
  - Subtropical and southern plankton species transported northward & onshore
  - Many fish spawn at this time

- **Spring Transition in April/May**

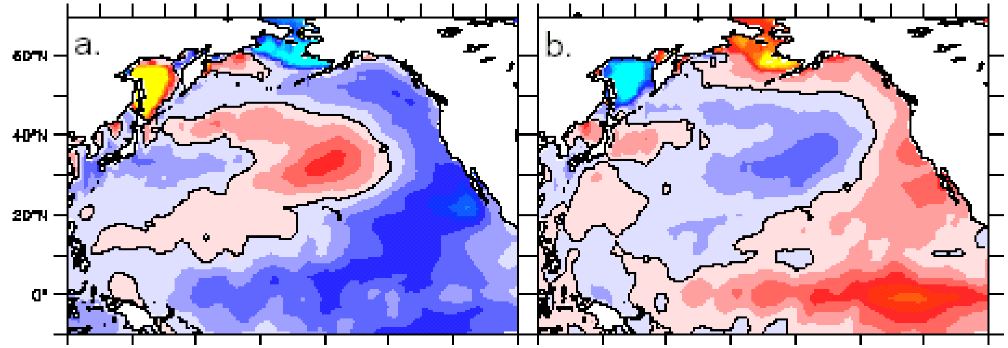
- Summer:
  - Strong winds from the North
  - Coastal upwelling
  - Equatorward alongshore transport
  - Boreal/northern species transported southward

- **Fall Transition in October**



The PDO has two phases, resulting from the direction from which winds blow in winter.

PDO & SST



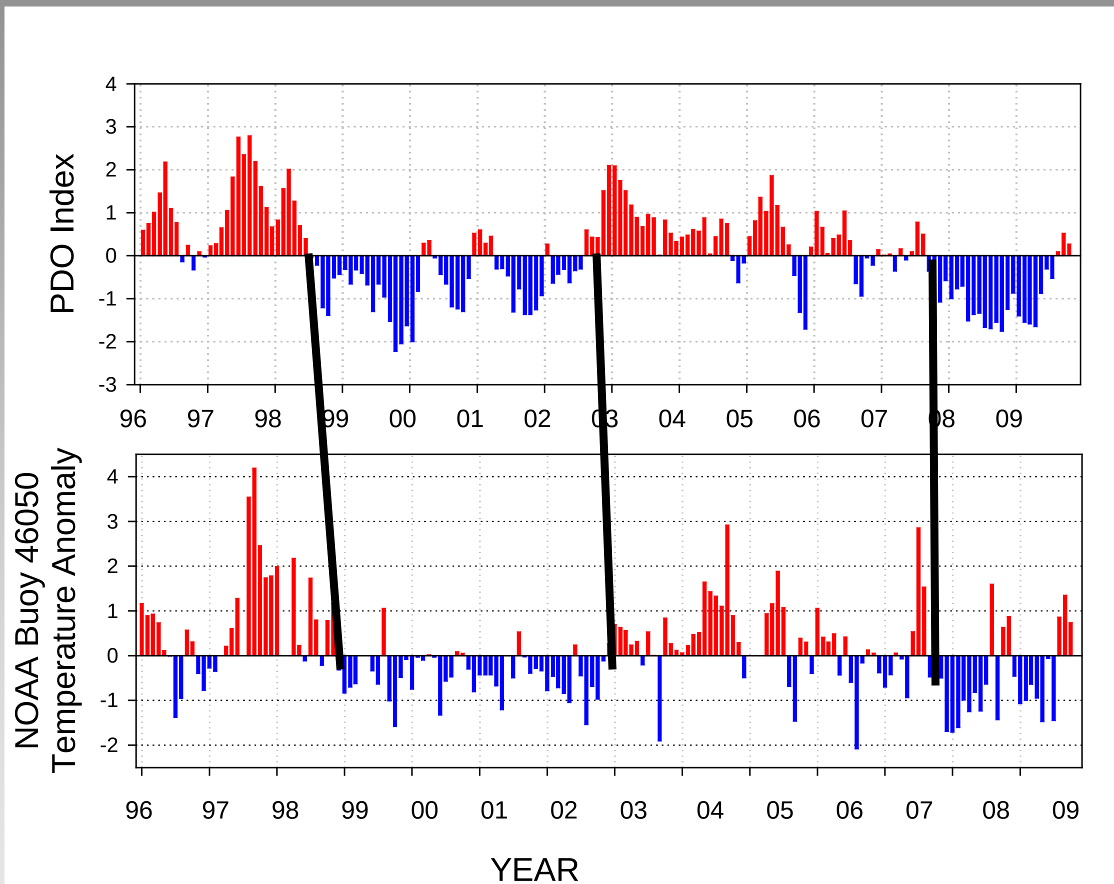
Negative Phase	Positive Phase
1948-1976	1925-1947
1998-2002	1976-1998
2006-	2003-2006

The SST anomaly patterns shown on the right results from basin scale winds: W'ly and NW'ly [negative phase] and SW'ly [positive phase]

Westerlies dominated winter (07-08), Not sure this winter

Blue is anomalously cold
Red is anomalously warm

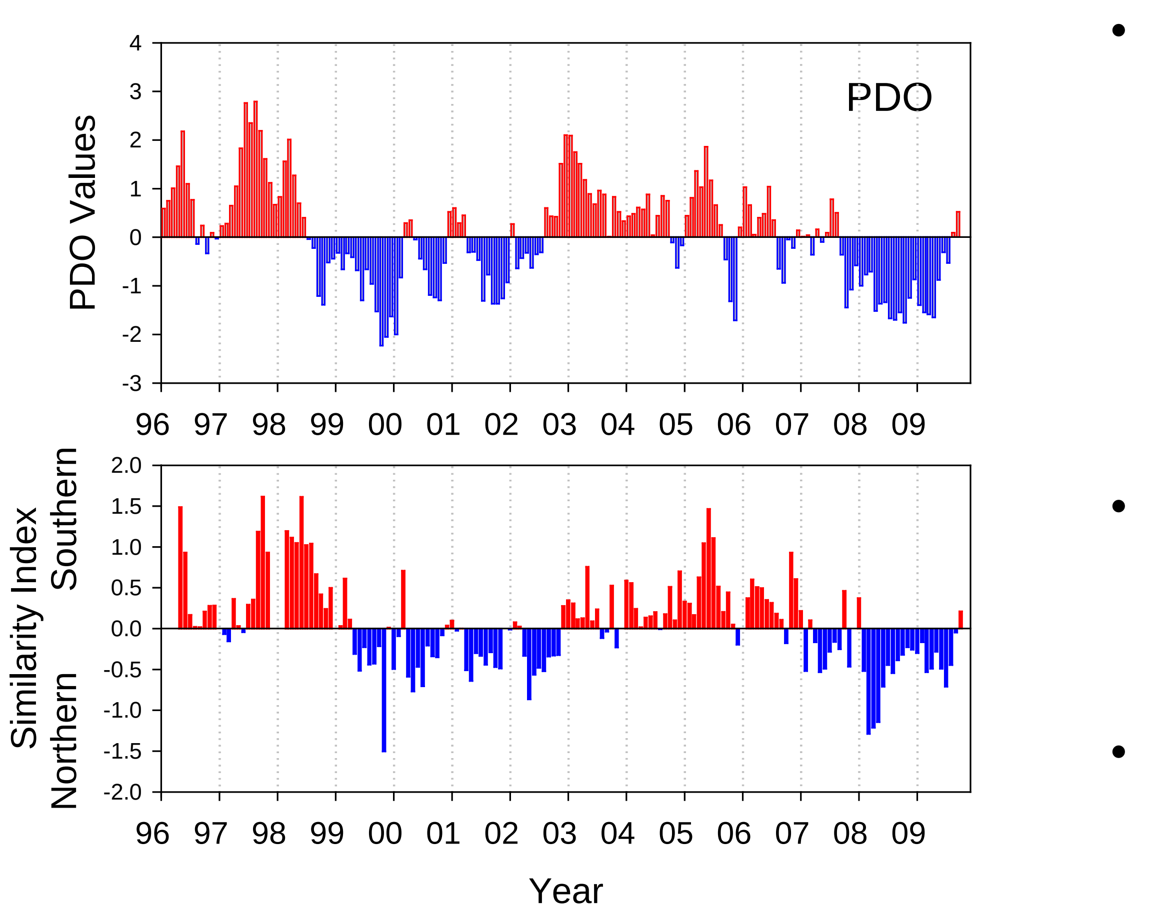
14 year time series of SST off Newport shows that PDO downscales to local SST



Temperature differences usually ± 1°C

- PDO and SST correlated, as they should be.
- Note the three recent period of persistent sign changes: 1999, 2003 and 2007
- However there are time lags between PDO sign change and SST response of ~ 3-5 months, suggesting perhaps that the PDO is an advective signal along the Oregon coast

Ordinations: x-axis score vs. PDO



- Ordination of copepod community structure shows that ~ 75% of the variance is explained by the x-axis
- Positive values are "warm water community"
- Negative values are "cold water community"

Contrasting Communities

- **Negative PDO = low diversity and “cold-water” copepod species.** These are dominants in Bering Sea, coastal GOA, coastal northern California Current
  – *Pseudocalanus mimus, Calanus marshallae, Acartia longiremis*
- **Positive PDO = high diversity and “warm-water” copepods.** These are common in the Southern California Current neritic and offshore NCC waters
  – *Clausocalanus spp., Ctenocalanus vanus, Paracalanus parvus, Mesocalanus tenuicornis, Calocalanus styliremis*

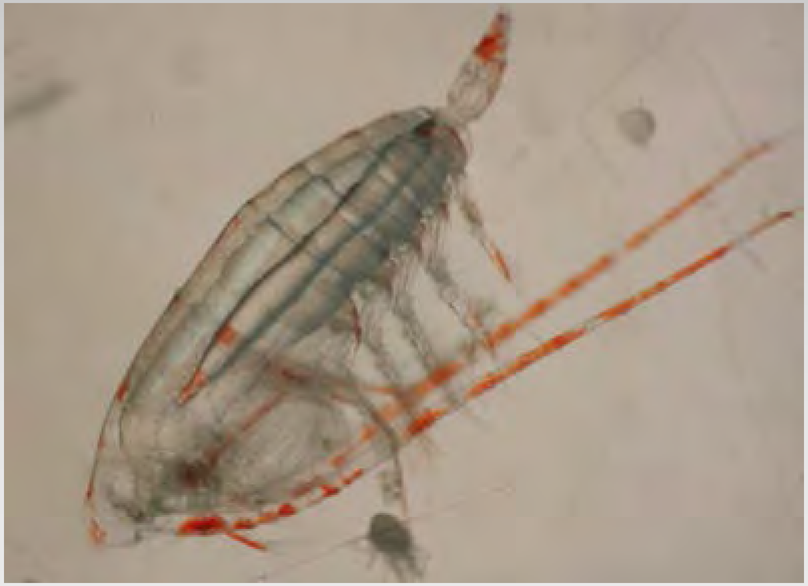
Based on Peterson and Keister (2003)

Comparisons in size and chemical composition

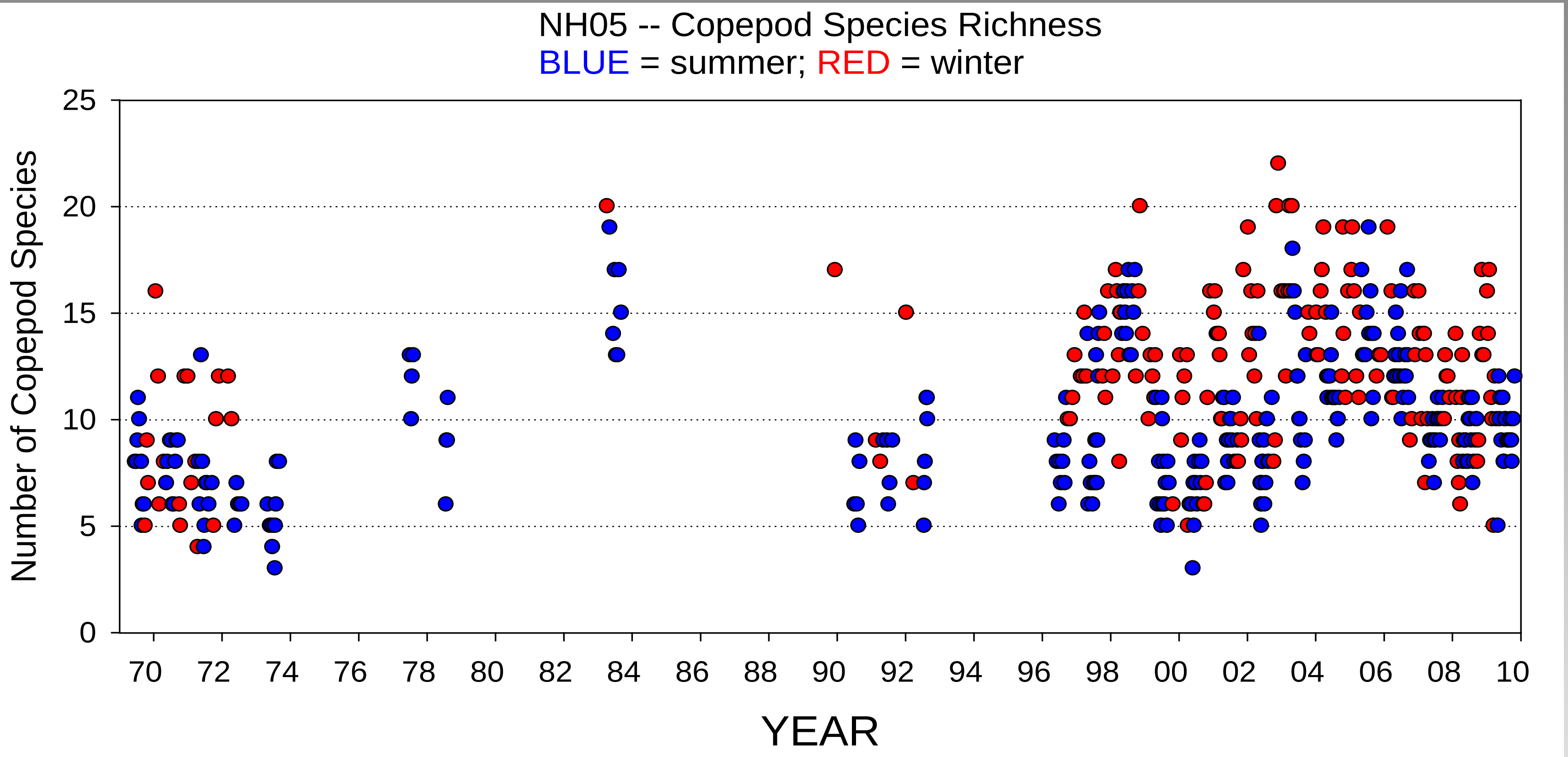
- **Warm-water taxa** - (from offshore OR) are **small** in size and have limited high energy wax ester lipid depots
- **Cold-water taxa** – (boreal coastal species) are **large** and store **wax esters** as an over-wintering strategy

Therefore, significantly different food chains may result from climate shifts;

copepod and krill



Are we seeing any indication of changes in copepods over the past 40 years?



- 69-73 = 6.68 species
- 96-08 = 10.24 species
- Despite recent cold ocean conditions we still see high species richness
- Over the same time period, the surface waters of the NCC shelf have warmed by 0.53°C. and 0.43 °C in deep waters 0.43 °C

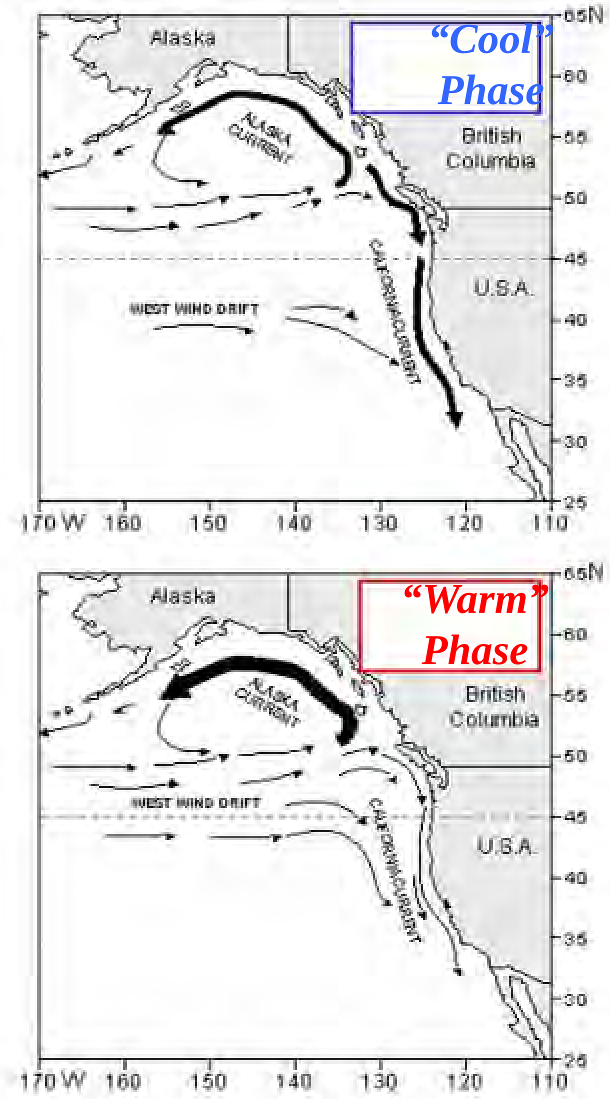
A working mechanistic hypothesis: source waters. . .

Cool Phase →

Transport of boreal coastal copepods into NCC from Gulf of Alaska

Warm Phase →

Transport of sub-tropical copepods into NCC from Transition Zone offshore

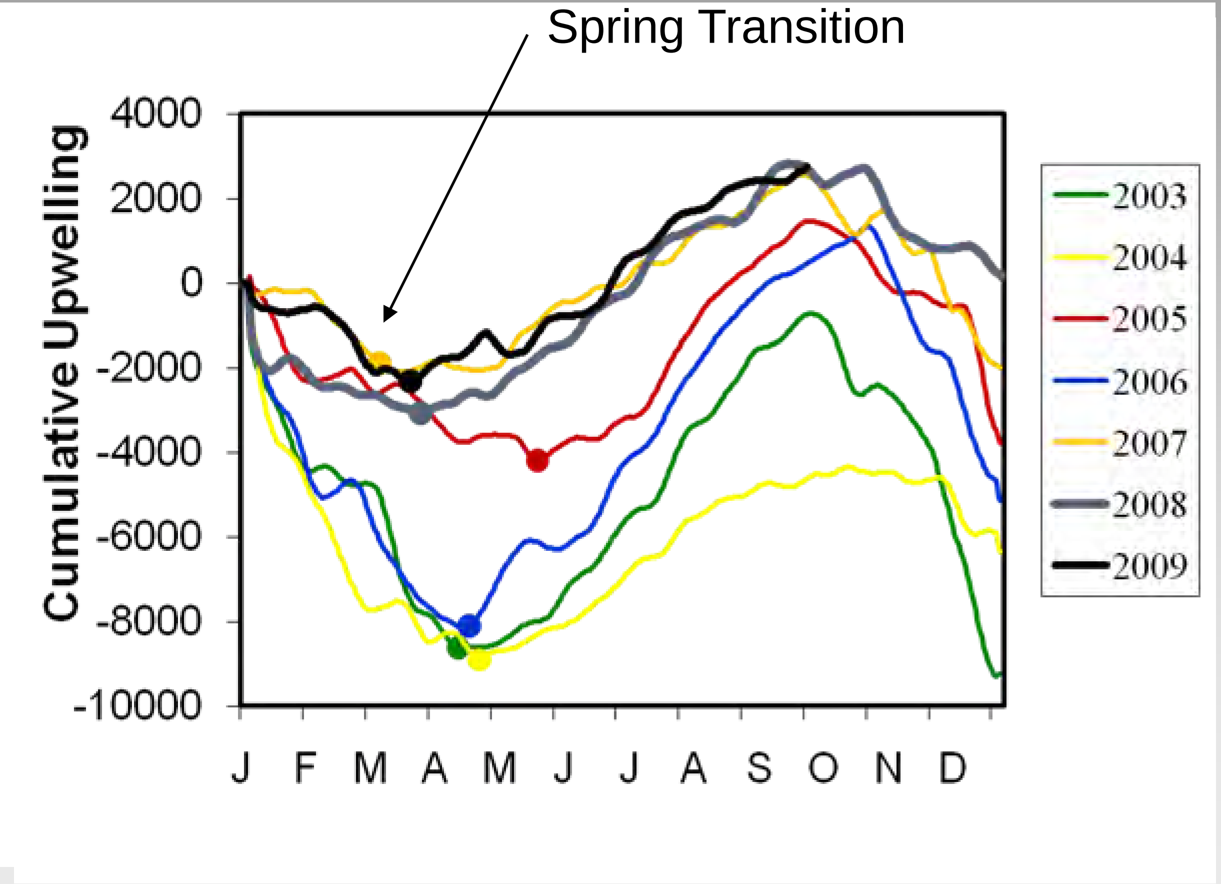


Importance of timing of ecosystem interactions: predictions for climate change

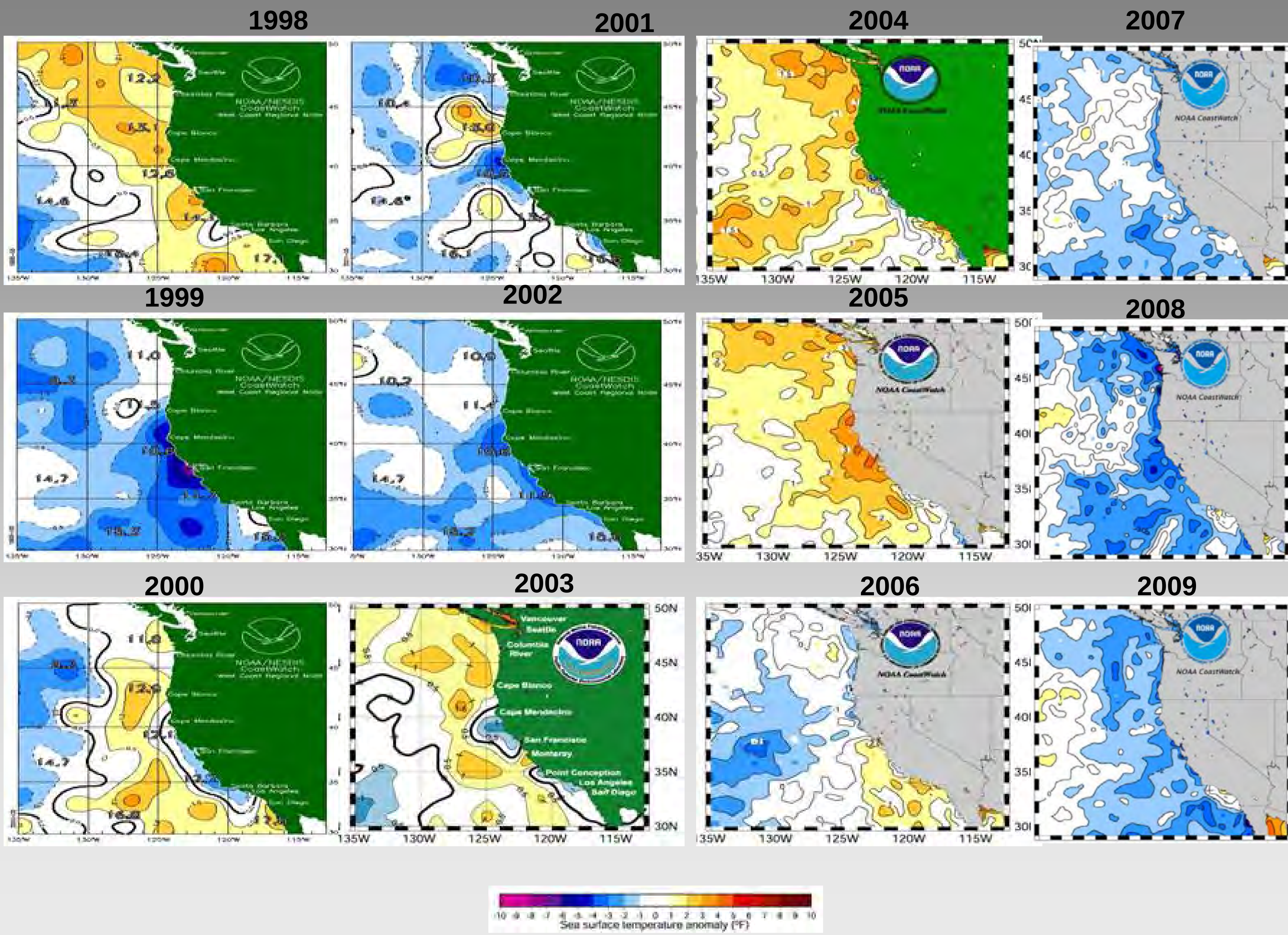
- The timing and strength of upwelling and ocean conditions are expected to change in the future

- Most ecosystem interactions are tuned to the timing of seasonal events (phenology)

  - Forage fish and juvenile salmon

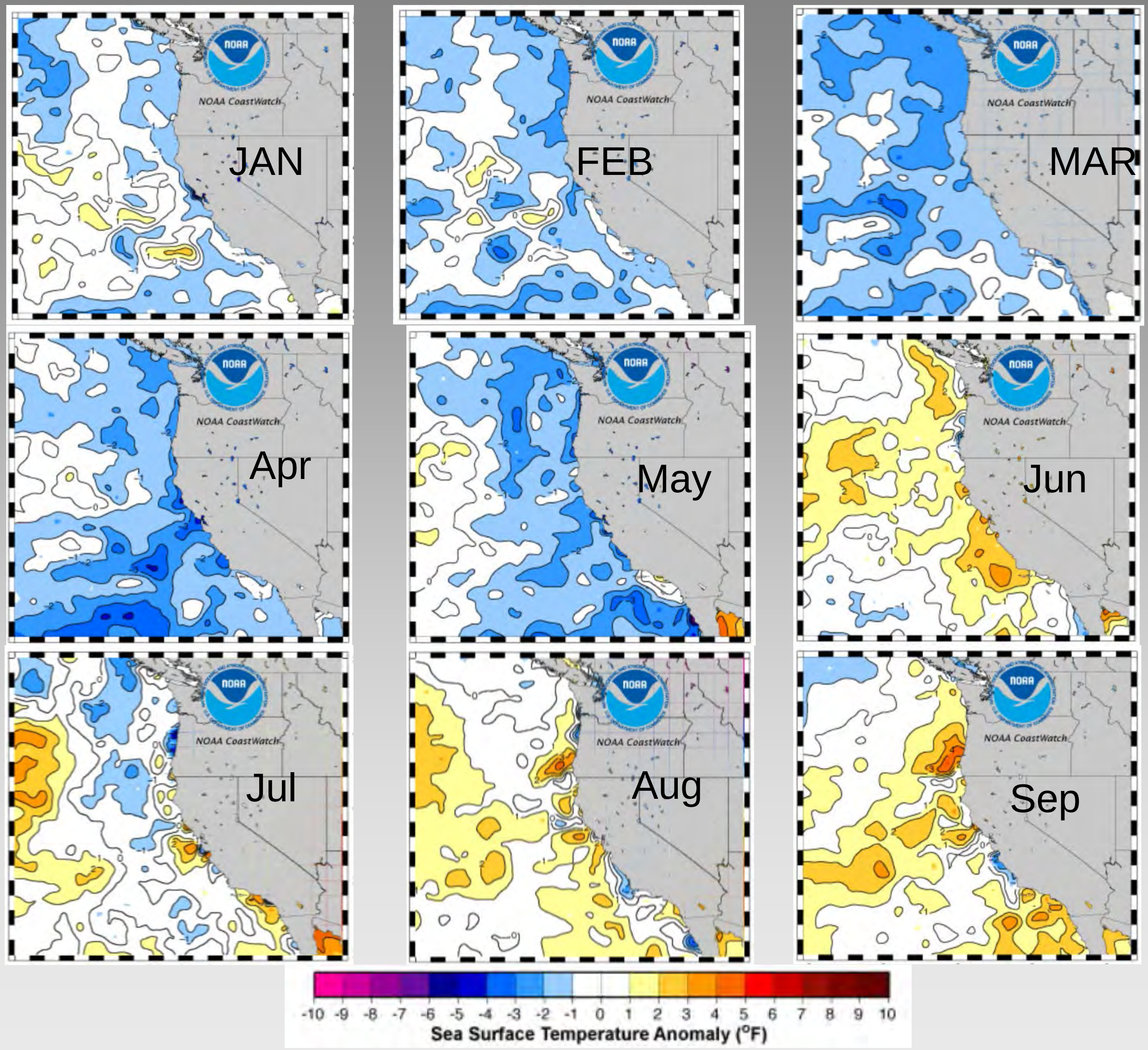


Sea surface temperature anomalies May 1998-2009



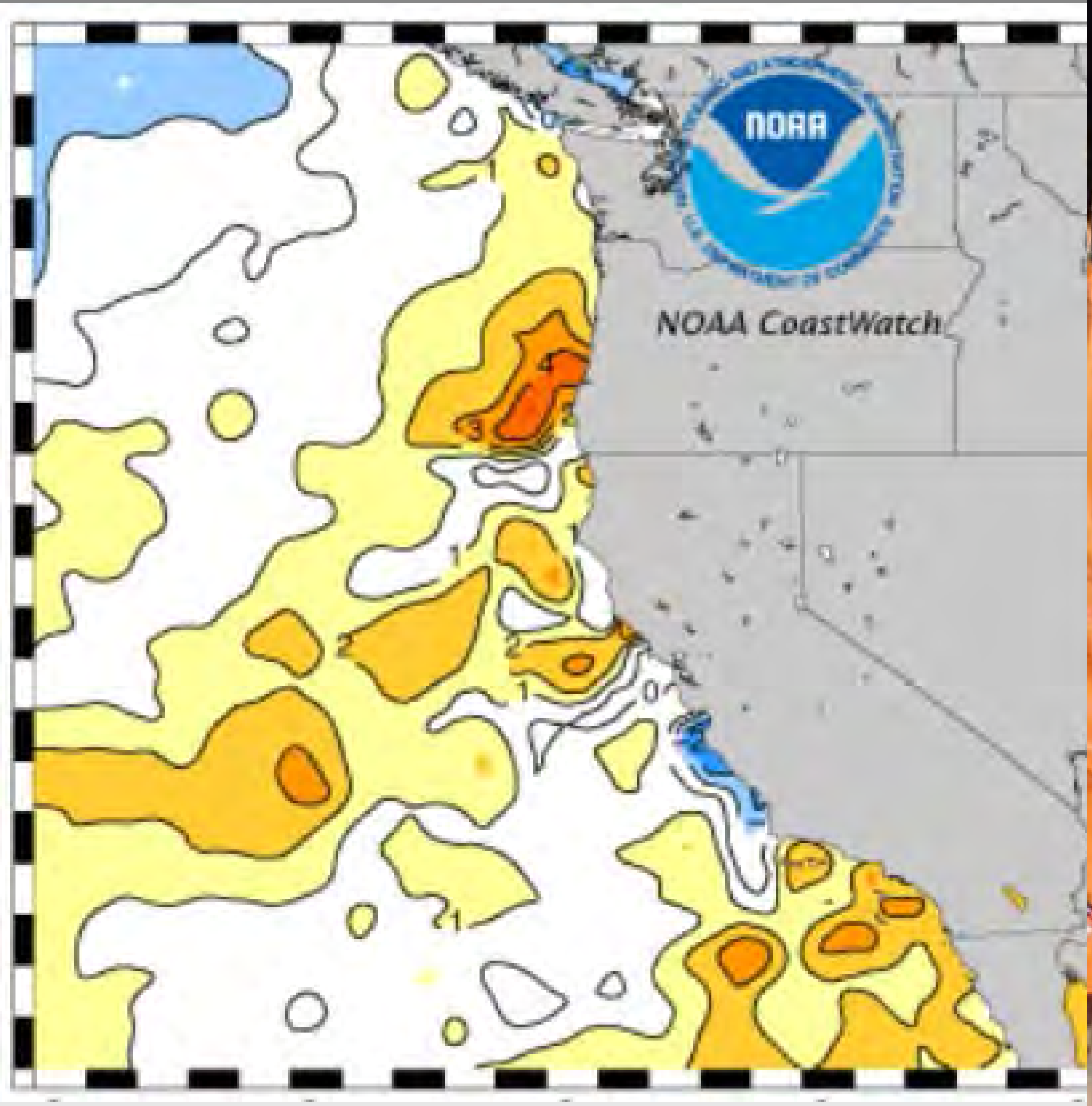
Ocean Conditions

2009 Sea Surface Temperature Anomalies



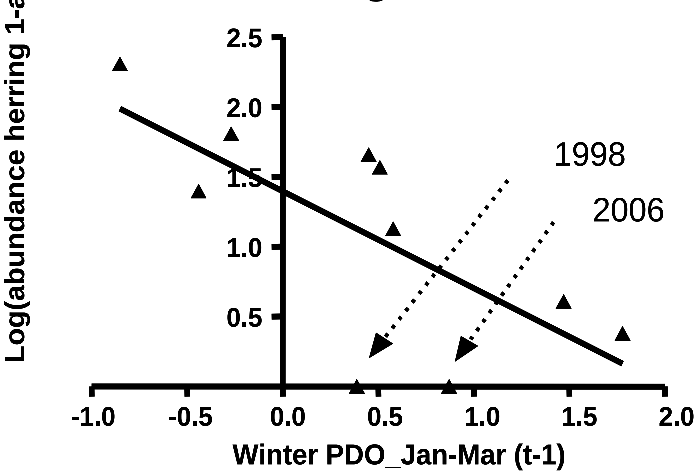
Ocean Conditions

Sept 2009 SST Anomaly

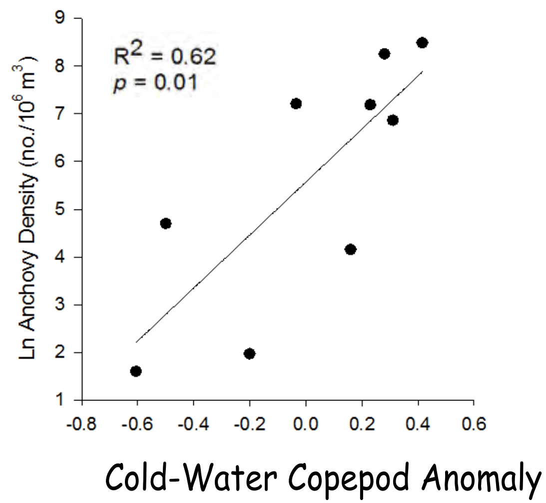


Oceanography and forage fish recruitment

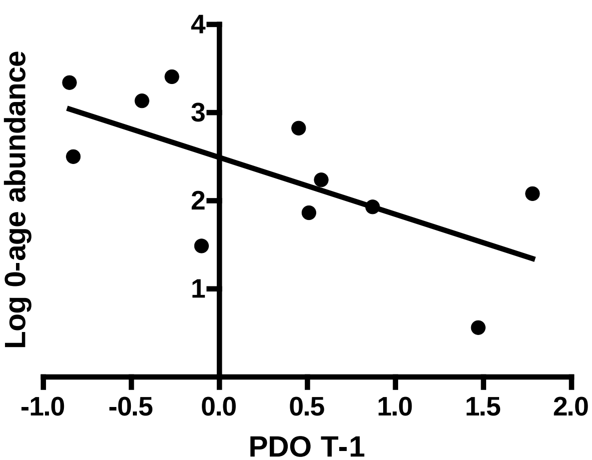
Pacific herring abundance



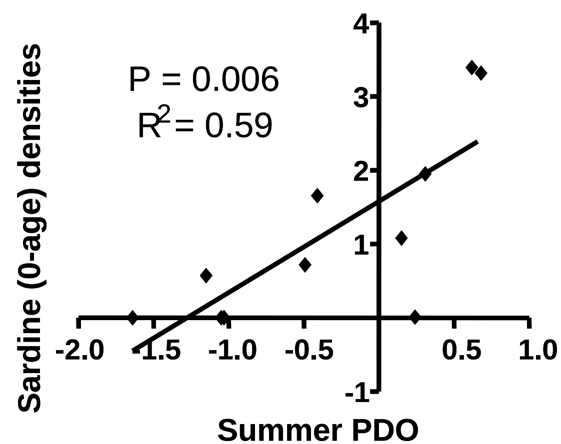
Anchovy abundance



Whitebait abundance (0-age) versus PDO (t-1)



Sardine abundance

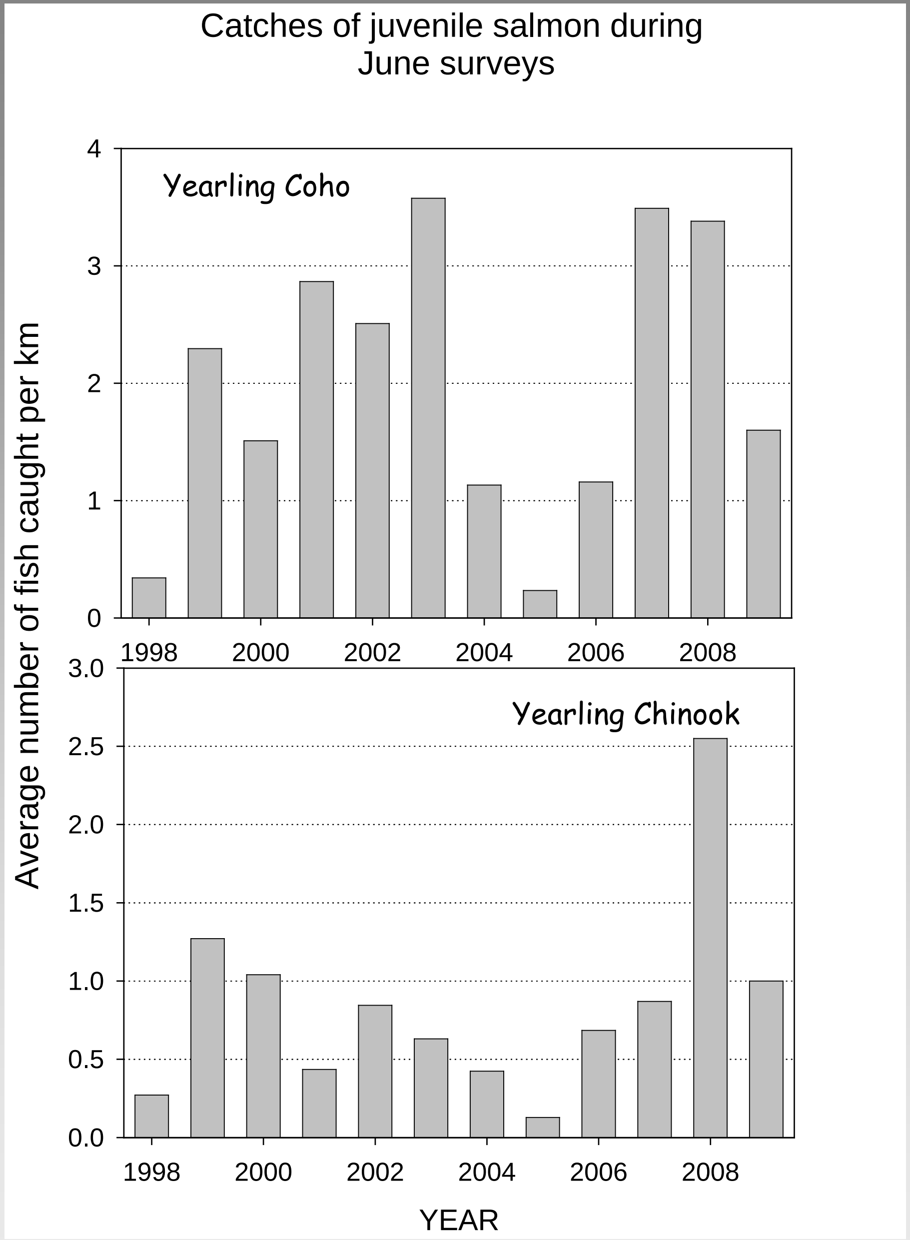


Observations in 2008

- PDO most negative since 1955
- SST very cold
- Deep water coldest in at least the past 13 years (but more likely, since mid 1970s)
- Copepod biomass returned to levels last seen 6 years ago (2002)
- Very high forage fish recruitment – larval fish survival

Observations in 2009

- PDO remained negative only through July
- SST anomalies -2°C through July then warmed to 3°C in August-September
- Copepod biomass dropped in September
- Humboldt squid very abundant in August/Sept
- Juv salmon catches very low in September survey



Catches of juvenile salmon in rope trawl surveys (June)

- Highest catches of spring Chinook in 2008, by a factor of 2.4; 2009 average
- High catches of coho in 2007 and 2008 but nothing special in 2009

Ranks of ecosystem predictors

Environmental Variables	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
PDO (December-March)	11	5	2	8	4	12	7	10	9	6	3	1
PDO (May-September)	9	2	3	4	6	11	10	12	8	7	1	5
MEI Annual	11	1	3	5	10	9	7	8	6	4	2	
MEI Jan-June	12	2	3	5	8	10	7	11	4	9	1	6
SST at 46050 (May-Sept)	10	8	4	5	1	6	12	9	2	11	3	7
SST at NH 05 (May-Sept)	8	2	1	4	6	7	12	11	5	9	3	10
SST winter before going to sea	12	7	5	6	4	8	11	10	9	3	1	2
Physical Spring Trans (Logerwell)	8	7	2	1	4	10	9	12	10	3	6	5
Upwelling (Apr-May)	7	1	11	3	6	10	9	12	7	2	4	5
Deep Temperature at NH 05	12	4	6	3	1	7	9	10	11	5	2	8
Deep Salinity at NH05	12	3	6	2	5	9	11	8	7	1	4	10
Length of upwelling season	7	3	2	10	1	11	9	12	6	5	8	4
Copepod richness	12	2	1	5	3	9	8	11	10	6	4	7
N.Copepod Anomaly	11	8	3	5	2	9	6	10	7	4	1	
Biological Transition	12	7	3	5	4	10	6	11	9	8	1	2
Copepod Community structure	11	4	3	4	2	8	7	10	9	6	1	
Catches of salmon in surveys												
June-Chinook Catches	11	2	3	9	6	8	10	12	7	5	1	4
Sept-Coho Catches	9	2	1	4	3	5	10	11	7	8	6	12
Mean of Ranks of Environmental Data	10.3	3.9	3.4	4.9	4.2	8.8	8.9	10.6	7.4	5.7	2.9	5.9
RANK of the mean rank	11	3	2	5	4	9	10	12	8	6	1	7

The "bottom line" is the "bottom line" (rank of the mean rank). 2008 was the best year of the past 12 and probably the best year since the 1970s

A chain of events

	High Survival	Low Survival
Changes in basin-scale winds lead to sign changes in PDO	Negative	Positive
SST changes as do water types off Oregon	Cold/salty	Warm/fresh
Spring transition	Early	Late
Upwelling season	Long	Short
Zooplankton species	Cold species	Warm species
Food Chain	Lipid-rich	Lipid-deplete
Forage Fish	Many	Few
Juvenile salmonids	Many	Few
Predators	Few	Many

But time lags can complicate interpretations!

Question: Does size at release/ocean entry play a role in marine survival of yearling Chinook salmon?

- ➢Every ten days April-May we released separate CWT groups of Willamette yearling Chinook annually from 2002-2006

- ➢Adult scale samples were recovered from the fishery, analyzed, and a length at ocean entry was calculated for each fish.

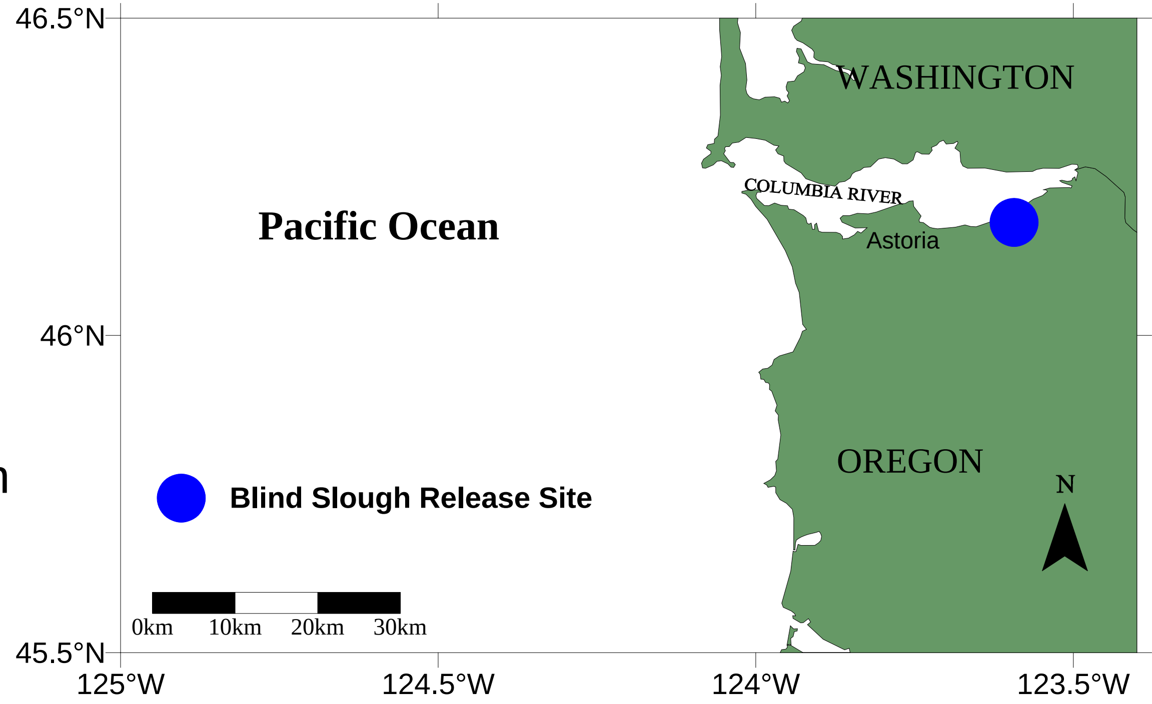
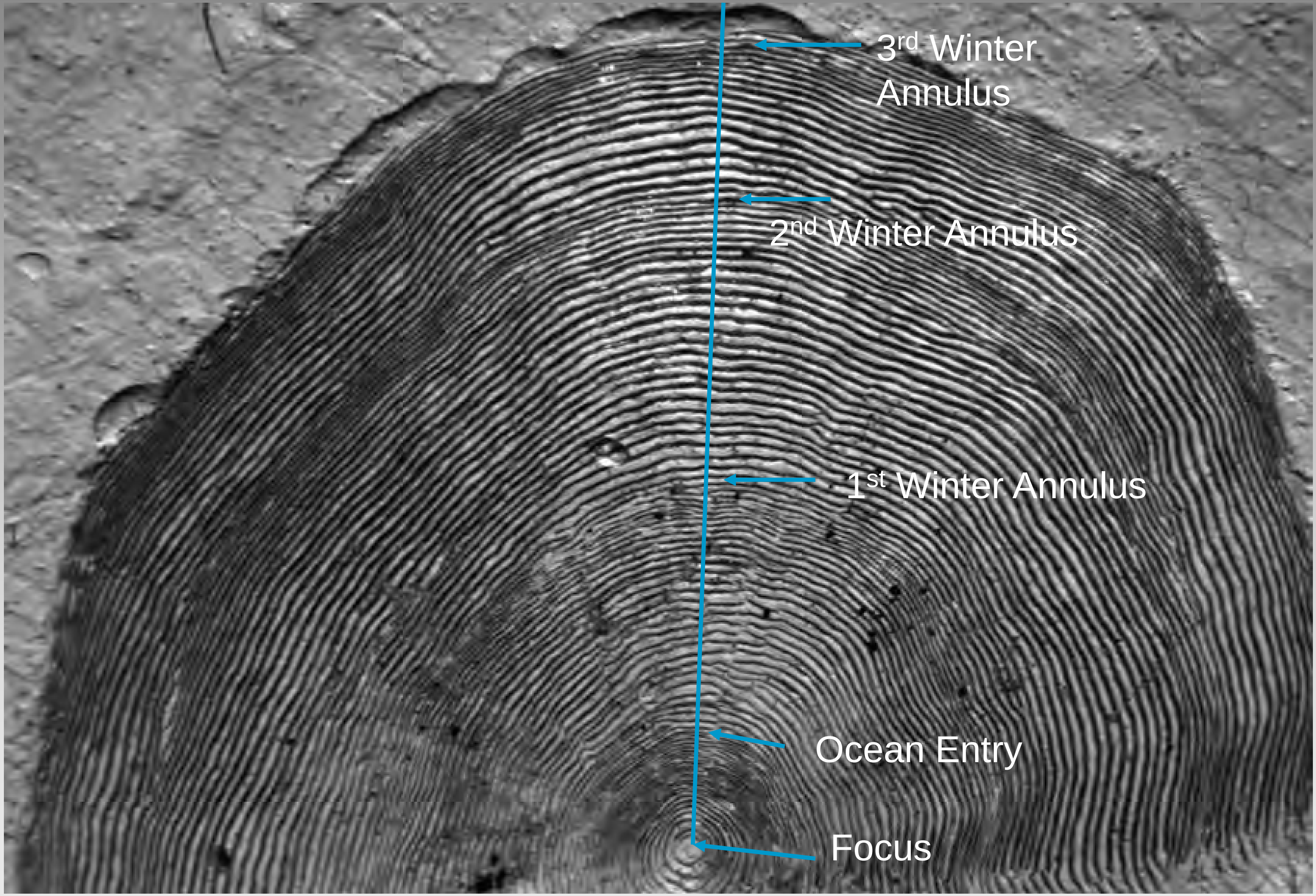
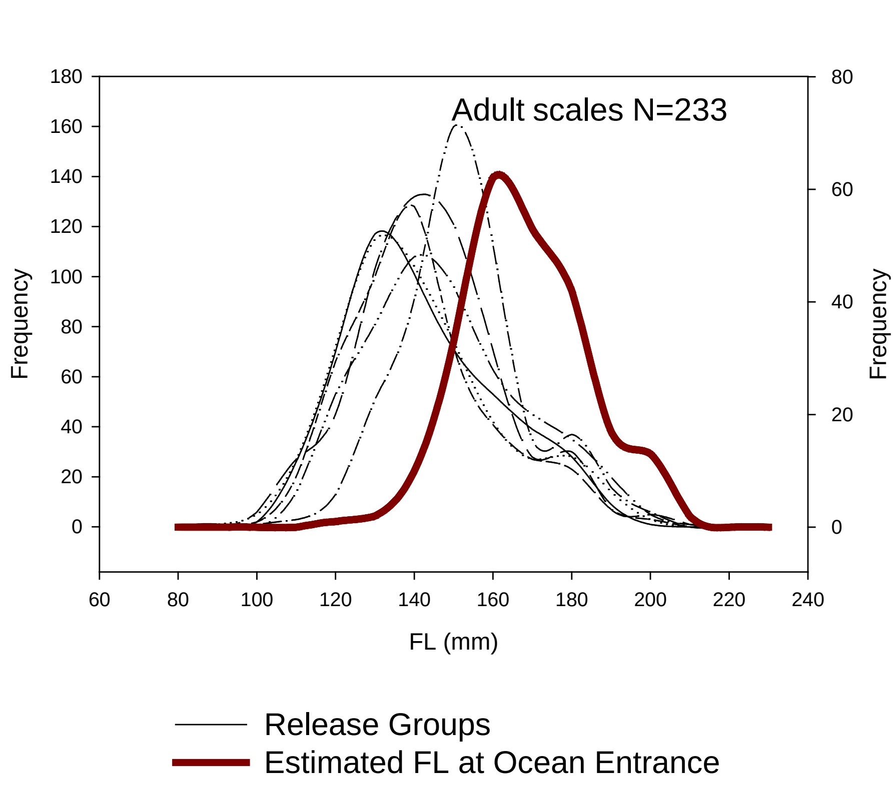


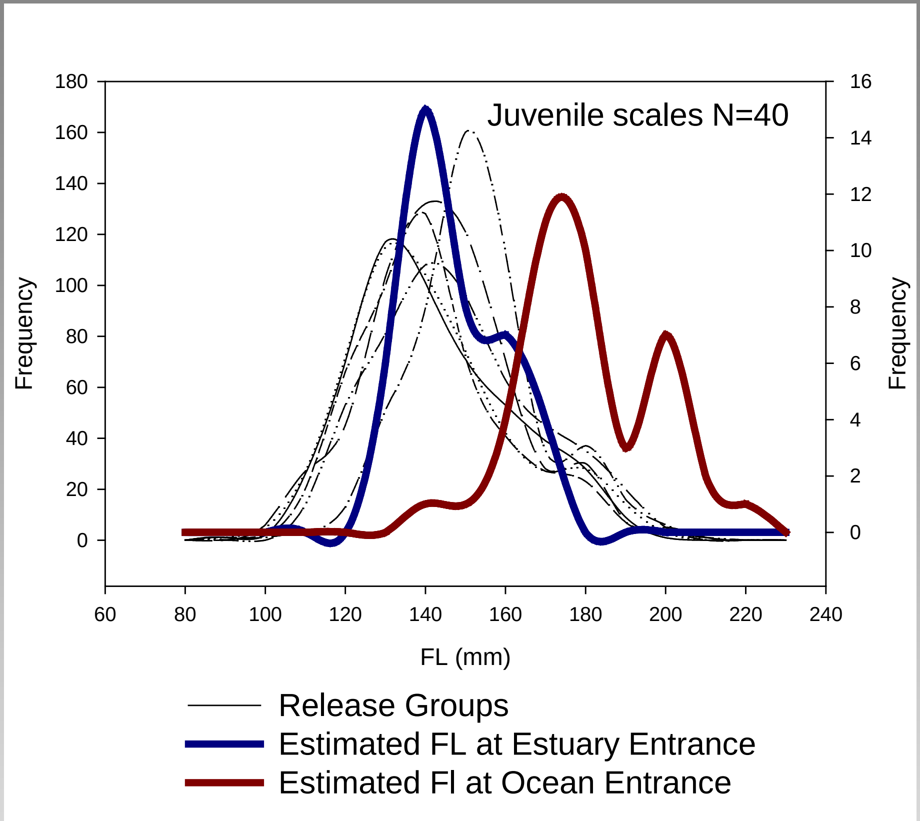
Image of Willamette Chinook; 2002 release 2005 return.



Chinook salmon scales

Results for 2002 release groups





- Preliminary results from 2002 release groups suggest size at ocean entry/release may play a role in marine survival.

- Surprisingly nearly 14% of 2002 releases show some “estuary?” residence before ocean entry.

El Nino this year?

- Subtle signs but are they linked to El Niño?
  - Upwelling relatively weak after June
  - Very warm water in August and September
  - Deep water throughout the summer was warmer and fresher than one might expect
  - Zooplankton diversity relatively high
  - Huge numbers of *Mola Mola* and Humboldt Squid in late summer
  - Record low catches of juv coho in September survey
  - Green and Olive Ridley turtles in Astoria
  - Massive and persistent "red tide" off WA and OR, Sep-Dec!
- Not so subtle signs that El Niño might fizzle
  - Upwelling winds have blown (from the north) from 27 Nov until ???
  - A "summer" zooplankton community persisted through November (usually a "winter" community is found by late October)
  - Recent outbreaks of cold arctic air
  - Ocean is again cooling with signs that the PDO will turn negative once again, and hopefully soon.

General Conclusions

- NWFSC – team focused on identifying the key components to marine survival
- PDO→ Copepods→ forage fish → GROWTH is primary
- Predators at times can be important
- Timing of ocean entry –Phenology
- The ocean is a continually changing and evolving ecosystem
- Salmon marine survival will always vary.

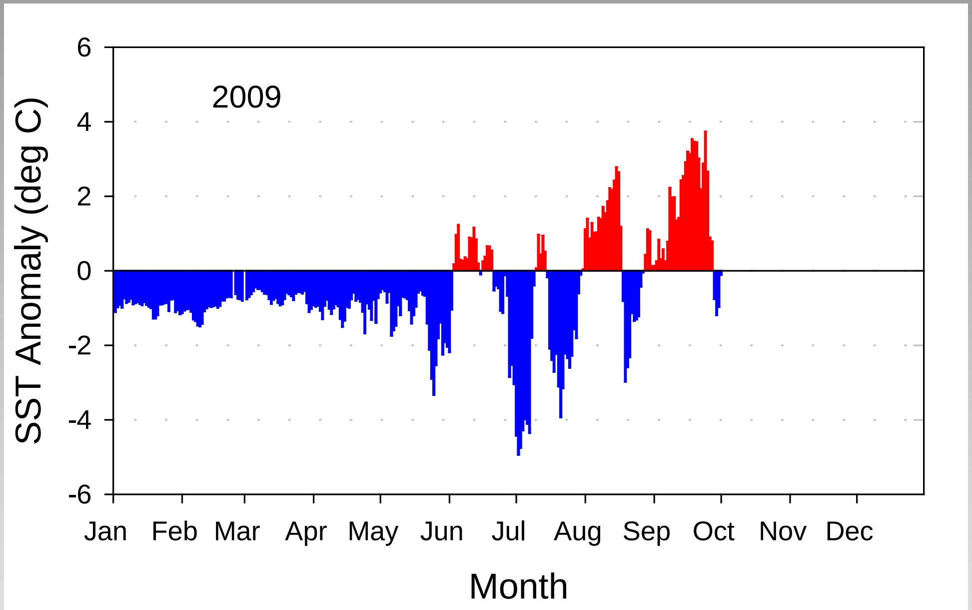
Acknowledgements

- Bonneville Power Administration
- U.S.GLOBEC Program (NOAA/NSF)
- Stock Assessment Improvement Program (SAIP-NOAA)
- Fisheries and the Environment (FATE-NOAA)
- National Science Foundation
- Office of Naval Research
- NASA

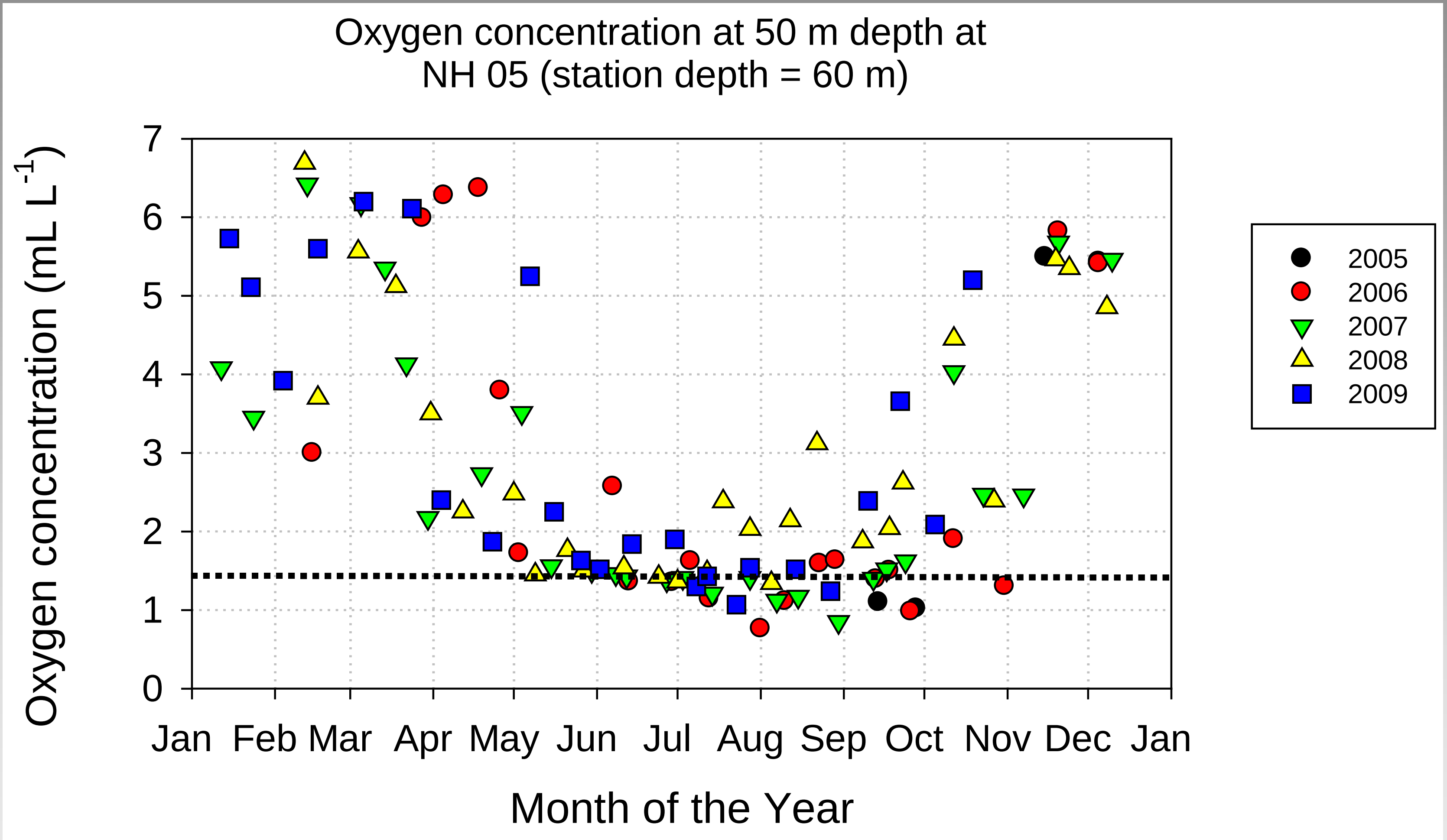
- See www.nwfsc.noaa.gov, "Ocean Index Tools"

Thank You..

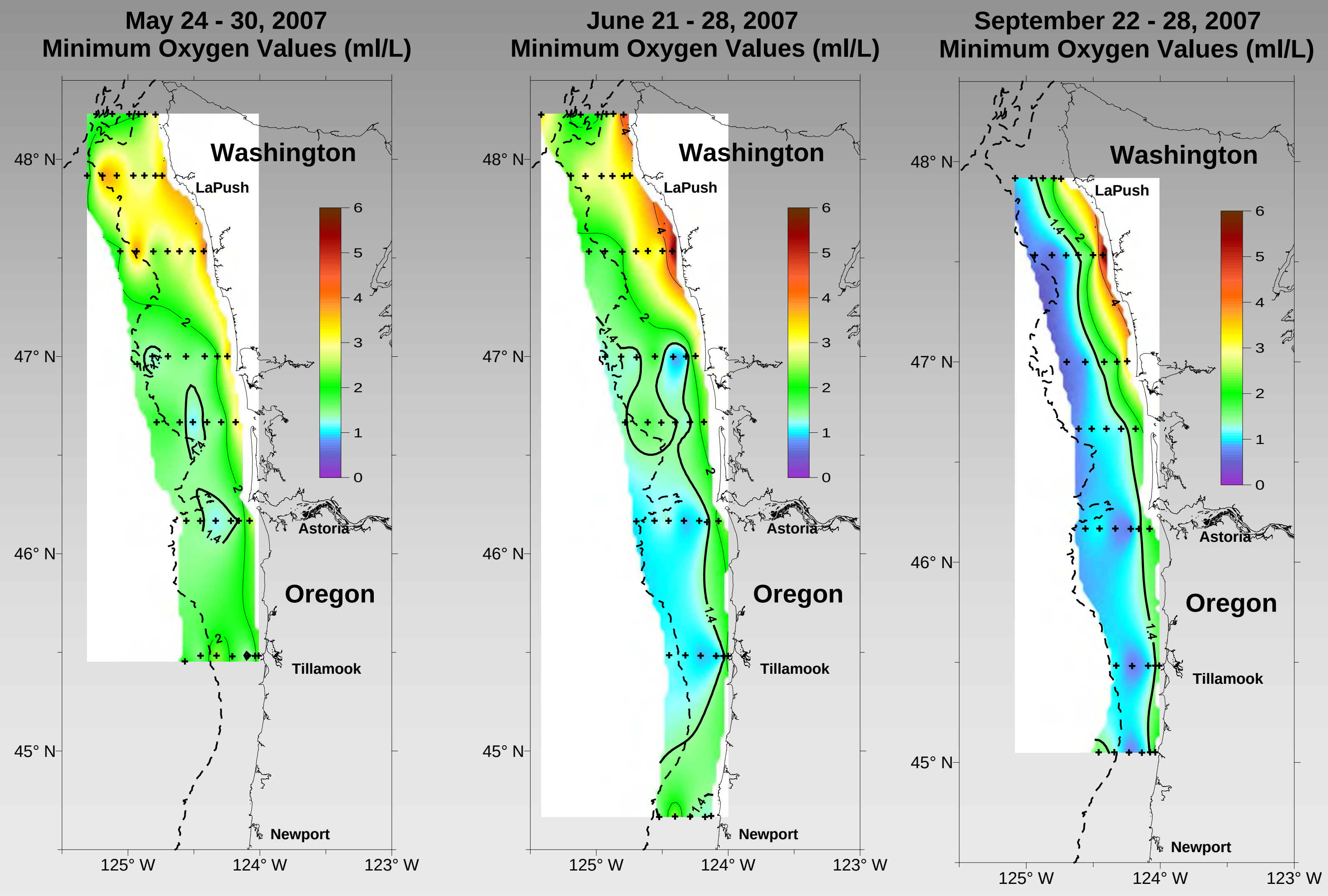
SST anomaly at Buoy 46050



Oxygen concentrations at a mid-shelf station off Newport



Hypoxia off WA and OR
May, June, Sept 2007

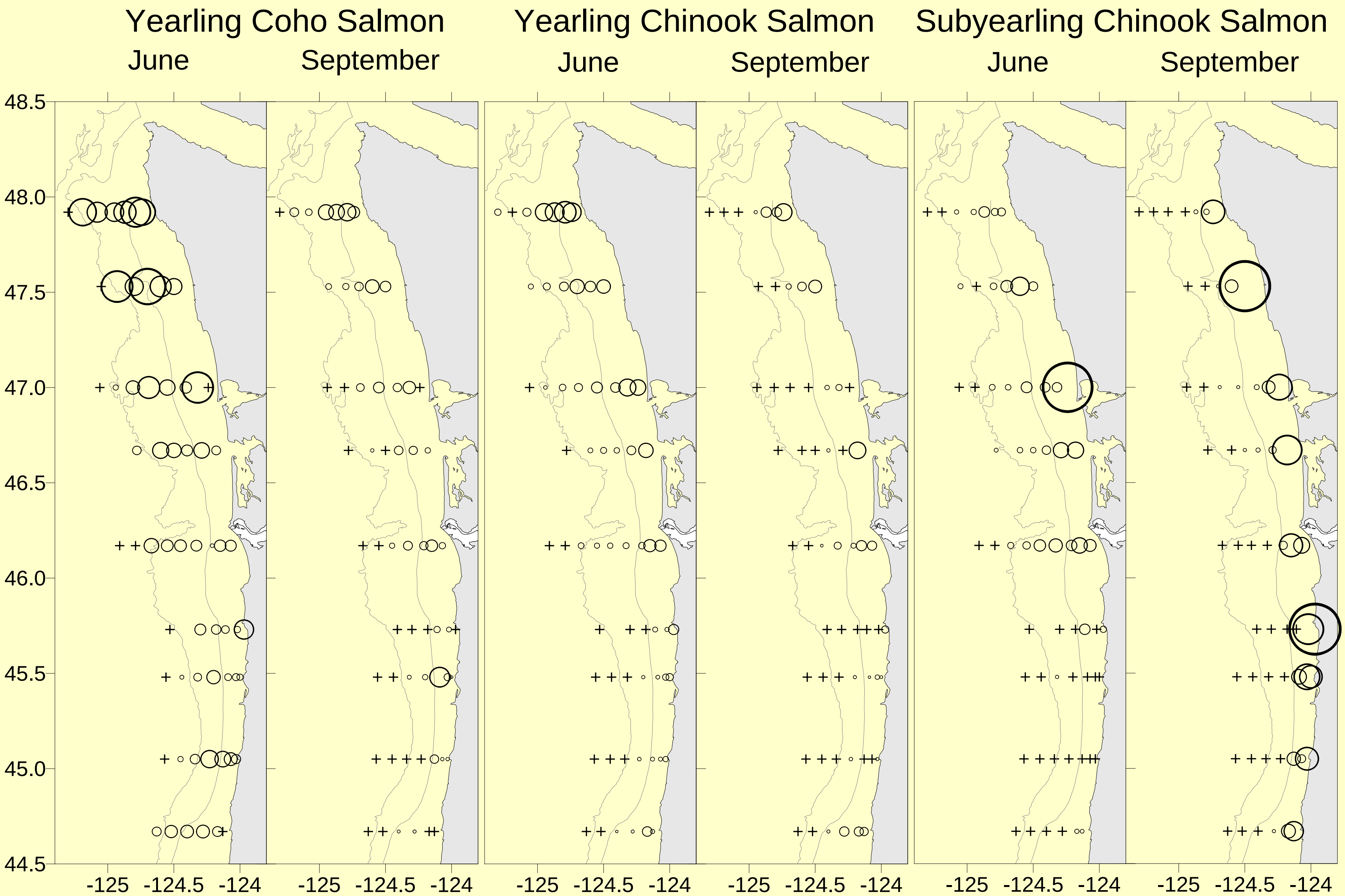





Forecasting –- since juvenile salmonids live on continental shelf waters, we use indices relevant to shelf waters

- Basin scale indicators
  - PDO
  - MEI
- Local indicators
  - SST
  - Upwelling
  - Date of spring transition
  - Length of upwelling season
- Biological indicators
  - Copepod biodiversity
  - N. copepod biomass anomaly
  - Copepod Community Structure
  - Catches of spring Chinook in June
  - Catches of coho in September

2009 Catches



Four factors affect plankton, food chains, pelagic fish and the growth and survival of salmon in the northern California Current

- Large-scale circulation patterns and the kinds of water that feed the California current
- Seasonal reversal of coastal currents: southward in summer – northward in winter
- Coastal Upwelling
- Phase of the Pacific Decadal Oscillation (PDO)

Much of our info is on the web at:
http://www.nwfsc.noaa.gov
"Ocean Index Tools"

Index Values

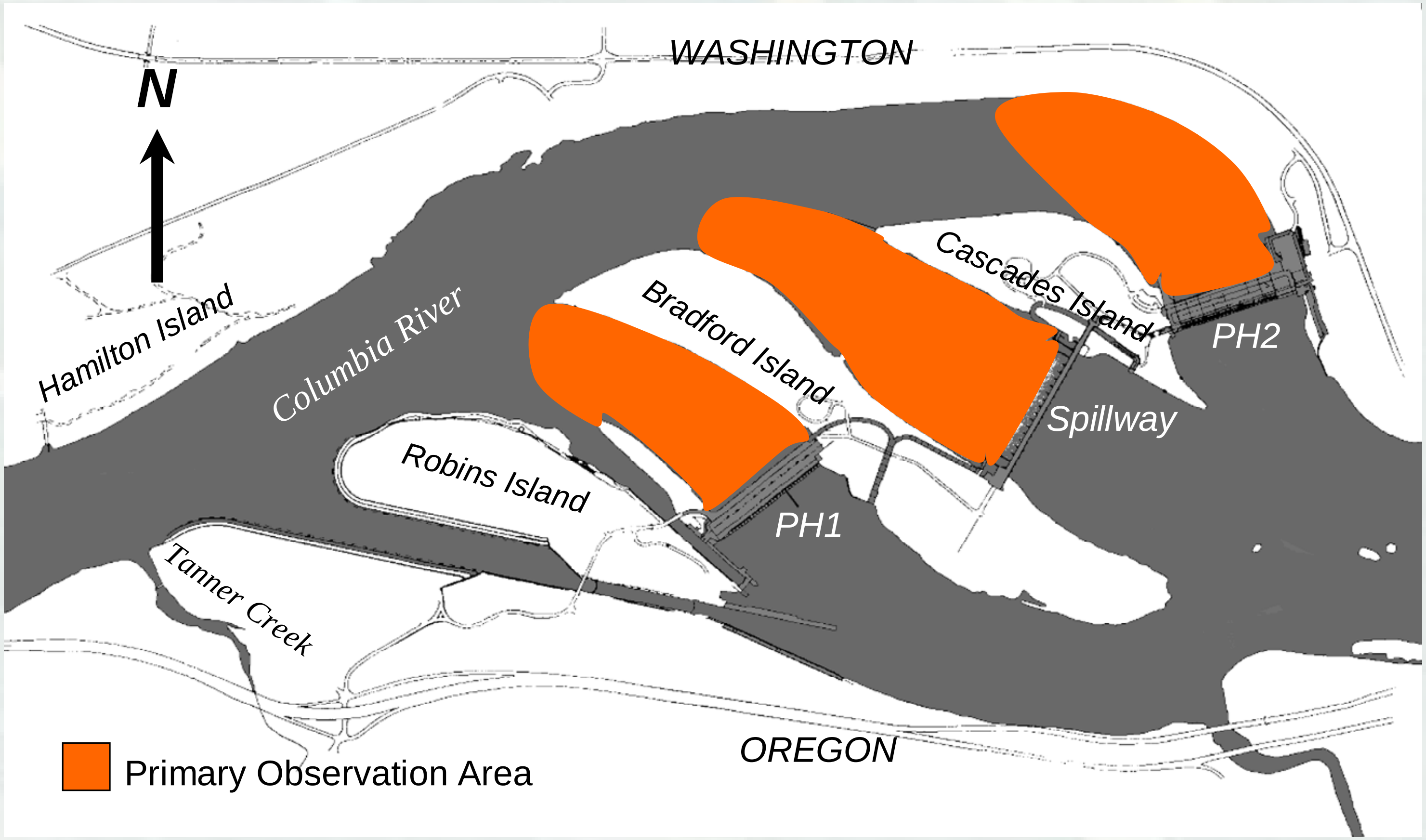
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
PDO (December-March)		5.07	-1.75	-4.17	1.86	-1.73	7.45	1.85	2.44	1.94	-0.17	-3.06	-5.41
PDO (Sum May-September)		0.9	-5.54	-3.23	-2.95	-0.47	3.42	2.21	3.94	0.28	0.18	-6.08	-1.11
MEI Annual		0.87	-0.85	-0.51	-0.18	0.59	0.46	0.38	0.40	0.22	-0.20	-0.65	
MEI Jan-June		2.28	-0.80	-0.63	-0.28	0.32	0.55	0.27	0.65	-0.42	0.49	-0.84	-0.23
SST 46050	deg C	13.70	13.14	12.54	12.56	12.30	12.92	14.59	13.43	12.60	13.88	12.45	13.02
SST NH 05 Summer	deg C	11.34	10.89	10.62	10.91	11.14	11.2	12.99	12.24	11.02	11.55	10.9	12.00
SST NH 05 Winter Before I	deg C	12.11	10.52	10.26	10.31	10.01	10.81	11.32	11.07	10.92	9.96	9.03	9.63
SST NH 05 Winter After Er	deg C	10.52	10.26	10.31	10.01	10.81	11.32	11.07	10.92	9.96	9.03	9.63	
Physical Spring Trans Loge	Day of Year	105	91	72	61	80	112	110	145	112	74	89	82
Upwelling Anomaly (April-May)		-14	19	-36	2	-12	-34	-27	-55	-14	9	0	-5
NH 05 Deep T	deg C	8.58	7.51	7.64	7.50	7.39	7.75	7.88	7.91	7.92	7.55	7.46	7.83
NH 05 Deep S		33.51	33.87	33.83	33.874	33.869	33.7039	33.659	33.79	33.82	33.88	33.872	33.68
Length of upwelling seasor	days	191	205	208	173	218	168	178	132	194	200	180	201
Copepod richness	no. of species	5.49	-2.46	-3.03	-0.41	-0.72	1.52	0.57	5.02	3.67	-0.39	-0.53	-0.35
	log biomass	-1.964	0.088	0.721	0.4899	0.8384	-0.0769	0.2663	-1.78	0.168	0.621	0.8717	
Biological Transition	Day of Year	240	134	96	130	128	156	145	237	150	123	64	83
Copepod Community struc	X-axis ordinatioı	0.74	-0.79	-0.8	-0.79	-0.9	-0.16	-0.2	0.54	-0.04	-0.67	-0.96	
June-Chinook Catches	fish per km	0.26	1.27	1.04	0.44	0.85	0.63	0.42	0.13	0.69	0.86	2.55	1.00
Sept-Coho Catches	fish per km	0.11	1.12	1.27	0.47	0.98	0.29	0.07	0.03	0.16	0.15	0.27	0.01

EVALUATION OF SEA LION PREDATION IN THE BONNEVILLE DAM TAILRACE

Robert J. Stansell
Sean C. Tackley
Karrie M. Gibbons

Fisheries Field Unit
USACE Portland District

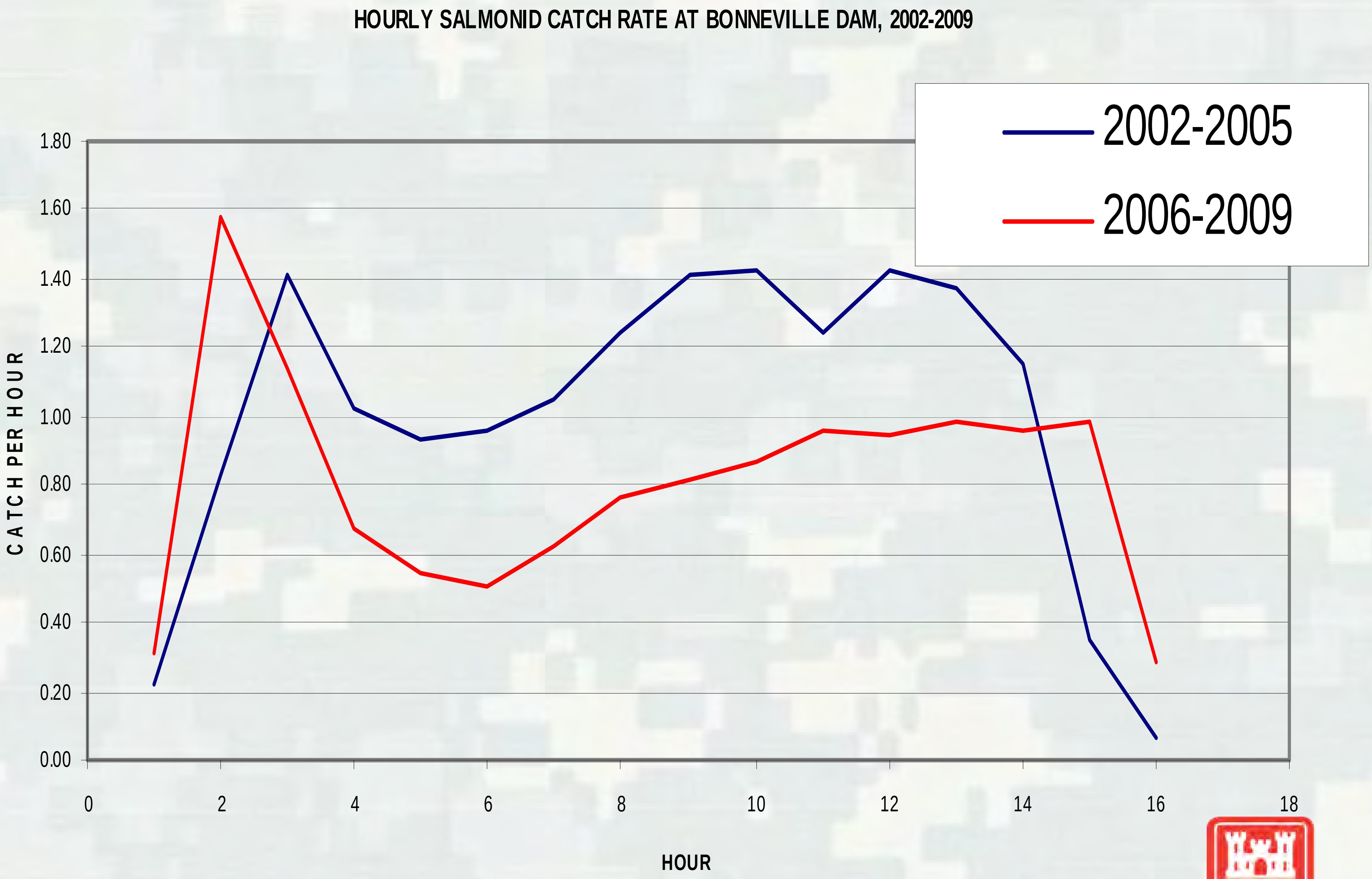
Observation Area, Bonneville Dam, 2002-2009



RESULTS: DETERRENTS, TRAPPING AND REMOVAL

Deterrent Measures at Bonneville Dam, 2009

- SLED's and FOG's installed and still effective (No entry into fishways observed after installed).
- ADD's installed near entrances and activated, no effect noticed.
- Hazing by USDA (land) and States (boat) continued, limited effectiveness.
- Trapping and removal program (15 removed in 2009, 11 in 2008).



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Trapping (ODFW and WDFW)

- Up to 4 floating traps
- ODFW and WDFW
- Located near corner collector outfall at PH2 and old Navigation Lock

- 3 Objectives:
  - ► Remove Calif. sea lions that meet permit criteria (At Bonn. 5d, seen to take salmon, individually identifiable)
  - ► Brand, acoustic tag, and release Calif. sea lions not on “the list”

Trapping and Removal Results, 2008-2009

- In 2008, 6 were trapped and sent to Sea World, 1 died under anesthesia, 4 died from a trap closure incident (3 not on list), 4 were branded and released.
- In 2009, 4 were trapped and sent to zoos/aquariums, 11 were euthanized after failing health exams, 5 were branded and given acoustic tags and released, 1 was already branded but given an acoustic tag and released.
- Total of 26 removed to date from list of 87 (only about 30 still likely to return in 2010).

Removal Program Targeting Biggest “Problem” Individuals So Far

Year	Salmonid Consumption per Removed CSL	Salmonid Consumption per Remaining CSL	Days Present per Removed CSL	Days Present per Remaining CSL
2002	12.5	9.9	6.3	5.2
2003	28.5	8.4	15.5	6.3
2004	7.1	4.0	10.1	7.6
2005	2.6	1.6	10.9	7.1
2006	23.8	12.4	28.3	18.2
2007	18.6	12.4	28.5	16.6
2008	30.9	17.9	38.8	14.4
2009				

RESULTS: PINNIPED ABUNDANCE

California sea lion
Zalophus californianus

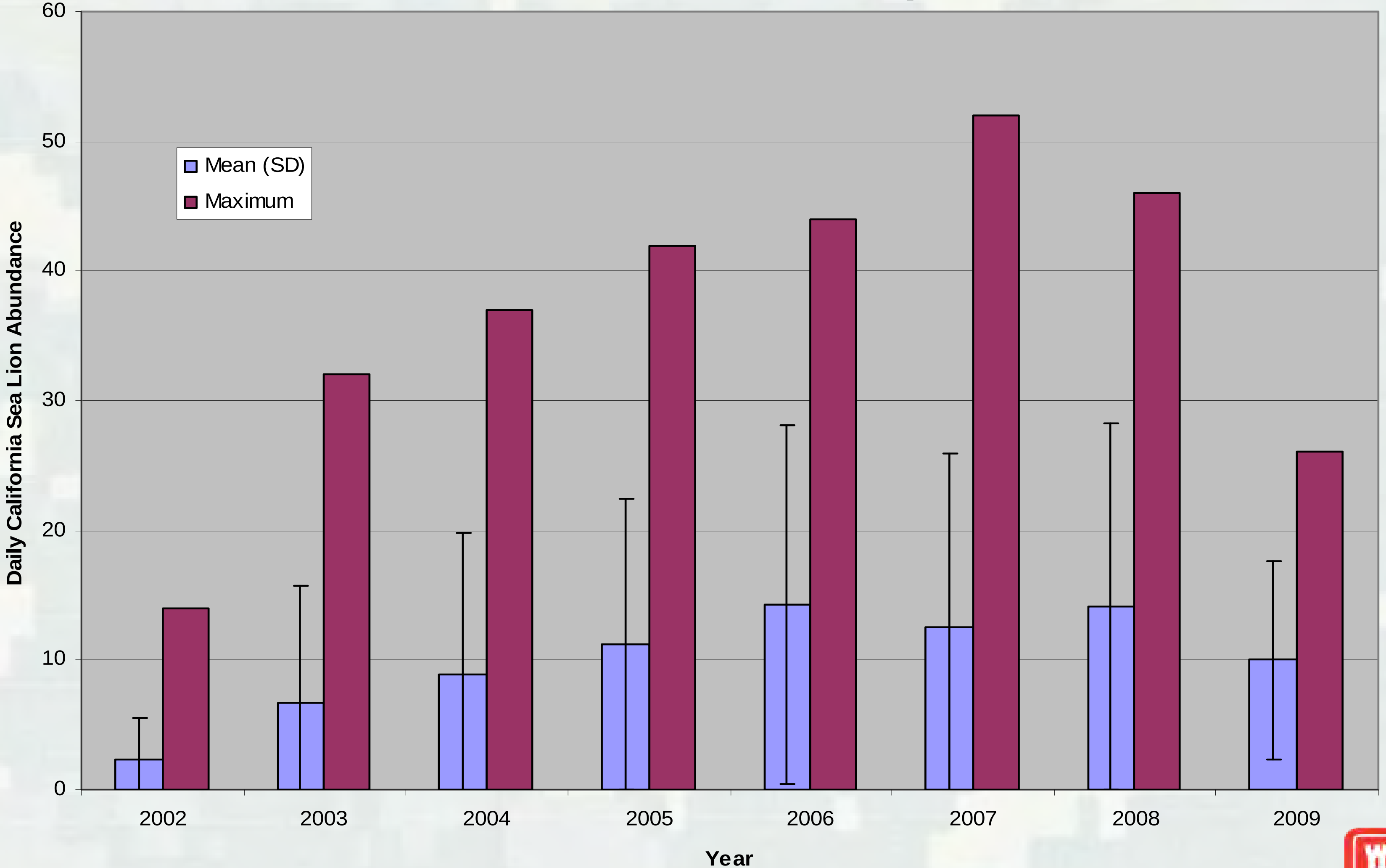
Steller sea lion
Eumetopias jubatus

Harbor seal
Phoca vitulina

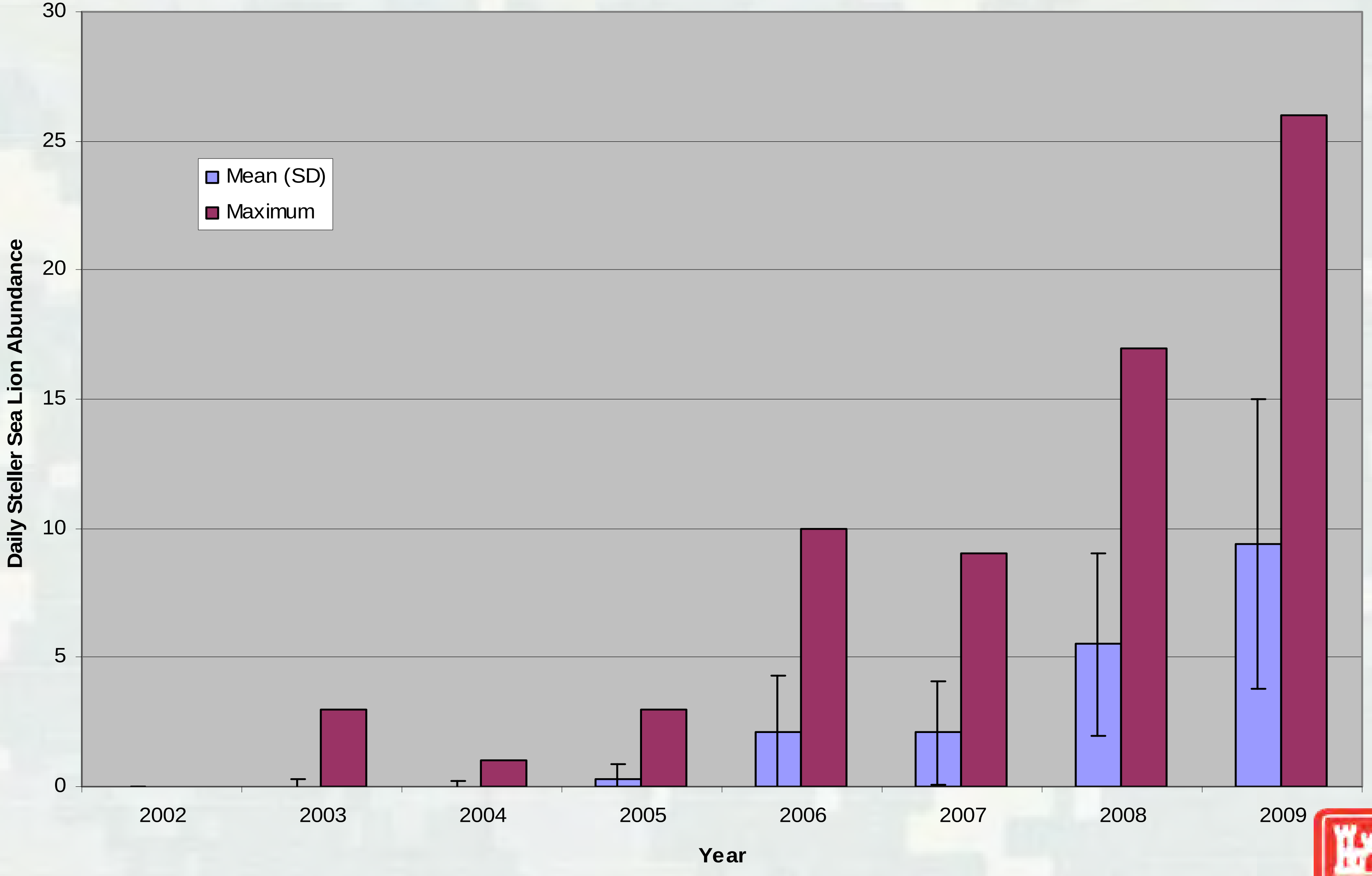
Minimum Estimated Pinniped Abundance at Bonneville Dam (Season Total), 2002-2009

	2002	2003	2004	2005	2006	2007	2008	2009
California Sea Lions	30	104	99	81+	72	71	82	54
Steller Sea Lions	0	3	2	4	10	9	17	26
Harbor Seals	1	2	2	1	3	2	2	2
Total Pinnipeds	31	109	103	86+	85	82	101	82

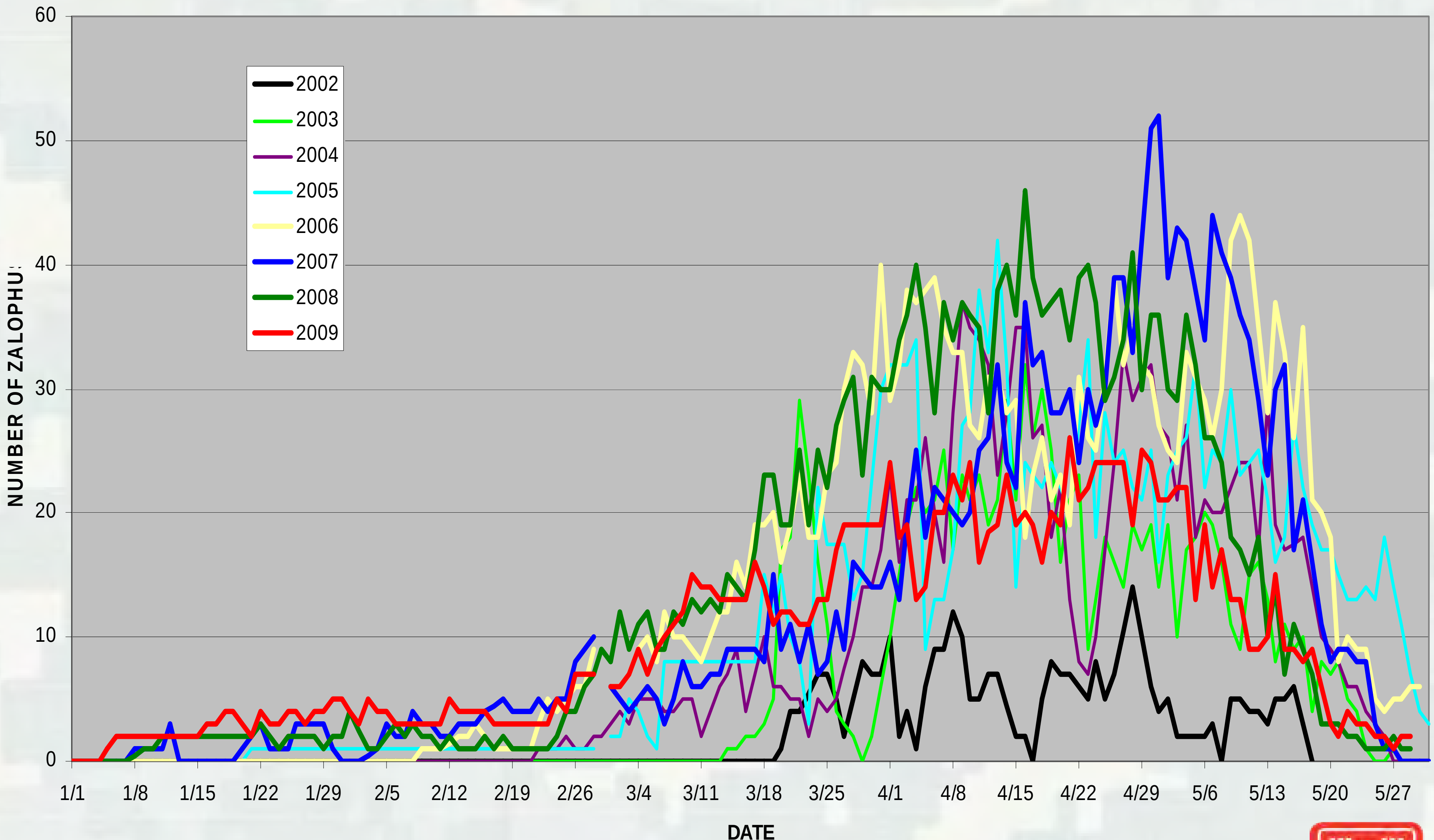
Daily Average and Maximum California Sea Lion Abundance, 2002-2009



Daily Average and Maximum Steller Sea Lion Abundance, 2002-2009



DAILY CALIFORNIA SEA LION ABUNDANCE, 2002-2009



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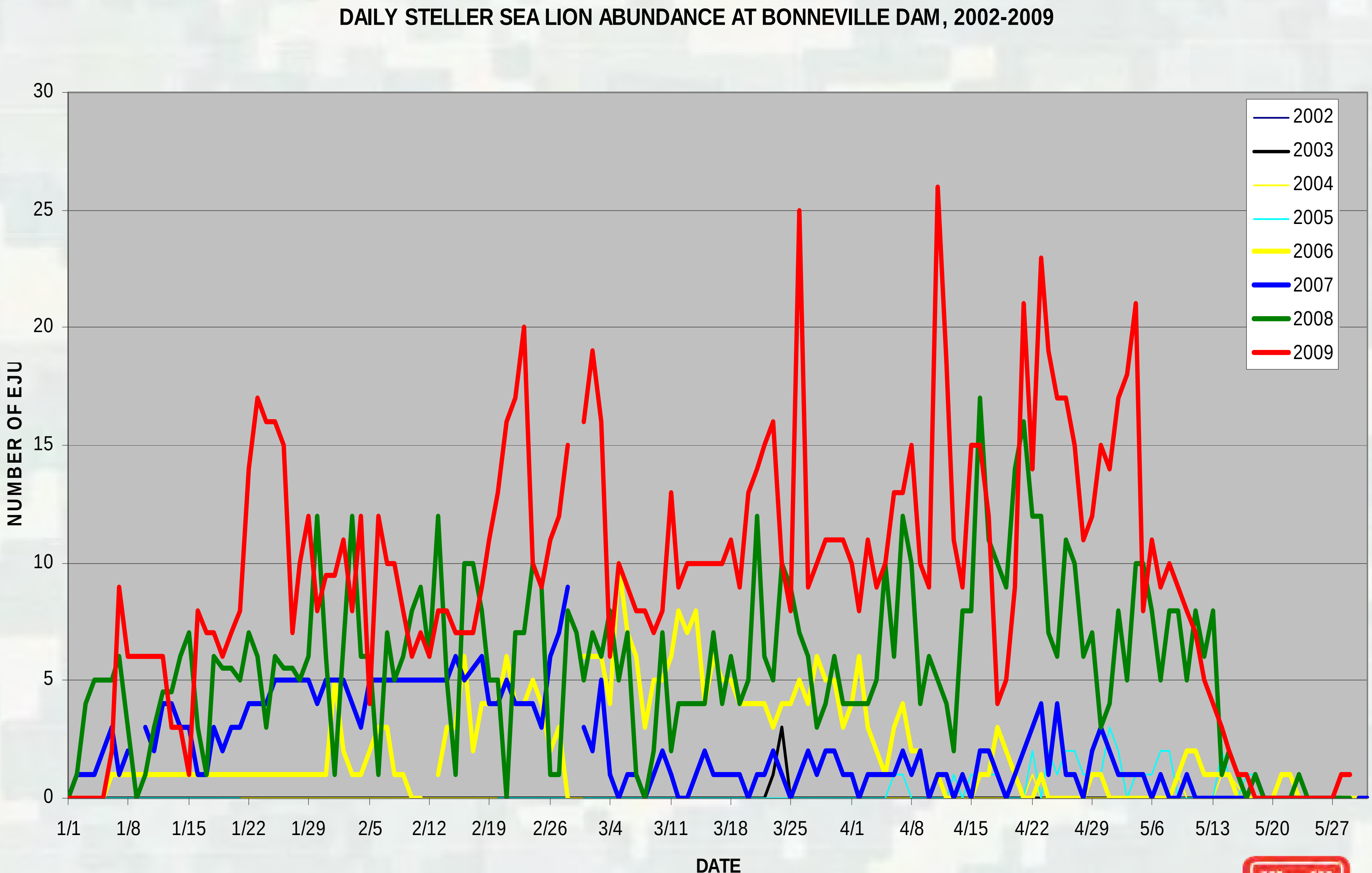

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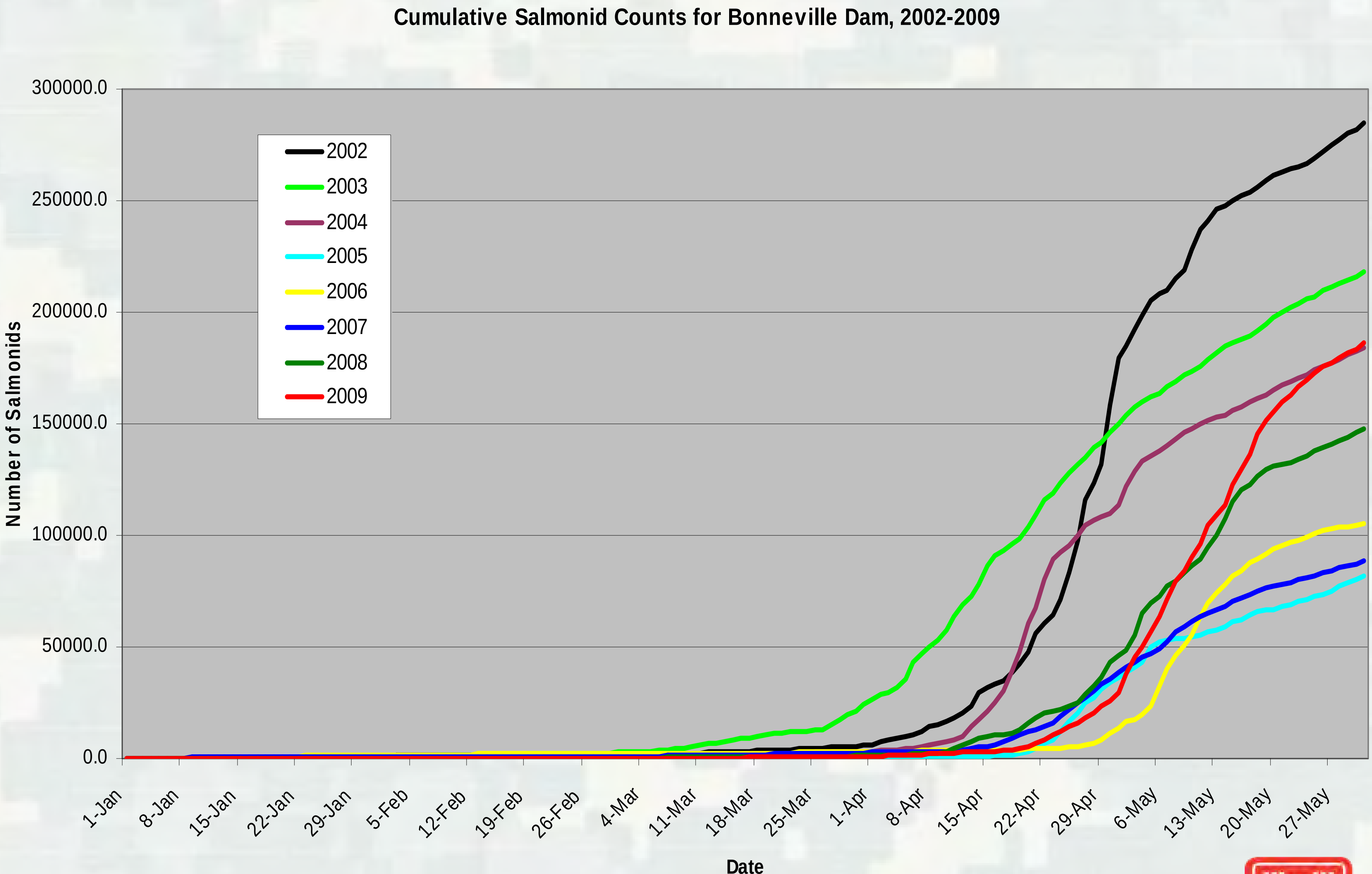
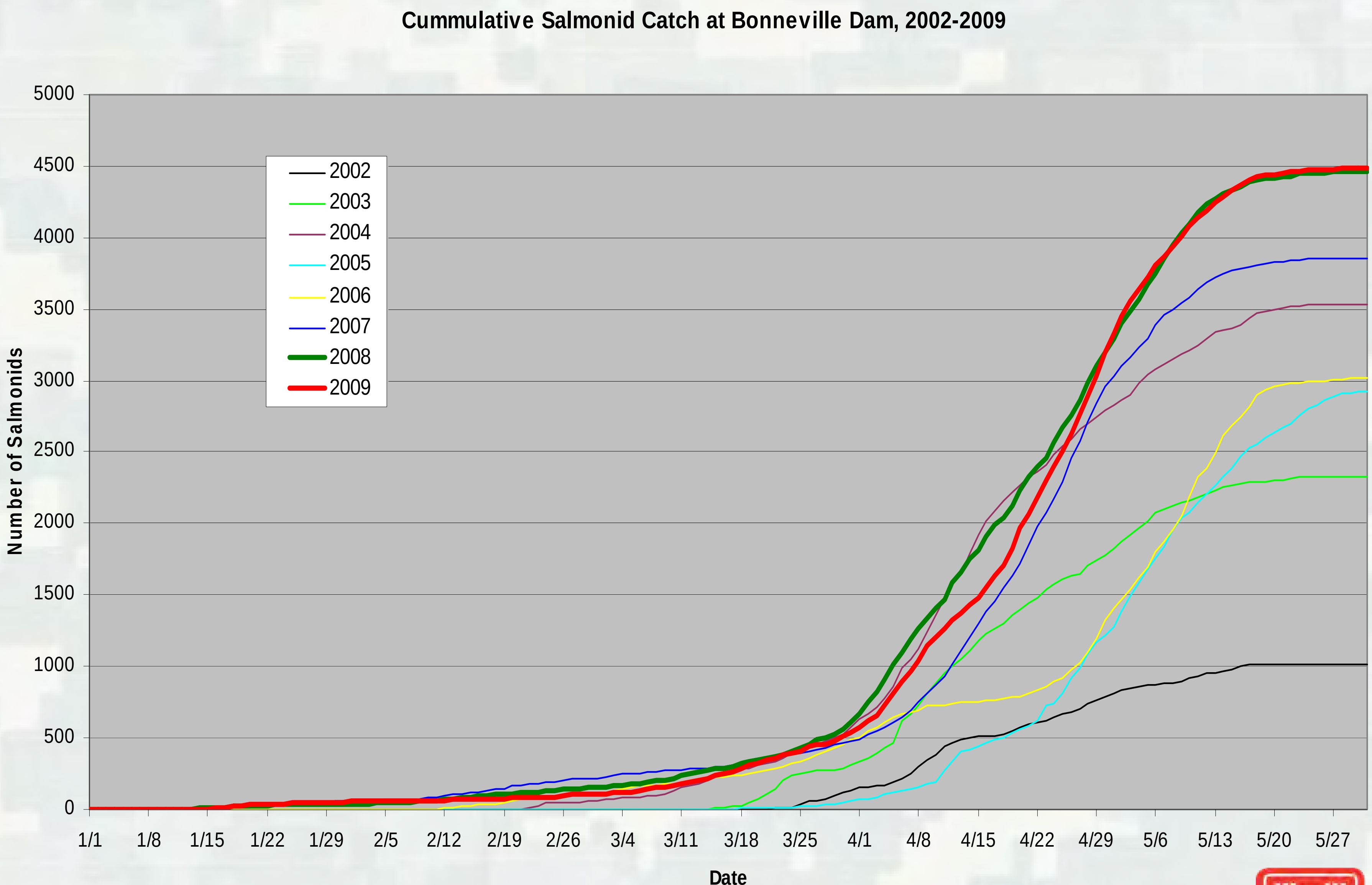
RESULTS: PREDATION

Annual Salmonid Passage and Estimated Consumption by Pinnipeds, Bonneville Dam

Year	Bonneville Dam Salmonid Passage	Expanded Salmonid Estimated Consumption	% of Run (Jan 1-May31)	Adjusted Salmonid Estimated Consumption	% of Run (Jan 1-May31)
2002	284,733	1,010	0.4%	-	-
2003	217,185	2,329	1.1%	-	-
2004	186,804	3,533	1.9%	-	-
2005	82,006	2,920	3.4%	-	-
2006	105,063	3,023	2.8%	3,401	3.1%
2007	88,474	3,859	4.2%	4,355	4.7%
2008	147,543	4,446	2.9%	4,927	3.2%
2009	186,060	4,489	2.4%	4,960	2.7%


Cumulative Salmonid Counts for Bonneville Dam, 2002-2009
300000.0
250000.0
200000.0
150000.0
100000.0
50000.0
0.0
Number of Salmonids
2002
2003
2004
2005
2006
2007
2008
2009
1-Jan
8-Jan
15-Jan
22-Jan
29-Jan
5-Feb
12-Feb
19-Feb
26-Feb
4-Mar
11-Mar
18-Mar
25-Mar
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
Date



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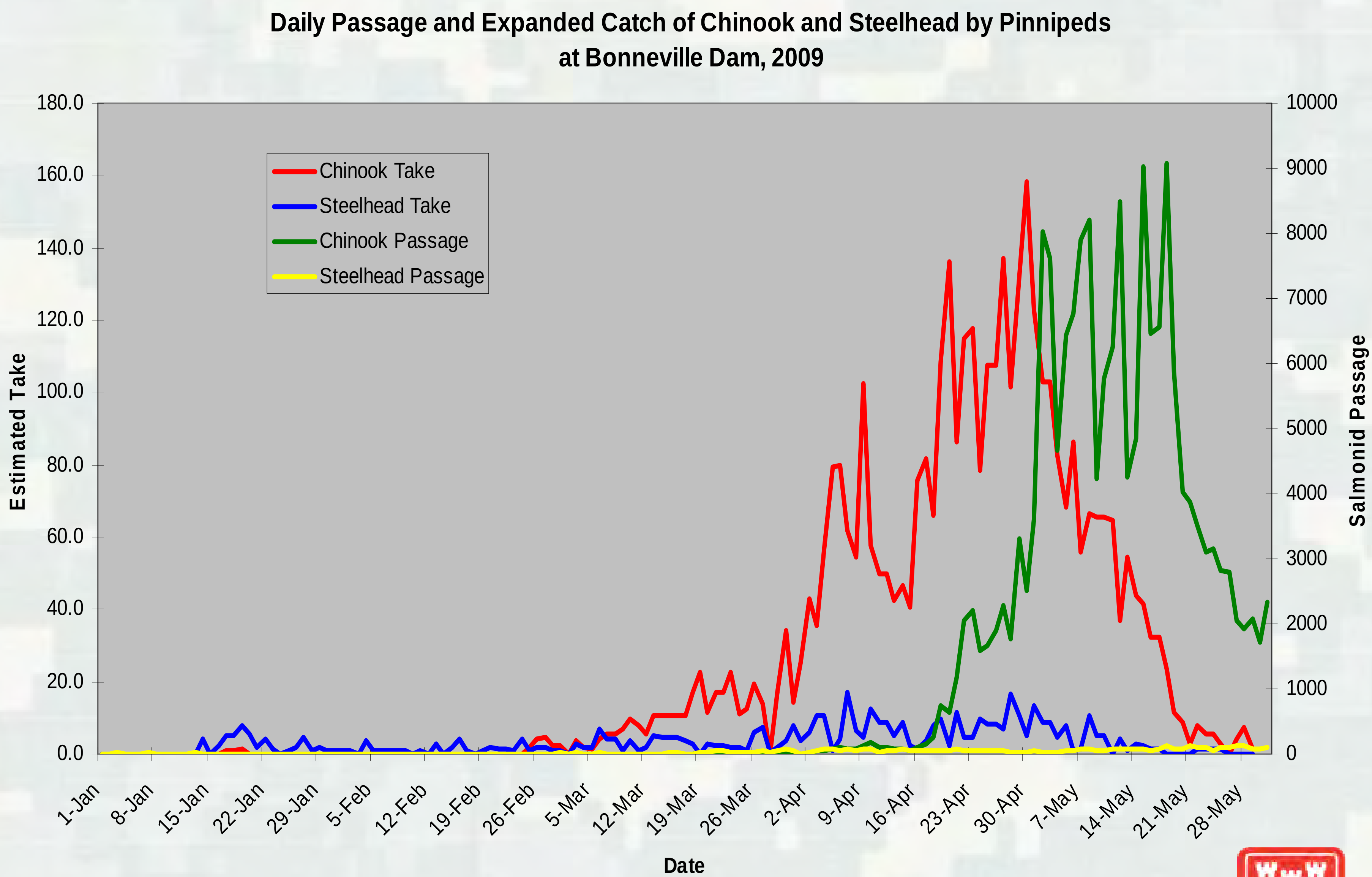
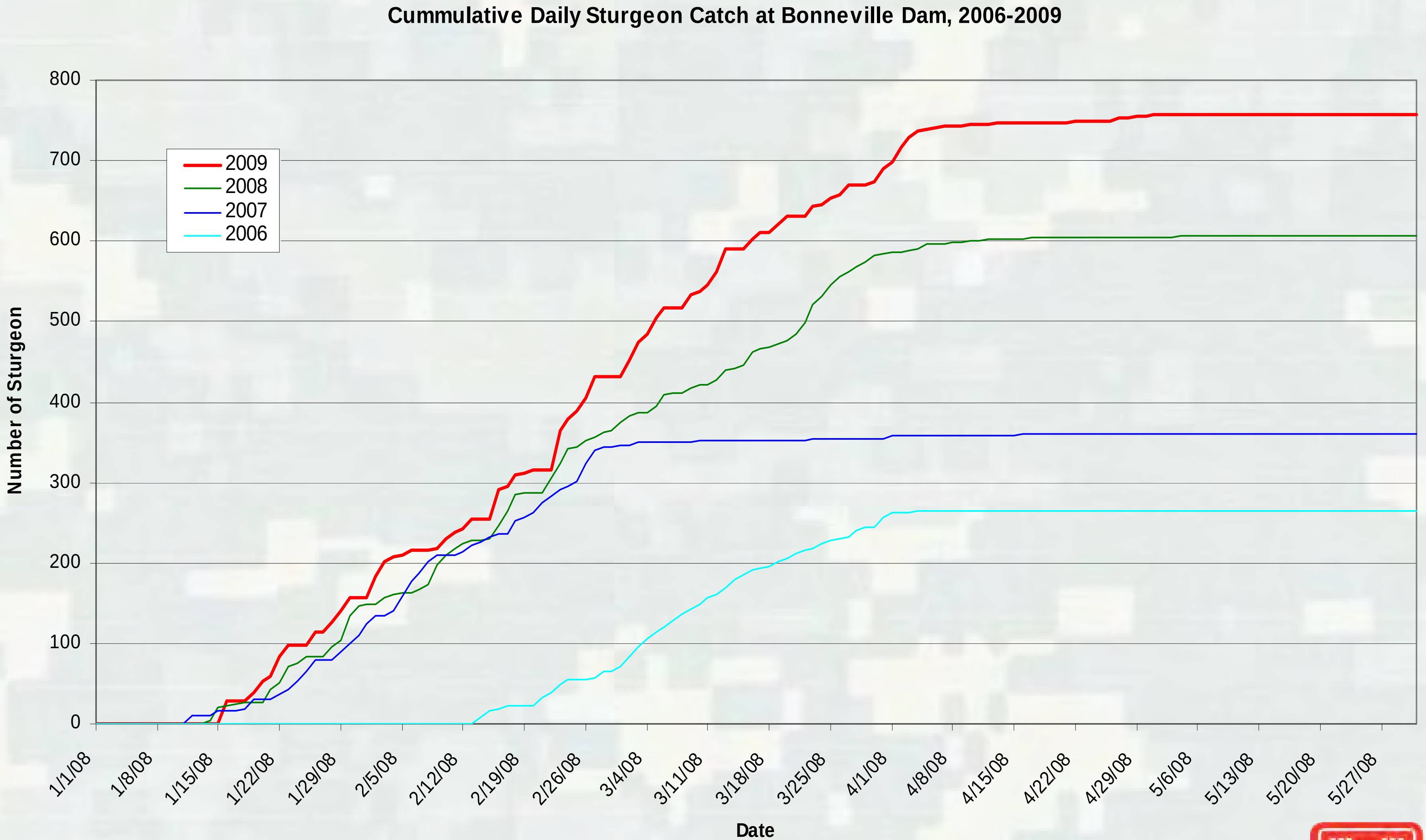

Daily Passage and Expanded Catch of Chinook and Steelhead by Pinnipeds
at Bonneville Dam, 2009
Chinook Take
Steelhead Take
Chinook Passage
Steelhead Passage
Estimated Take
Salmonid Passage
Date
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1-Jan
8-Jan
15-Jan
22-Jan
29-Jan
5-Feb
12-Feb
19-Feb
26-Feb
5-Mar
12-Mar
19-Mar
26-Mar
2-Apr
9-Apr
16-Apr
23-Apr
30-Apr
7-May
14-May
21-May
28-May


Cummulative Daily Sturgeon Catch at Bonneville Dam, 2006-2009
Number of Sturgeon
800
700
600
500
400
300
200
100
0
2009
2008
2007
2006
1/1/08
1/8/08
1/15/08
1/22/08
1/29/08
2/5/08
2/12/08
2/19/08
2/26/08
3/4/08
3/11/08
3/18/08
3/25/08
4/1/08
4/8/08
4/15/08
4/22/08
4/29/08
5/6/08
5/13/08
5/20/08
5/27/08
Date

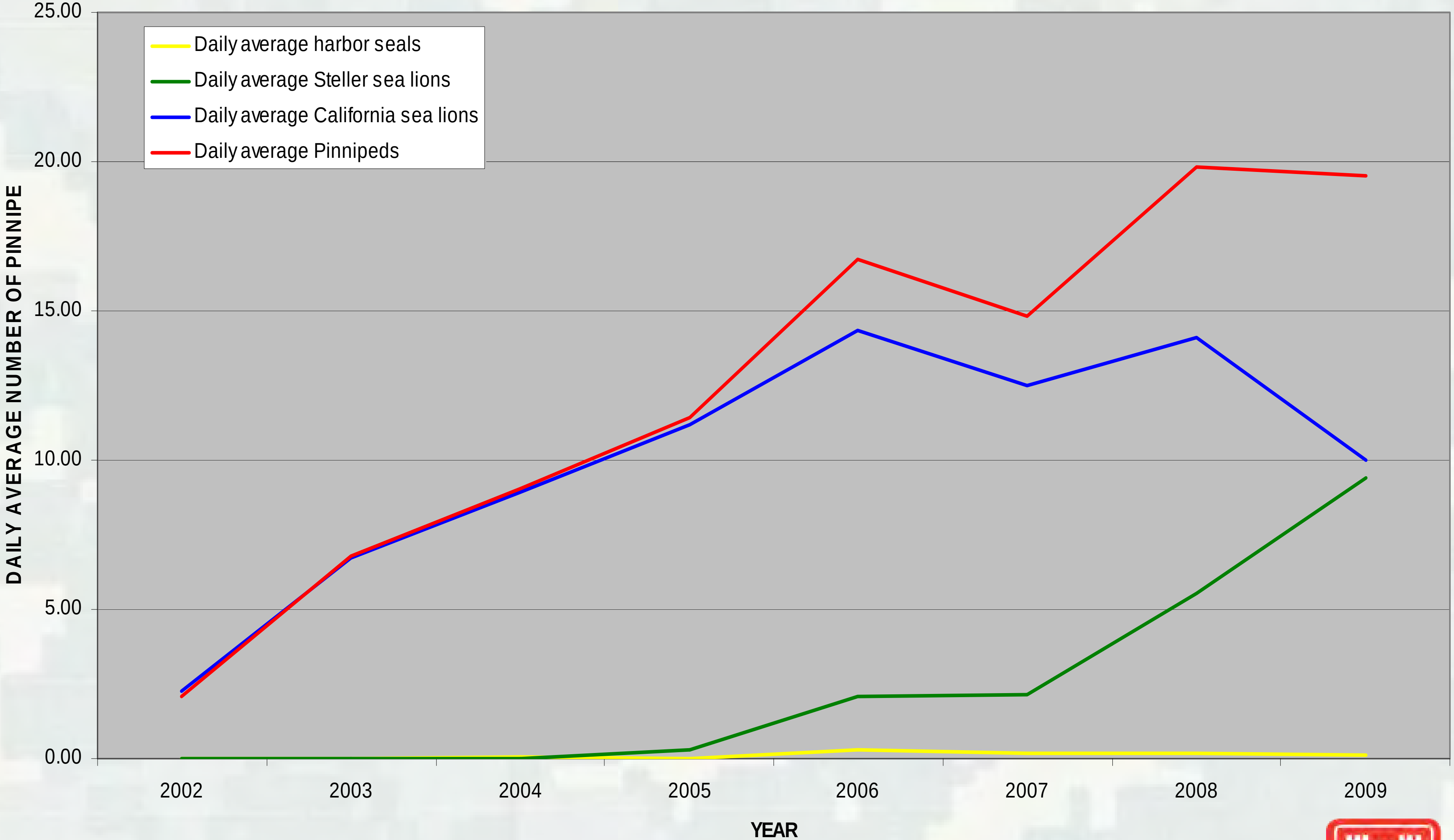
Year	Total Hours Observed	Expanded Pacific Lamprey Consumption Estimate	Percent of Total Observed Fish Catch
2002	662	47	5.6%
2003	1,356	317	11.3%
2004	553	816	12.8%
2005	1,108	810	25.1%
2006	3,647	424	9.8%
2007	4,433	143	2.6%
2008	5,131	145	2.0%
2009	3,455	102	1.4%

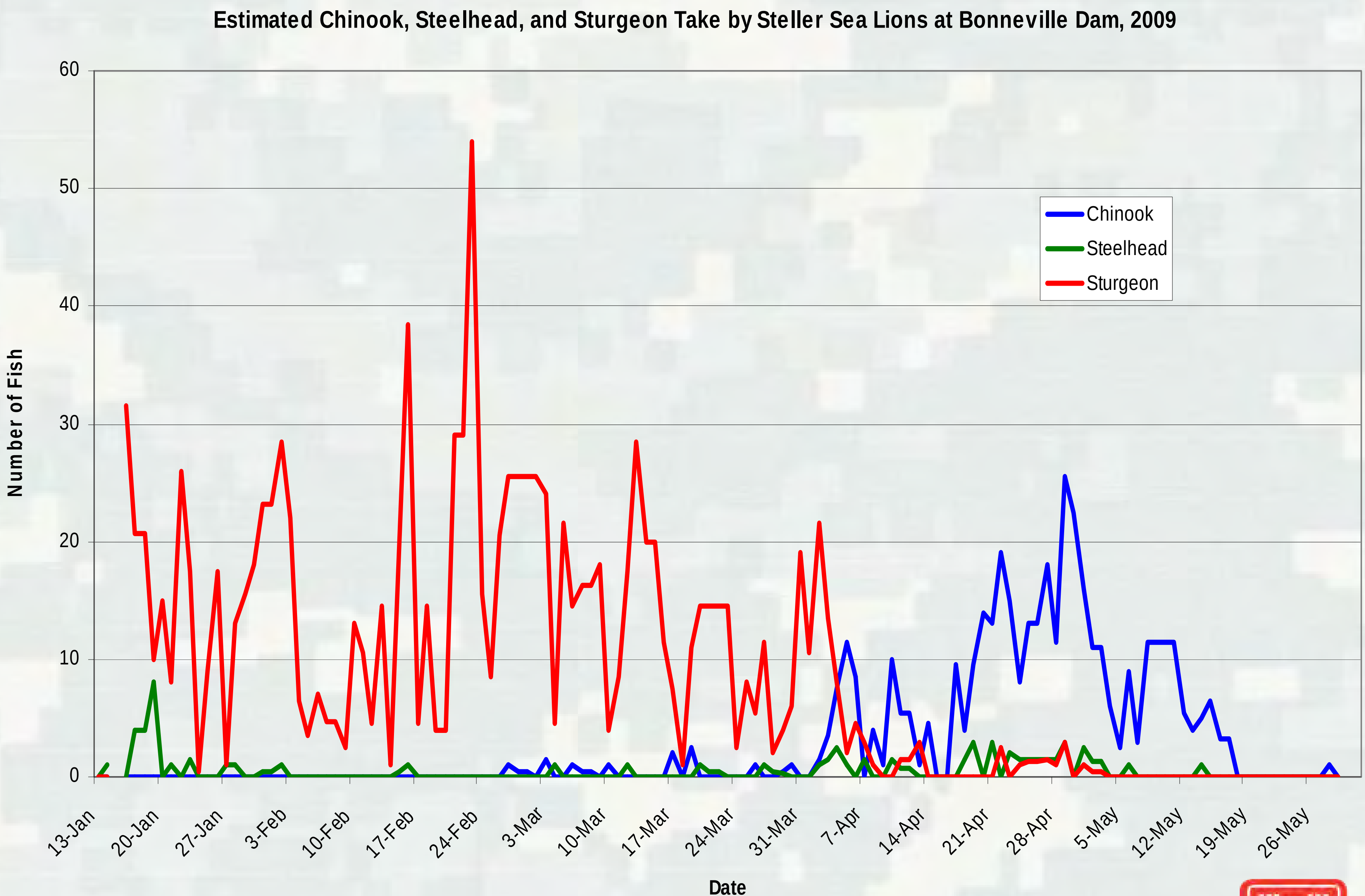
Salmonid Consumption by California and Steller Sea Lions at Bonneville Dam, 2002-2009

Year	Expanded Salmonid Consumption CSL	Salmonid Consumption per California Sea Lion	Maximum # Salmonids Caught by Individual CSL	Expanded Salmonid Consumption SSL	Salmonid Consumption per Steller Sea Lion
2002	1,010	33.7	51	0	0
2003	2,329	22.4	52	0	0
2004	3,516	35.1	35	13	7
2005	2,904	35.9	11*	16	4
2006	2,944	40.9	79	76	8
2007	3,846	54.2	64	13	1
2008	4,294	52.4	107	176	10
2009	4,014	74.3	157	475	18

* - Observers not trained on individual ID of CSL due to late start.

DAILY AVERAGE OF PINNIPEDS AT BONNEVILLE DAM, 2002-2009



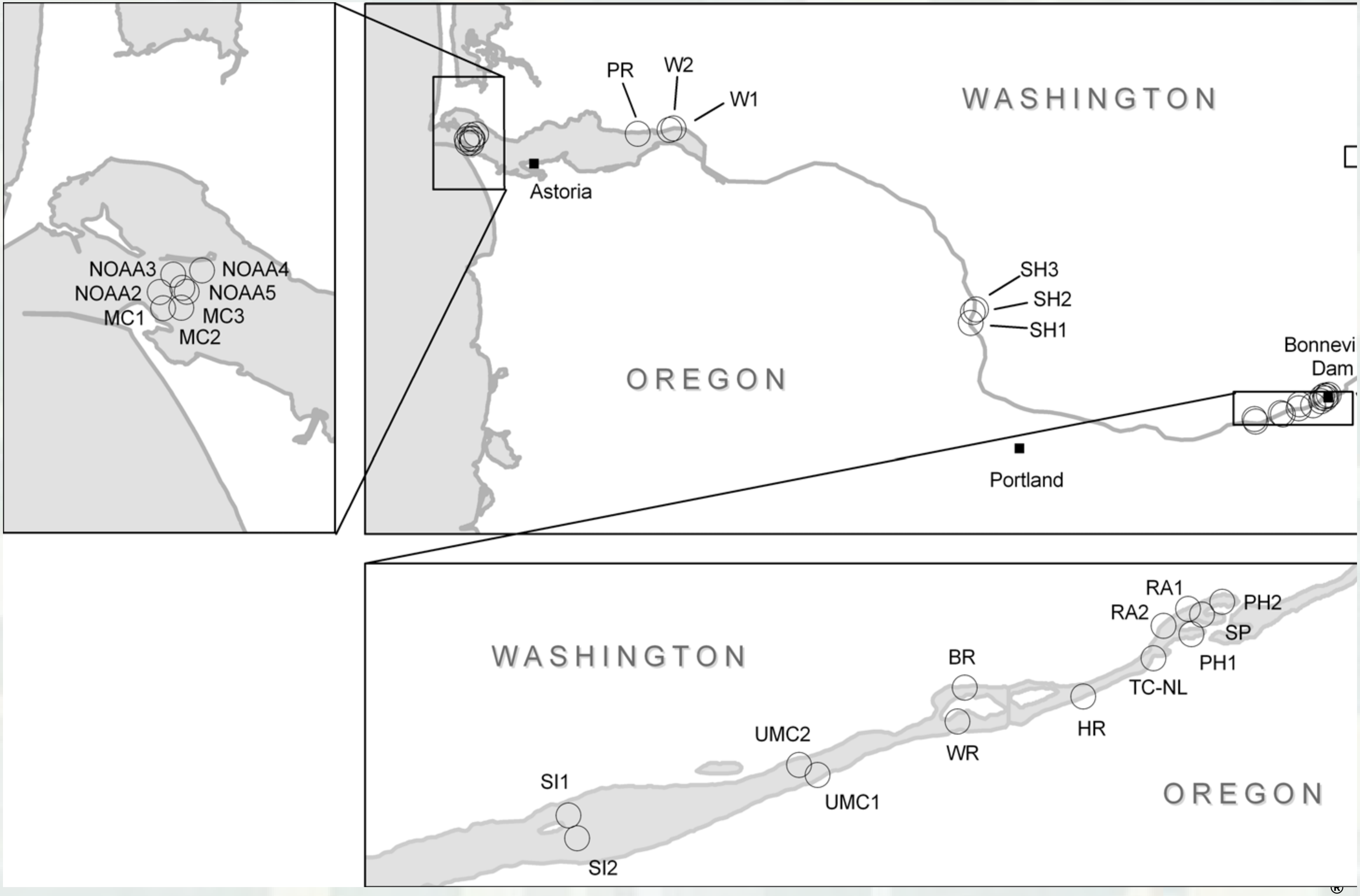


Estimated Chinook, Steelhead, and Sturgeon Take by Steller Sea Lions at Bonneville Dam, 2009
Number of Fish
60
50
40
30
20
10
0
Chinook
Steelhead
Sturgeon
13-Jan
20-Jan
27-Jan
3-Feb
10-Feb
17-Feb
24-Feb
3-Mar
10-Mar
17-Mar
24-Mar
31-Mar
7-Apr
14-Apr
21-Apr
28-Apr
5-May
12-May
19-May
26-May
Date

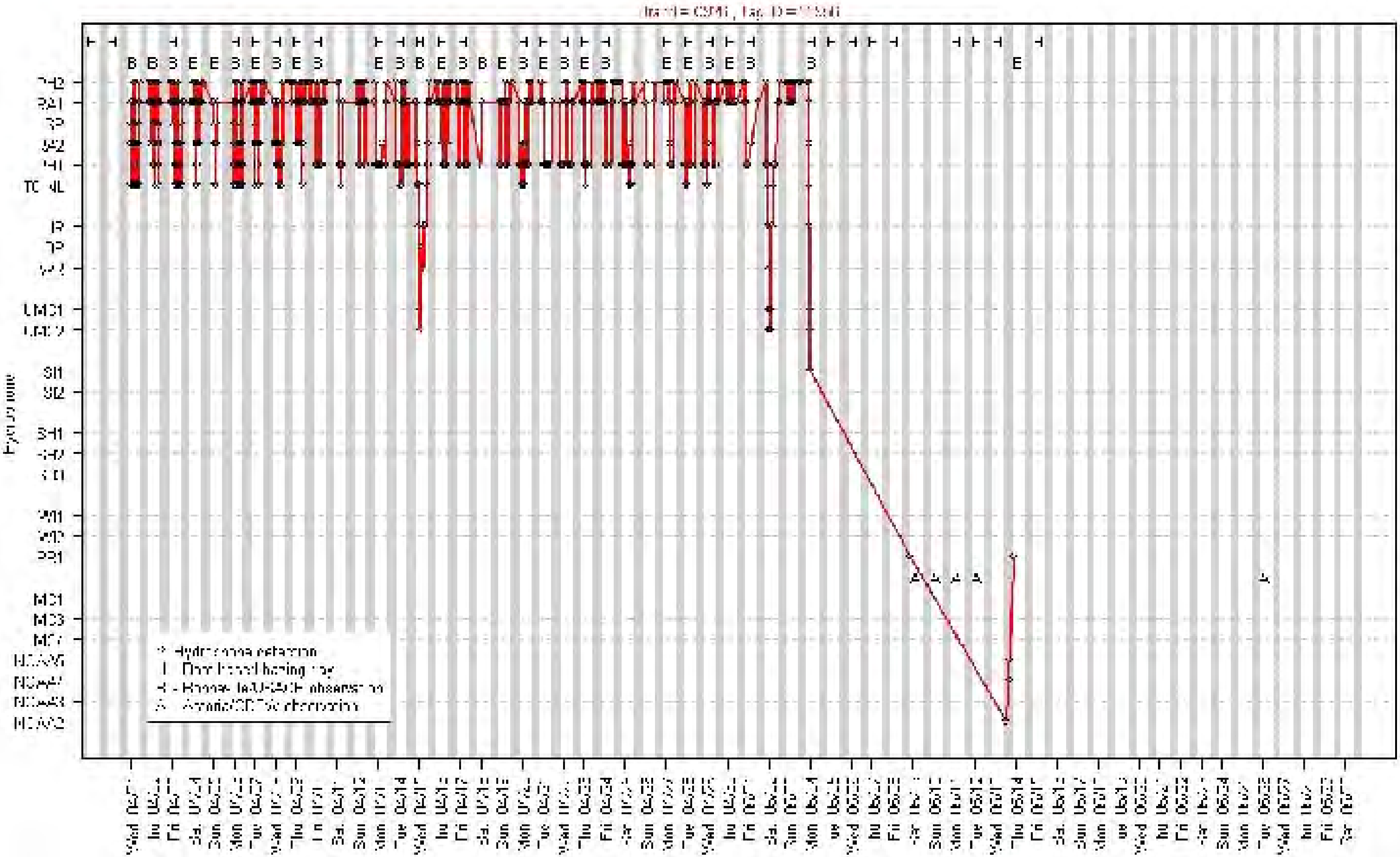
Summary - Key points

1. Physical barriers effectively block access to fishways.
2. Trapping and removal program working for California sea lion abundance, but full benefits not know until after 5 years (ODFW estimates 800 to 1,700 salmon "saved" so far), but Steller sea lions beginning to become more of a problem with increasing abundance and more predation on both white sturgeon and salmon species.
3. Salmonid catch totals continue to increase (4,489; 2.4% of run in 2009). Higher if unidentified fish are included.
4. 4 years of active deterrence efforts failed to reduce predation on salmonids and sturgeon at the dam.
5. California Sea lions coming earlier each year (some in fall), and having impact on early spring Chinook stocks.

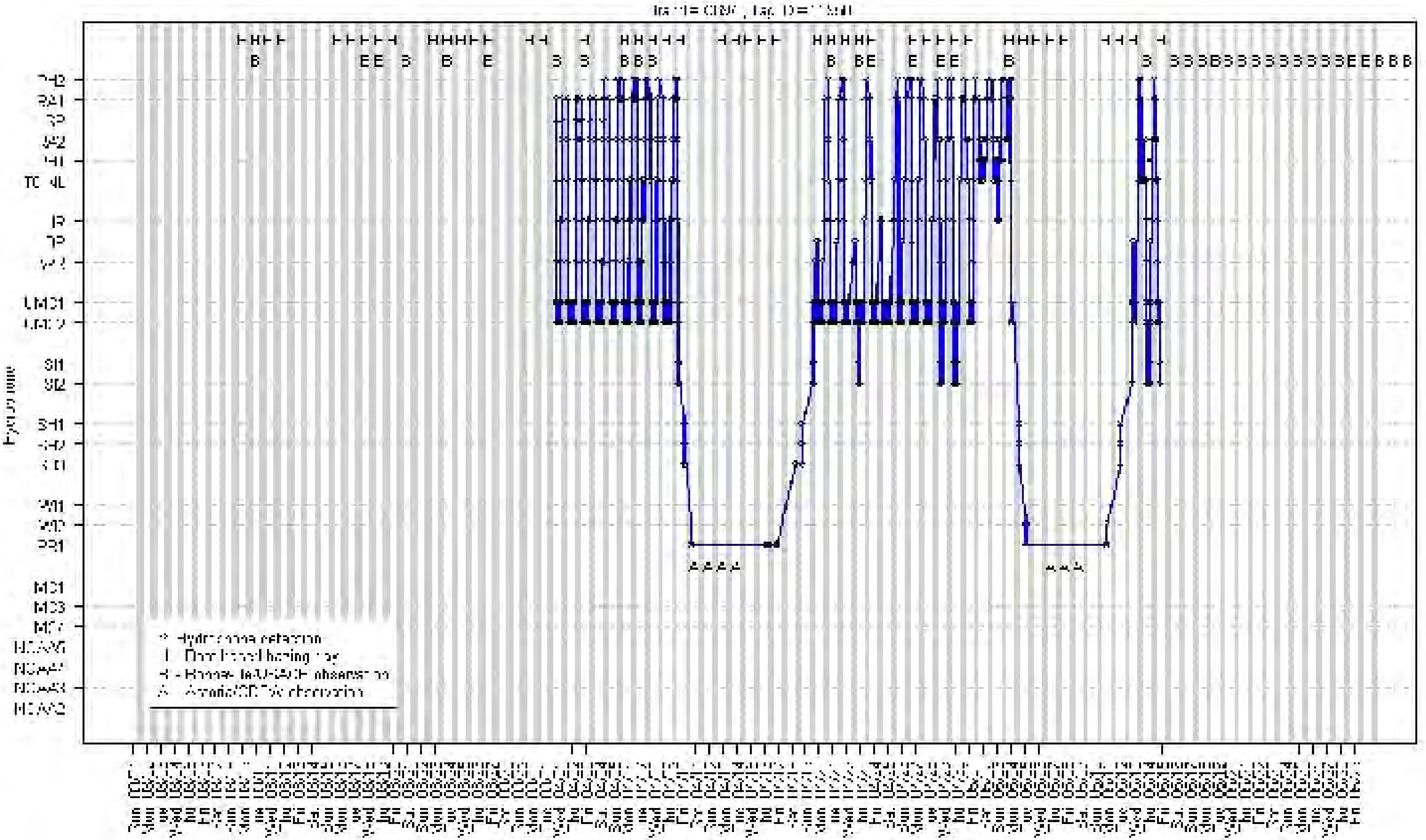
Acoustic Antenna Array Locations



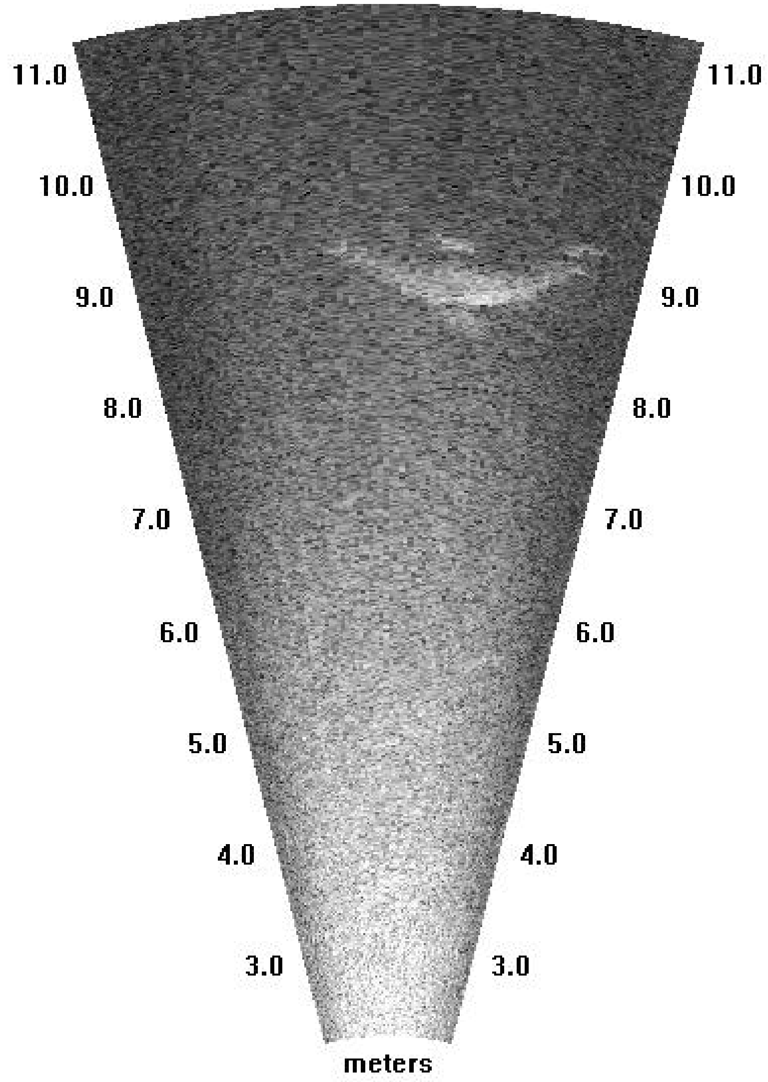
Acoustic Tracks for C926

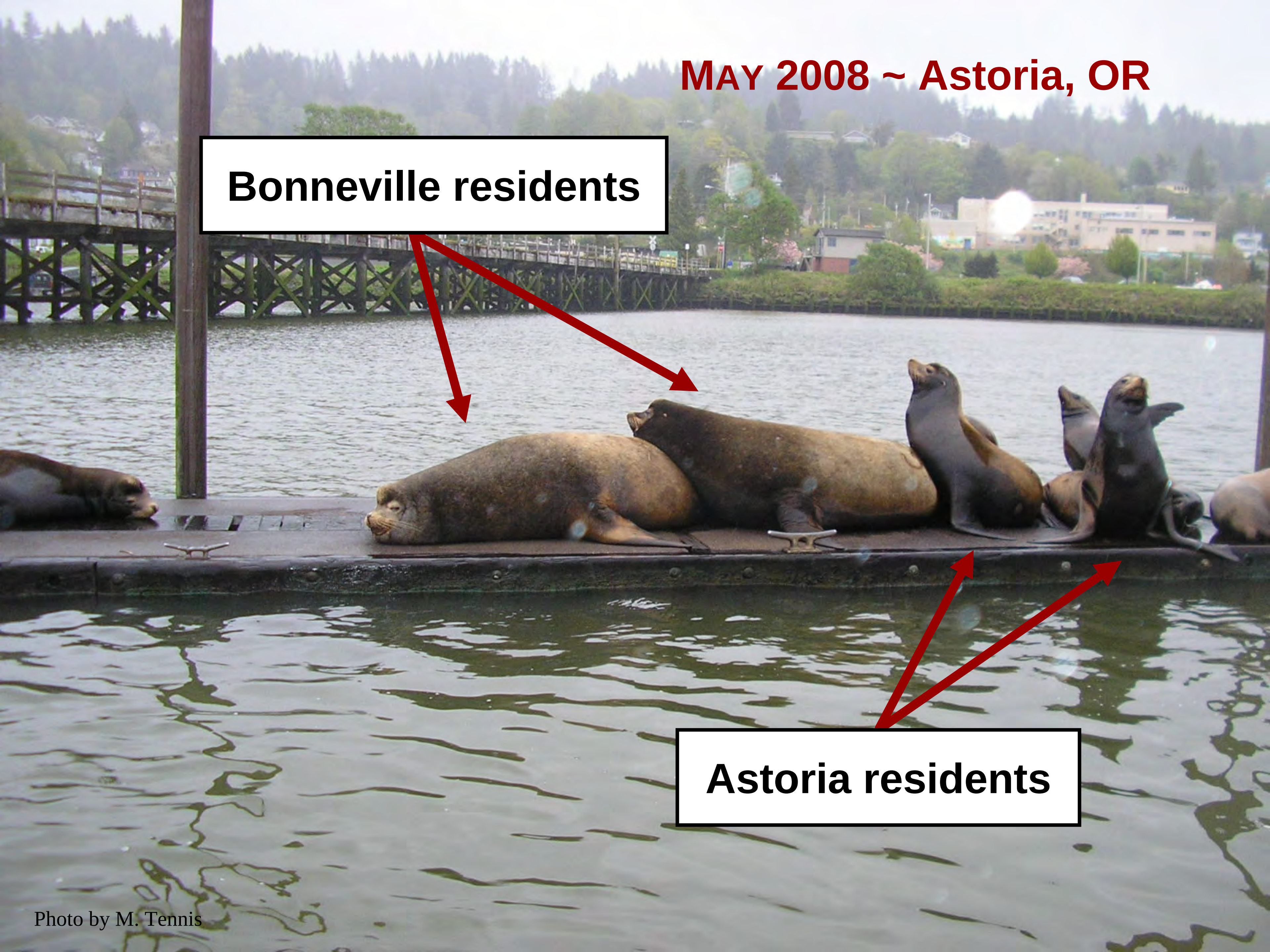


Acoustic Track for C697



Didson Image of Sea Lion Near Powerhouse 2 North Upstream Fish Entrance




MAY 2008 ~ Astoria, OR
Bonneville residents
Astoria residents
Photo by M. Tennis

Spring Chinook Adult Migration Timing at Bonneville Dam

Brandon R. Chockley
Fish Passage Center
TMT Year End Review – December 11, 2009

Historic Adult Counting at BON

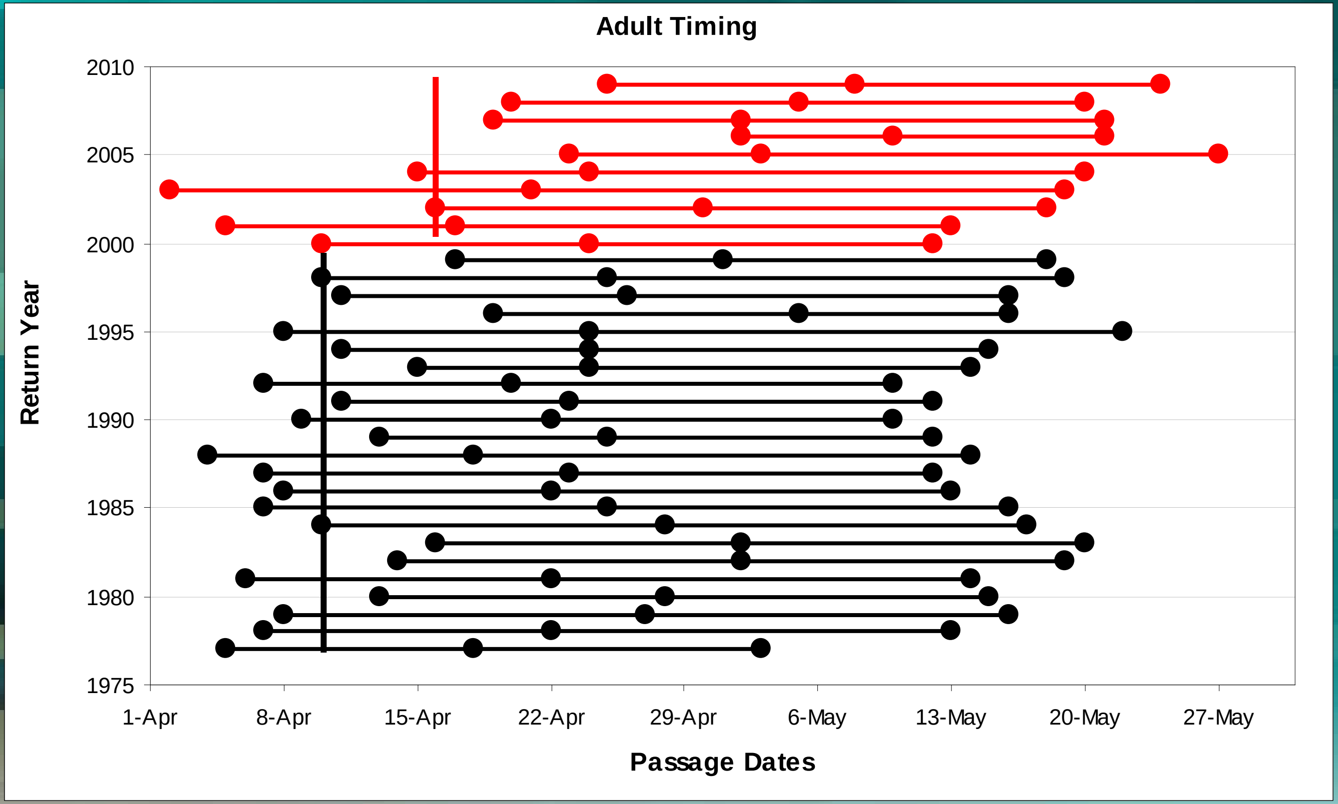
- Prior to 2001, counting at BON began on March 15th and ran through November 15th
- Since 2001, counting at BON is year round
  - Video counts from Nov. 1st to Mar. 31st
  - Direct counts from Apr 1st to Oct. 31st
- All Chinook counted from Jan 1st to May 31st, are considered spring Chinook
  - Adults are those > 22 inches in length
  - Jacks are those < 22 inches in length

Historic Adult Timing at BON

- FPC adult count database has daily counts at BON back to 1977
- Daily counts allowed for estimation of 10%, 50%, and 90% passage date for each year
  - Passage dates for spring Chinook adults and jacks were estimated separately
- Compared adult and jack spring Chinook passage dates of most recent 10 years (2000-2009) to earlier years (1977-1999)
  - Timing comparisons based on historic counting dates, beginning on March 15th

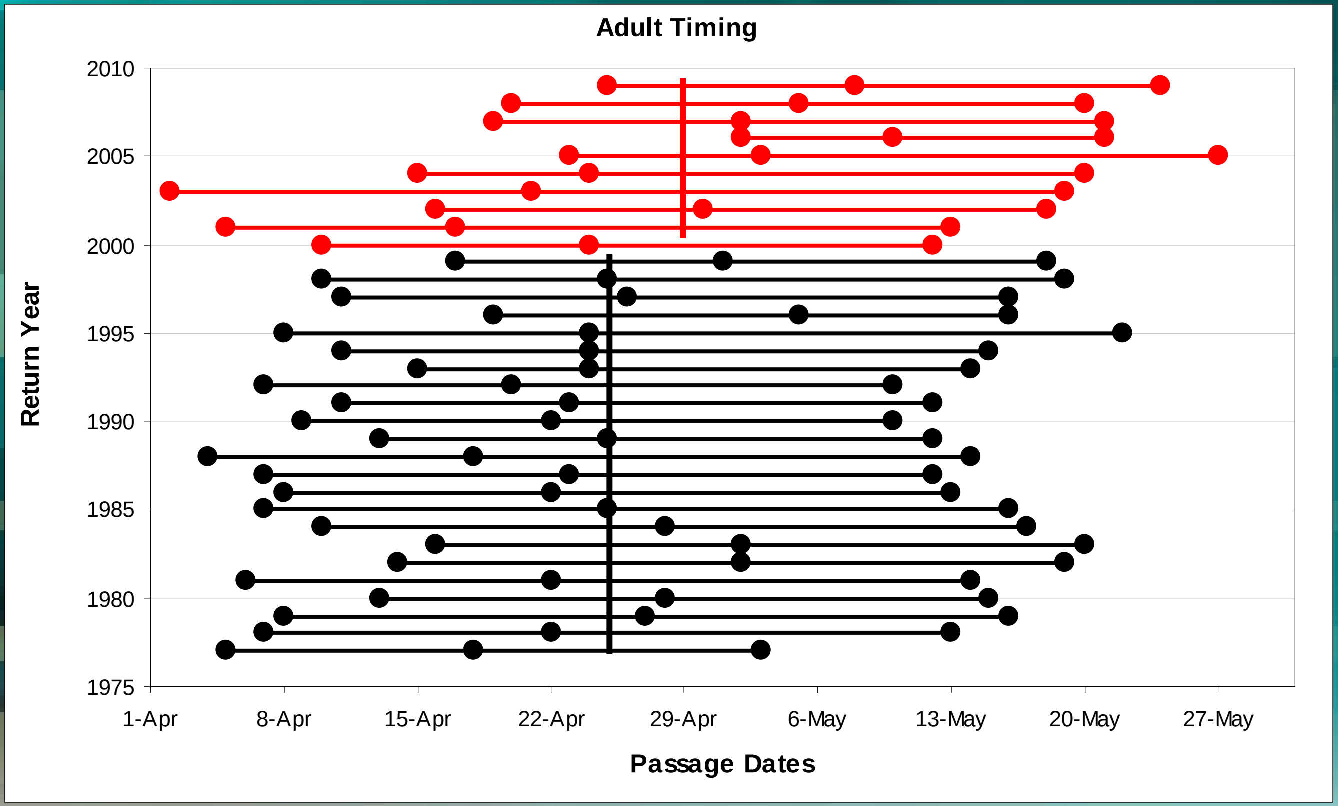
Historic <u>Adult</u> Timing at BON

- **Across years, passage dates are highly variable**
- **Average 10% passage date among recent years (2000-2009) is later**
  - **Average 10% Passage Date (1977-1999) was April 10th**
  - **Average 10% Passage Date (2000-2009) was April 16th**



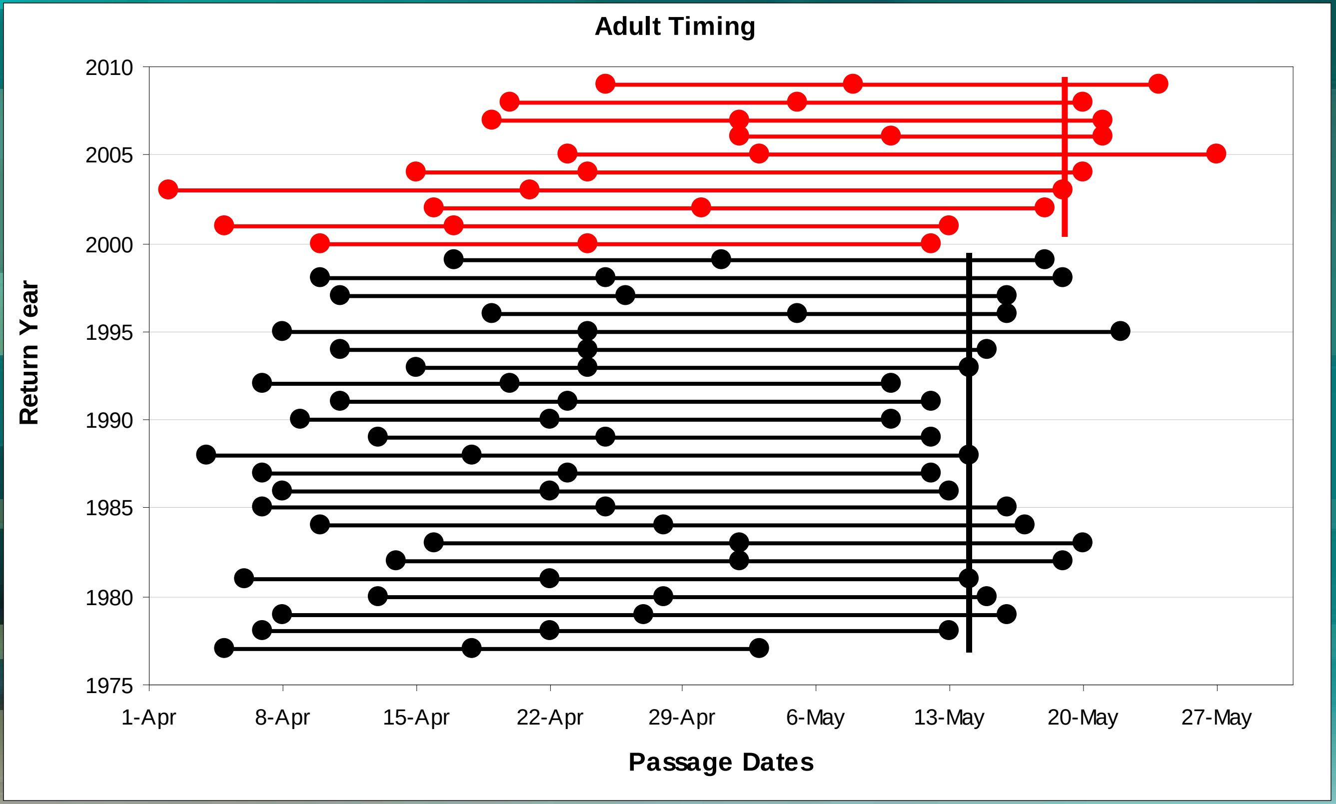
Historic Adult Timing at BON

- **Average 50% passage date among recent years (2000-2009) is later**
  - **Average 50% Passage Date (1977-1999) was April 25th**
  - **Average 50% Passage Date (2000-2009) was April 29th**



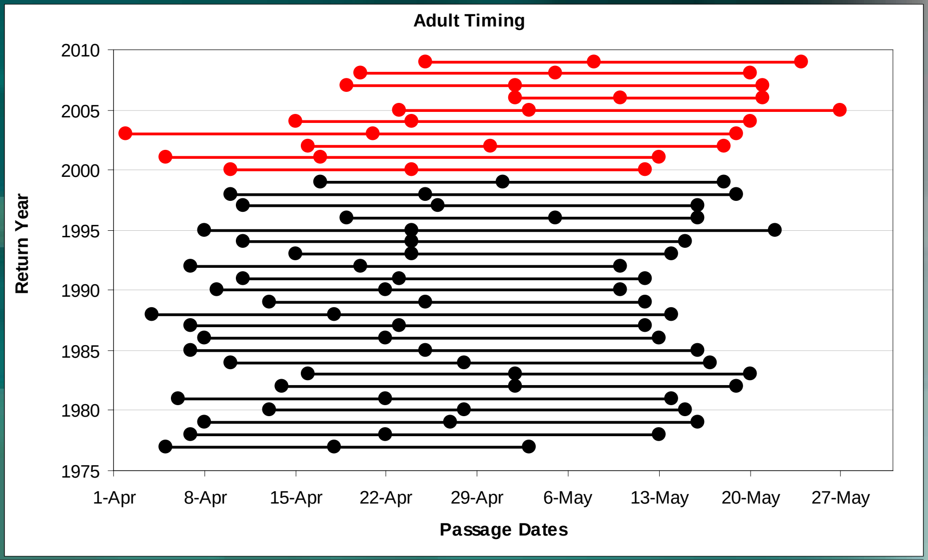
Historic Adult Timing at BON

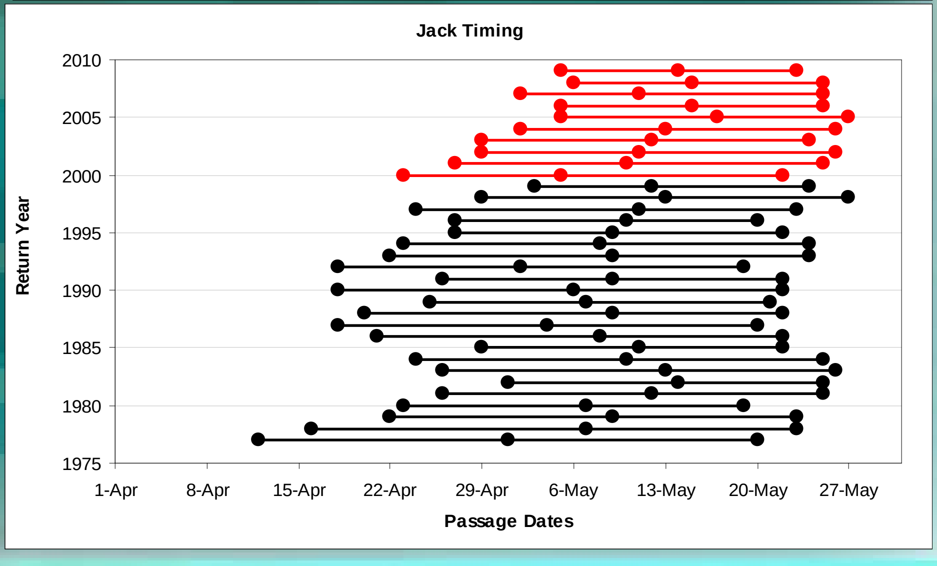
- **Average 90% passage date among recent years (2000-2009) is later**
  - **Average 90% Passage Date (1977-1999) was May 14th**
  - **Average 90% Passage Date (2000-2009) was May 19th**



Historic Jack Timing at BON

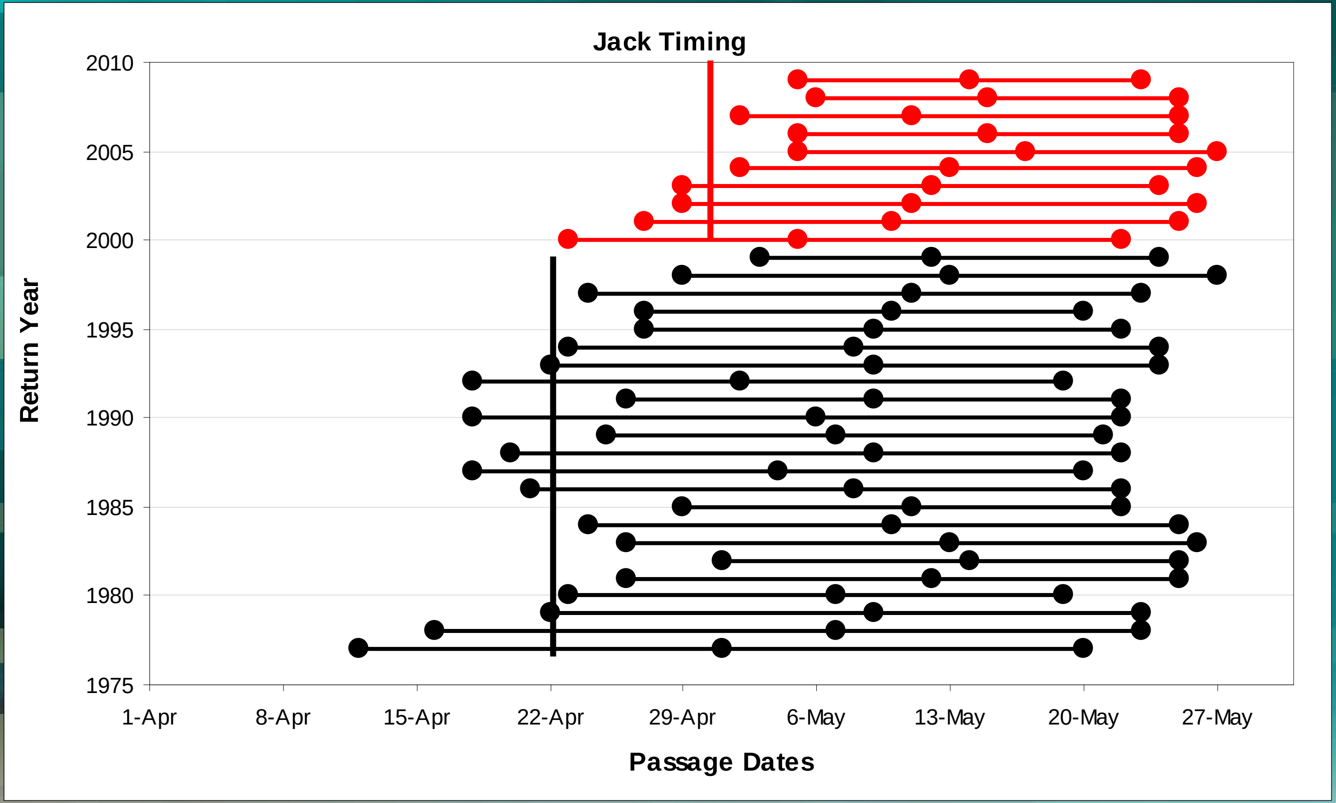
- **Spring Chinook jacks arrive at Bon later than do adults**





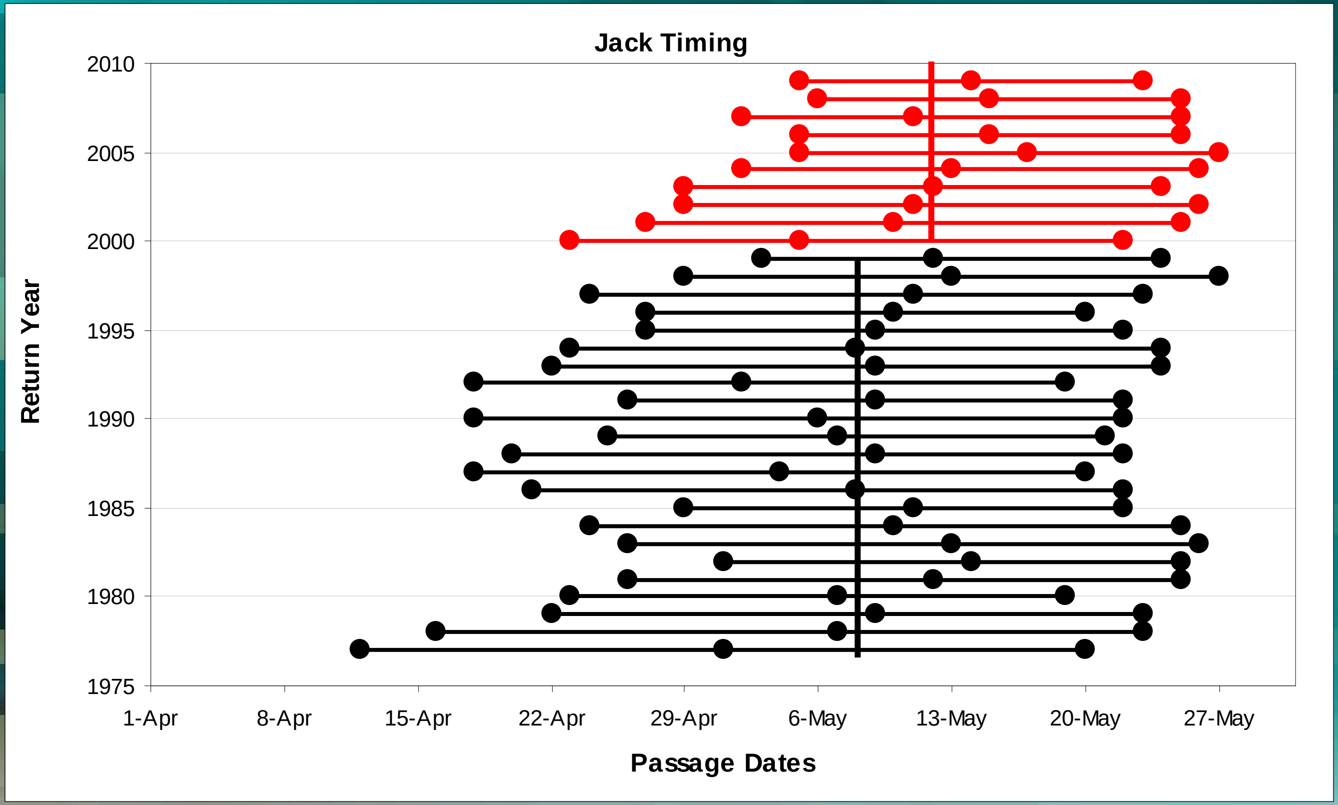
Historic Jack Timing at BON

- **Average 10% passage date among recent years (2000-2009) is later**
  - **Average 10% Passage Date (1977-1999) was April 23rd**
  - **Average 10% Passage Date (2000-2009) was May 1st**



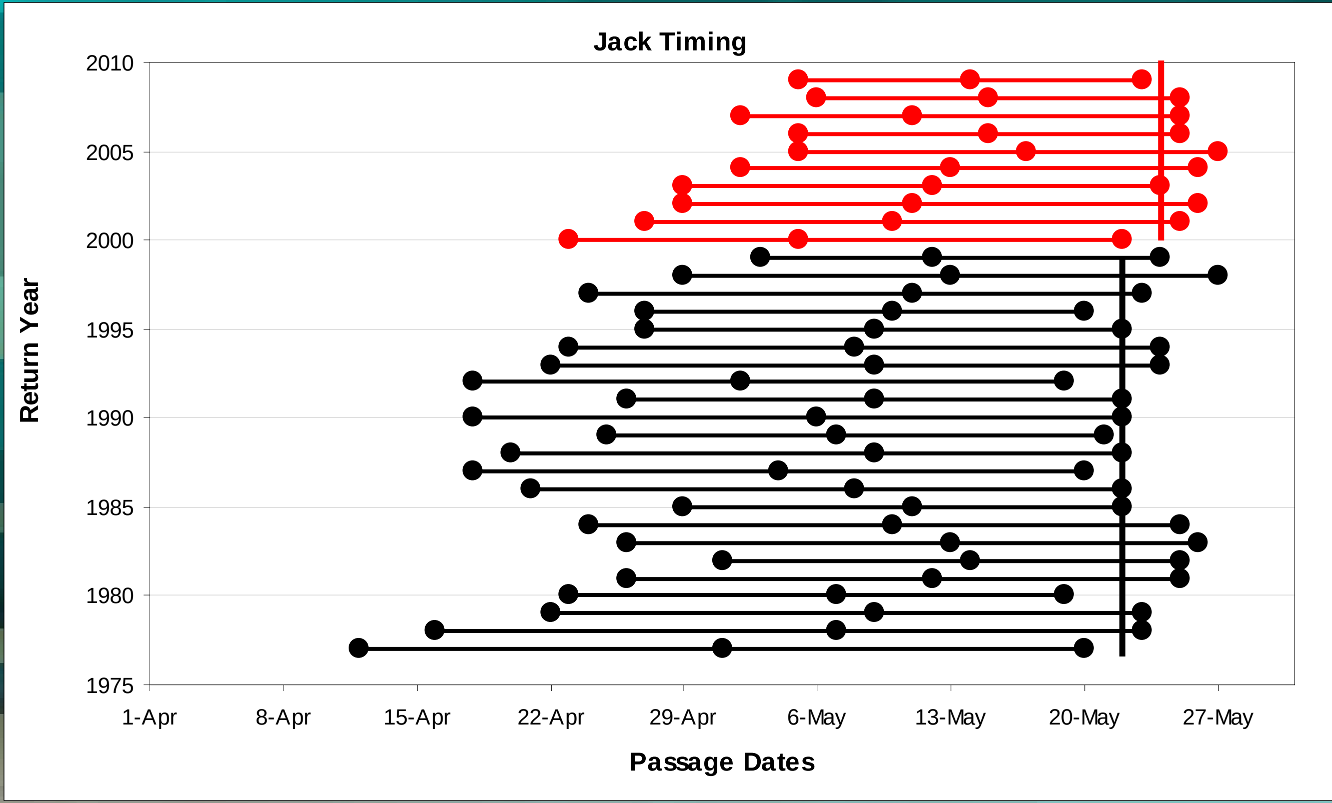
Historic Jack Timing at BON

- **Average 50% passage date among recent years (2000-2009) is later**
  - **Average 50% Passage Date (1977-1999) was May 8th**
  - **Average 50% Passage Date (2000-2009) was May 12th**



Historic Jack Timing at BON

- **Average 90% passage date among recent years (2000-2009) is later**
  - **Average 90% Passage Date (1977-1999) was May 22nd**
  - **Average 90% Passage Date (2000-2009) was May 24th**

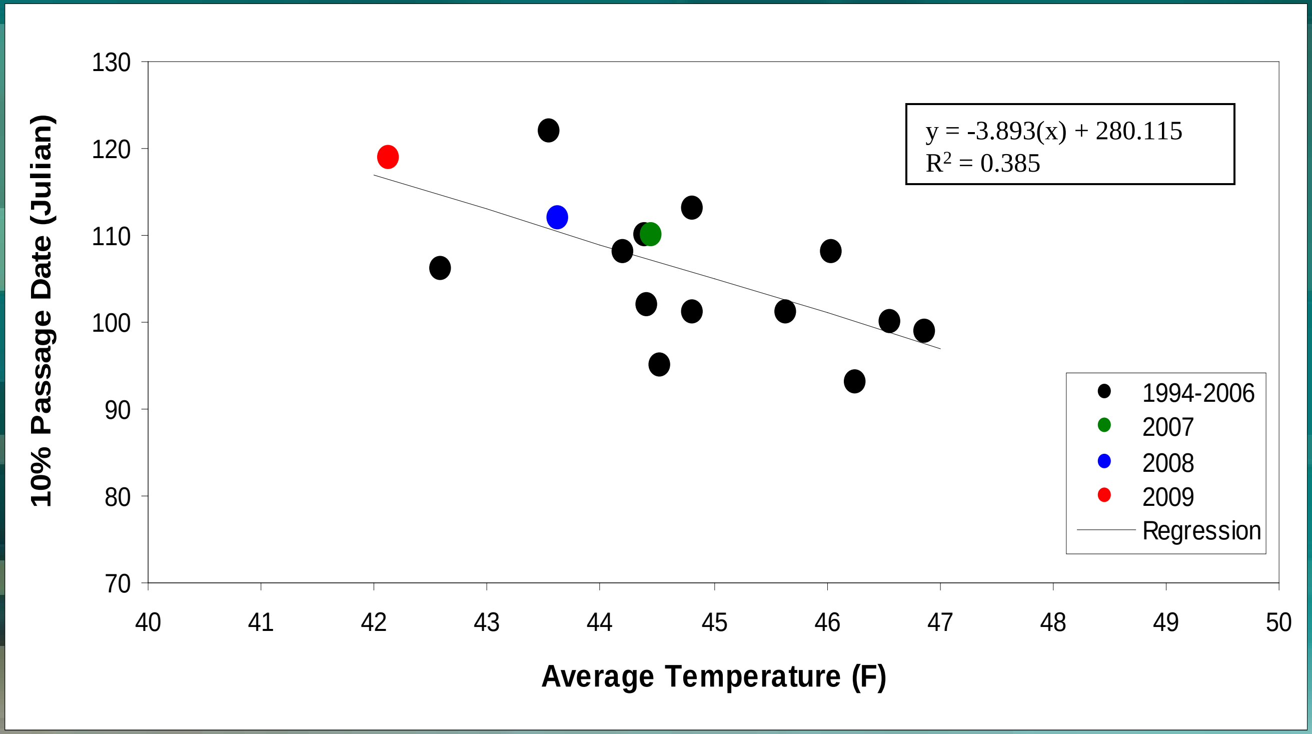


Adult Timing and Environmental Variables

- FPC conducted linear regression analyses to investigate relationships between environmental variables and 10% passage date of spring Chinook adults and jacks
  - Jacks and adults were not separated for these analyses
- Environmental variables were temperature and flow
- Temperature data used were from Warrendale TDG gauge
  - Located approximately 6 miles downstream of BON
  - Temperature data available back to 1994
- Flow data for analysis were total outflow at BON (Kcfs)
- Used temperature and flow data from March 15th to April 1st
  - Describe condition encountered at beginning of run
- Analyzed return years 1994 to 2009

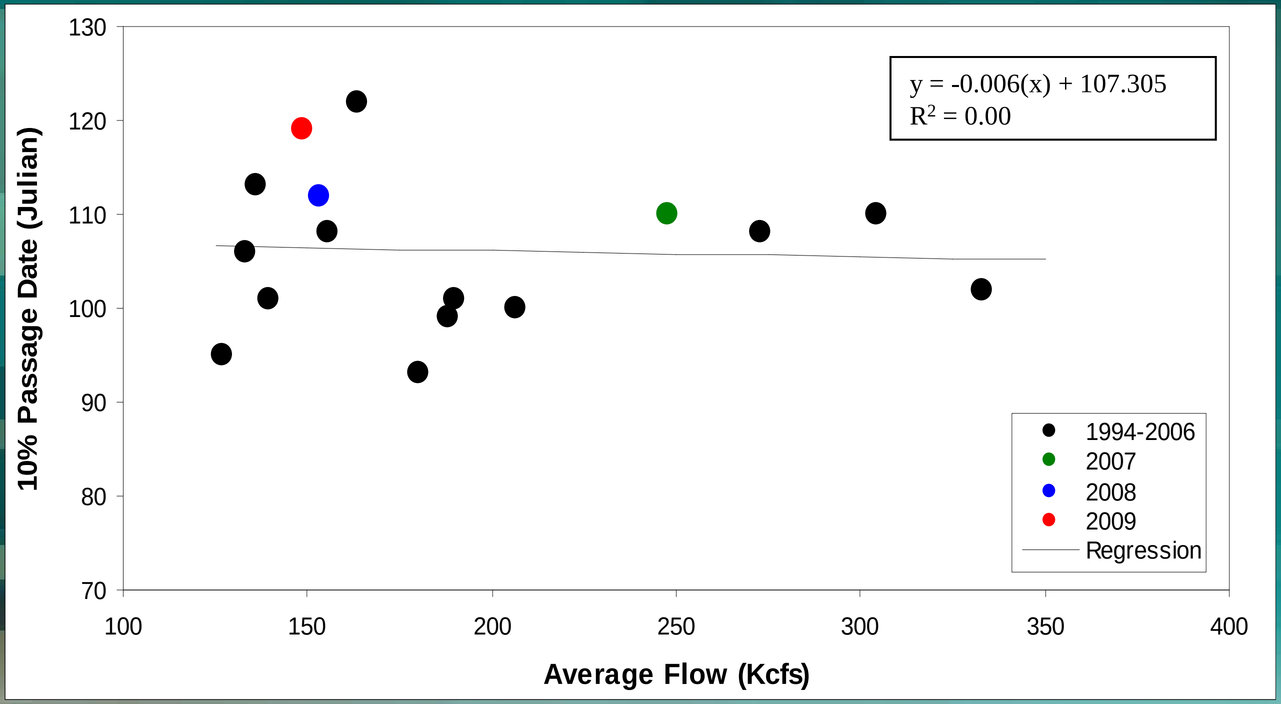
Adult Timing and Temperature

- **Significant relationship between average temperature (Mar 15-Apr 1) and 10% Passage Date (p = 0.006)**
- **Later passage dates were associated with cooler temperatures**



Adult Timing and Flow

- **No significant relationship between average flow (Mar 15-Apr 1) and 10% Passage Date (p = 0.886)**



Summary

- Based on the years we used to describe recent years (2000-2009), timing of spring Chinook adults and jacks is later than earlier years
  - 4-6 days for spring Chinook adults
  - 2-8 days for spring Chinook jacks
- Temperature seems to have an effect on timing of spring Chinook adults at BON
  - Cooler temperatures associated with delayed passage timing
- Flow does not have an effect on timing of spring Chinook adults at BON

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Fax (503) 235-4228
www.critfc.org

TO: Technical Management Team (TMT)
FROM: Kyle Dittmer, *Hydrologist-Meteorologist*, CRITFC's Hydro Program
DATE: December 11, 2009

SUBJECT: **Summary of Water Year 2009 Weather**

At the request of the TMT, this memo summarizes monthly weather events that impacted basin flows and fish migrations in Water Year 2009 (October 2008 - September 2009). WY 2009 had extreme variability in precipitation and temperature patterns than in past years (Figures 1 and 2).

Autumn started off tame, except for a mid-October snow storm, wet blast in early November, then quiet until early December. A very strong series of snow storms left much of the PNW buried in record low temperatures and low elevation snow piles for over two weeks. Portland NWS office received 19-inches of snow in December – a new record. Temperatures were near normal (-0.1 to +5.3) with basin departures of -7 to +12 ^{O}F.

Winter began with heavy rain in early-January and stayed cold, dry until late February. Strong late-winter storms dominated in March and helped to rebuild depleted mountain snow-packs. Temperatures were below normal (-0.6 to -2.6) with basin departures of -8 to +7^{O}F.

Spring was cold and wet – continuing into June – punctuated by record heat on April 20/21. Many low temperature and rainfall records were set. June was very rainy in all of the Snake. Temperatures stayed slightly below normal (-0.9 to +0.2) with basin departures of -9 to +5 ^{O}F.

Summer went from a very cold record-breaking start in early July, then record heat two weeks later, and stayed fairly warm through September. The hottest temperatures struck on July 28 (101 to 108 ^{O}F), July 29th (103 to 109 ^{O}F), and Aug. 1st (101 to 108 ^{O}F) and mid-September (87 to 94 ^{O}F). Temperatures stayed above normal (+0.7 to +2.2) with basin departures of -2 to +5 ^{O}F. The rain returned by late September and temperatures moderated.

Cumulative precipitation totals for Water Year 2009 for Columbia at The Dalles ended at 97%. The driest basins of the Columbia (Figure 3) were Central Washington (79%), Northeast Washington (81%), and Okanogan (84%). The wettest basins were Upper Snake (122%), Hood / Lower Deschutes & Snake River Plain (109%), and Owyhee/Malheur (108%).

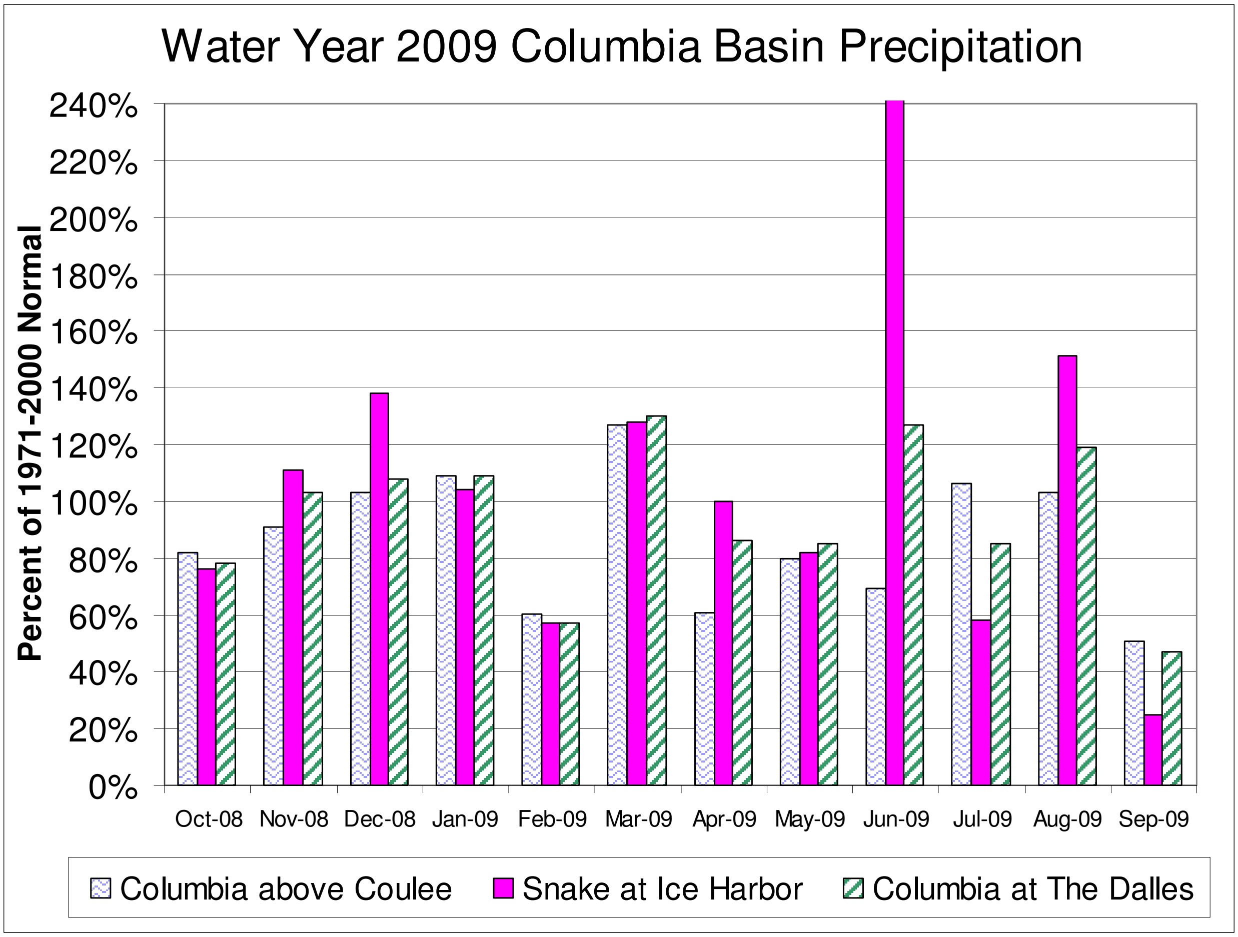


Figure 1. Water Year 2009 Division Precipitation Summary (NOAA-NWS data).

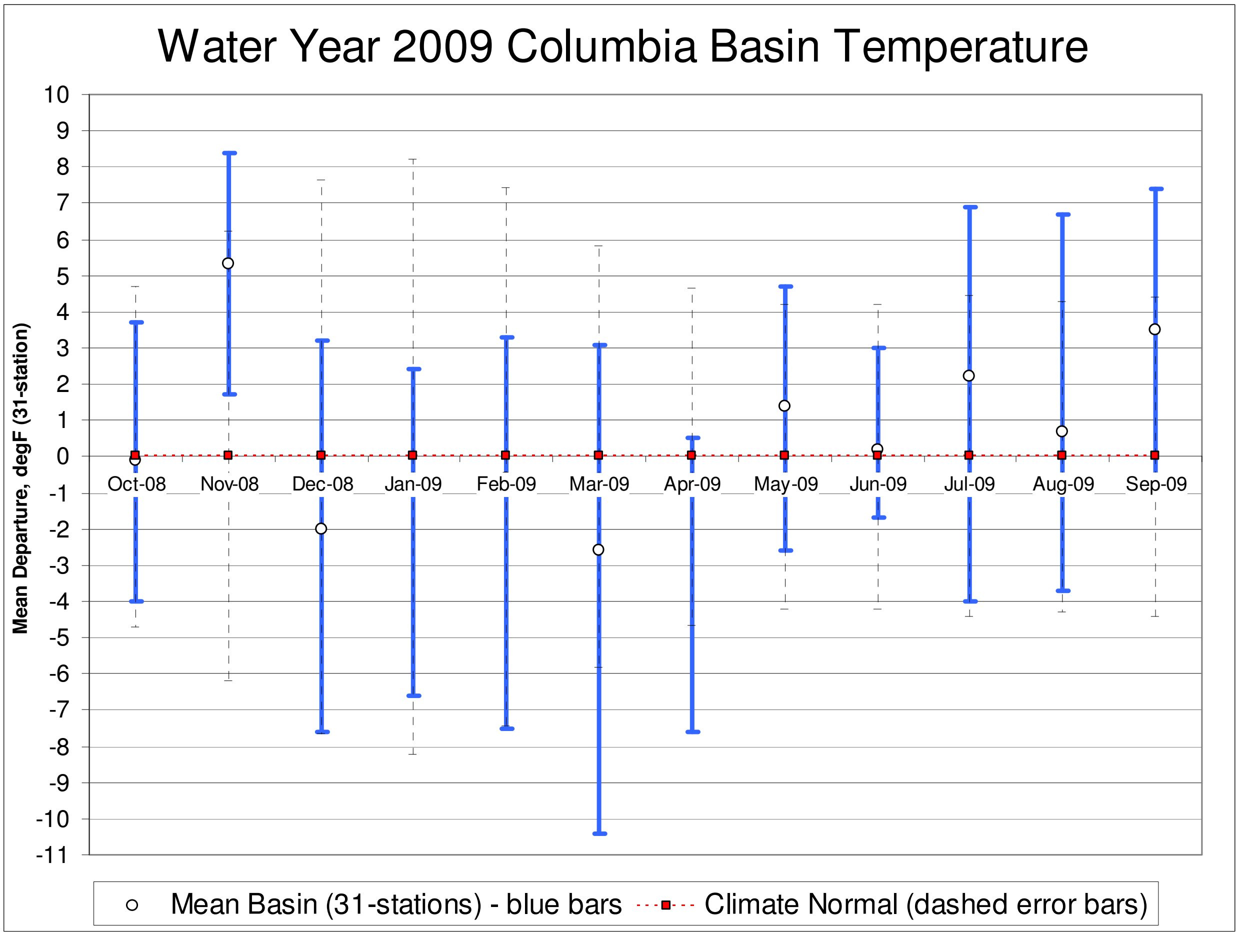


Figure 2. Water Year 2009 Temperature Departure Summary (NOAA-NWS data).

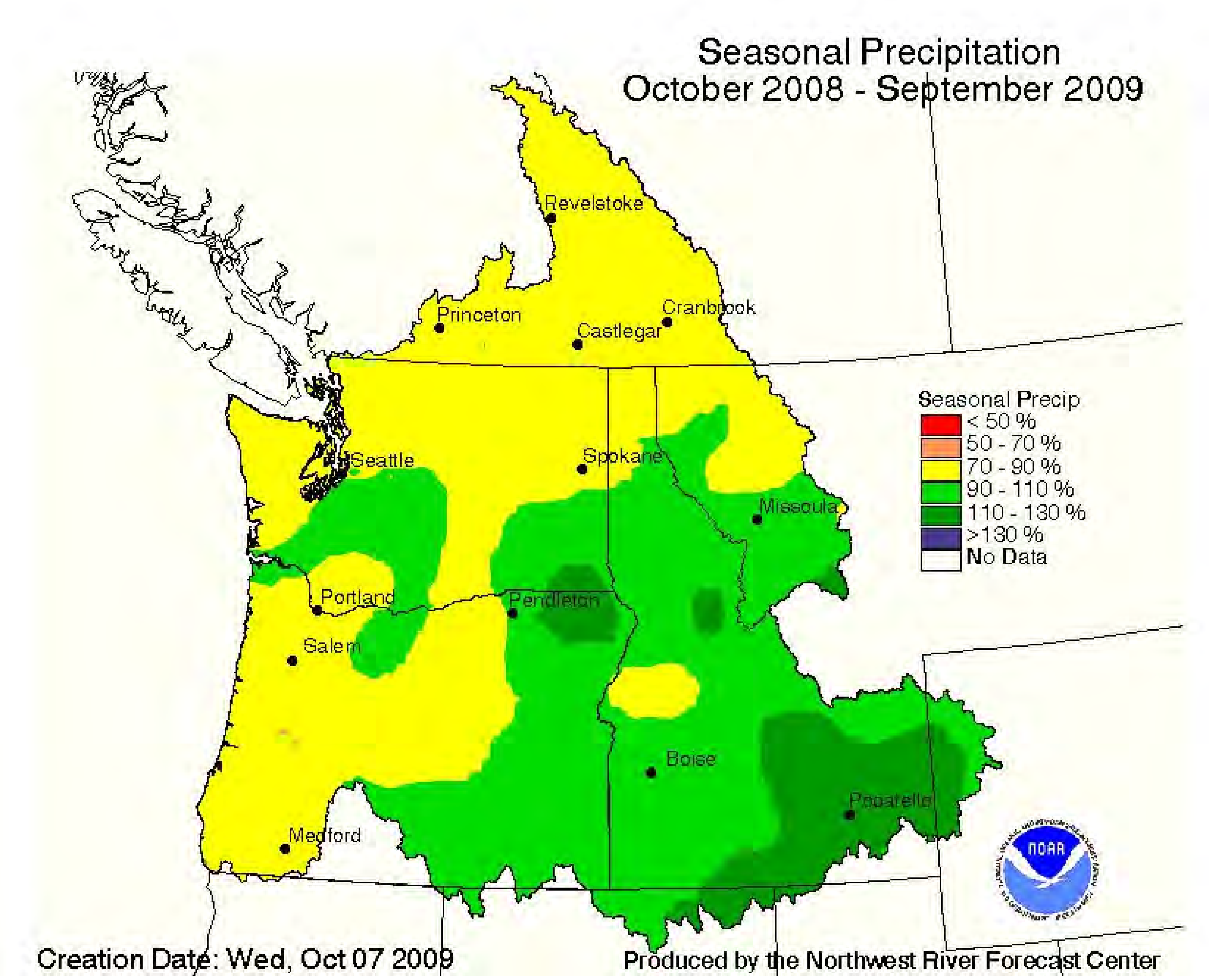


Figure 3. Water Year 2009 Columbia Basin Cumulative Seasonal Precipitation.

Survival of Migrating Salmonid Smolts in the Snake and Lower Columbia Rivers, 2009

Technical Management Team
Lessons Learned 2009

December 11, 2009

Bill Muir bill.muir@noaa.gov
Jim Faulkner jim.faulkner@noaa.gov

Outline

- Juvenile travel time and survival through the hydropower system

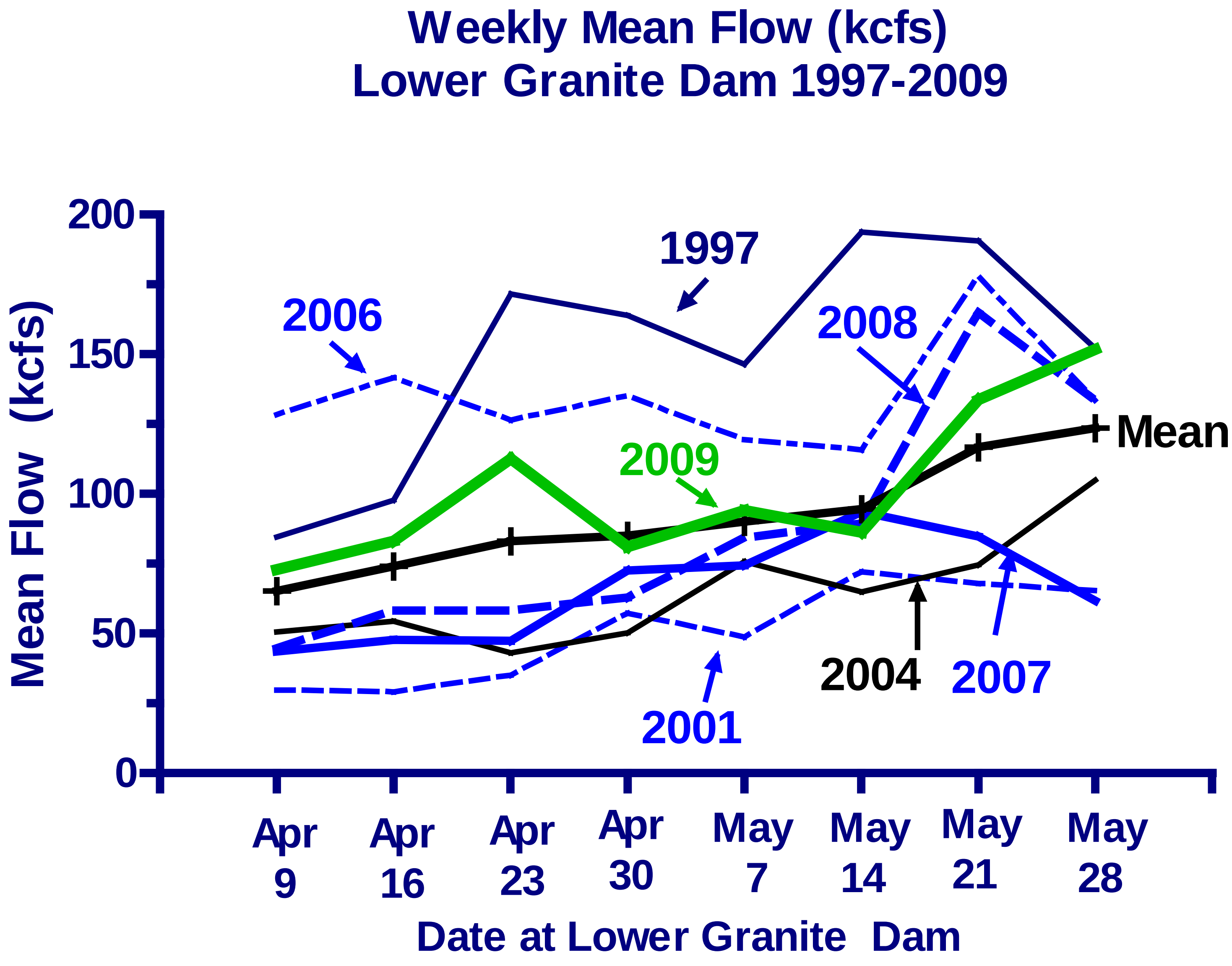
Outline

- Juvenile travel time and survival through the hydropower system
- Percentage transported

Outline

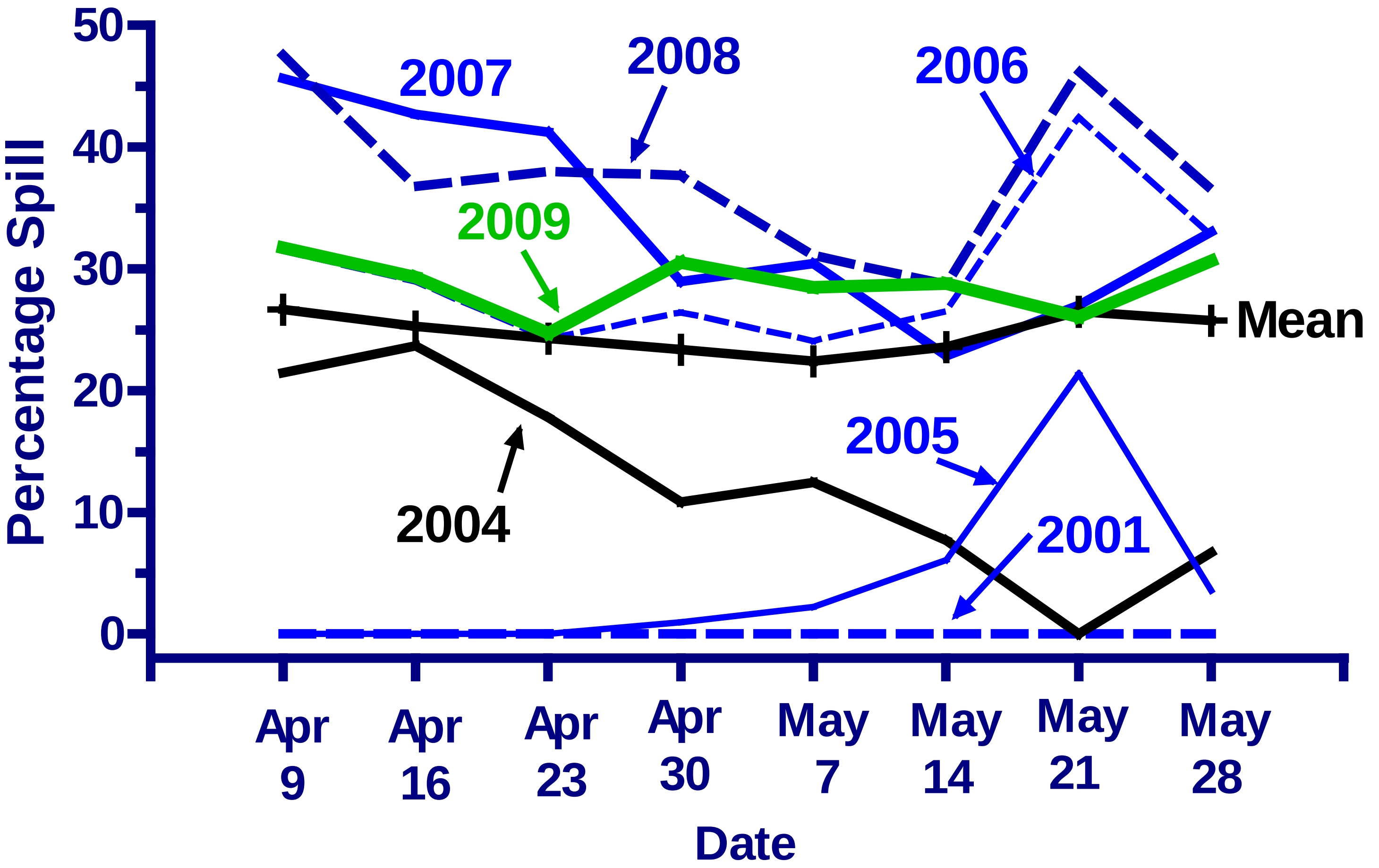
- Juvenile travel time and survival through the hydropower system
- Percentage transported
- Factors affecting travel time and survival

Travel Time and Survival for PIT-tagged Spring Migrants

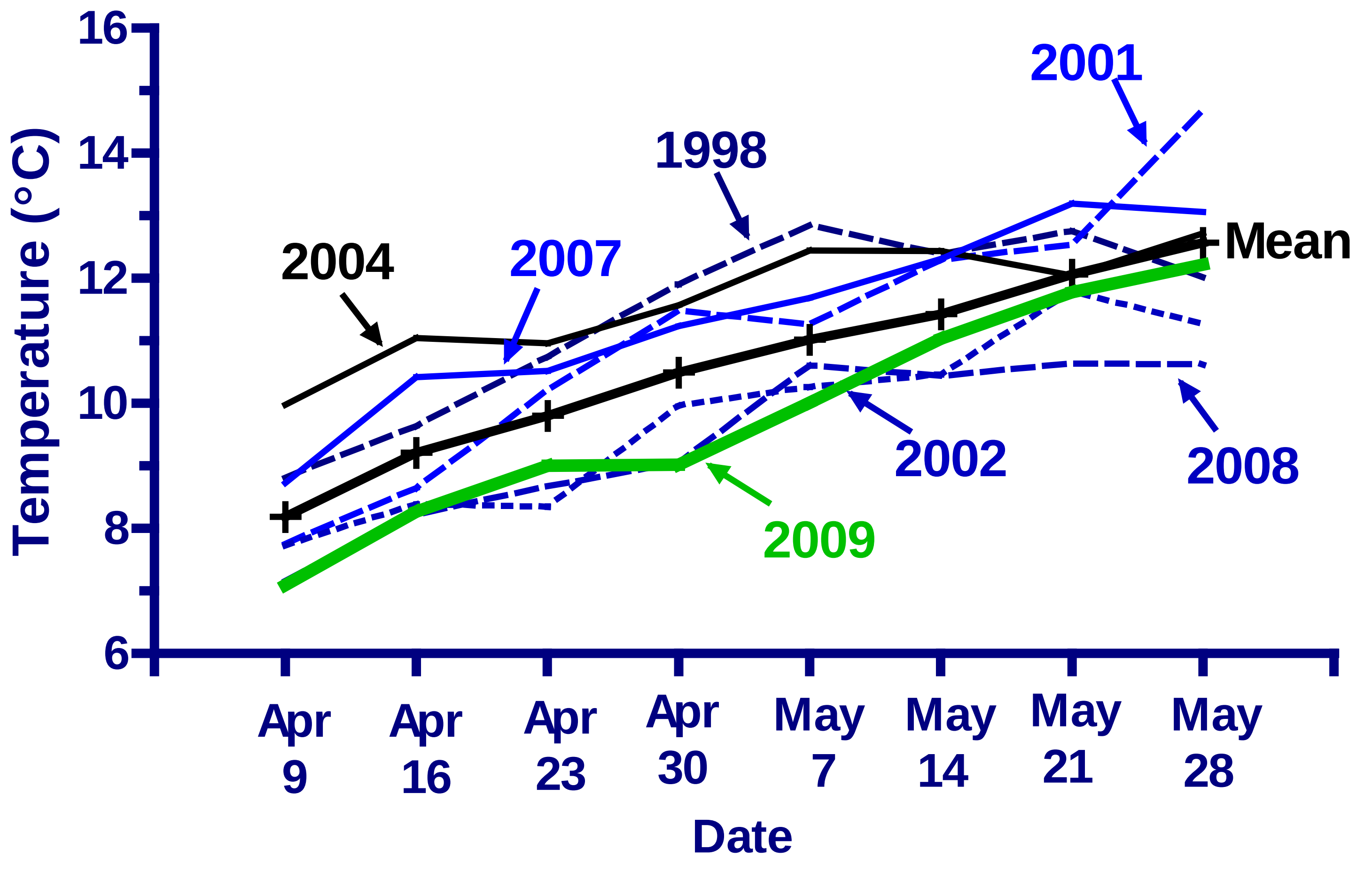


Weekly Mean Flow (kcfs)
Lower Granite Dam 1997-2009
Mean Flow (kcfs)
200
150
100
50
0
1997
2006
2008
2009
Mean
2004
2007
2001
Apr 9
Apr 16
Apr 23
Apr 30
May 7
May 14
May 21
May 28
Date at Lower Granite Dam

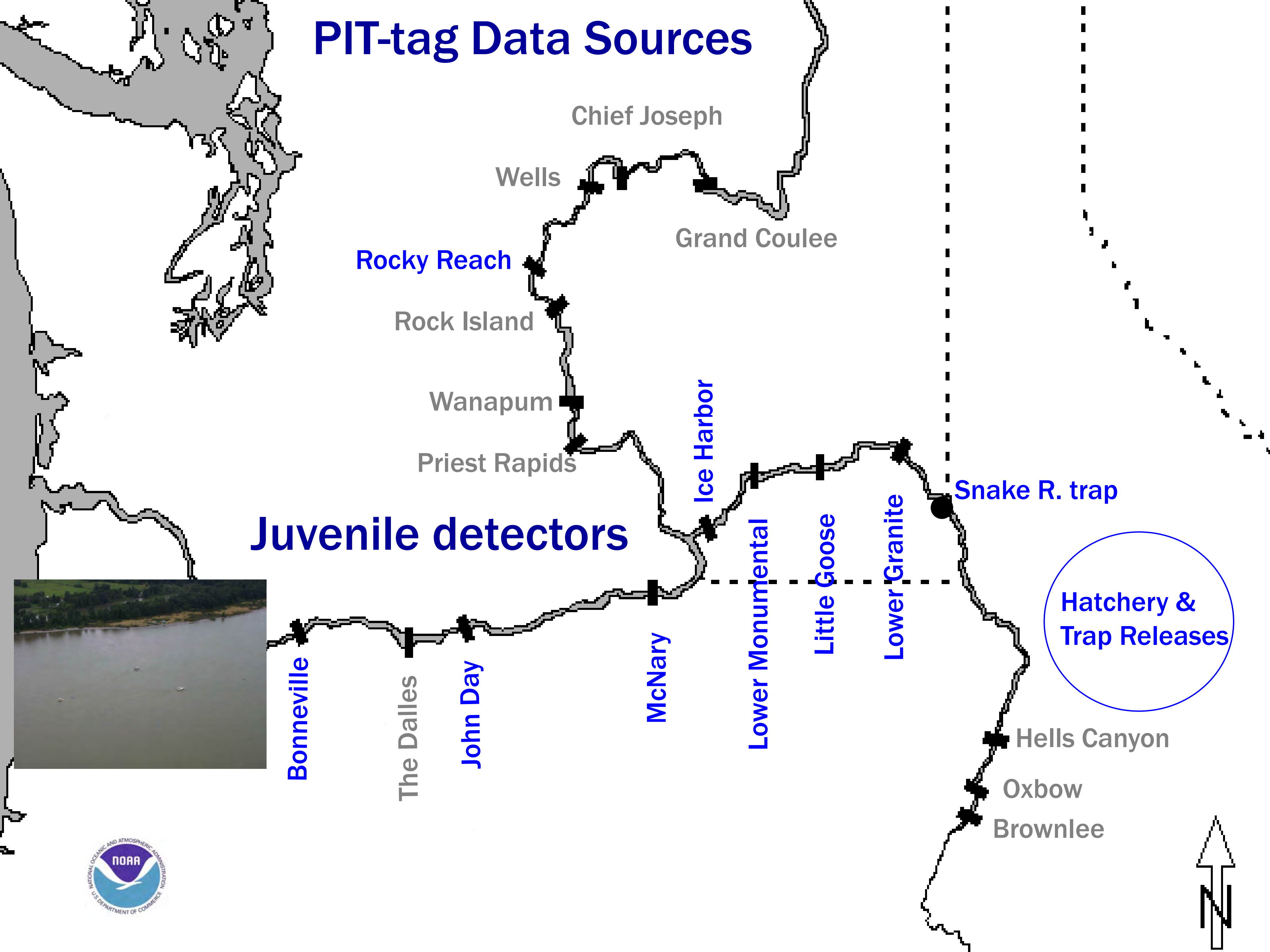
Weekly Mean %Spilled
LGR, LGS, LMN 1997-2009



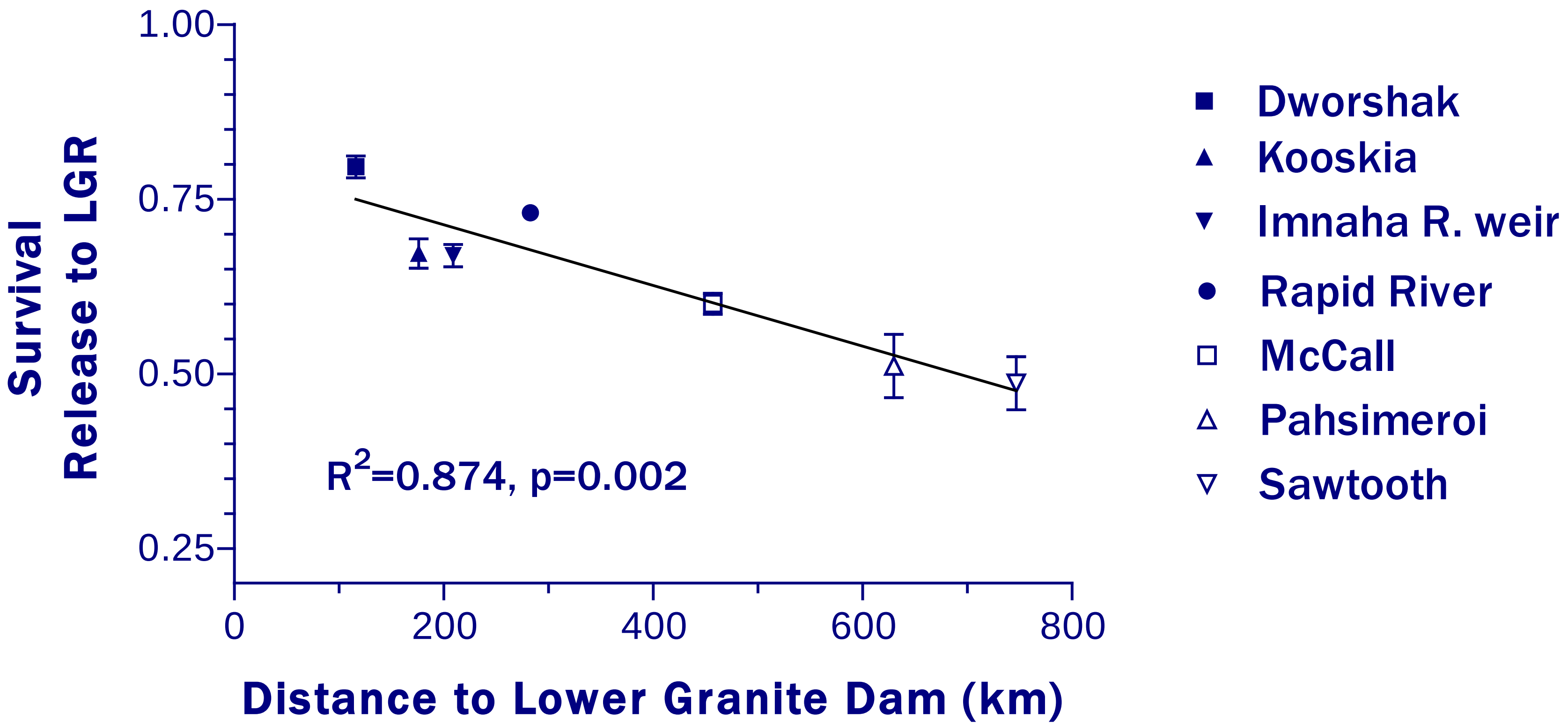
Weekly Mean Temperature
Little Goose Dam 1997-2009



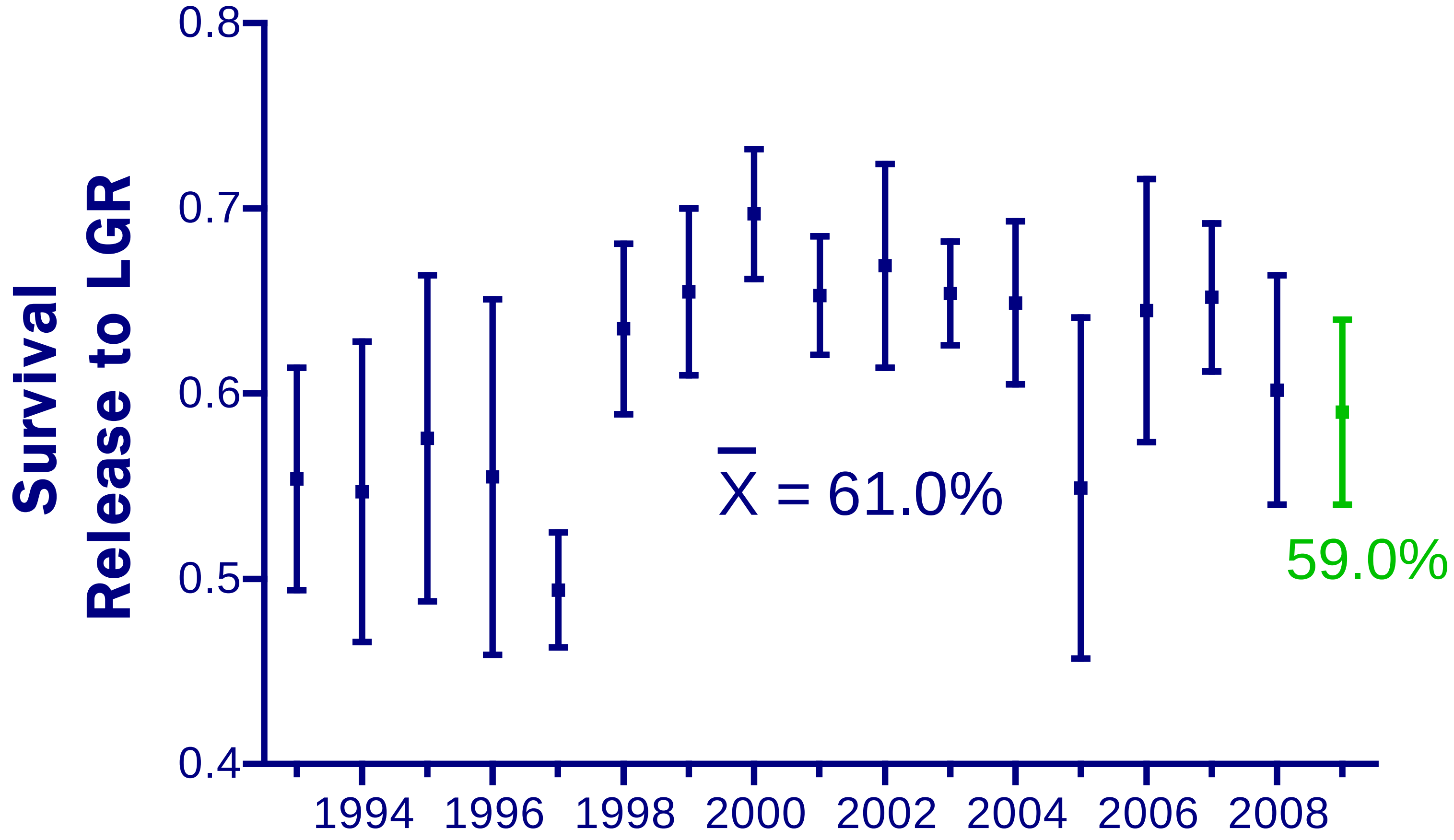
PIT-tag Data Sources



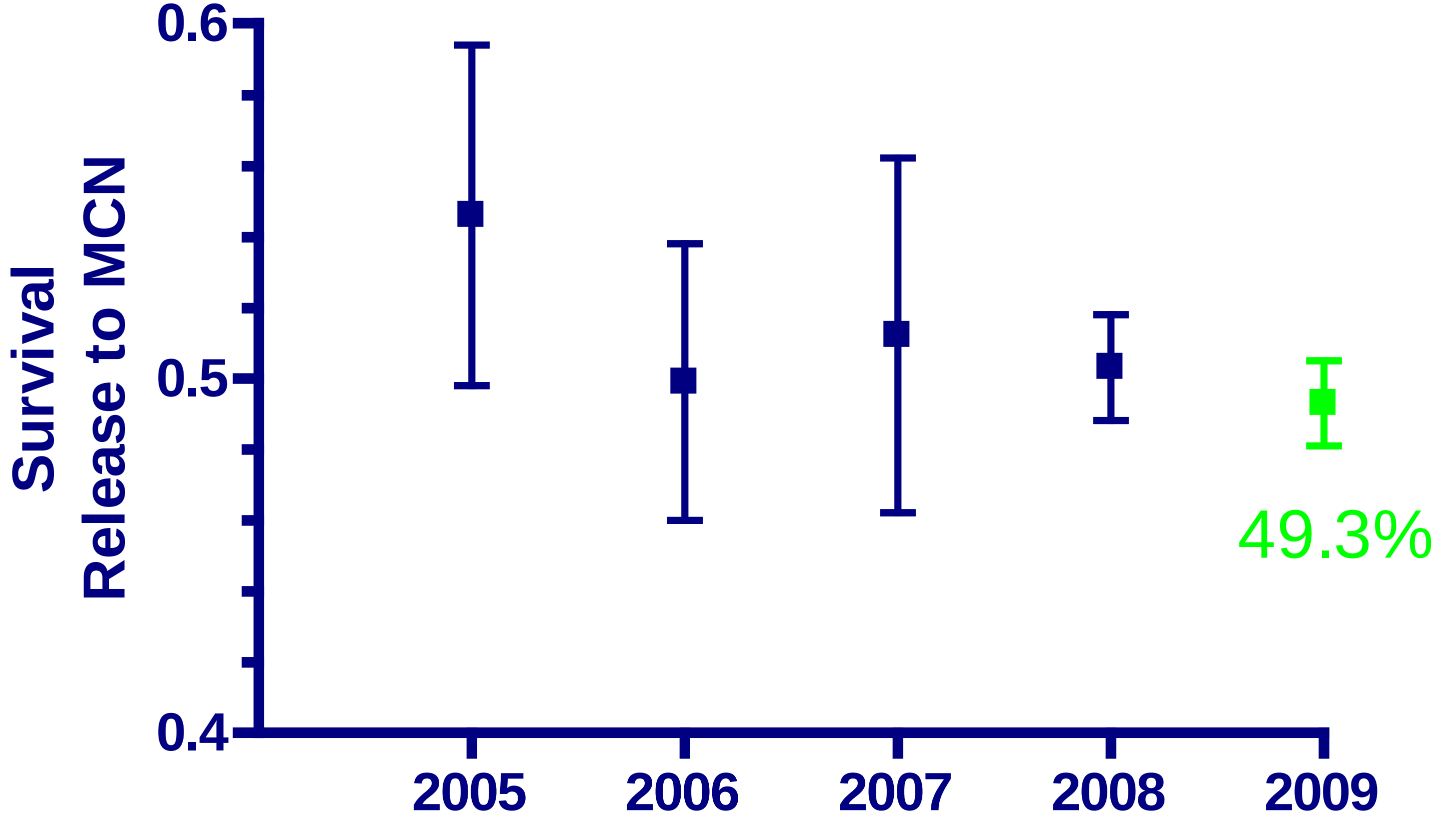
Hatchery stream type Chinook (1998-2009)



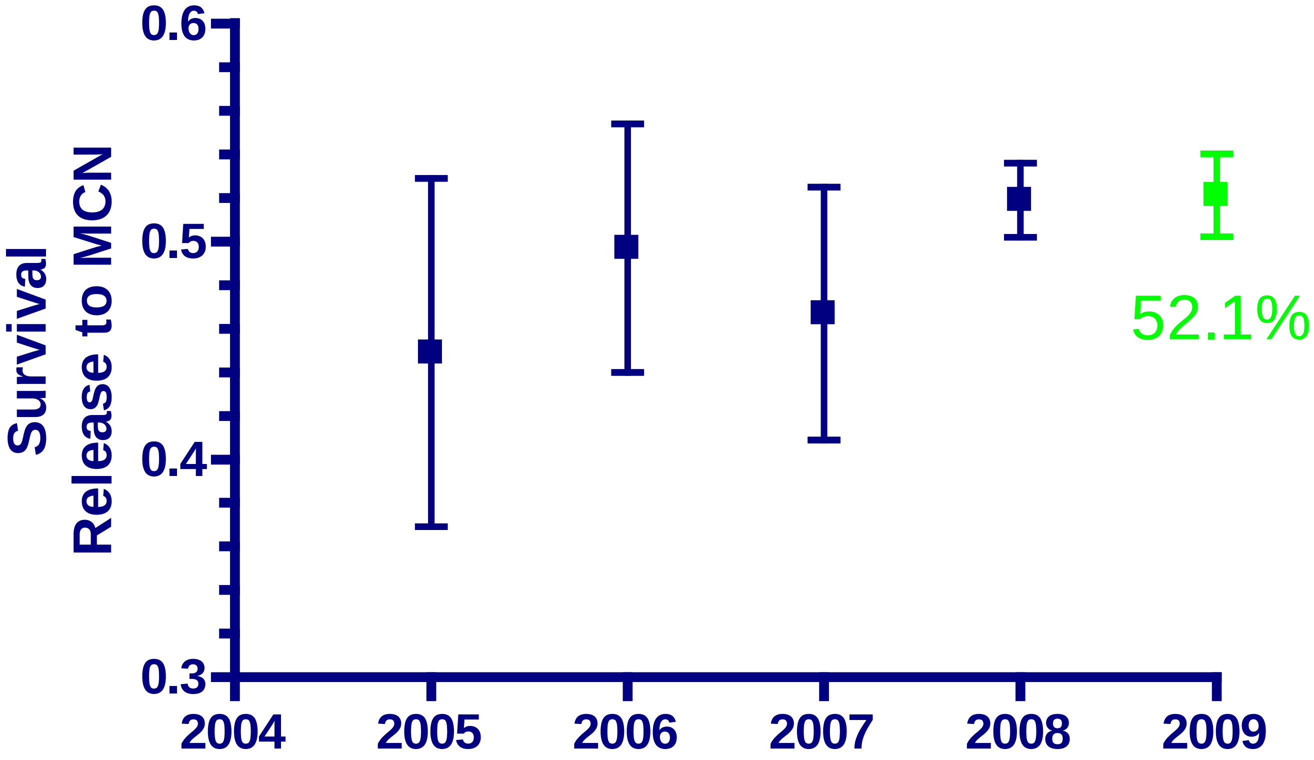
Stream Type Chinook
Snake River Basin Hatcheries
Mean of Index Groups



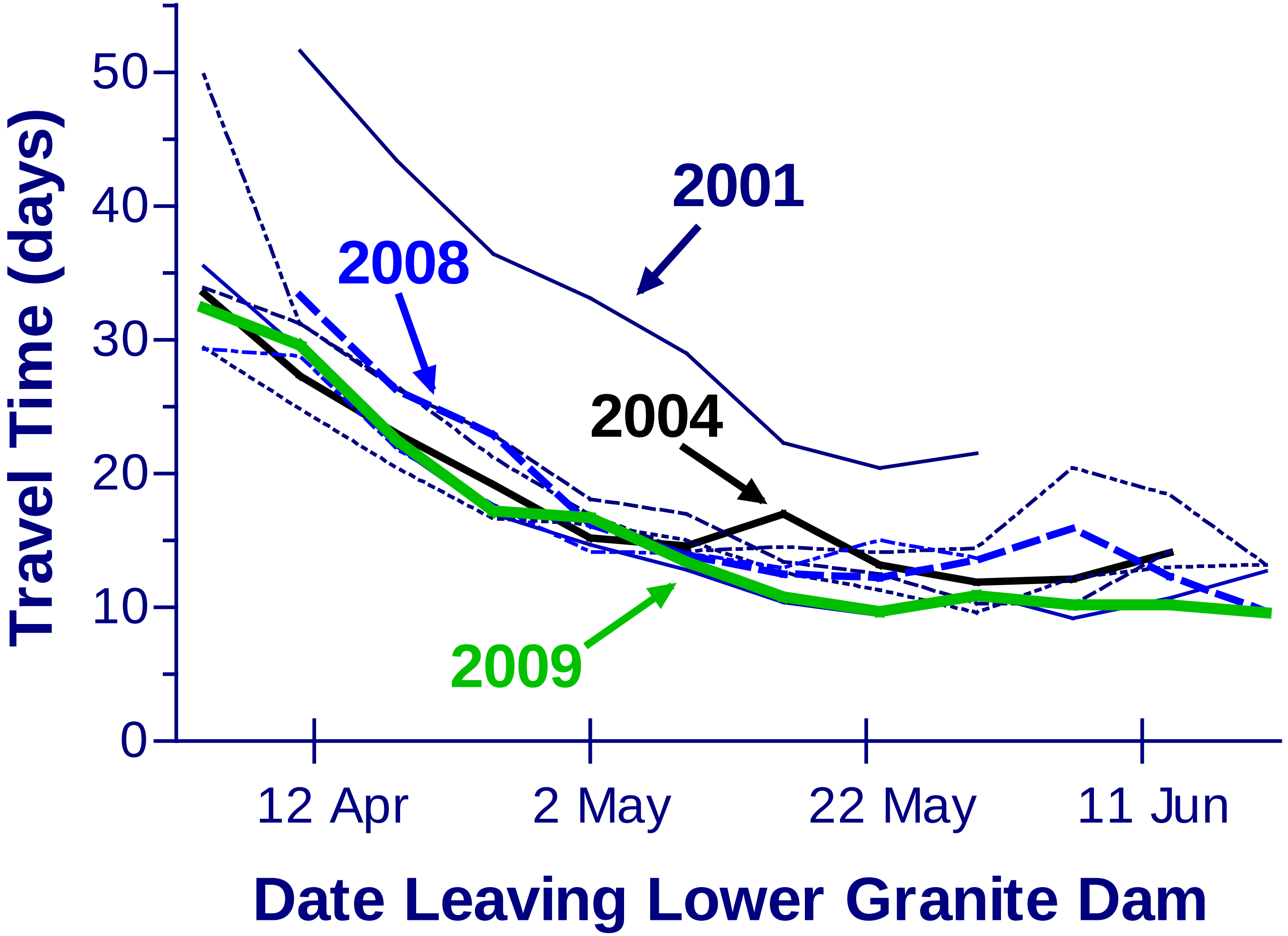
Yearling Chinook
Upper Columbia River Hatcheries



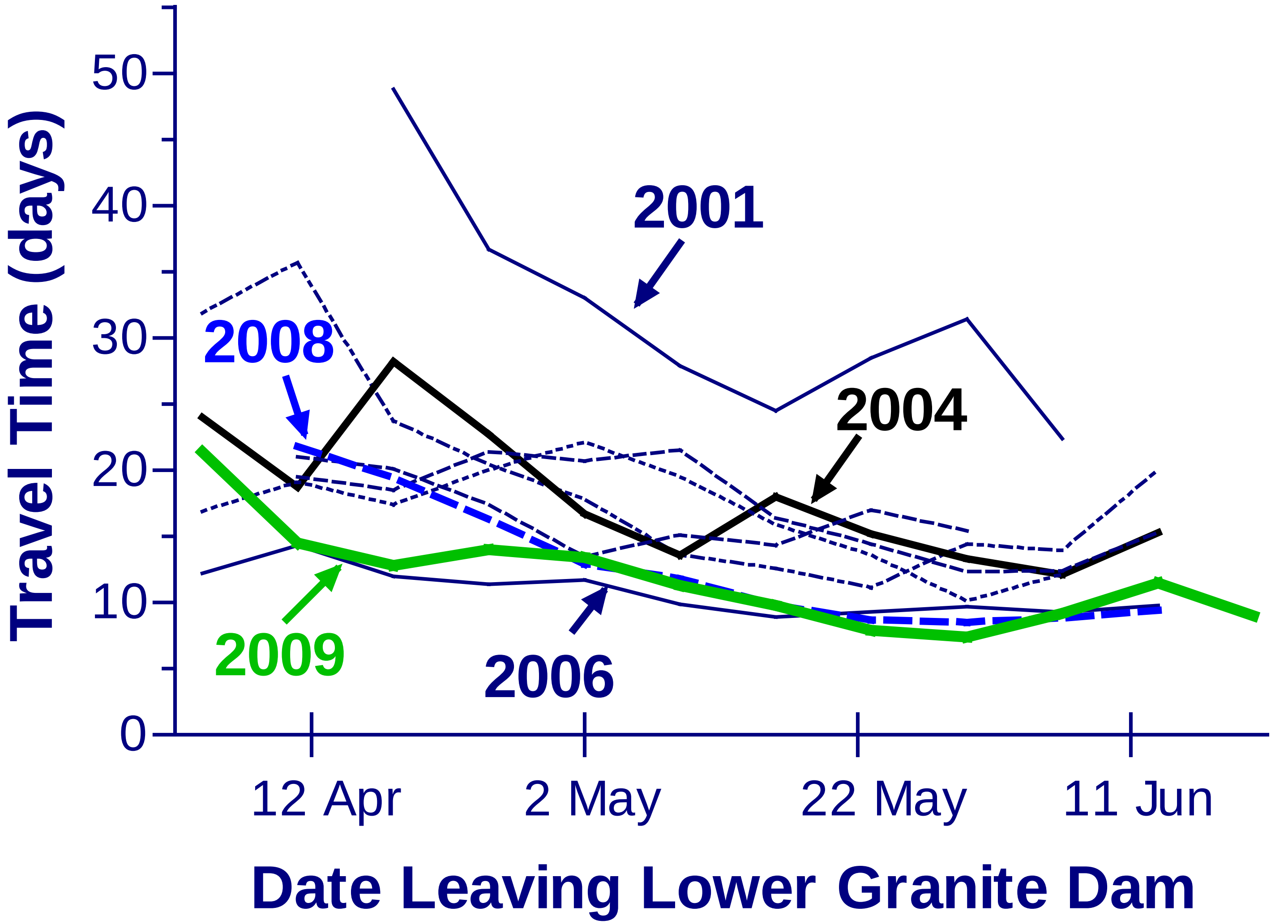
Steelhead
Upper Columbia River Hatcheries



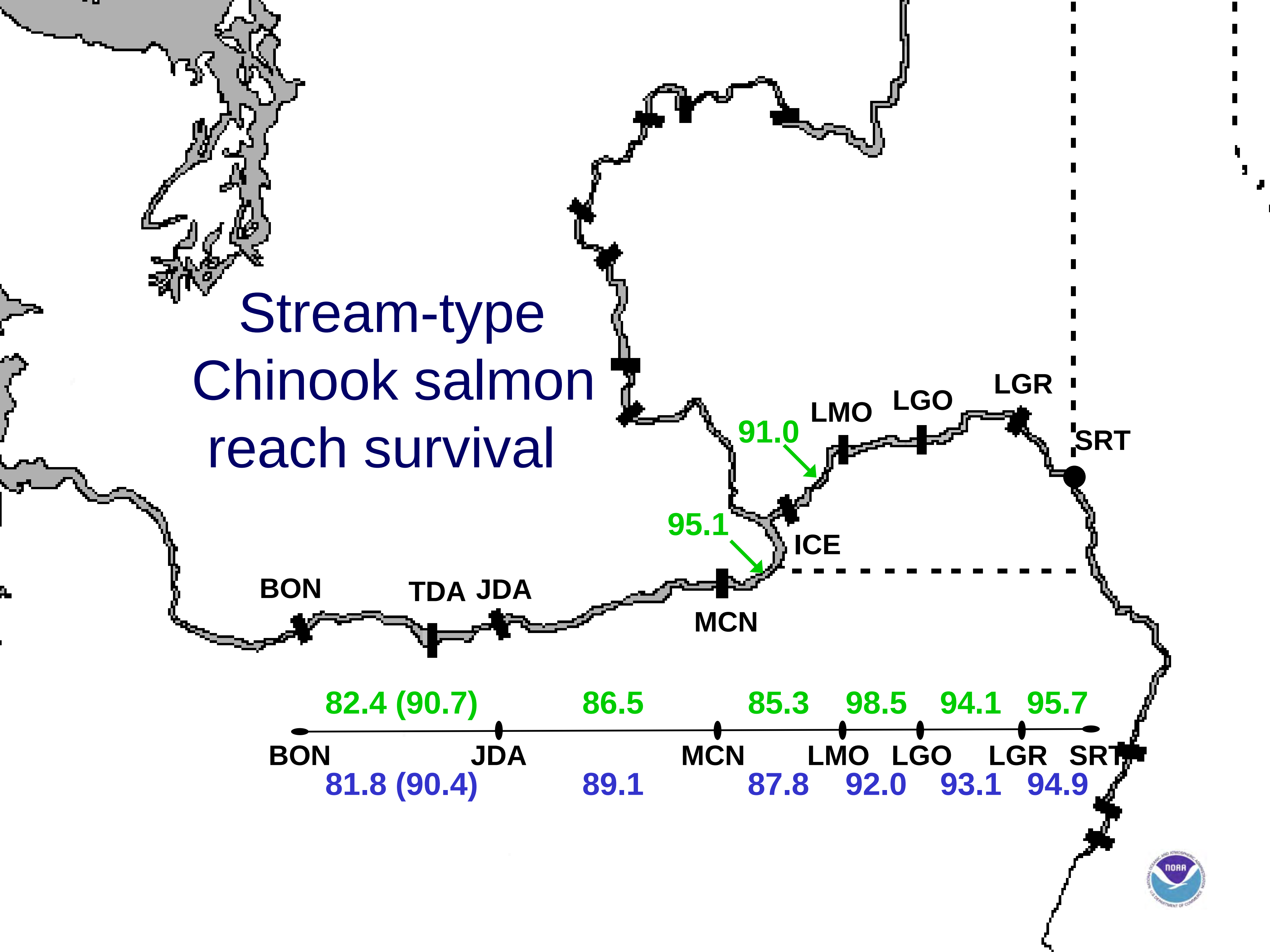
Stream-type Chinook Median Travel Time Lower Granite to Bonneville (461 km)

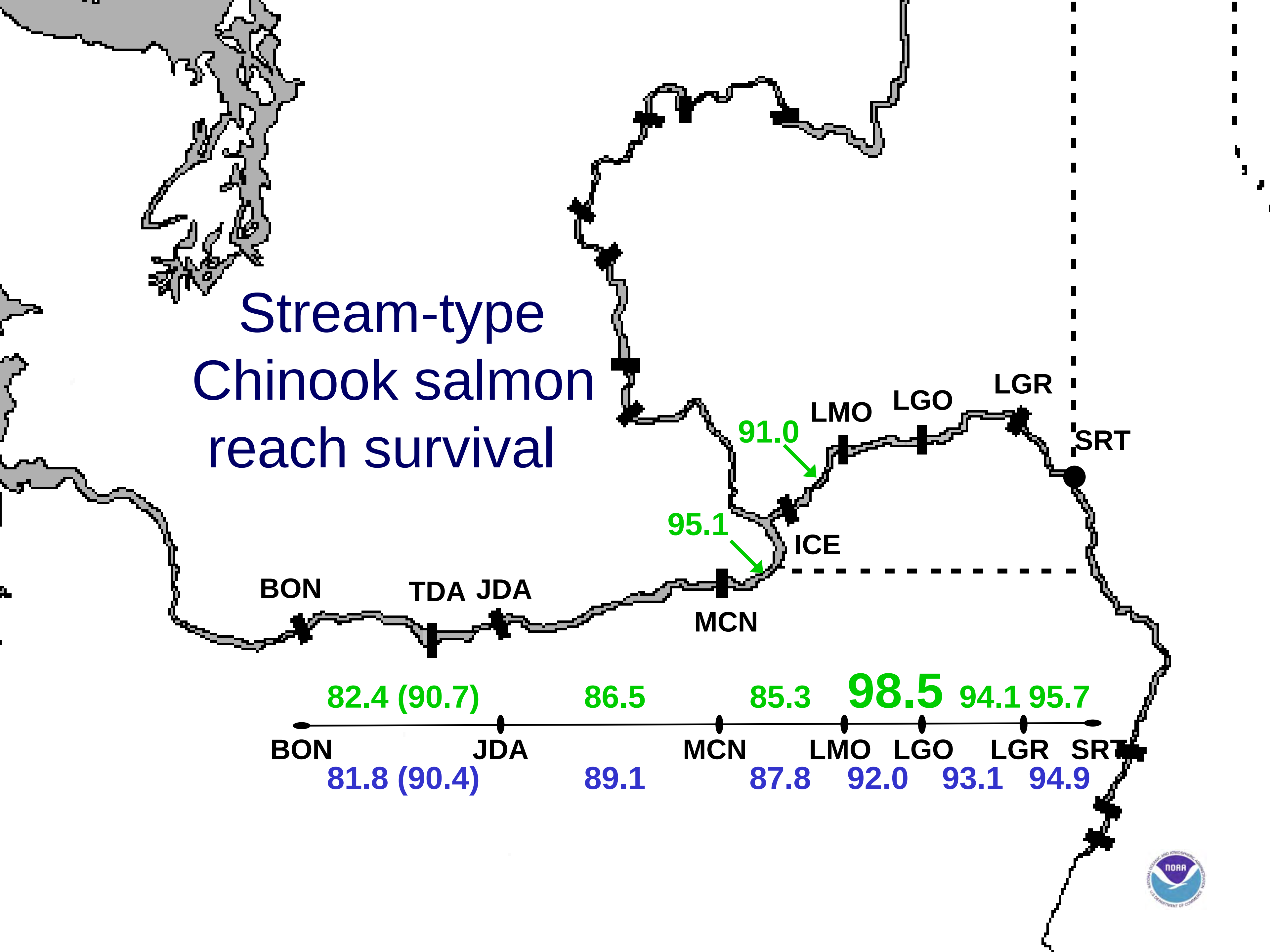


Steelhead Median Travel Time
Lower Granite to Bonneville (461 km)



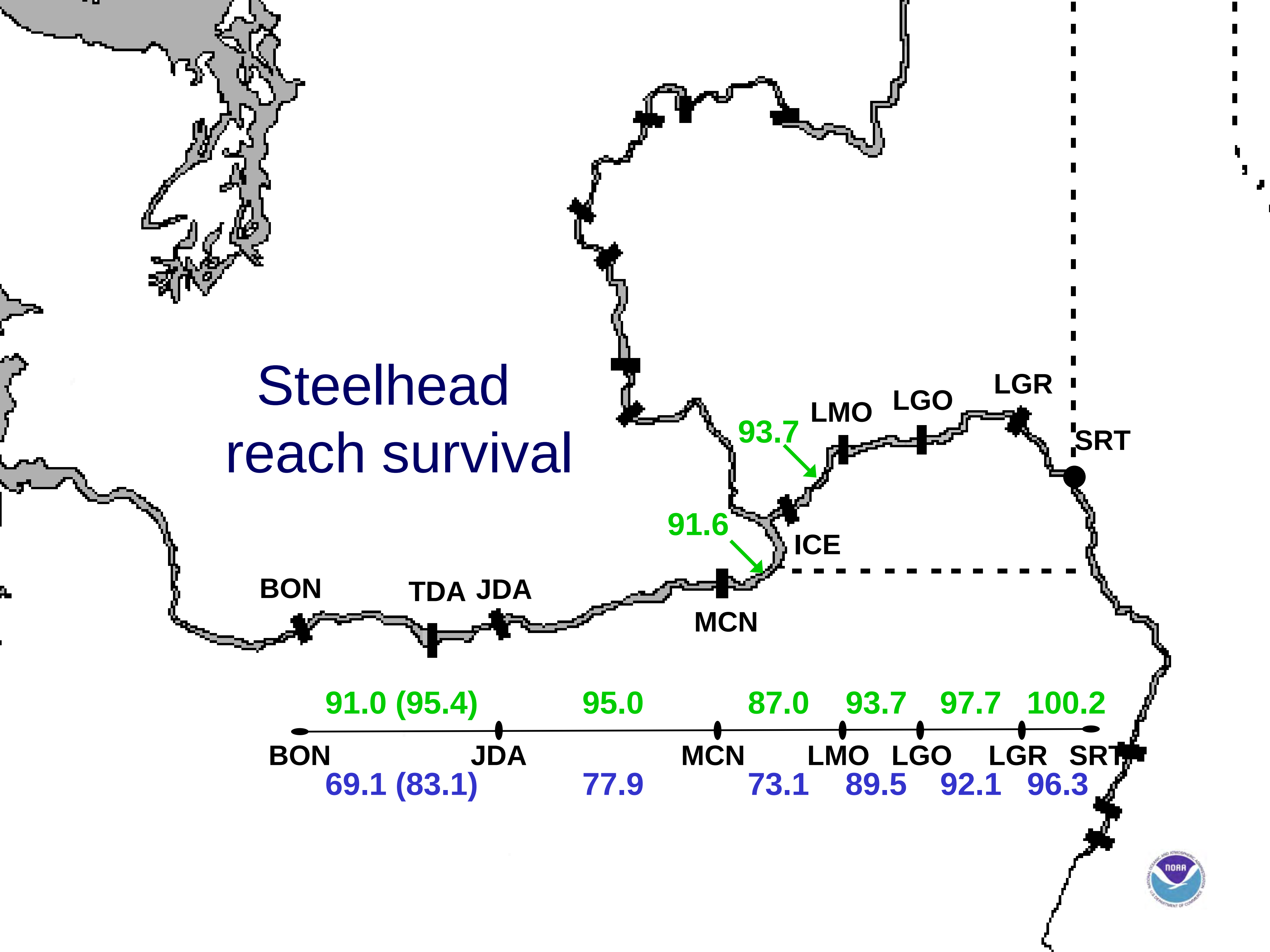
Stream-type Chinook salmon reach survival

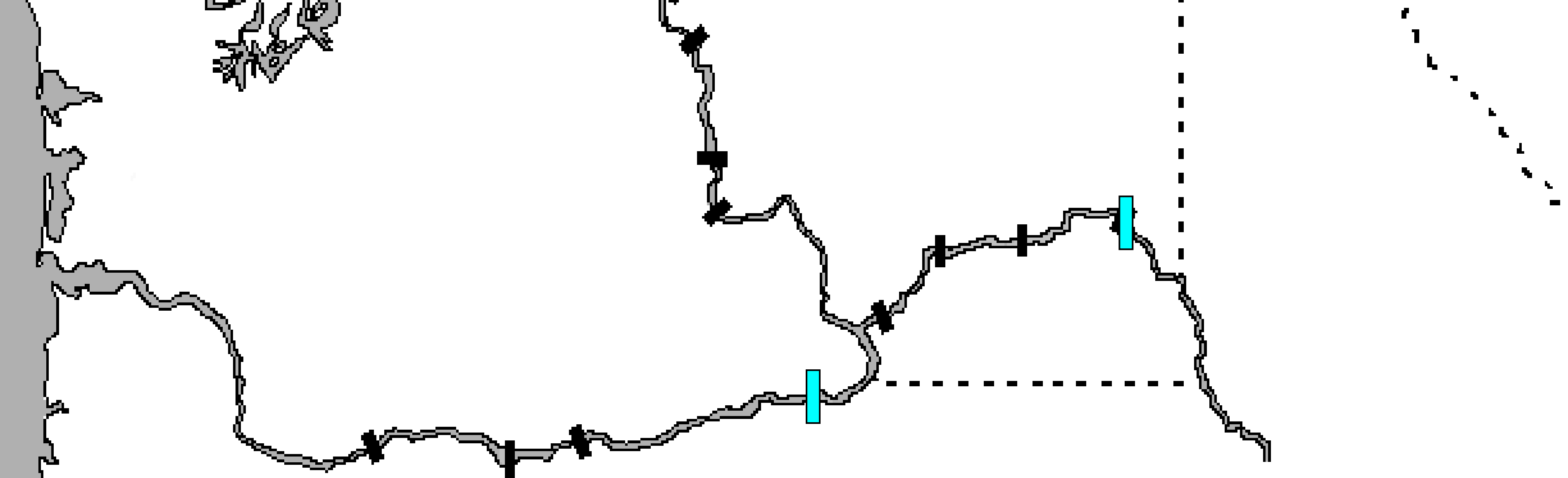




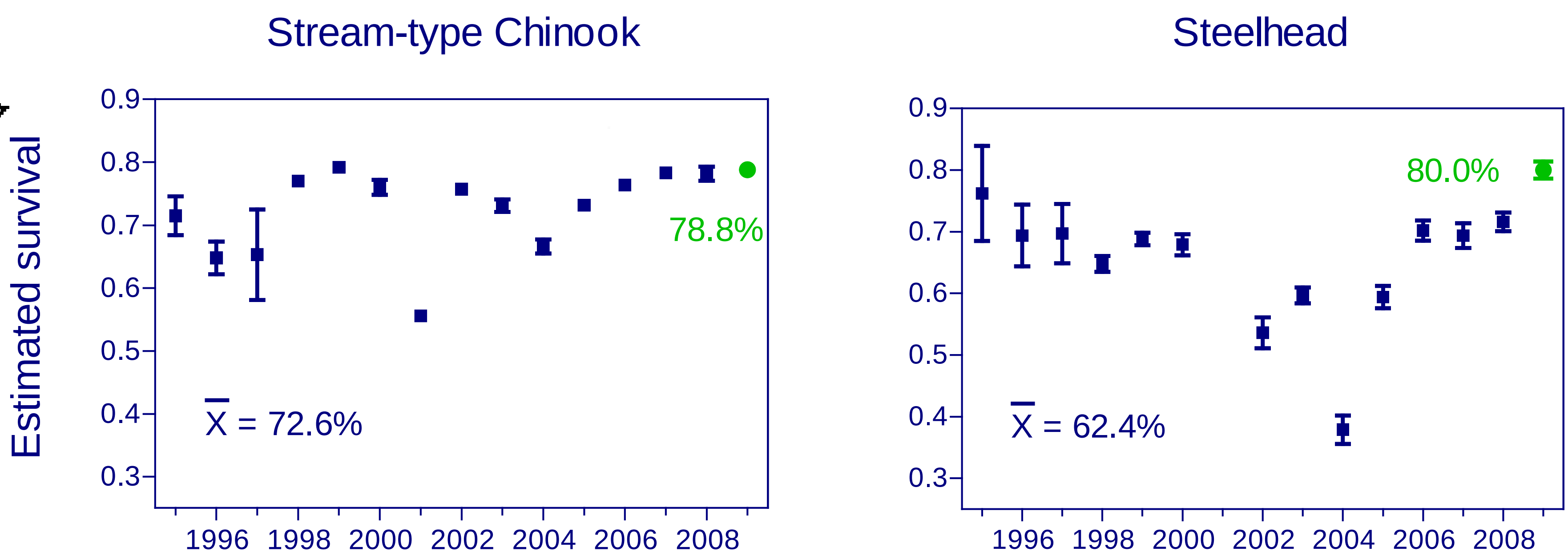
Stream-type
Chinook salmon
reach survival
LMO
LGO
LGR
SRT
91.0
95.1
ICE
BON
TDA
JDA
MCN
82.4 (90.7)
86.5
85.3
98.5
94.1
95.7
BON
JDA
MCN
LMO
LGO
LGR
SRT
81.8 (90.4)
89.1
87.8
92.0
93.1
94.9

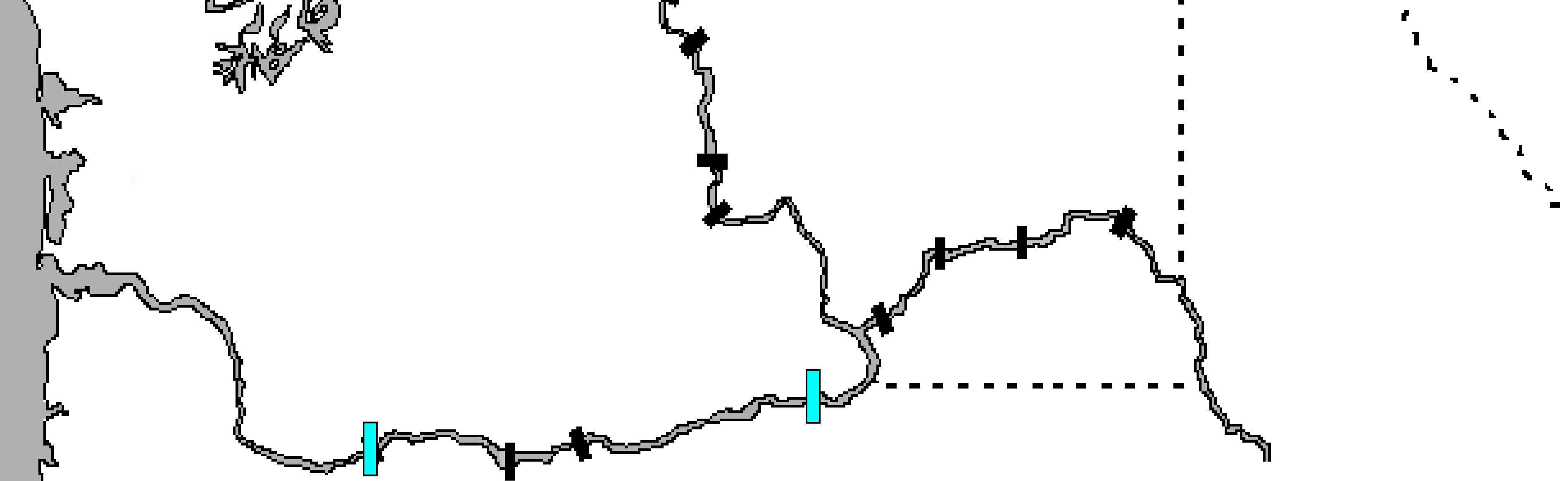
Steelhead reach survival



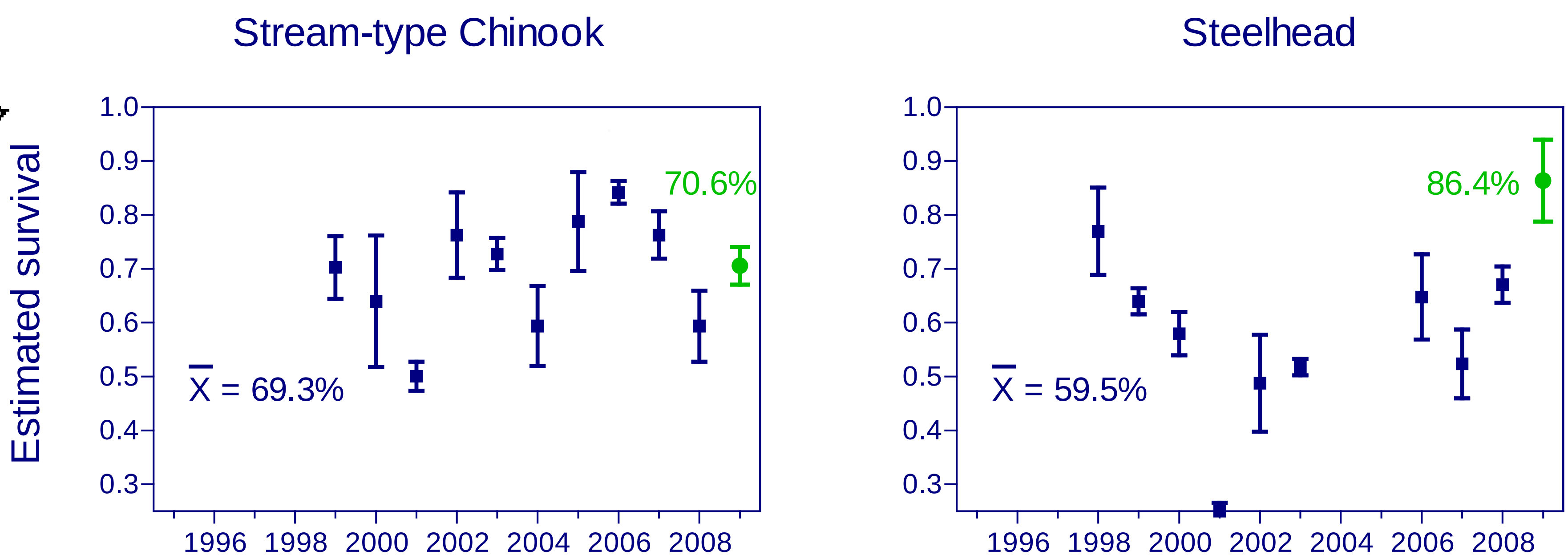


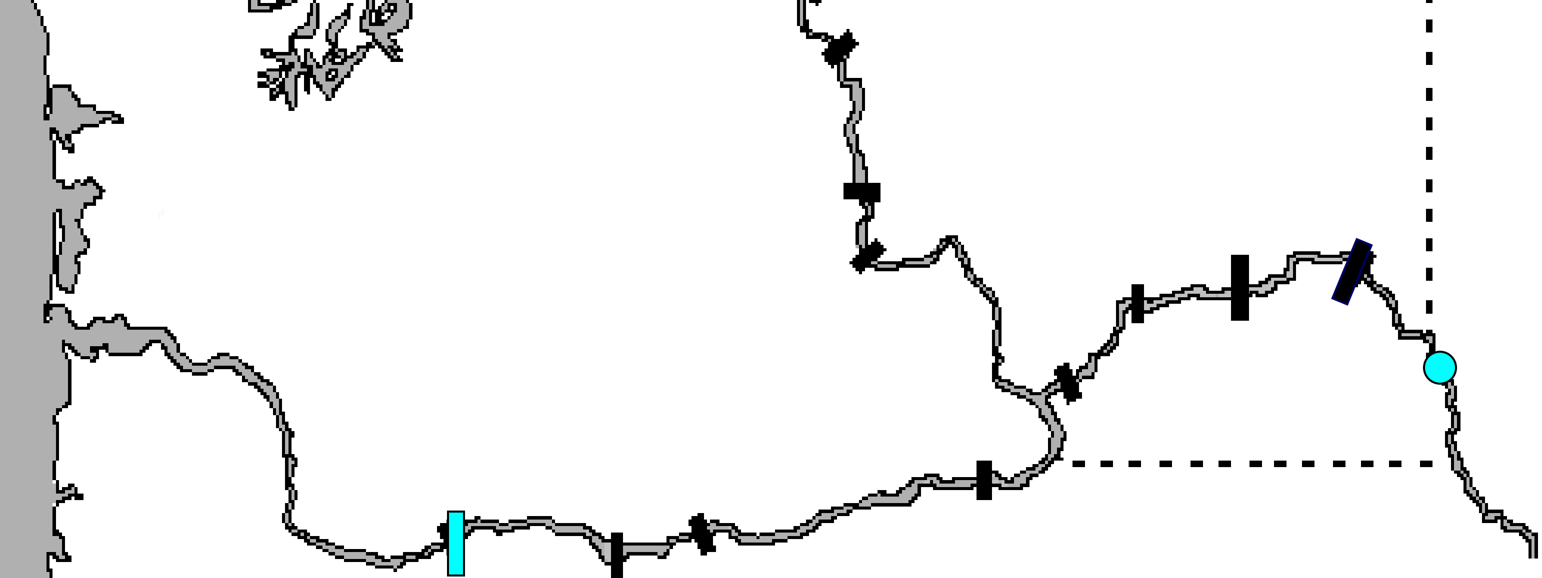
Lower Granite to McNary



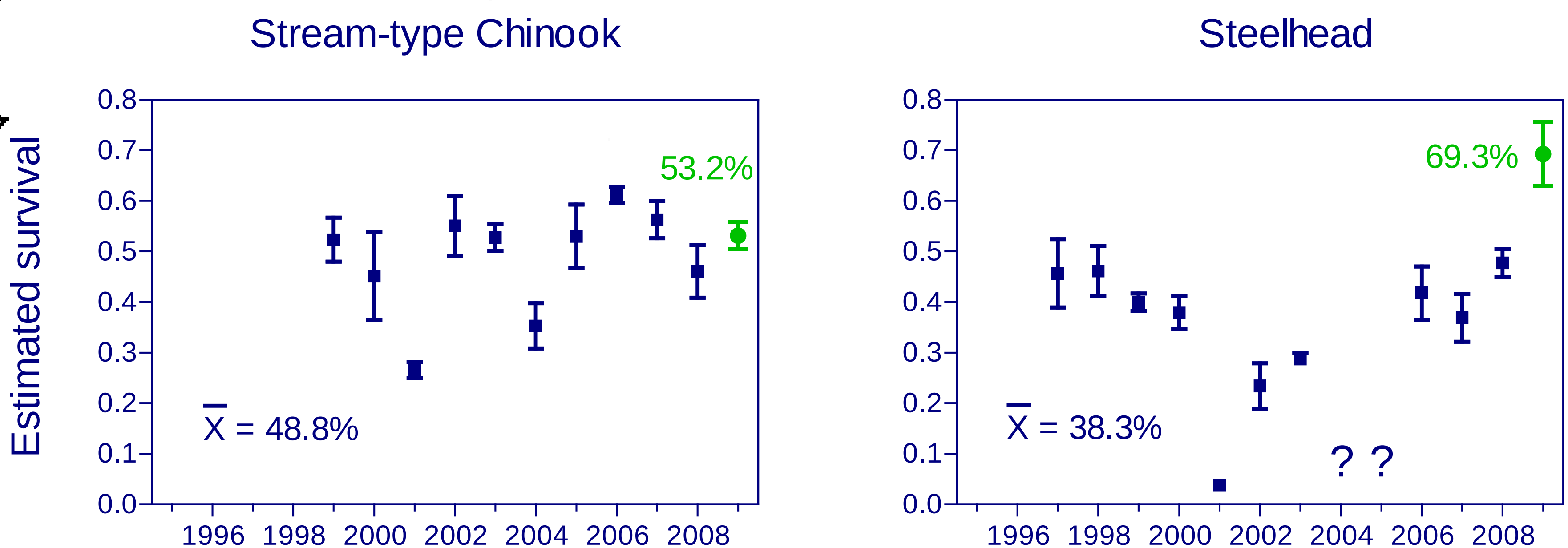


McNary to Bonneville

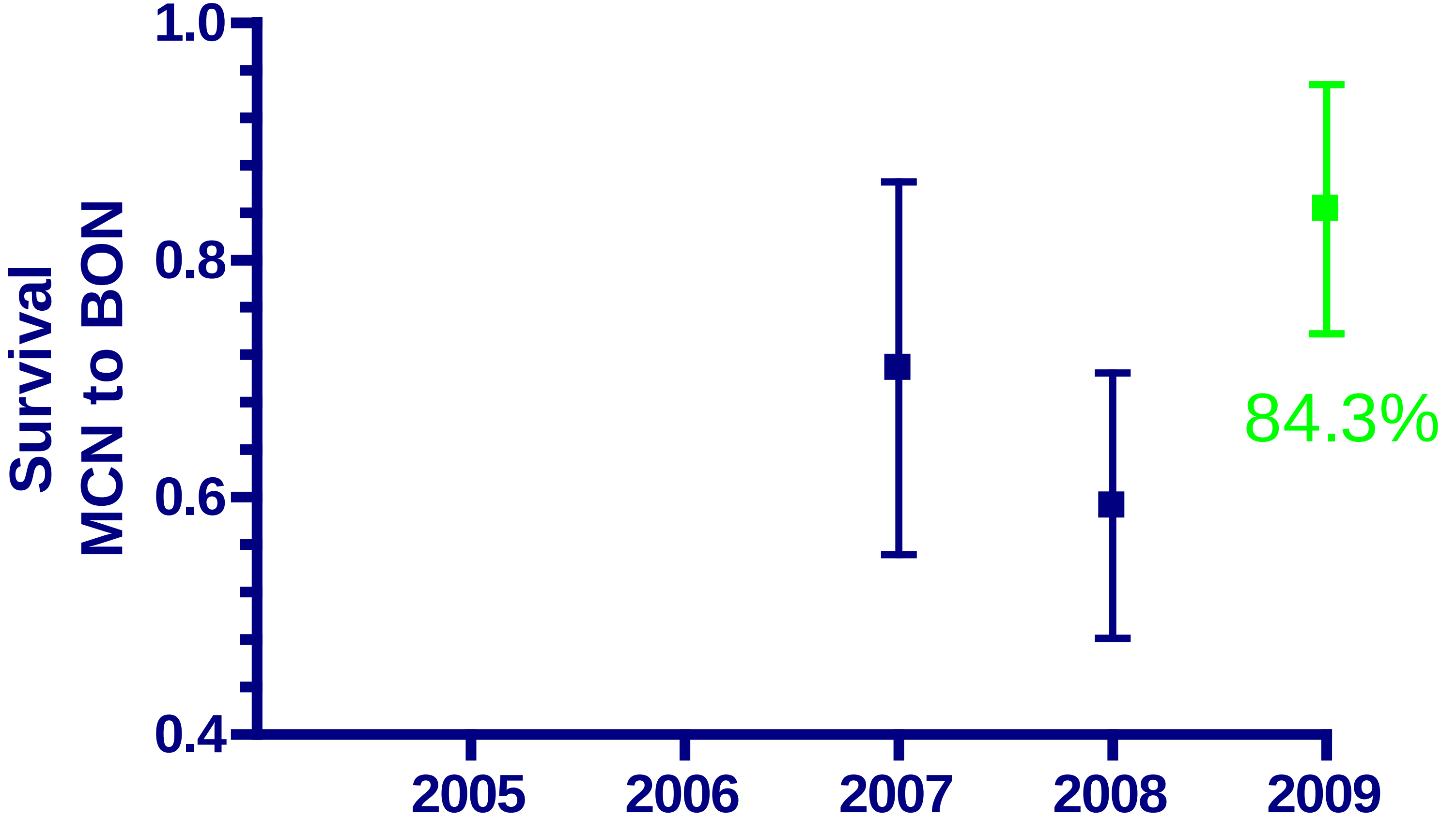




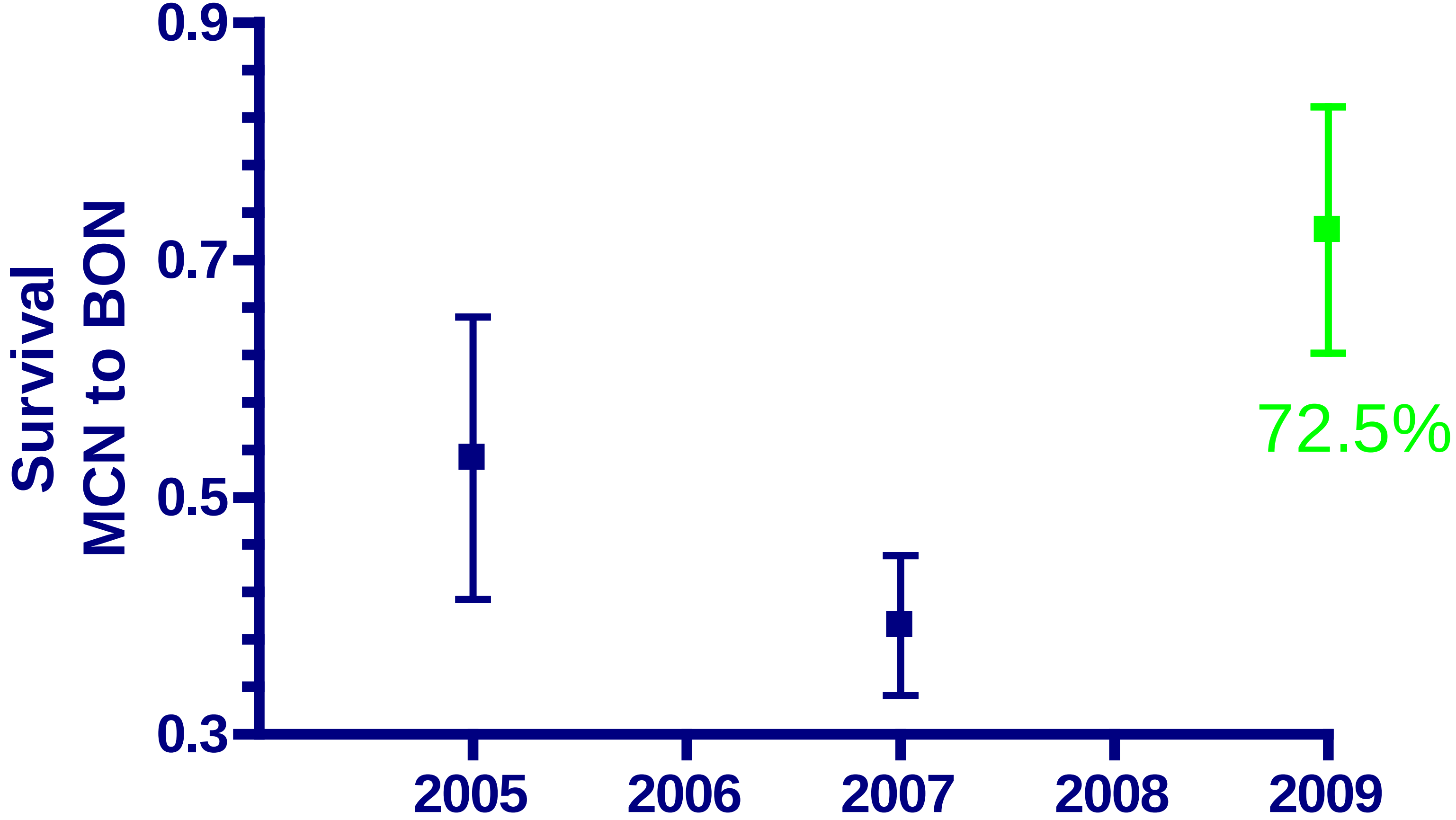
Snake River Trap to Bonneville

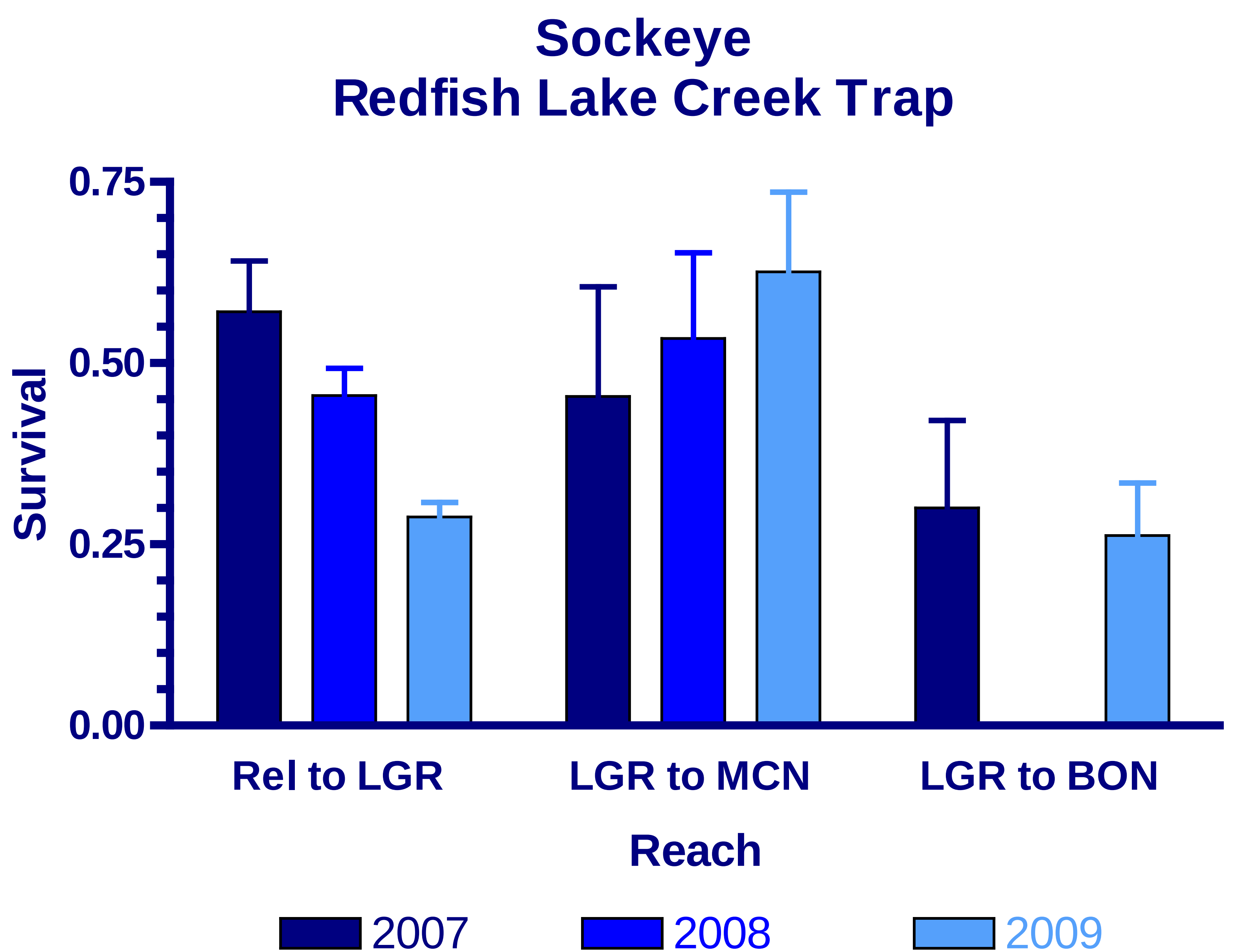


Yearling Chinook
Upper Columbia River Hatcheries

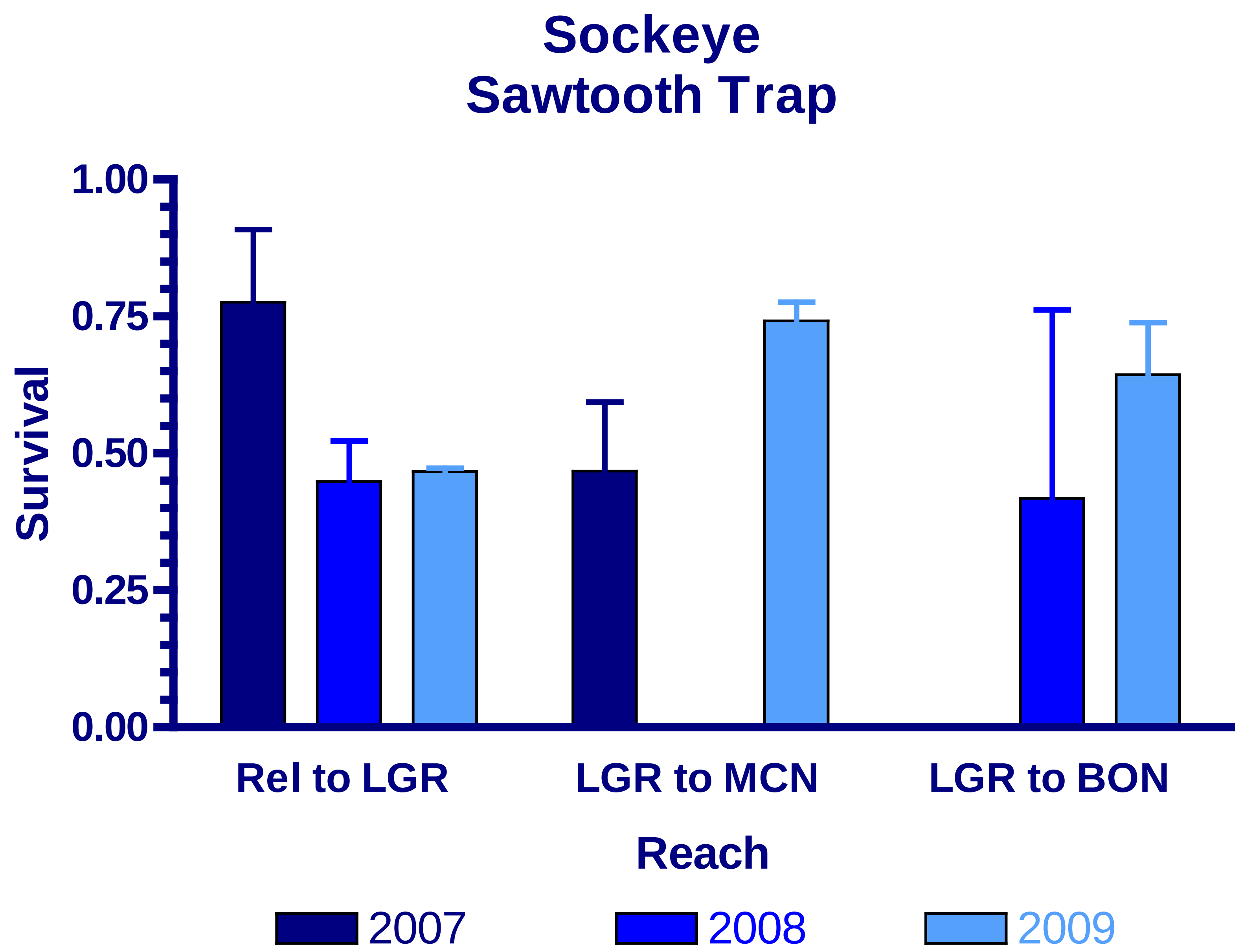


Steelhead
Upper Columbia River Hatcheries





Sockeye
Redfish Lake Creek Trap
Survival
0.75
0.50
0.25
0.00
Rel to LGR
LGR to MCN
LGR to BON
Reach
2007
2008
2009



Sockeye
Sawtooth Trap
Survival
1.00
0.75
0.50
0.25
0.00
Rel to LGR
LGR to MCN
LGR to BON
Reach
2007
2008
2009

Sockeye fall releases

- Alturus Lake, Pettit Lake, and Redfish Lake

Sockeye fall releases

- Alturus Lake, Pettit Lake, and Redfish Lake
- Survival to Lower Granite, 2009 – 10-37%

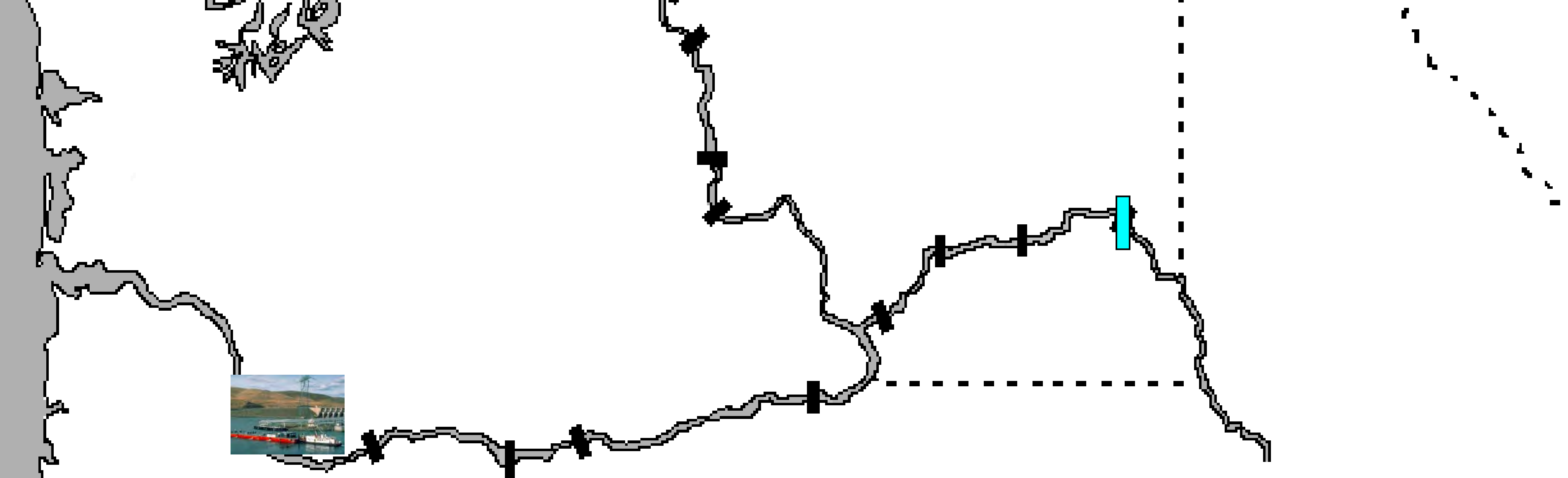
Sockeye fall releases

- Alturus Lake, Pettit Lake, and Redfish Lake
- Survival to Lower Granite, 2009 – 10-37%
- 2007 and 2008, – 12-28%

Spill, Transport, In-River Population Size, and Survival

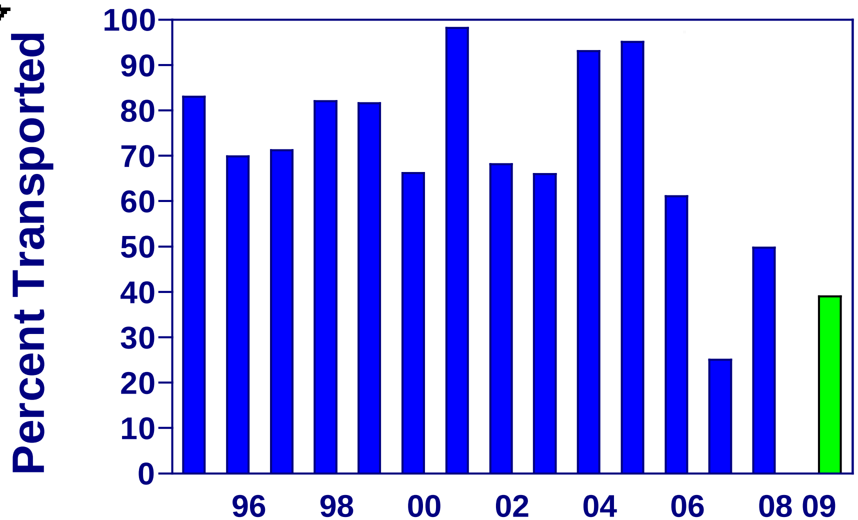
Preliminary estimates of transport % for 2009 based on PIT-tag data:

- 40% wild Chinook
- 38% hatchery Chinook
- 46% wild steelhead
- 43% hatchery steelhead

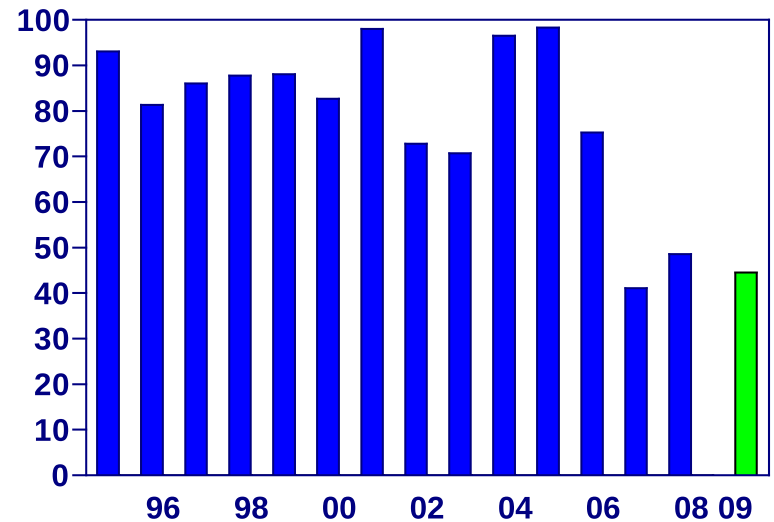


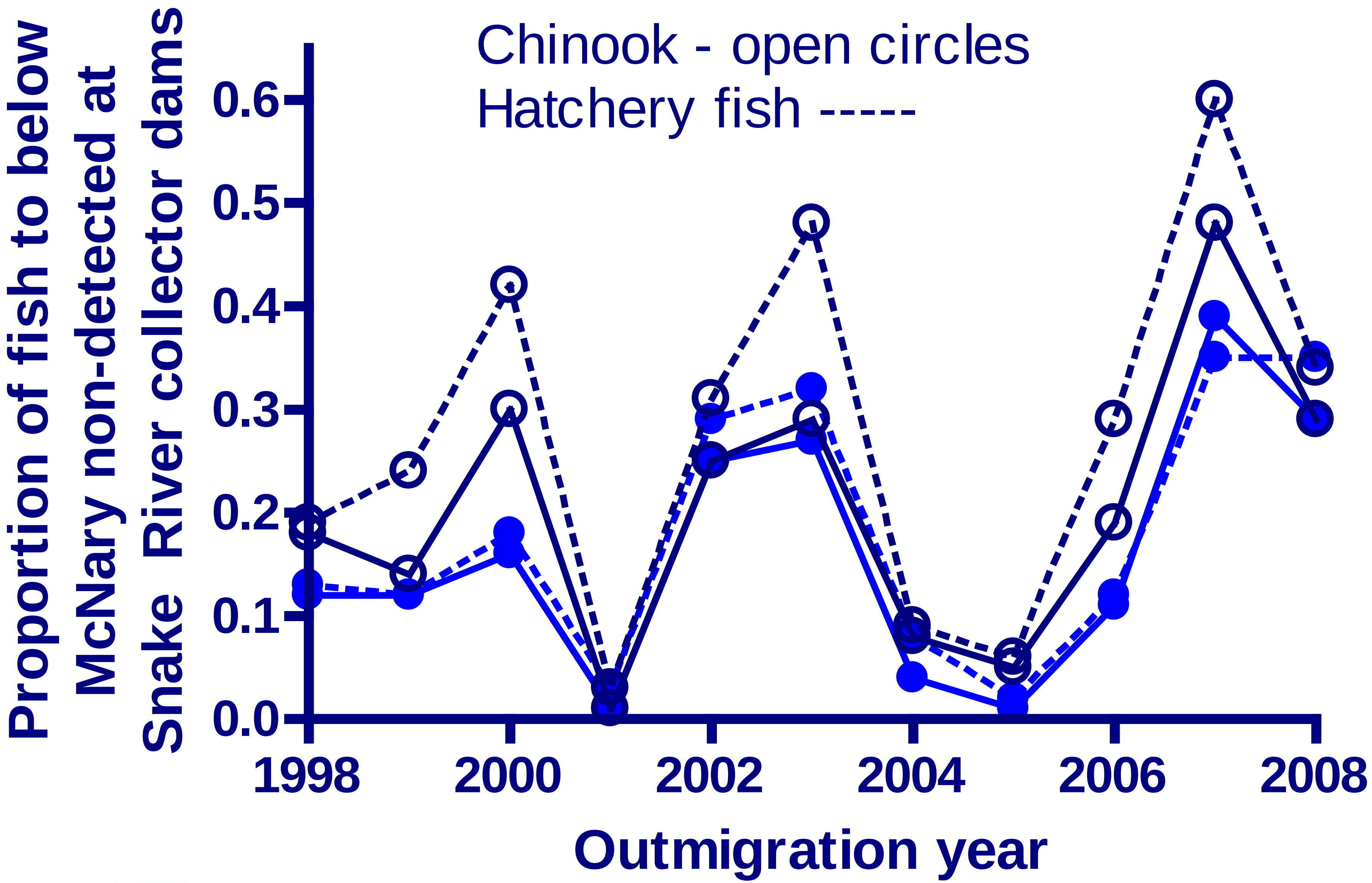
Percent Transported to Below Bonneville

Stream-type Chinook



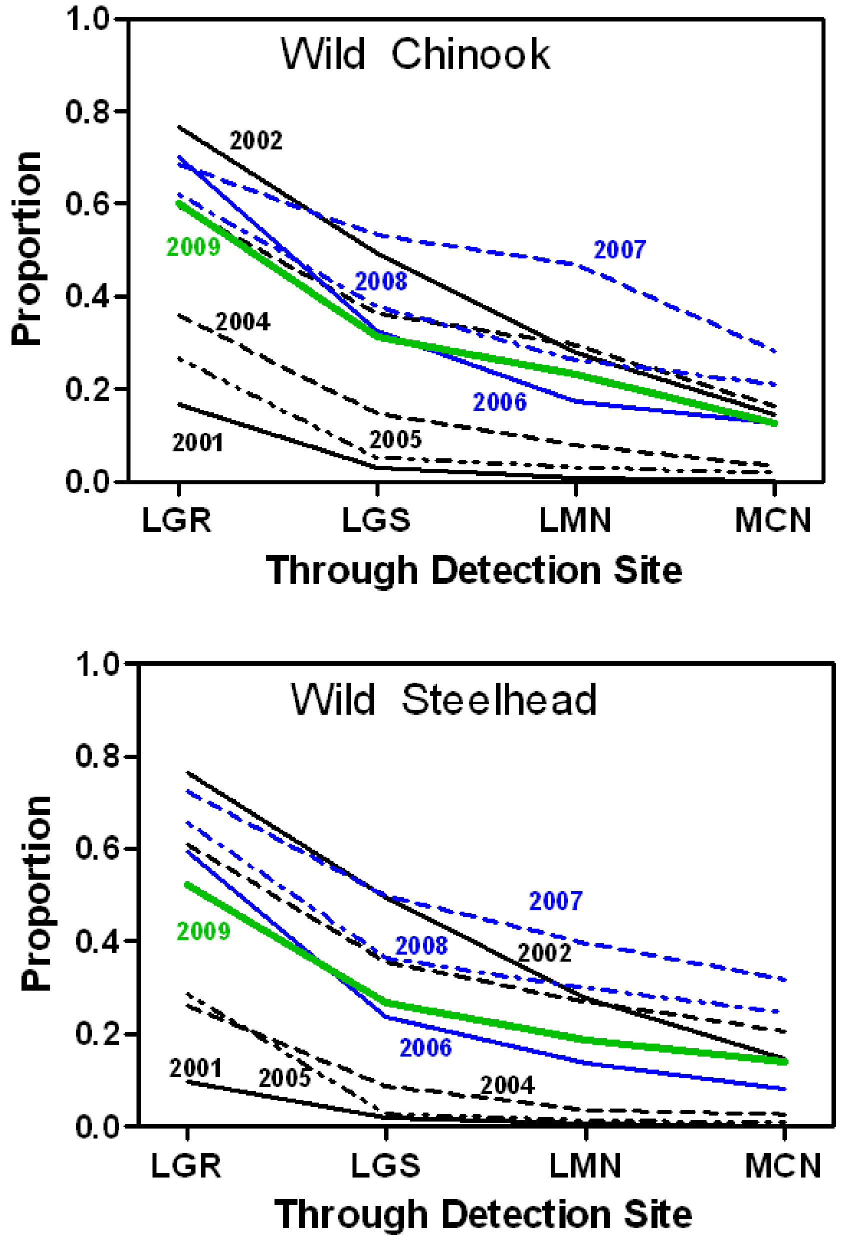
Steelhead



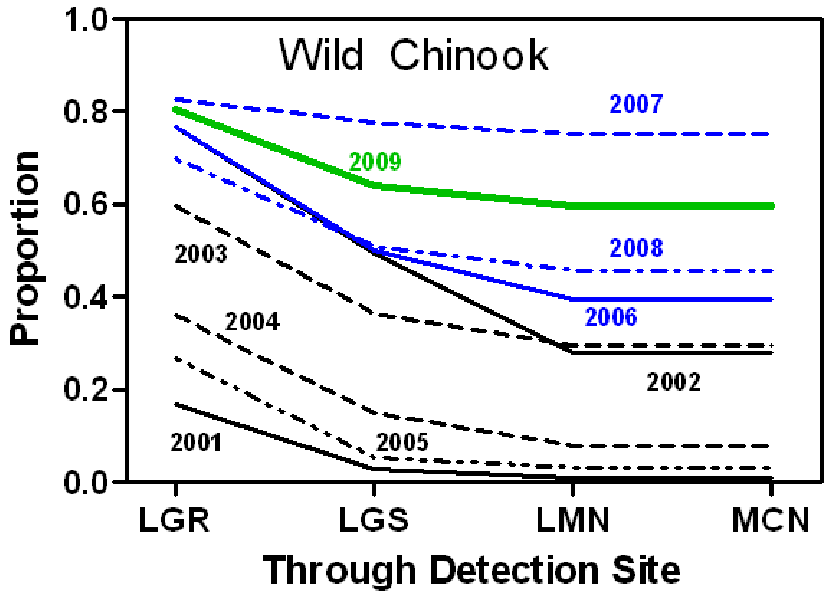


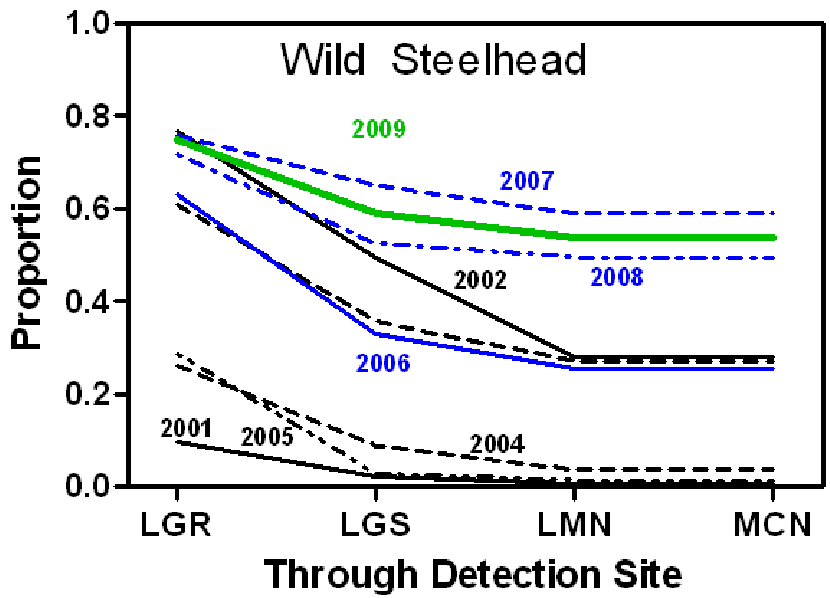
Chinook - open circles
Hatchery fish -----
Proportion of fish to below McNary non-detected at Snake River collector dams
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1998
2000
2002
2004
2006
2008
Outmigration year

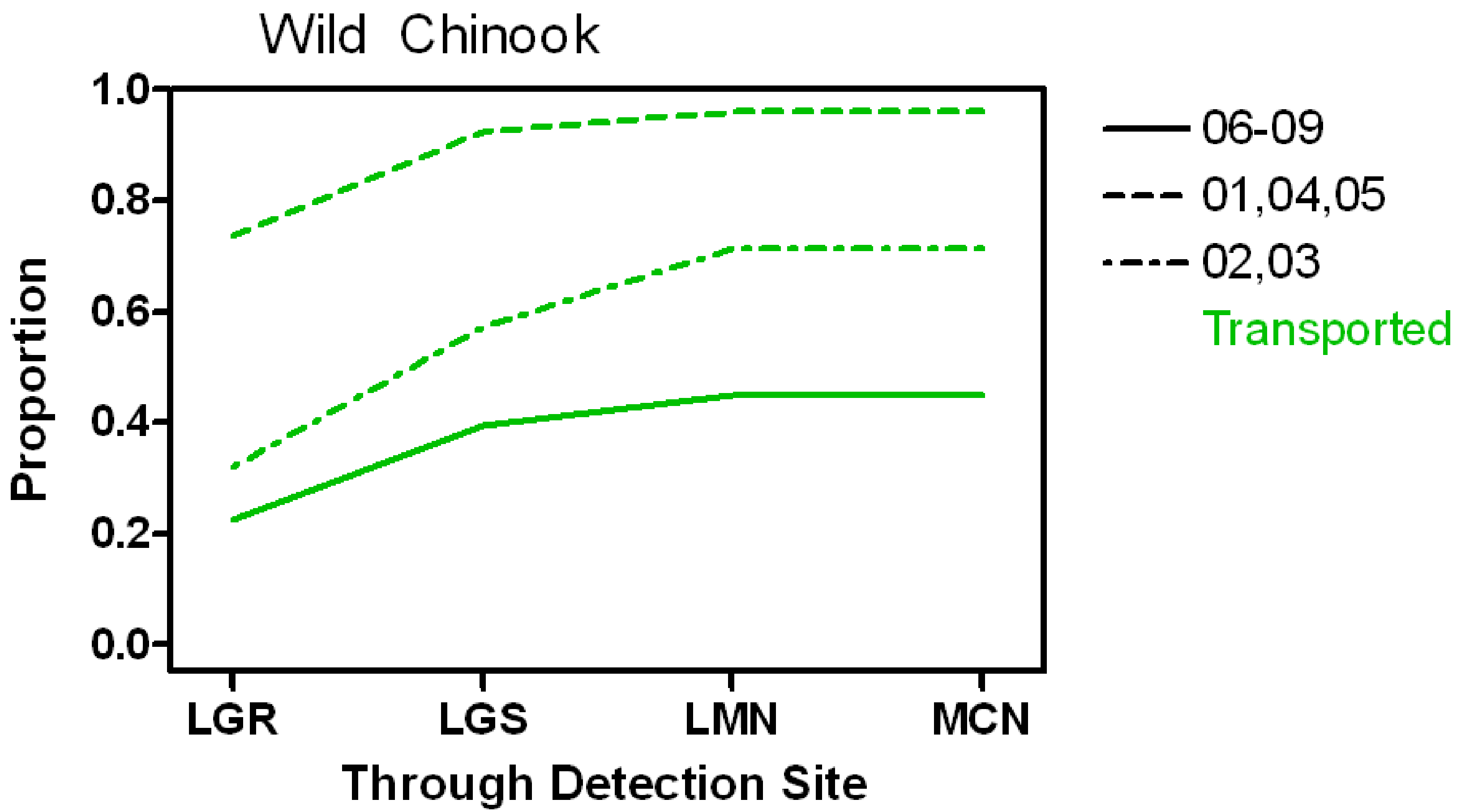
Proportion Not Detected

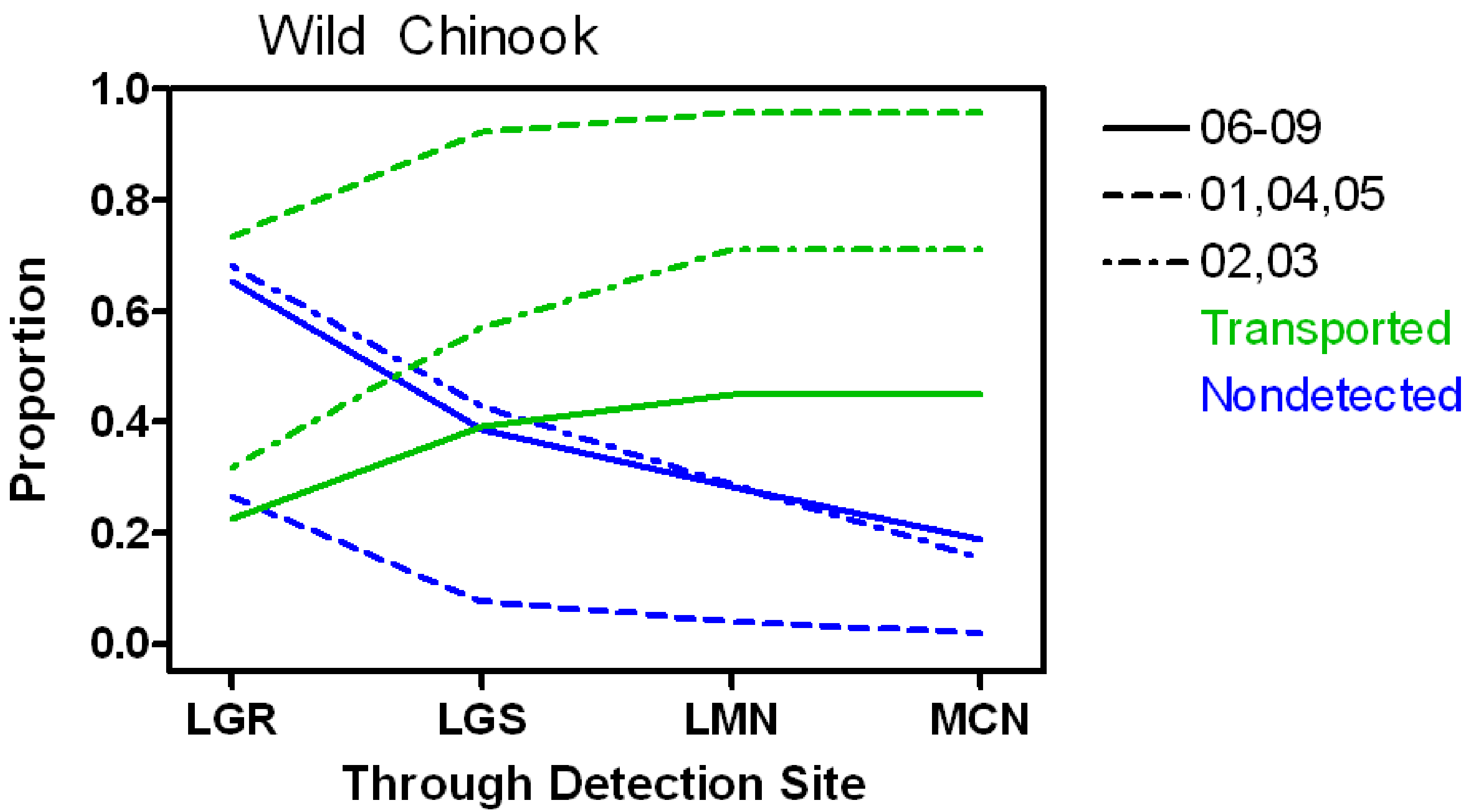


Proportion Not Transported

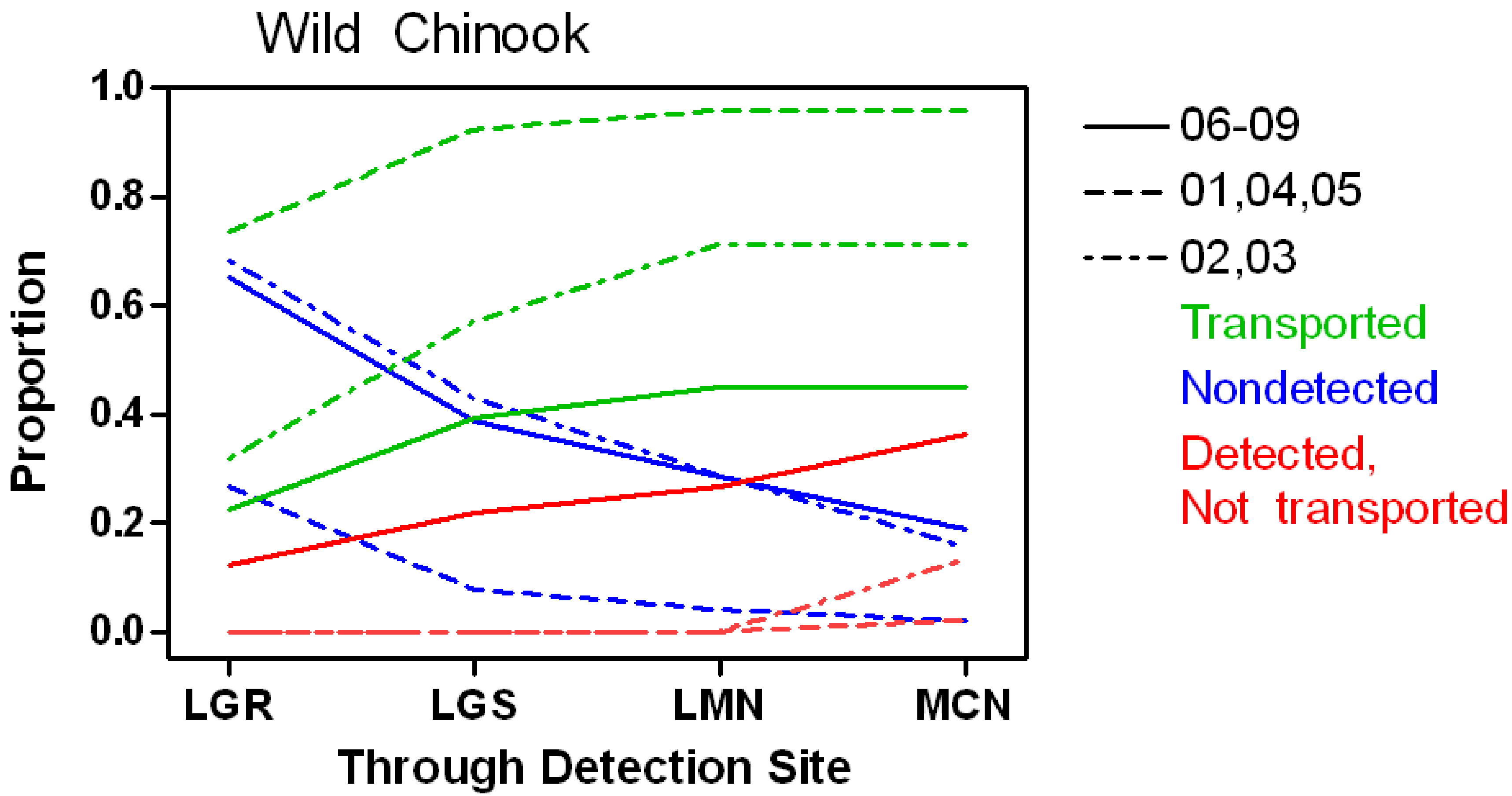





Wild Chinook
1.0
0.8
0.6
0.4
0.2
0.0
Proportion
LGR
LGS
LMN
MCN
Through Detection Site
06-09
01,04,05
02,03
Transported



Wild Chinook
1.0
0.8
0.6
0.4
0.2
0.0
Proportion
LGR
LGS
LMN
MCN
Through Detection Site
06-09
01,04,05
02,03
Transported
Nondetected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1.0
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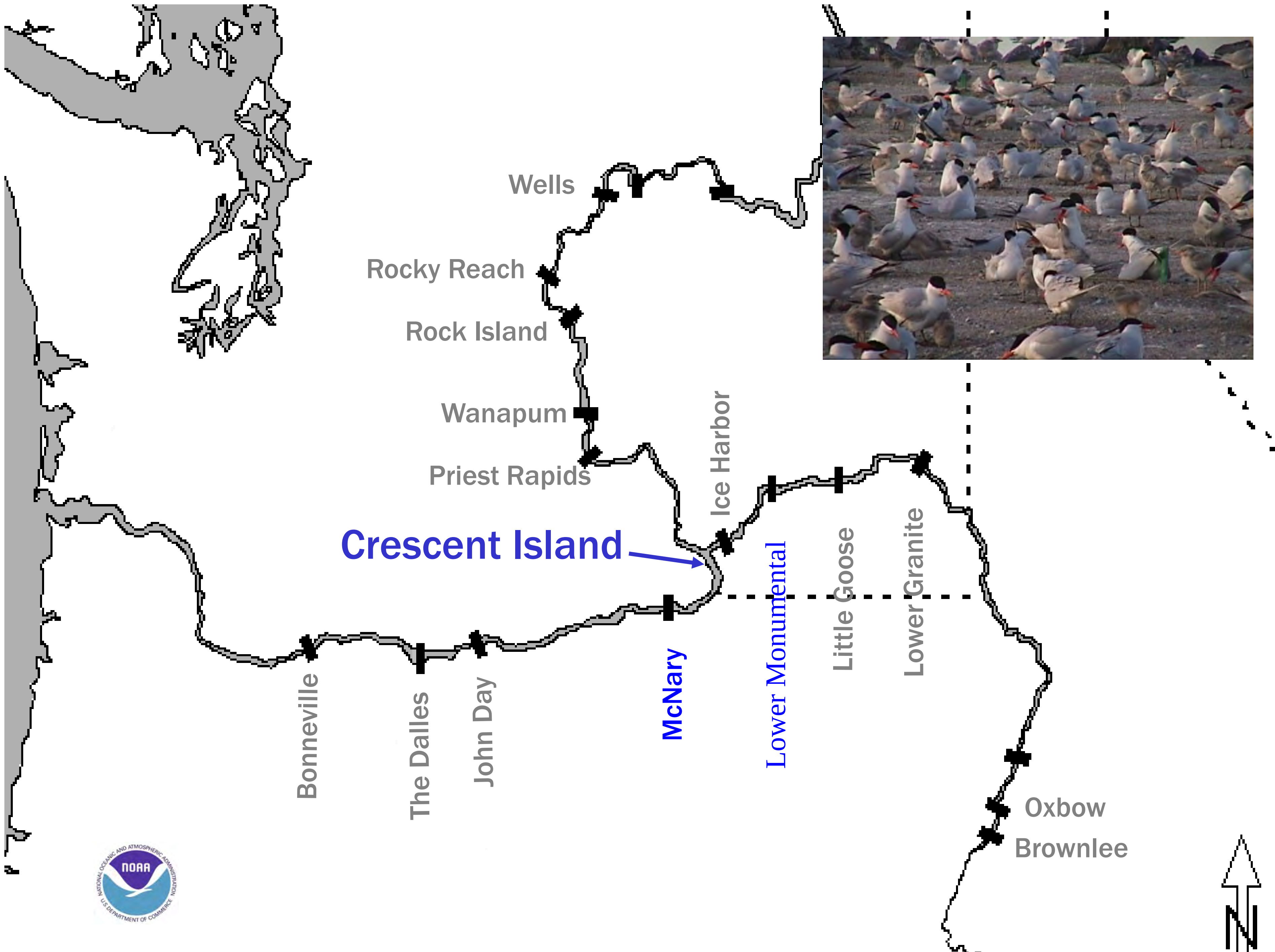
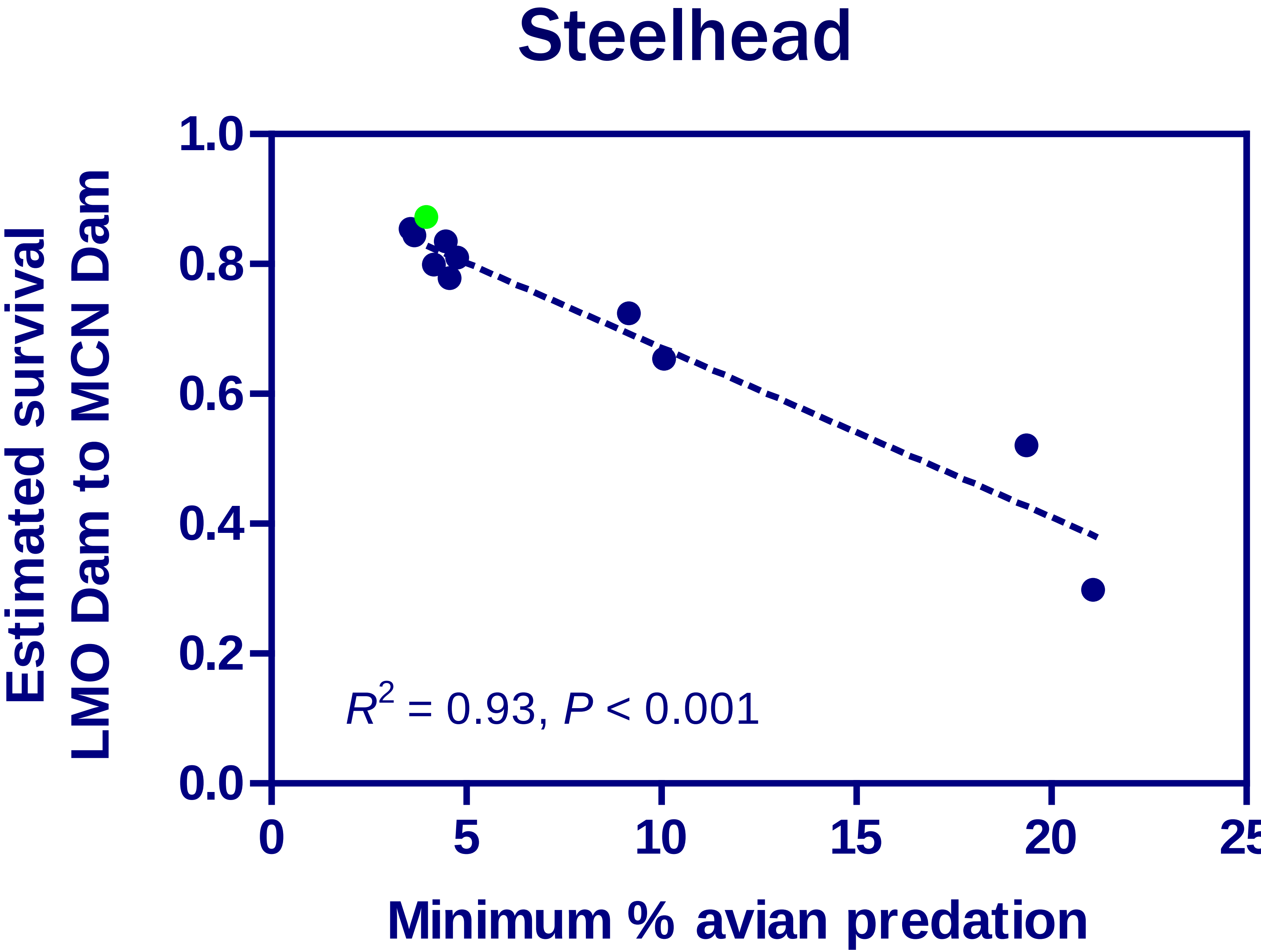
0.0
Proportion
LGR
LGS
LMN
MCN
Through Detection Site
06-09
01,04,05
02,03
Transported
Nondetected
Detected,
Not transported

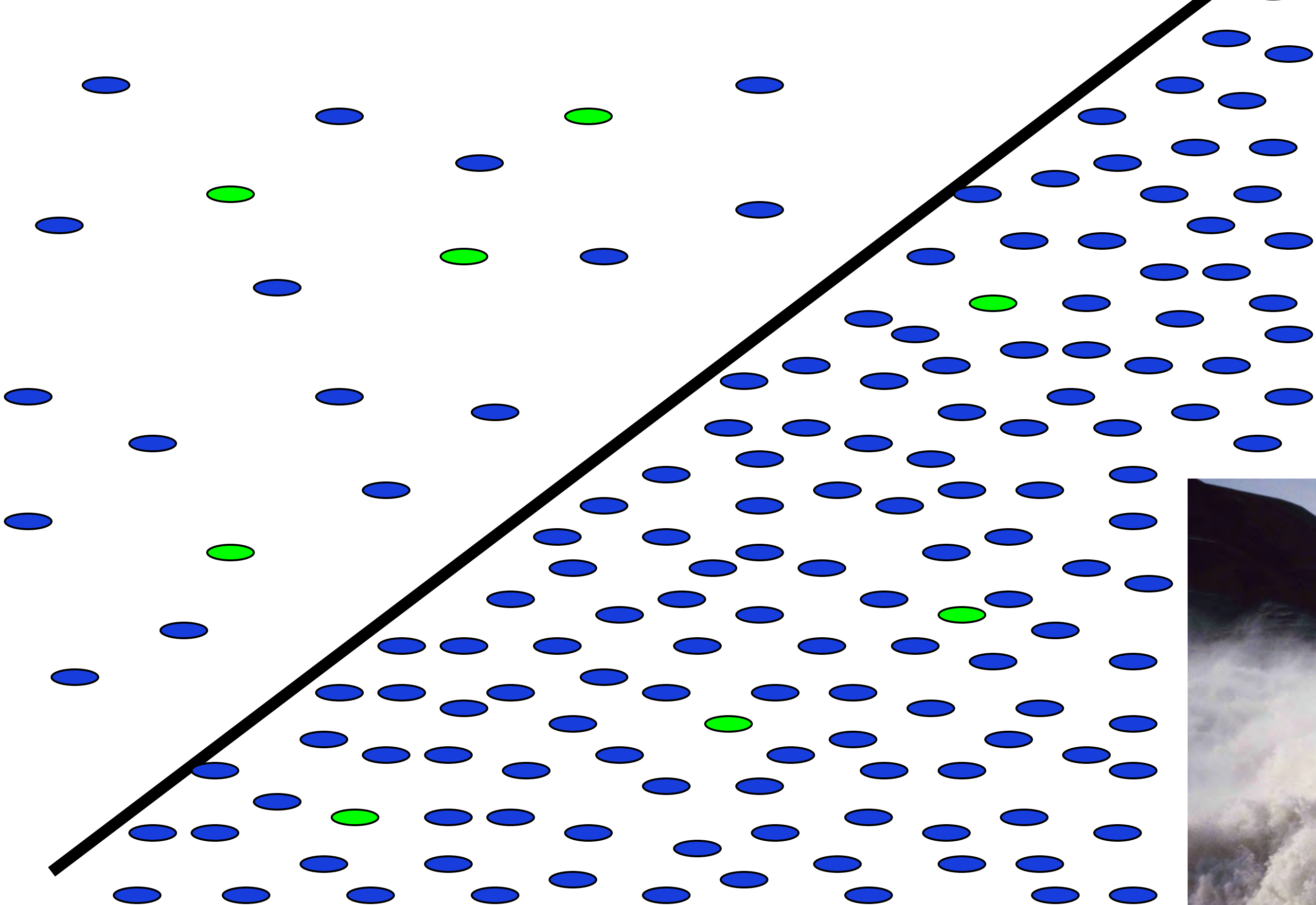

Wells
Rocky Reach
Rock Island
Wanapum
Priest Rapids
Crescent Island
Ice Harbor
Lower Monumental
Little Goose
Lower Granite
Bonneville
The Dalles
John Day
McNary
Oxbow
Brownlee
N
NOAA

Minimum Estimate of Mortality from Avian Predation

- Percentage of PIT-tagged steelhead detected at LMN eventually recovered on nesting colonies

1998	4%	2004	19%
1999	5%	2005	9%
2000	4%	2006	5%
2001	21%	2007	4%
2002	10%	2008	5%
2003	4%	2009	4%


Steelhead
Estimated survival
LMO Dam to MCN Dam
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
Minimum % avian predation
R2 = 0.93, P < 0.001


Maximum transport
Transport with spill

Conclusions

- In low-spill (high transport) years, lower survival results, in part, simply from fewer fish in the river

Conclusions

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  - In-river survival would have been higher if non-tagged bypass fish had been returned to the river

Conclusions

- In low-spill (high transport) years, lower survival results, in part, simply from fewer fish in the river
  - In-river survival would have been higher if non-tagged bypass fish had been returned to the river
- Converse is also true: in-river survival increases with increasing spill through indirect effect of reducing individual vulnerability to predation

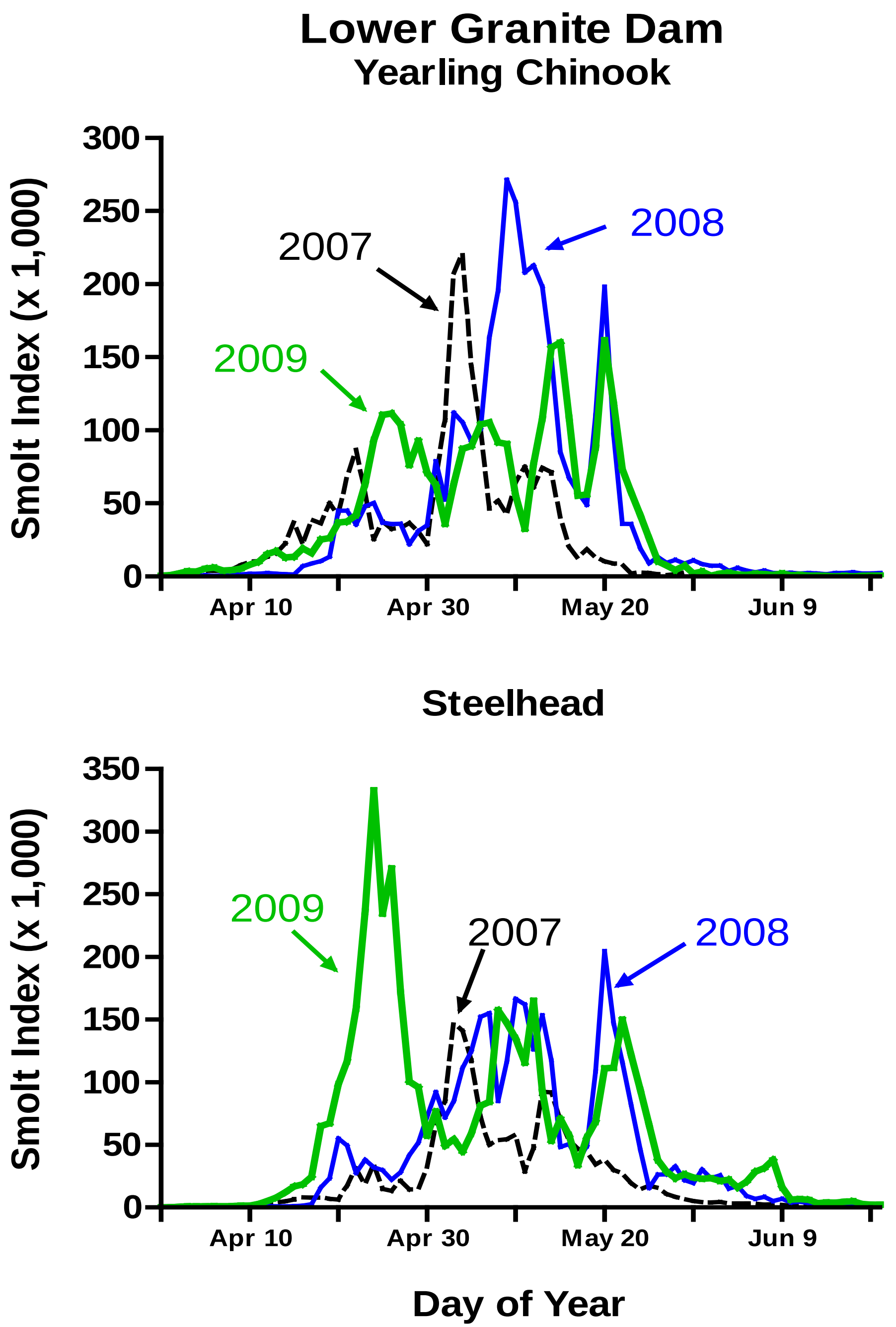
Conclusions

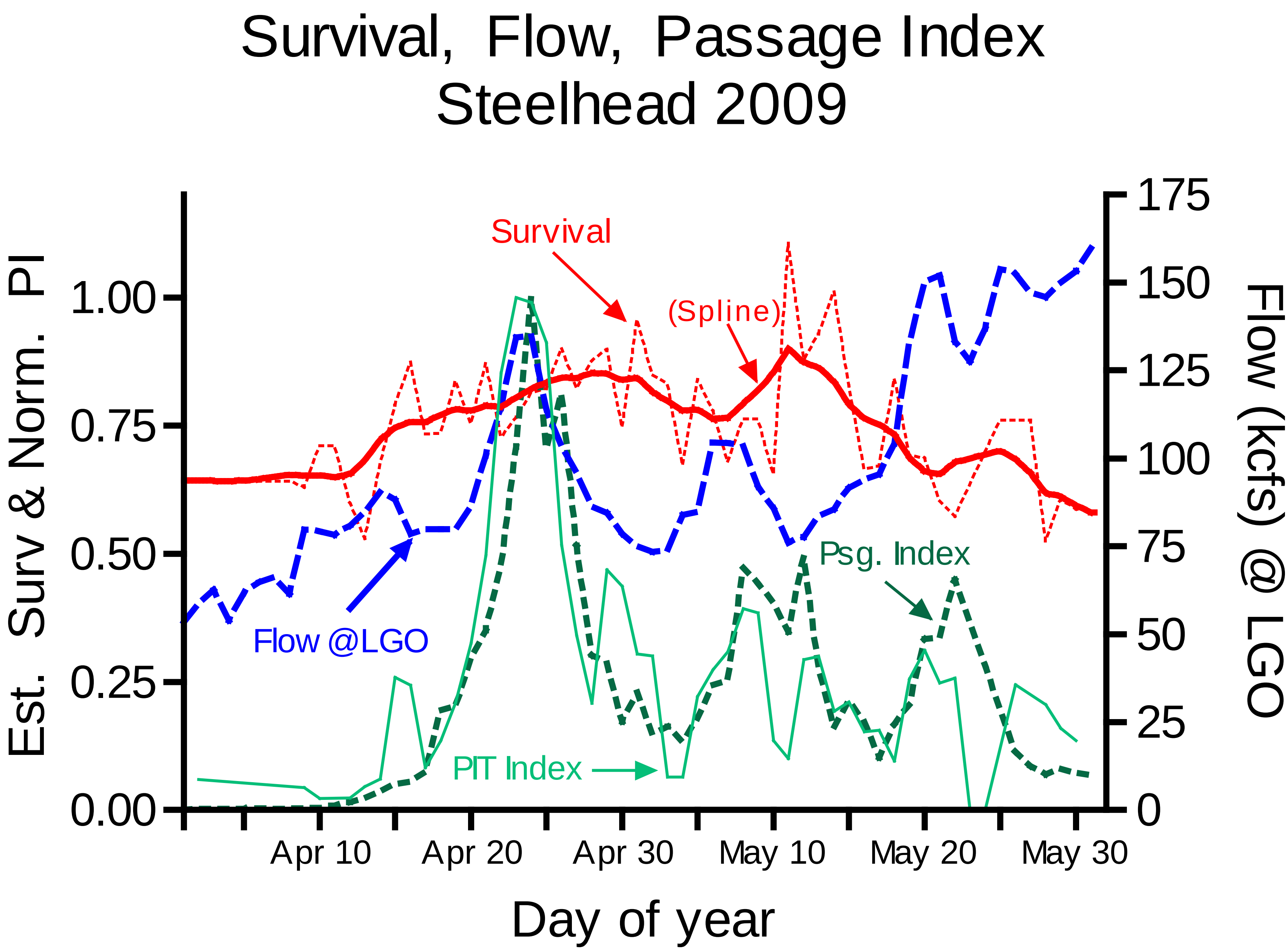
- Direct or indirect effects of increased spill may not improve smolt-to-adult survival for the population

Conclusions

- Direct or indirect effects of increased spill may not improve smolt-to-adult survival for the population
  - Cumulative effect must offset effect of transporting fewer steelhead

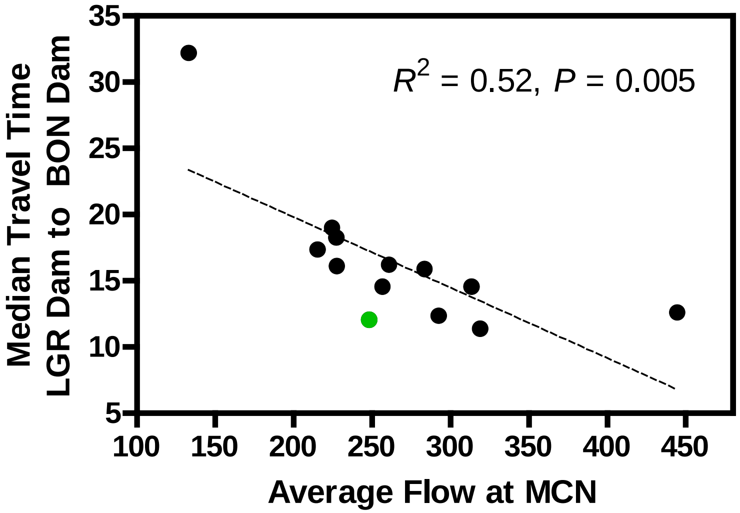
So why was steelhead survival so high in 2009?


Lower Granite Dam
Yearling Chinook
Smolt Index (x 1,000)
300
250
200
150
100
50
0
2007
2008
2009
Apr 10
Apr 30
May 20
Jun 9
Steelhead
Smolt Index (x 1,000)
350
300
250
200
150
100
50
0
2009
2007
2008
Apr 10
Apr 30
May 20
Jun 9
Day of Year

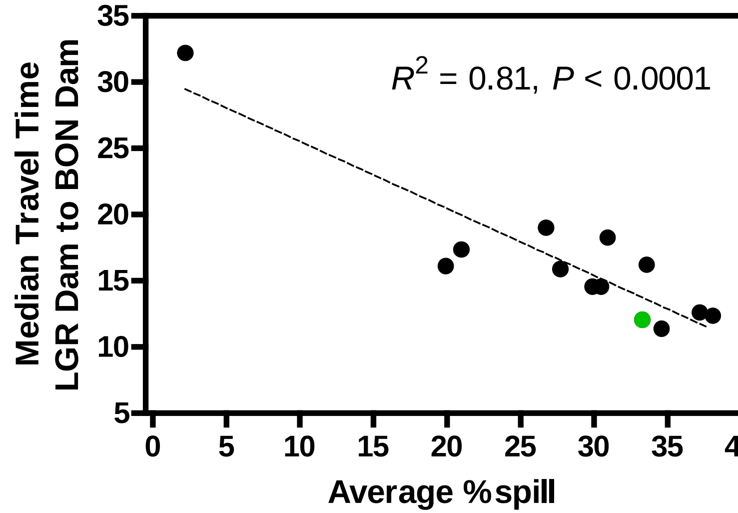

Survival, Flow, Passage Index
Steelhead 2009
Survival
(Spline)
Psg. Index
Flow @LGO
PIT Index
Est. Surv & Norm. PI
Flow (kcfs) @ LGO
Day of year
1.00
0.75
0.50
0.25
0.00
175
150
125
100
75
50
25
0
Apr 10
Apr 20
Apr 30
May 10
May 20
May 30

Steelhead Travel Time LGR to BON

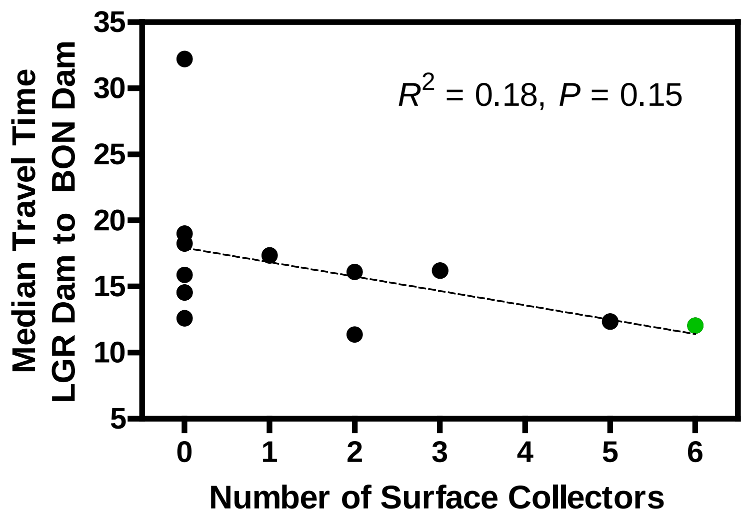
Travel Time vs. Flow



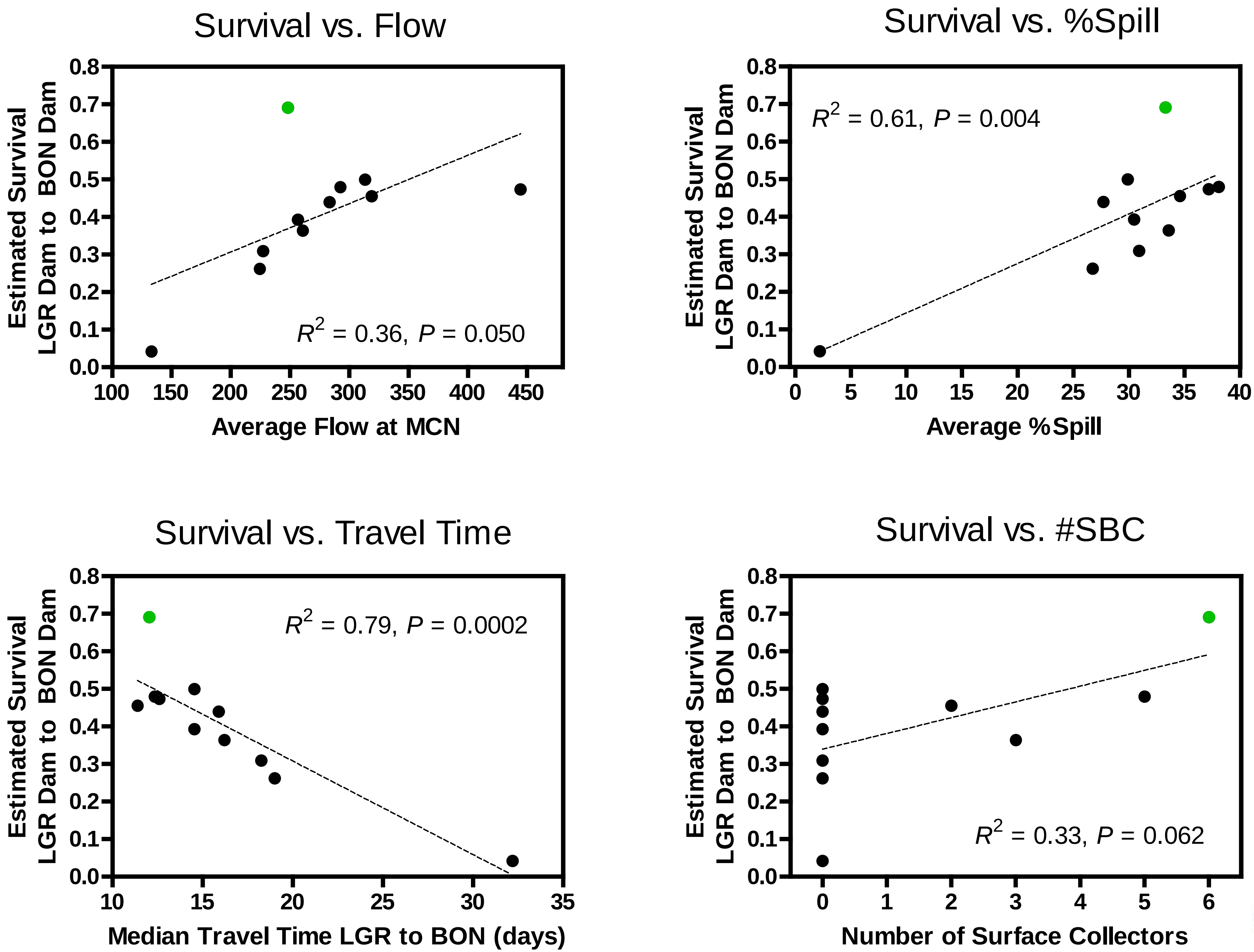
Travel Time vs. %Spill



Travel Time vs. #SBC



Steelhead Survival LGR to BON



Effect of Number of Dams with Surface Collectors on Migration Rate

<u>Steelhead</u>

After accounting for day of release, flow, and spill percentage in a multiple regression model, each additional surface collector was associated with an increase in median migration rate from Lower Granite to Bonneville of 1.8 km/day ($P < 0.0001$).

Effect of Number of Dams with Surface Collectors on Migration Rate

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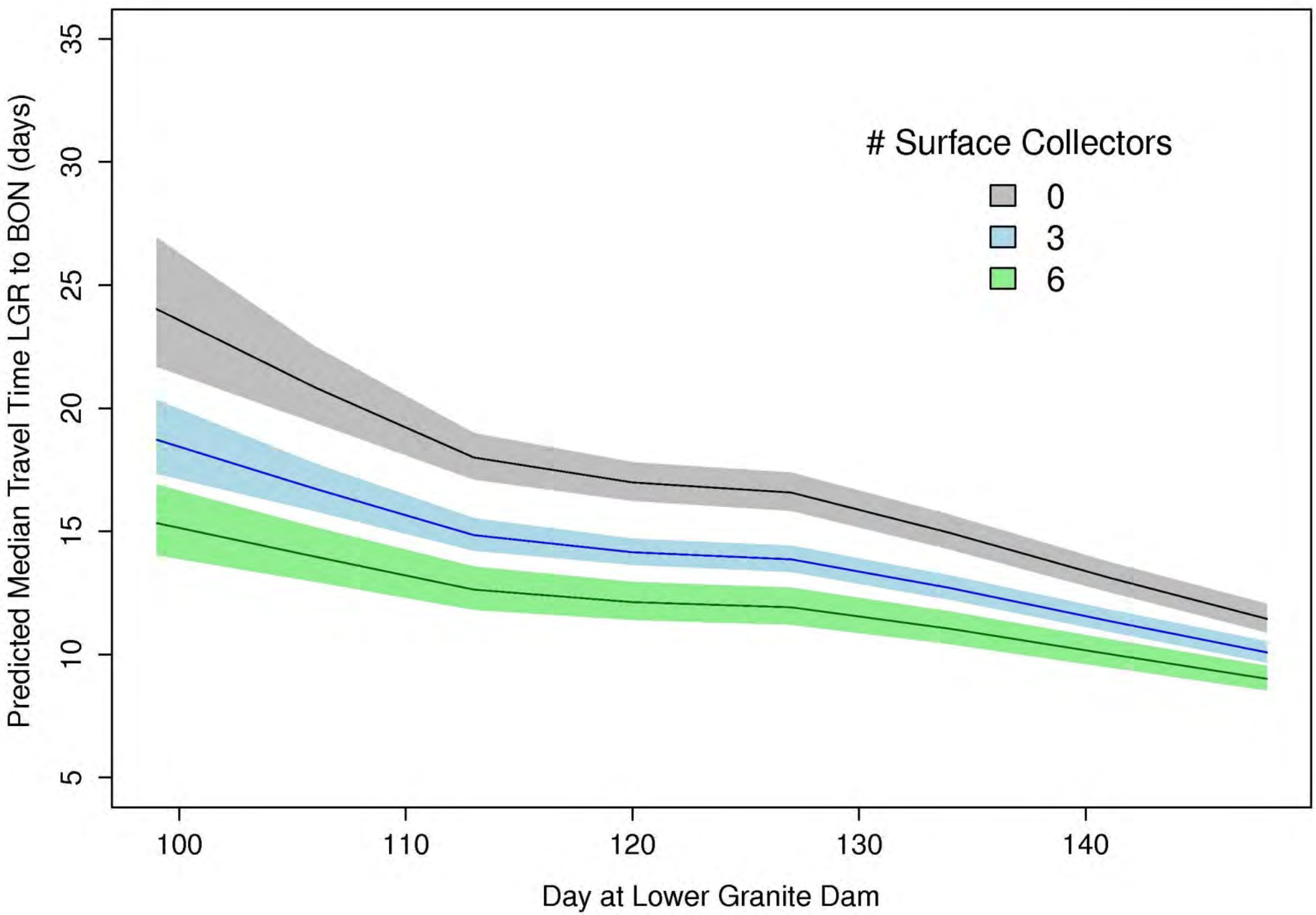
After accounting for day of release, flow, and spill percentage in a multiple regression model, each additional surface collector was associated with an increase in median migration rate from Lower Granite to Bonneville of 1.8 km/day ($P < 0.0001$).

Stream-type Chinook

There was no evidence for an effect of number of surface collectors on migration rate for stream-type Chinook after accounting for these factors ($P = 0.38$)

Steelhead Predicted Median Travel Time by Number of Dams with Surface Collectors



Effect of Number of Dams with Surface Collectors on Survival

Steelhead

After accounting for temperature, flow, %spill, and %bird predation in a multiple regression model, each additional surface collector was associated with an increase in estimated mean survival from Lower Granite to McNary of 1.85% (*P* = 0.0125).

Effect of Number of Dams with Surface Collectors on Survival

Steelhead

After accounting for temperature, flow, %spill, and %bird predation in a multiple regression model, each additional surface collector was associated with an increase in estimated mean survival from Lower Granite to McNary of 1.85% (*P* = 0.0125).

Stream-type Chinook

For Chinook, each additional surface collector was associated with an increase in estimated mean survival from Lower Granite to McNary of 1.01% (*P* = 0.0013).

Conclusions

- Juvenile steelhead survival was the highest yet measured

Conclusions

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- Contributing factors include relatively high flow and spill rates, cool water temperatures, early migration, increased number of surface passage structures, and more fish left inriver

Conclusions

- Juvenile steelhead survival was the highest yet measured
- Contributing factors include relatively high flow and spill rates, cool water temperatures, early migration, and an increased number of surface passage structures
- Reduced steelhead residualization?


Questions

RECLAMATION
Managing Water in the West

Upper Snake Flow Augmentation 2009

U.S. Department of the Interior
Bureau of Reclamation

SOURCE	AMOUNT (acre-feet)	DATES OF DELIVERY
Upper Snake above Milner Dam		
Reclamation Uncontracted Space	19,758	July 5 – July 31
Reclamation Powerhead Space	0	
Rentals – Water District 01	180,000	
Rentals – Tribes	0	
Subtotal	*199,758*	
Payette		
Reclamation Space	95,000	June 24 – August 28
Rentals	71,402	
Subtotal	*166,402*	
Boise		
Reclamation Uncontracted Space	41,343	June 19- July 13
Reclamation Powerhead Space	0	
Rentals	1,848	
Subtotal	*43,191*	
Natural Flows		
IWRB Lease (Idaho)	60,000	April 3 – August 31
Skyline Farms (Oregon)	17,649	
Subtotal	*77,649*	
TOTAL	**487,000**	

RECLAMATION

Winter 2009-2010 Climate Forecast

Kyle Dittmer

Hydrologist-Meteorologist

December 11th, 2009

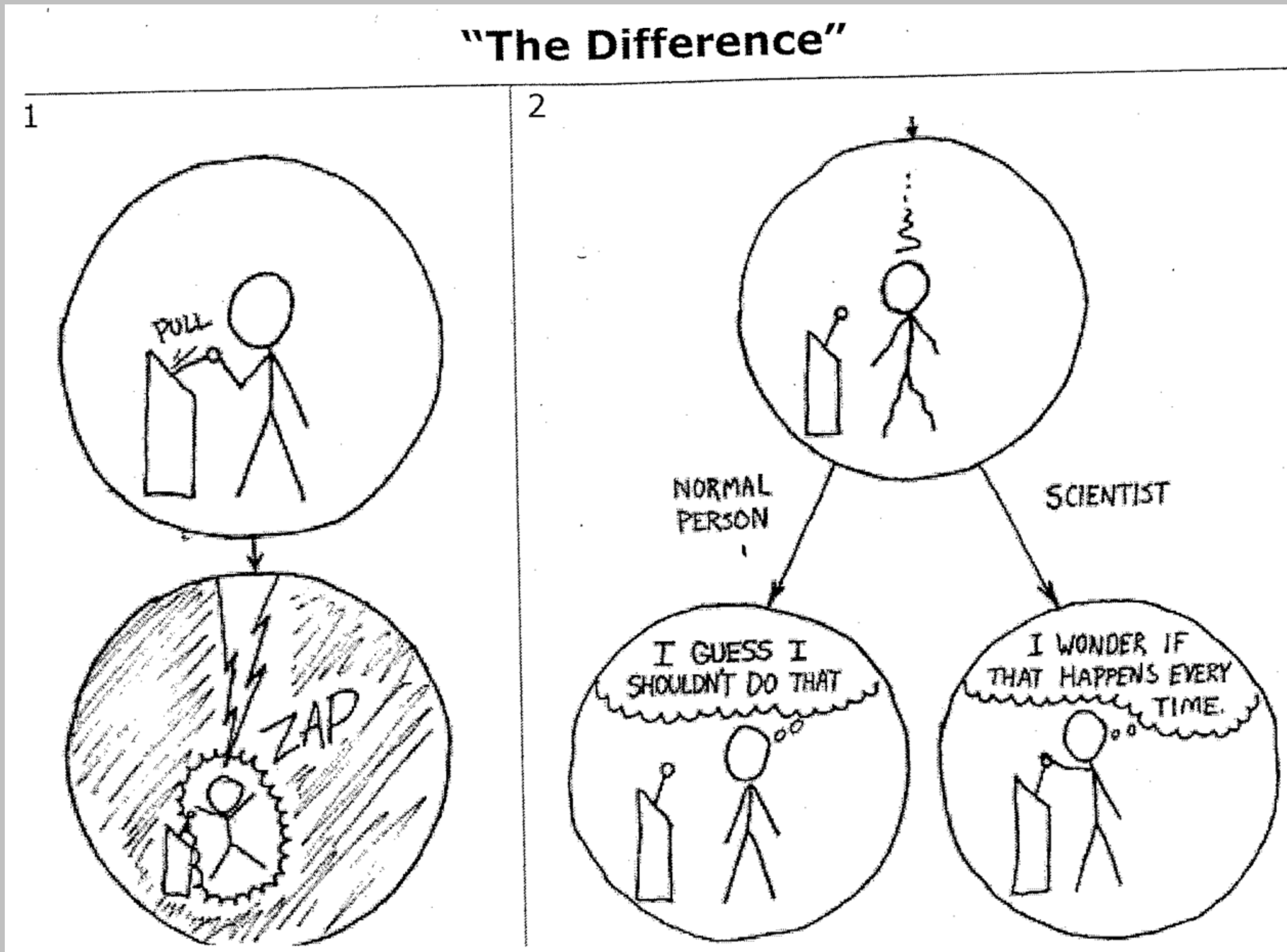
TMT End-of-Year Review Meeting

Columbia River Inter-Tribal Fish Commission
Portland, Oregon

Famous NWS quote:

"I KNOW WHAT THE COMPUTER MODEL SAYS…BUT WHAT'S ***REALLY*** GOING TO HAPPEN?" ☺

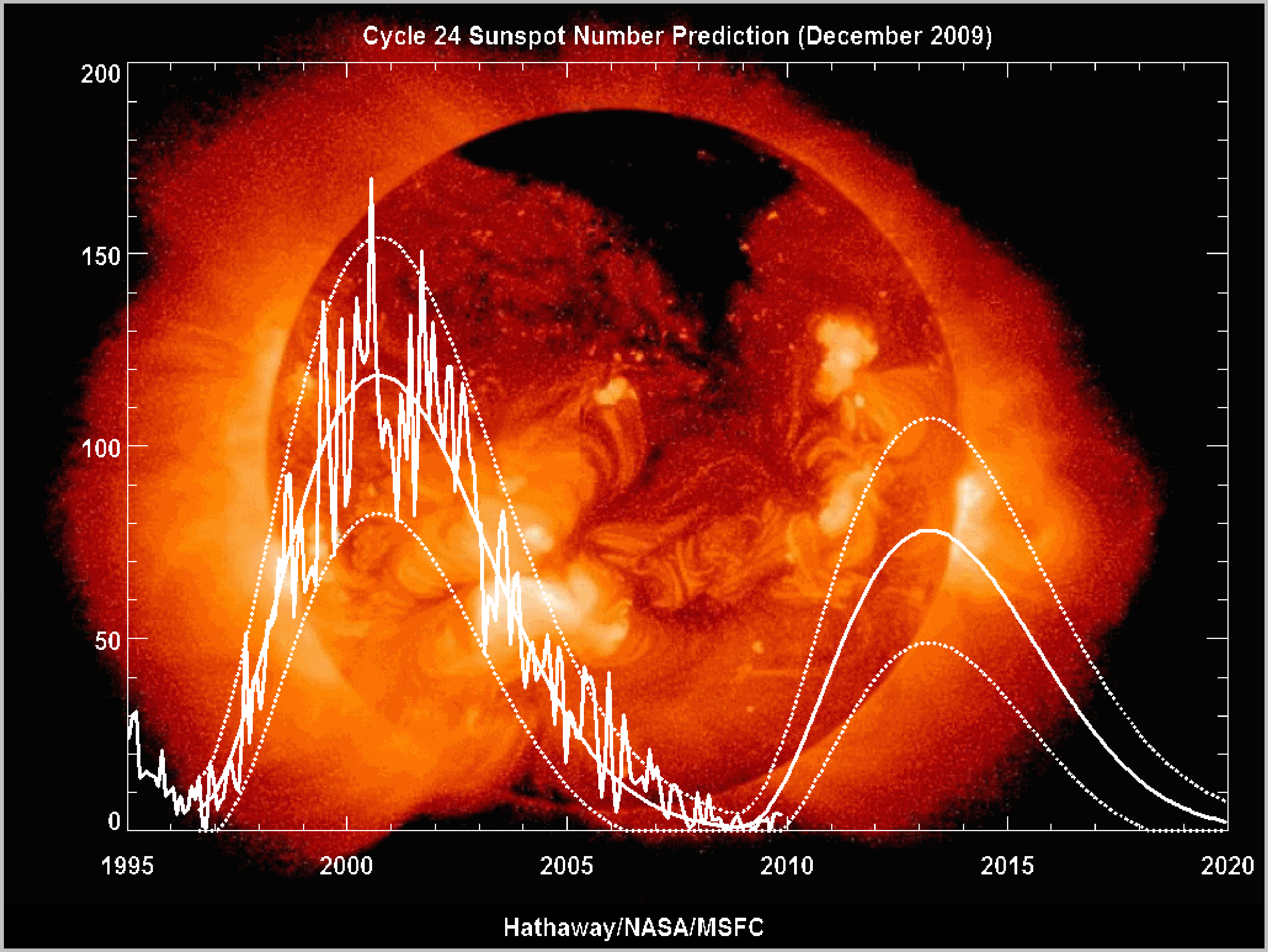
The Scientific Method



Introduction – Methods

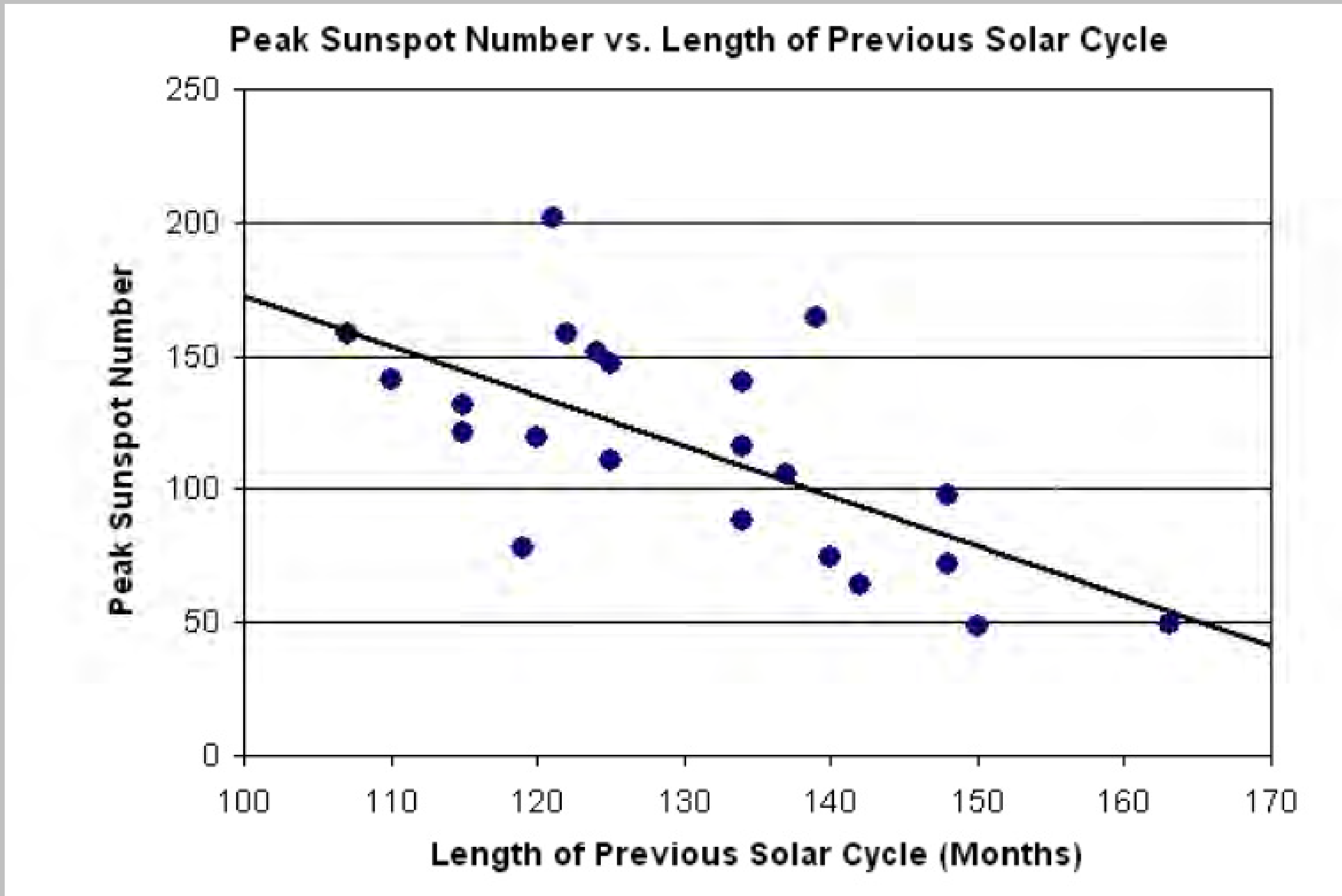
- Forecast uses a holistic, integrated big picture view.
- Big-picture: **Solar Forcing** (e.g., sunspot cycles) does influence our global weather patterns.
  In memoriam: Dr. Landscheidt, 1922 – 2004.
- Track ENSO with the Multi-variable ENSO Index.
- Sea-Surface Temperature Departure Forecasts.
- Hydro-Climate approach: Water year 2010 volume forecast uses regressed Multi-variable ENSO Index vs. historic runoff for the Columbia at The Dalles and the average of 20 surrogate water years.

SUNSPOT COUNTS SUGGEST "LA NINA" WINTER WEATHER



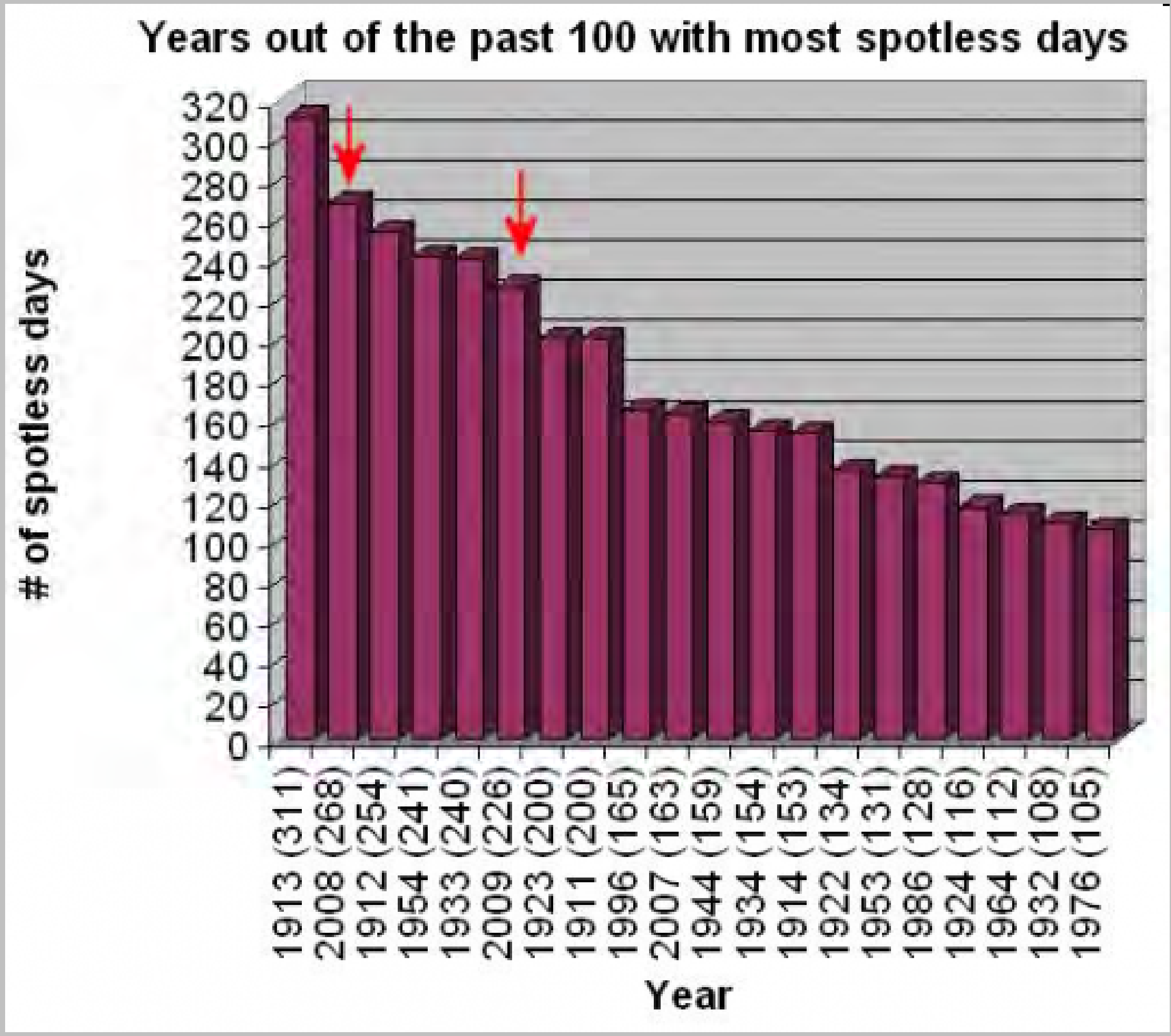
http://solarscience.msfc.nasa.gov/images/ssn_predict_l.gif

SUNSPOT COUNTS SUGGEST “LA NINA” WINTER WEATHER



http://ncwatch.typepad.com/dalton_minimum_returns

SUNSPOT COUNTS SUGGEST "LA NINA" WINTER WEATHER



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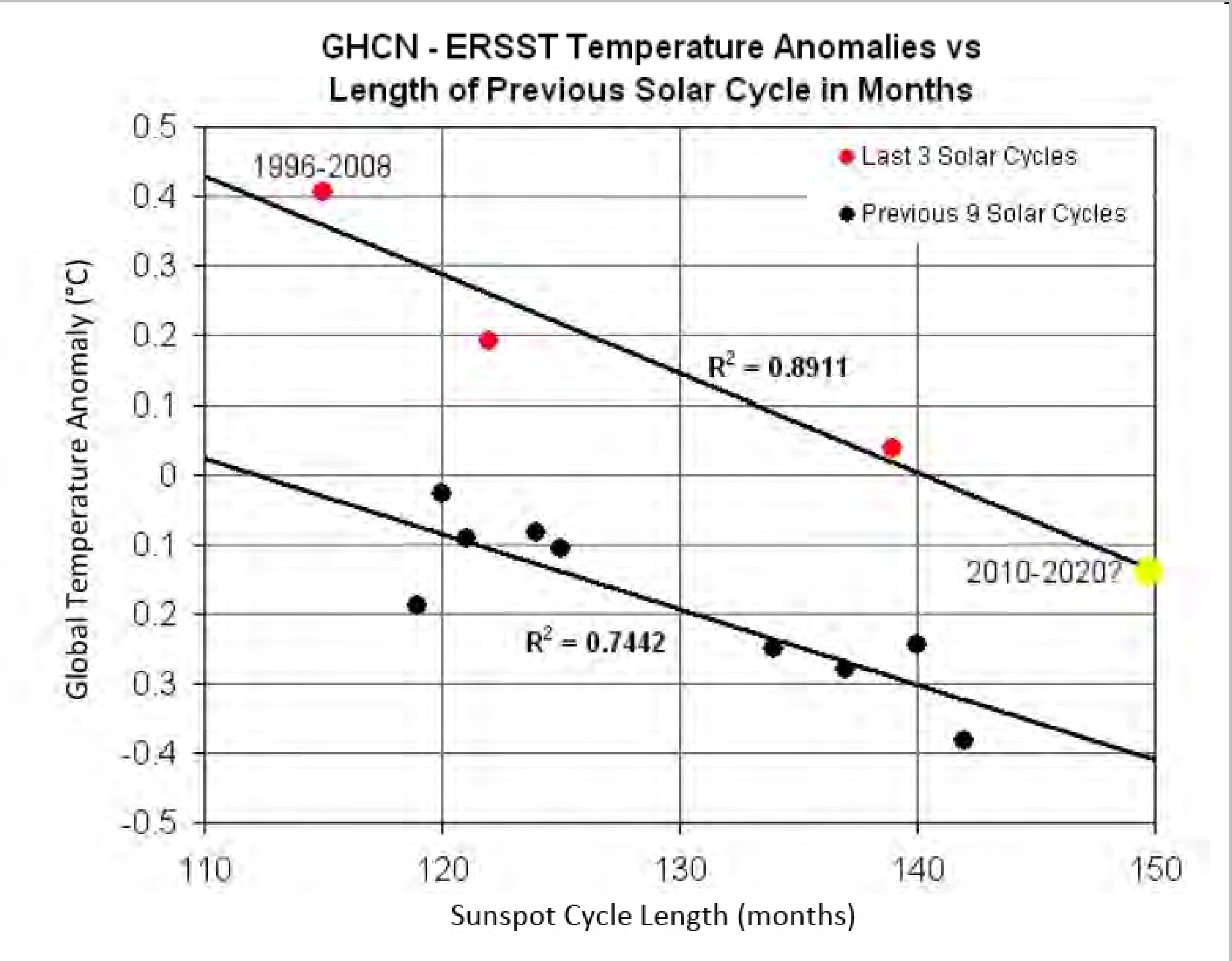
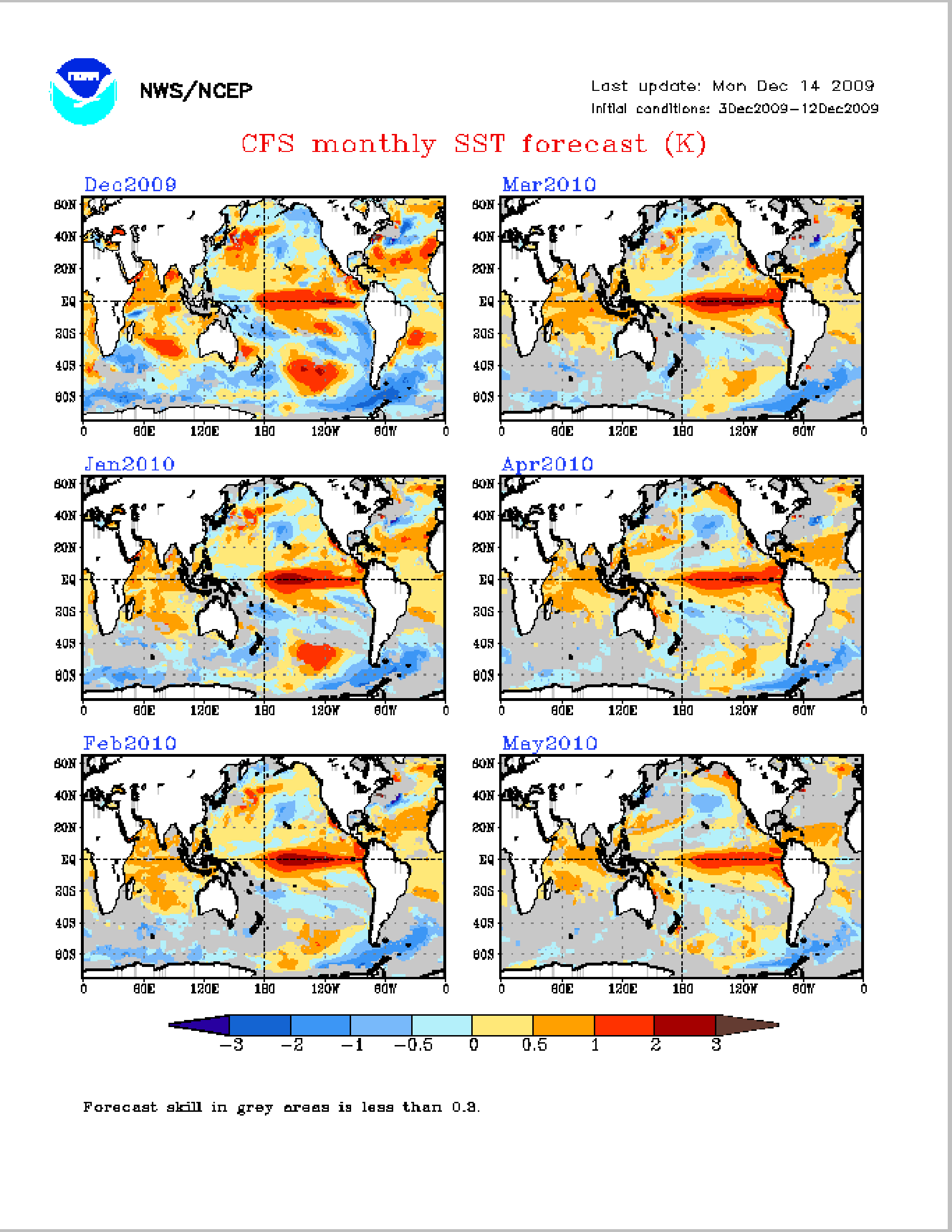
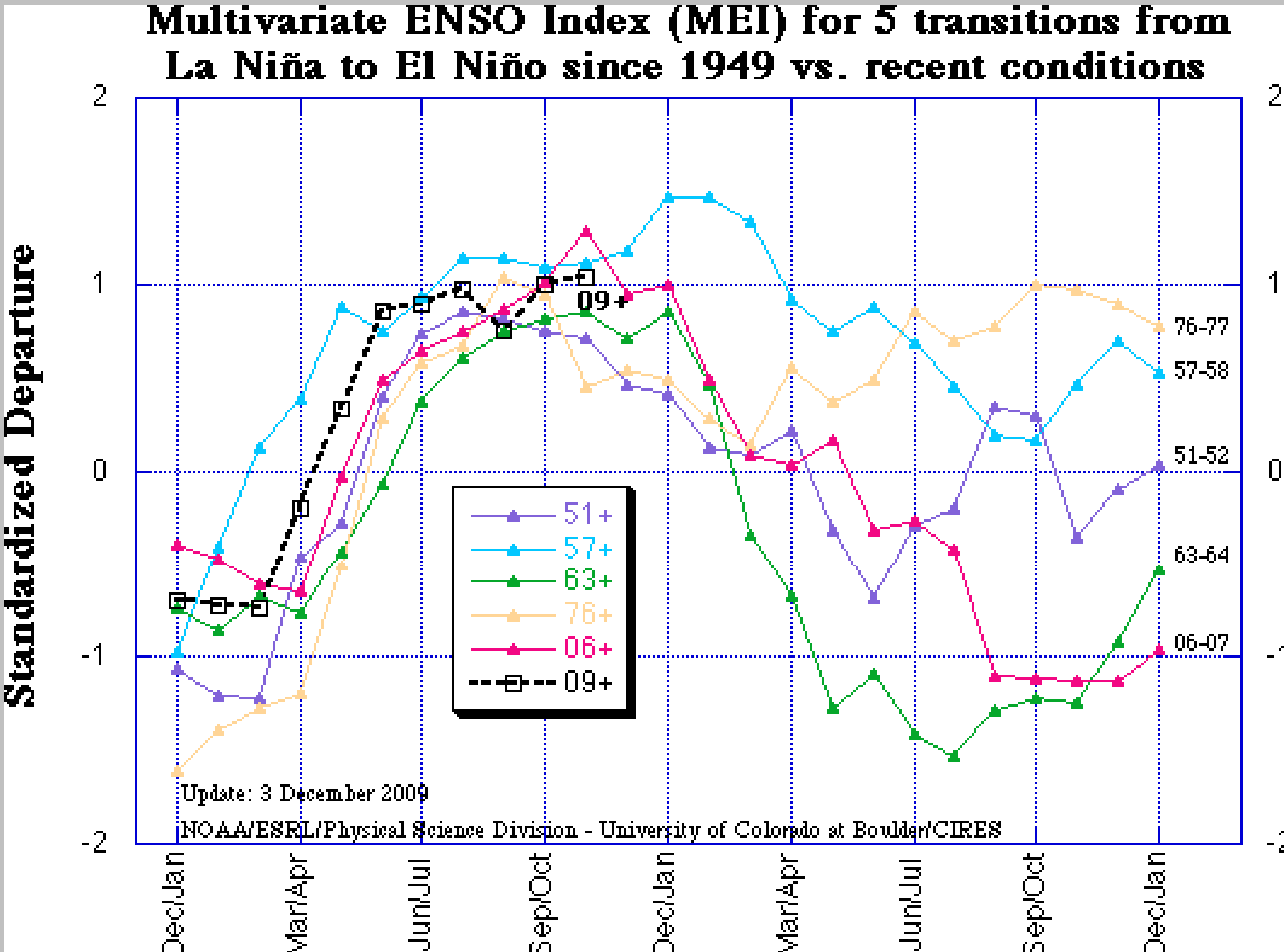
SUNSPOT COUNTS SUGGEST “LA NINA” WINTER WEATHER



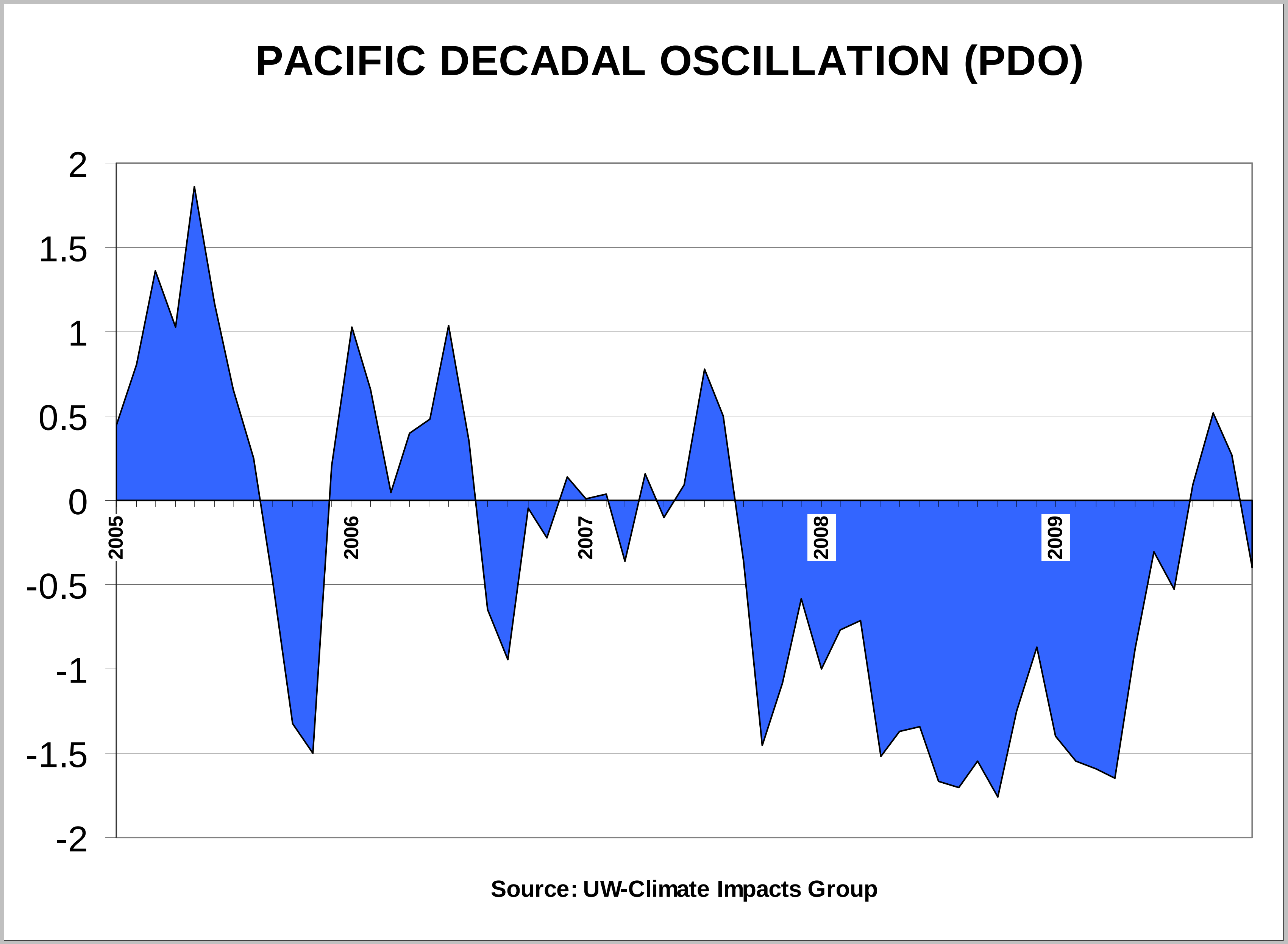
http://ncwatch.typepad.com/dalton_minimum_returns

SEA SURFACE TEMPERATURE DEPARTURE FORECAST



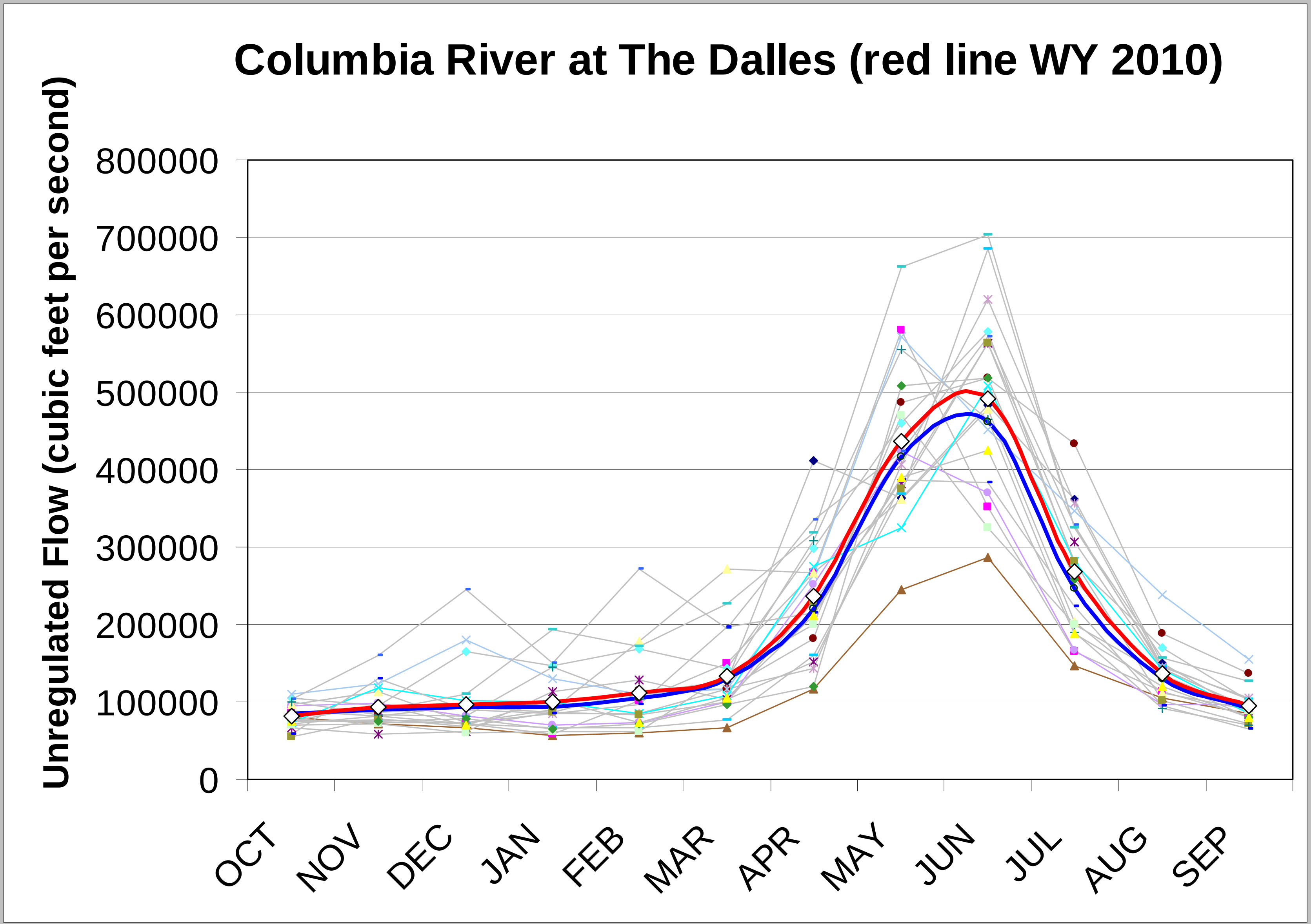


Updated Dec. 4, 2009: http://www.esrl.noaa.gov/psd/people/klaus.wolter/MEI



Updated Dec. 11, 2009: http://jisao.washington.edu/pdo/PDO.latest

ENSEMBLE STREAMFLOW FORECAST



Blue line = long-term average (WY 1929-2009)

Summary: The Forecast

Month:	Temperature (mean monthly):	"Hedge"	Precipitation (% normal):	"Hedge"
November	Near Normal (-1.8 to + 1.8 degF)	-0.3	Above Normal (110 - 130%)	115%
December	Near Normal (-1.8 to + 1.8 degF)	-0.8	Near Normal (90 - 110%)	98%
January	Near Normal (-1.8 to + 1.8 degF)	0.4	Above Normal (110 - 130%)	111%
February	Near Normal (-1.8 to + 1.8 degF)	-0.8	Below Normal (70 - 90%)	86%
March	Near Normal (-1.8 to + 1.8 degF)	-0.6	Below Normal (70 - 90%)	88%

EXPECT MORE VARIABILITY IN THE WEATHER – PINEAPPLE EXPRESS EVENTS, ARCTIC BLASTS, WIND, FLOODS, etc.

...but what about snow events?!

Expect SIX events...each one 2 to 3 inches (or more), during DEC through FEB.

COLUMBIA RIVER REGIONAL FORUM
TECHNICAL MANAGEMENT TEAM
2009 Year End Review
December 11, 2009

FACILITATOR'S SUMMARY NOTES ON FUTURE ACTIONS
Facilitators: Donna Silverberg/Robin Gumpert
Notes: Erin Halton

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. Most presentations were accompanied by Power Point or other electronic information. Please go to the agenda on the TMT web page to see more detailed information.

2009 TMT YEAR END REVIEW

Please note that all power point presentations shared during the Year End Review can be found attached as links to the agenda on the COE's TMT web page: http://www.nwd-wc.usace.army.mil/tmt/agendas/2009/1211.html

Conditions Review
Weather: Kyle Dittmer, CRITFC, provided a memo and presented an overview of 2009 weather. He noted that conditions were extremely variable. The National Weather Service reported a record-breaking over 19" of snow in December. While overall temperatures were normal, December was lower than average. Early 2009 conditions were cold and dry. December, June and August saw big hits of precipitation. Record cold temperatures in the spring were followed by record high temperatures in the summer. Temperatures then moderated by September. Upper Snake precipitation was above normal.

Kyle's presentation outlined the sunspot methodology used to do holistic, big picture forecasting for 2009-10. Sunspot counts are the lowest seen in 80 years – which may be a favorable indication of La Nina (i.e., colder, wetter for the PNW). However, El Nino is trying to re-surge (i.e., warmer, dryer for the PNW). The latest scientific analysis indicates there may be colder weather trends over the next few years; however, the Northwest may see warmer temperatures. NOAA predictions show a borderline El Nino / ENSO-neutral condition. Overall, this winter looks to have near normal/slightly below normal temperature and water conditions. He forecasted 6 snow events for the winter season in the Portland area and noted the most recent forecast consensus showed an 88% of normal water year.

Additional 2010 climate forecasts can be found on the Oregon Chapter of the American Meteorological Society's website: www.ametsoc.org/chapters/oregon/index.html.

- *Question:* What was the River Forecast Center's forecast for the water year? 84% of normal.

Water Conditions: Steve Barton, COE, provided an overview of water runoff and water quality conditions from 2009. Overall, runoff was below normal for 2009 – with the exception of Lower Granite during the April-August period. Steve noted the 2009 condition was almost an exact reverse of 2007. The story for the year was a declining water supply forecast, most notably at Libby. However, overall spring and summer flow objectives were met or nearly met, except during the summer at McNary.

Question: The graph showed two distinct flow peaks at McNary – did conditions dry in between? Answer: Yes, these spikes were due to a major heat wave.

Steve also reported that changes were made to the Oregon and Washington state TDG waivers and that these changes would likely be put into effect in 2010. The categories of TDG exceedances were shared and Steve reported 308 total exceedances for 2009. He said that Bonneville had 32 exceedances and this was mainly due to The Dalles spillwall construction. Overall, exceedances were down from last year's 500+.

Questions:

- Does the COE track consecutive gas exceedances? Answer: Yes – this information can be found as a link to the TMT home page.
- Is there a pattern of where the types of exceedances are located – or by time? Answer: The COE has the data to do this analysis but has not done so.

Ocean Conditions: Bob Emmett, NMFS Science Center, shared a presentation on ocean conditions. He shared that the Science Center contributes to salmon management by studying the ocean phase of their life history and developing management advice based on a suite of physical, biological and ecological indicators:

- Local physical conditions (e.g. sea surface temperature – SST, coast currents)
- Large scale forces acting at the local scale (e.g. ENSO/PDO)
- Local biological conditions (e.g. predators, nutrients)

Bob provided an "Oceanography 101", detailing circulation off the pacific NW coast, how winds and the earth's rotation drive currents. The Pacific typically experiences strong winds from the south in the winter and from the north in the summer. PDOs measure ocean temperatures in the Pacific and have two patterns: positive (warm water) and negative (cold). PDOs and SST are correlated.

Question: The graphs depict a PDO phase change in 2003 and 2006 – what does this mean? Answer: This could indicate that the PDO is not actually decadal; however more data from more years is needed to substantiate this. Ultimately, the message is that oceanographic conditions are changing.

Bob reported that despite recent cold ocean conditions, the Pacific saw relatively high species richness. This was not a good year for juvenile ocean survival; however the timing of upwelling is expected to change in the future which could have a positive impact. Bob reviewed sea surface temperature anomalies from May 1998 – 2009, and showed that the period 2006-2009 saw good cold ocean conditions and high productivity for fish.

Observations for 2009:

- 2009 saw a negative PDO through July, followed by an increase in ocean temperatures which led to an increase in predator squid.
- The copepod biomass dropped in September; juvenile salmon catch also dropped.
- The coho catch was high.

Finally, Bob noted that the Science Center is conducting an analysis on how the size of juveniles as they enter the ocean impact ocean survival rates. Overall, he concluded that predators at times play an important role in survival; the timing of entry into the ocean is critical; and the ecosystem is continually evolving.

Fish Conditions: Paul Wagner, NOAA, reported on juvenile fish conditions for 2009. Steelhead numbers saw a big bump in early April (due to an earlier than normal migration) at Lower Granite, slightly above average in May at Rock Island, and above average April-May at McNary and Bonneville. Chinook numbers were fairly close to average, with peaks near transportation times at McNary. Juvenile sockeye abundance was fairly low.

Cindy LeFleur, Washington, reported on 2009 adult fish conditions. Spring chinook jack counts were higher than ever recorded, over 80,000. Run timing for spring chinook has shifted to much later in recent years. Summer Chinook numbers totaled about 54,000 for 2009, and the forecast for 2010 is 88,000. Sockeye numbers in 2009 tracked pretty close to this year's forecast; and are forecasted at 25,000 in 2010 (higher than recent years). Upriver bright fall chinook counts were about 200,000 in 2009. Summer steelhead numbers were also high.

- *Comment*: It should be noted that Pacific lamprey numbers saw a record low this year – around 9,000 total. The dismal numbers in the Snake Basin (12 at Lower Granite) should be of interest and concern for those looking at the ecosystem overall.
- It was noted that over 1,200 sockeye were counted at Lower Granite – how many made it back to the lake? Answer: Approximately 826.

Brandon Chockley, Fish Passage Center, reviewed adult run timing information from memos that are posted to the FPC website. Considering the past 10 years as "recent", he reported that the average spring chinook adult passage timing has been later in recent years (around April 16th) and that spring chinook jacks are arriving later than adults – jacks also are arriving later than previous years, with May 24 being the recent year average passage date. He noted correlations between environmental variables (Mar 15 – April 1 temperature, flow) and the timing of the 10% passage data for 1994 – 2009: the analysis found a significant relationship between run timing and temperature, with later passage associated with cooler temperatures. No significant relationship was found between passage and flows. The analysis indicates that spring chinook adults and jacks are arriving later.

- *Comment*: For the recent past 4 years, 50% of passage has been later than anything seen on record.

Sea Lions: Robert Stansell, COE reviewed the results of pinniped deterrent measures for 2009, noting that most data is for the observation area just in front of Bonneville. Generally, he reported that physical barriers continue to be very effective deterrents while acoustic devices are having no observable effect. Hazing has continued and a shift has occurred in the patterns of numbers of take each hour: since hazing measures began, take by sea lions have shifted to earlier and later in the day. A trapping program is also in place to remove animals that meet specific criteria (observed at Bonneville 5 days, observed 'taking' and individually identifiable). Robert noted that 54 sea lions are currently identifiable. In 2009, 4 sea lions were removed to zoos, 11 were euthanized after failing health exams; 5 were branded and tagged and 1 was already branded, given an acoustic tag and released. Robert suggested that overall the program has been fairly effective. He also noted that Steller sea lion numbers are rising. More salmon were taken in 2009 than in previous years; however the percentage of the total run was down.

In summary, Robert said that physical barriers and trapping have been the most effective management tools, and by ODFW estimates, 800-1,700 salmon have been 'saved' by the program. While overall the numbers of take have not gone down, the percentages have and those responsible for the sea lion management program feel that more indications of the effectiveness of the program will be seen through a continuation of the program.

Questions and comments:

- Were the numbers reported today minimum estimates? Answer: Yes, we do know that some take cannot be observed, and we know that Steller sea lions can swallow steelhead and lamprey whole.
- Do you think the presence of sea lions is having an effect on the timing of the run? Answer: We don't think fish are sensing the presence of sea lions, but we do think take is higher in March and early April.
- Can you tell the difference between adult and jack take? Answer: Not really – but we can distinguish between chinook and steelhead if they are observed within a close enough range.

Reservoir Operations Review

Libby Operations: Joel Fenolio, Seattle District COE, shared an overview of operations at Libby. He noted that the project was drafted to 2411' at the end of December 2008 and that refill began on April 28th. VARQ was in place until the sturgeon pulse operation began, which was implemented from June 10th – July 11th.

- *Question:* Did the December 2411' target consider bull trout minimums? Answer: No – there is no relation between the two requirements.
- *Question/Comment*: Are sturgeon pulse flows considered when setting flood control minimums? This could help 'buy' some flow by working it into the spring VARQ calculations – and the COE could pursue deviation requests during dry years.

Brian Marotz, Montana, added that Libby is one of the most difficult projects to operate, and expressed an interest in revisiting the Jan 1 flood control draft criteria. For example, during drier years, the region has more time to react and months to release water before the runoff hits; he also expressed a desire to revisit the way sturgeon flows and VARQ are modeled. Montana is currently analyzing IFIM results from the Flathead River and the Columbia Falls minimums. A similar analysis will soon begin in the Kootenai. Results may allow for more flexibility at Hungry Horse and Libby dams. The group agreed that any proposed management changes would need to be discussed as a region and addressed in the FCRPS BiOp.

- Would a revision to the current BiOp be needed to alter minimum flows at Columbia Falls? Answer: Likely yes.

Lessons Learned:

- Revisit the variable end of December draft target and effects of bull trout flow on monthly elevation targets.
- Revisit the way VARQ operations at Libby and the sturgeon pulse operations are modeled when setting targets.
- Consider using a Deviation Request for VARQ operations at Libby in dry years.
- Overall, all targets and known operations throughout the year should be considered holistically since management decisions made early in the year have an impact on later operating decisions.

Hungry Horse Operations: John Roache, BOR, reviewed 2009 Hungry Horse operations: During the Fall-winter period the project operated at minimum flows. Jan-July inflow volumes were about 91% due to low precipitation. On May 1st, the project was operated to VARQ, based on the 99% of normal forecast, but by June the forecasts had dropped and subsequently outflows were reduced. The maximum elevation was 3559.15', on July 19th, and the project was drafted to elevation 3550' by September 30th.

- *Question*: What is the powerhouse capacity at Hungry Horse? Answer: 12,000 cfs.
- *Question*: What is the normal winter flood control elevation? Answer: 3546' end Jan (Note: actual end of January flood control elevation for a 100% of average forecast is 3543.6 ft.). Hungry Horse is operated under VARQ flood control, which was designed, in part, to shift flows from winter to spring.

Grand Coulee Operations: John Roache continued with a review of Grand Coulee operations. He noted that 2009 was a 'typical' winter in terms of operations, and the project went up as high as elevation 1289' during the winter. Mar-April saw more significant changes in forecasts: The forecast increased by 9% in April, which had an effect on flood control operations. There was a difference of 24 ft. between the March and April forecasted April 30 flood control elevation. 24 feet amounts to 1,727 KAF of storage. Grand Coulee reached elevation 1290' on July 6th and drafted to 1277.5' on August 31st.

Upper Snake Flow Augmentation: John also reported on Upper Snake flow augmentation. A total of 487 KAF was released was released for flow augmentation in 2009. Flow augmentation was released between June 19 and August 31 with the majority being released by July 31. This followed the 2008 BiOp, with the release being slightly earlier than the typical July – August release period seen in previous years. Heavy precipitation and flood control operations in the Upper Snake above Milner during June

resulted in the system filling in early July and the need to adjust some of the flow augmentation releases from June to July; releases in the Upper Snake above Milner were completed by July 31.
Canadian Operations and Impacts on the Columbia River System: Tony Norris, BPA, reported that 1 MAF of Canadian water was stored in January and released in July.

Dworshak Operations: Steve Hall, Walla Walla District COE, reviewed flood control, transition, refill and summer operations at Dworshak. He reviewed the project's operating objectives and noted that runoff overall was fairly average for the year. 134 kaf was shifted to Grand Coulee on April 1st. The spring flood control operation did result in a TDG exceedance for a short period of time. The COE was surprised by the early (June 22) refill this year. He acknowledged that this caused some concerns in the region, but noted that earlier in the spring, the COE used snow flight information that showed extra snow in the area and based on that, the COE made the management decision to refill earlier. Overall, the Dworshak temperature augmentation operation was managed very well.

> **Lesson Learned**: The COE should build the lessons learned this year into future years. For example, if a shift in the Dworshak forecast is 'typical', build it into overall forecasting management procedures.

Review of Specific Operations
Dworshak SOR: As a quick update, Steve Hall noted that the Dworshak Unit 3 repair work appears to be holding up well. Re: SOR 2009-2 (Transition to refill) – Steve reviewed the request (full powerhouse discharge from May 12-17 as needed to achieve 100 kcfs flow at Lower Granite) and resulting decision (a compromise between the request and minimum discharges out of Dworshak, to increase the probability of refill). He shared summary bullets from April 22 and 29th; and May 5th, 6th, 12th and 13th regional correspondence and TMT meetings. Operating decisions were based on fish needs and the request in the SOR, balanced with the risk of refill and flood control computations. This year, the COE felt the risk of not refilling was high.

Lessons Learned:

- Balancing the refill curve with the spring flow augmentation needs for fish is always a challenge, and decisions are based on risk management. The COE welcomes a regional dialogue about 'acceptable level of risk'.
- Better communication and transparency about forecasts and uncertainty are needed, e.g. snow pack forecasts. All existing and new forecasting tools should be explored by the region, to look at the capabilities and limitations each tool provides.
- A mild end of August kept temperature exceedances at bay.
- When setting refill curves the COE needs to retain some flexibility in order to be able to respond to changing conditions. E.g., they always have to account for additional precipitation May-June. For 2009, the COE used a conservative value of 2 kcfs. The region needs to revisit the refill curve, in the context of risks and tradeoffs.

Chief Joseph Dam Spillway Flow Deflector: Amy Reese, COE, presented information developed by Mike Schneider and Kent Easthouse regarding spill tests with new flow deflectors in place at Chief Joseph. She reported good gas abatement and overall TDG reduction of 16% saturation for comparable spill with the addition of the new deflectors on all 19 spill bays. Her slides showed the overall test results. In summary, spill capacity was tripled for a TDG of 120%.

- *Question*: Based on this report, could spill caps be set greater than 100 kcfs? Answer: 100 kcfs is our suggested estimate to start the spill season for the project to reach 120% TDG. Spill caps will be adjusted real-time during spill season to reflect actual TDG values.

- *Question*: Looking at the photos, there is a reduction in gas but the turn radius is increased – in the lower Columbia and Snake, have injury and survival tests been done? Answer: The COE will look into this and respond.

  Lesson Learned: Overall the region is satisfied with how well the spill deflectors are working. More discussion is needed now on where to place Chief Joseph on the spill priority list.

Libby 2008 End of December Variable Draft Methodology and 2009 SOR: Joel Fenolio, COE, offered to do a more formal presentation on the Libby variable draft methodology at a future TMT meeting if there was interest from the group. Today, he provided an example forecast of 5650 KAF, noting that last December's forecast was 5937 KAF and which dictated operating to 2411' per the Water Management Plan. Joel noted that the WMP was updated, and the language has been changed to reflect the correct methodology that uses the forecast to interpolate the end of December flood control target (see the slides posted as a link to this agenda item).

Lessons Learned:

- While there was some flexibility in the summer, VARQ flows during dry years could be better optimized.
- Revisit the COE's flexibility around VARQ flows, during dry years. Overall, look at how 'low flow' conditions impact Libby operations.
- Need to discuss trends in December forecasts as part of an overall regional follow up discussion of Libby operations.

Joel also reviewed the 2009 SOR, noting that the timing of the pulse was weighted heavily on temperature – the operation was modified in June via collaboration between the COE and regional partners.

Juvenile Survival for 2009: Bill Muir, NMFS Science Center, presented information on juvenile survival and travel times; and transportation effects on juvenile survival. Steelhead survival, particularly from Lower Granite to McNary, was much higher this year, with the overall survival Snake River trap to Bonneville at 69% -- the highest percentage ever seen. Snake River sockeye survival showed a notable increase this year compared to 2008 for the Lower Granite to Bonneville reach.

During the last several years, transportation start has been delayed until May 1st. With surface passage structures at all three Snake River collector dams and the delayed start to transport, fewer smolts were transported in recent years.

In conclusion, Bill showed a slide that showed why steelhead survival was so high in 2009. An early migration, a higher proportion migrating inriver and swamping predators, fast travel time and help from surface bypass structures were key to high survival rates. However, adult return data will need to be analyzed to determine effects on overall survival to returning adults.

Lesson Learned:

- With the new RSW's in place, surface passage percentages should be studied in relation to survival, especially for steelhead.

Fall Chinook Survival 2009 – Jerry McCann, Fish Passage Center, reported on PIT-tagged hatchery fall chinook survival over Lower Granite during the period May 20-July 15. Overall, 2009 saw relatively good survival in the reach. Flows overall were lower in 2009, but spill was higher, so overall conditions were fairly average. Transit times were shorter and this was a reflection of good flow conditions. Temperatures ranged between 13 and 17 degrees C. 2009 and 2008 were similar with respect to probability of being transported. In conclusion, increased spill and decreased water transit time improved survival, while higher temperatures decrease survival. Survivals were relatively high in 2009 because of higher flows in June and above average spill, while temperatures were near average for the period of years analyzed (1998-2009).

- *Question*: How do you account for fish that are not observed but die before they would have been observed? Answer: The analysis takes into account about 35% mortality of these fish.

Chum: Tony Norris, BPA, provided an overview of chum operations this year, noting that since Bonneville is the last project in the system, many variables need to come together to support the chum operation (e.g. a consistent daytime tailwater elevation) and regional power demands during winter weather. He shared slides of the chum spawning operation area and the evolution of management around the chum spawning elevation.

- *Question*: Would a 12' or 12.5' upper limit be a better option for chum? Answer: It would provide more flexibility, but so far the target range, 11.5 (11.3-11.7 range) and 18' nighttime limitation has been very manageable.
- *Question*: How does BPA address issues that come up around their ability to manage to the targets? These issues are brought to TMT for discussion and recommendation.
- *Comment*: While this year sufficient habitat coverage was provided for spawning chum, spawning grounds have been flooded in the past.

Lesson Learned: TMT did a great job managing chum operations this year, even with any added constraints from The Dalles spillwall construction project.

Concluding Observations: TMT wrapped up with concluding observations and lessons learned from the 2009 season:

- Deviations from flood control could provide additional needed flexibility to system operations.
- Clear and consistent communication about risks is critical for the region to understand.
- This year, there were fewer issues with temperature, and temperature management worked well.
- With so many mandated operations, TMT has been limited in what we can make decisions around.
- TMT needs to re-visit the spill priority list, given the new structures in place (e.g. spill deflectors at Chief Joseph).
- Process suggestion: TMT should find times throughout the year to get into more in depth discussions that will lead to meaningful changes.
- Many issues have been resolved after over a decade of discussion and debate – which may mean some of the necessary solutions are in place.
- Many issues have been addressed at TMT, and the team has figured out where good productive discussion can be had – as opposed to those topics that are part of litigation or mandates. The process for discussing and responding to requests from the salmon managers has improved, e.g. requests are taken seriously as opposed to analyzed for why they cannot be granted.
- With more sophisticated technologies and data sets, conflicts and finger-pointing have been reduced.
- TMT has developed into a higher functioning team – more communication is happening outside the meetings.
- There is appreciation for the willingness amongst members to acknowledge the complexities and work together to make the system work as best as possible.
- There is hope to start 2010 with a better sense of Regional Implementation Oversight Group process.
- The presentations were very interesting and educational.
- The facilitation team has helped TMT stay focused and moving forward.

  ACTION: TMT will look at the list of 'needs more improvement' from this year's review at a meeting in the New Year and set a course for making those improvements.

Thank you to all the presenters who took the time to put together very good presentations from which everyone could learn and benefit.

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NOTE: All power point presentations from the TMT Year End Review can be found linked to the agenda on the TMT web page. Thank you all for your participation!

Columbia River Regional Forum
Technical Management Team 2008 Annual Review
December 11, 2009

1. Introduction

Today's meeting was facilitated by Donna Silverberg (DS Consulting) with representatives from the COE, NOAA, NPCC, FPC, USFWS, BPA, BOR, CRITFC, Nez Perce Tribe, Montana, Washington, Oregon, Idaho and others participating. What follows is a summary (not a verbatim transcript) of the discussion and the issues raised during the review. Anyone with questions or comments about these notes should provide them to the TMT chair or bring them to the next regular TMT meeting.

2. Conditions Review. *What were the water, weather and fish conditions that existed throughout the year? How did this year compare to others? Is there something we can learn from this? Anything unique that bears sharing?*

A. Weather. The 2009 water year started with a snowstorm in mid-October and a blast of rain in November and December, followed by record-breaking snowfall, Kyle Dittmer (CRITFC) recalled. The 20-day snowstorm in December dumped 19 inches of snow in Portland alone.

Temperatures started off normal in October and rose to 5 degrees F above normal in November, which caused early snowfall to melt. That was followed by a blast of cold, which also broke records from Portland to Seattle, causing late snowfall to freeze in place. In spring, the weather went from cold to warm almost overnight.

It was a year of extreme temperature swings, from snow and low temperatures to heat waves soaring above 100 degrees F for more than a week in July and August. The extremely cold winter helped to moderate water temperatures throughout the heat wave that followed. By September, temperatures became more normal.

Precipitation was heavy in late December and early January, causing flooding. Then the weather turned dry and cold for almost 8 weeks. Like temperatures, precipitation levels in water year 2009 fluctuated wildly. Spring was wet and cold. Throughout the rest of the year, precipitation in most of the mid- and upper-Columbia basin was lower than normal, while the upper Snake basin saw surges of rain that were beyond normal.

Forecasting has elicited a divergence of opinion in terms of weather conditions for the coming year. In making his forecast, Dittmer considered solar activity, sea surface temperatures, the multi-variable ENSO index, the PDO index of ocean conditions, and an ensemble streamflow forecast.

Data on solar activity suggest that 2010 will have one of the lowest sunspot counts in 80 years, which is similar to 2009. Years having few sunspots tend to be cooler La Nina years. However, sea surface temperatures indicate a slight warming trend in the Pacific Ocean, making 2010 a borderline El Nino year. The multi-variable ENSO index, which tracks 6 different parameters including sea surface temperatures, also foresees a year of borderline El Nino patterns.

Dittmer forecasted 6 snow events for 2010, with snowfall of 2-3 inches apiece in the Portland area. The ensemble streamflow forecast calls for normal to slightly below normal temperatures in 2010, with less than normal inflows for the rest of this winter.

Based on three pre-season forecasts (NOAA, CRITFC and SIG), Dittmer predicted inflows this year would be 88-100% of normal, with an 88% average for all three forecasts. The RFC's water supply forecast for 2010 is 84% of normal.

Lessons Learned:

- Considering a variety of forecasts can help compensate for the extreme variability in weather patterns during recent years. These conditions can make it very challenging for resource managers to predict weather patterns accurately and manage reservoirs accordingly.

B. Runoff, Flow Objectives and Water Quality. Steve Barton (COE) presented a retrospective of water conditions and streamflows in 2009.

Runoff: All projects received less than normal inflows in 2009 except Lower Granite, where inflows were above normal from April to August. This situation was the reverse of the 2007 water year. The story of 2009 was declining water forecasts, especially at Libby Dam where inflows from April to August were only 71% of normal. Areas in the Snake Basin such as Dworshak, McNary, and Albeni Falls had near-normal precipitation, boosted significantly by the wet weather of June.

Flow objectives: Overall, the projects met or nearly met their spring and summer flow objectives, with the exception of summer flows at McNary. Runoff as a whole was well controlled, with an average flow of 360 kcfs and a regulated peak at The Dalles Dam in early June. There were two distinct peaks in runoff at McNary, the first in late April, Paul Wagner (NOAA) said. Warm weather in mid April melted the snow at lower elevations, Dittmer said. The resulting double peak was one driver of the Dworshak SOR in summer, Barton recalled. Both peaks corresponded to warm spells. Barton presented project-specific data.

- Lower Granite Dam – The spring target objective was 100 kcfs. Actual flows slightly exceeded that at 110 kcfs. The summer objective was 52 kcfs; actual average flows were 48 kcfs.

- McNary Dam – The spring flow objective of 228 kcfs was exceeded with average flows of 268 kcfs. The summer objective of 200 kcfs wasn't met; actual flows were 142 kcfs.

- Priest Rapids Dam – The summer objective of 135 kcfs was nearly met with an average flow of 132 kcfs.

Water quality: With 29 fixed monitoring stations in place, the COE made no changes to the network this year. The average for data completeness was 98-99% for gages in all three districts, Portland, Seattle and Walla Walla.

This year brought several changes to state water quality standards. Although both Washington and Oregon removed Camas Washougal gage from their waiver requirements, the COE continued to use the gage for water quality management per the court-ordered rollover operation. Oregon no longer requires the use of forebay gages for water quality management. Washington changed the way TDG exceedances are calculated to the highest 12 consecutive hours instead of a rolling average. None of these changes could be implemented in 2009 due to the 2008 BiOp litigation. Jim Ruff (NPCC) asked whether the state changes would go into effect for 2010. That's still under discussion; the Action Agencies have not heard back from Judge Redden, Barton replied.

In 2009 the COE refined its definition of exceedances to 3 major types:

- Type 1 – These occur when inflows exceed powerhouse capacity and result in TDG levels that exceed state standards. They are beyond Action Agency control. The definition applies to any exceedances that involve generation, Intertie activity, or powerline outages, planned or unplanned.

- Type 2 – These are due to operational or mechanical failure of non-generating equipment, such as malfunctioning spill bays or gages.

- Type 3 – These are the result of SYSTDG model uncertainty. They occur despite use of best professional judgment.

Over the last 10 years there have been 308 TDG exceedances. The Bonneville forebay has had 32 exceedances, mainly due to spill wall construction at The Dalles. The graph attached to this item on today's agenda breaks down the exceedances by project and type.

In 2009 there were 1,038 water temperature exceedances, up from 545 in 2008. Most of these occurred during the sweltering summer of 2009. Every year the COE provides states with progress reports after being granted waivers. There has been no negative feedback from the states in response to these reports. Brian Marotz asked whether the COE tracks the length of consecutive exceedances. Yes, that information is available on the TMT site, Barton said.

Lessons Learned:

- Look for temporal or spatial patterns in the types of exceedances that occurred during certain time periods. Information to follow up on this suggestion is readily available, and it's a good idea.

C. Ocean Conditions and Salmon Productivity. Bob Emmett (NOAA Science Center) discussed recent research on fish and birds, using various models. The Science Center has a forecast on their web page regarding timing of salmon ocean entry, estuary survival, parasites, genetics and other indicators of salmon life history as they pass through ocean phases. The Science Center forecasts also take into account local conditions such as upwelling, spring transition, coastal current, and PDO as an index of ocean temperatures.

The researchers started at the bottom of the food web with zooplankton, then looked from the top down, i.e. predation. Sampling has done in May, June and September since 1998. Sites on the Columbia River were sampled twice monthly from May through August, including daytime and nighttime sampling. Historical data were also considered.

Researchers identified 4 factors that strongly impact the salmon ecosystem:

1. Source waters
2. Upwelling
3. Seasonal reversals in ocean currents
4. PDO ocean phases

Emmett showed TMT an oceanographic map that depicts ocean conditions and subarctic currents. Fish do well when upwelling brings cold, deep water high in nutrients close to shore, feeding the phytoplankton. Upwelling is productive, but also tends to wash fish off shore. Some fish spawn in winter and early spring so their offspring will have time to grow before having to fight the tendency to be washed off shore. Rotation of the earth in winter drives downwelling to the right of the wind. Summer is the reverse, with winds circling in the opposite direction. Local winds drive currents along the coast.

The PDO index measures ocean temperatures in the Pacific. A positive PDO phase indicates southerly winds and warm conditions along the coast. A negative PDO phase indicates low species diversity and cooler ocean conditions. Positive PDO phases bring greater species diversity, but that's not necessarily productive because individuals are smaller and may fail to thrive. This phenomenon plays an important role in fish biology.

Recent years have been unusual, with contrary trends happening at the same time. Cold water copepods store more fat in winter, which is valuable to fish, whereas warm water copepods don't store much fat because they're busy producing eggs. From 1996 to 2008, there has been an increase in species diversity (up from 6.68 to 10.24) which is not necessarily good news. This could be a climate change issue.

Lack of upwelling in early 2005 might have been a reason that was a bad year for salmon and other species. Upwelling began in 2006 and ended in May 2009. Fish passing later this year didn't fare as well as those passing in spring. Downwelling tends to bring the Humboldt squid to the surface, a major predator.

Cooler ocean temperatures and lower PDO readings are related to prolific herring spawning. Herring are a major food source for juvenile salmon. They need cold ocean conditions and the right copepods to flourish, as do anchovies, another major food source for juvenile salmon.

An overview of the past decade (1998-2009) showed that PDO readings in 2008 were the most negative since 1955. The years 2006-09 had good, cold ocean conditions that were conducive to high productivity. The year 2008 was extremely favorable for salmon, the best on record, with copepod levels not seen since 2002. Coho catches that year were high. Juveniles migrating in the 2007-08 water year had an abundance of food.

By comparison, 2009 was the seventh best year on record. Until July, PDO readings remained negative as upwelling continued. When PDO readings rose in August and September, copepod populations dropped off. Accordingly, spring 2009 juveniles and yearling salmon fared well, but fall runs declined. Coho catches in September were alarmingly low. The Humboldt squid, a major predator, was abundant in August-September, and juvenile catches were low.

The Science Center is studying whether fish size at the time of release plays a role in the marine survival of yearling Chinook salmon. In terms of adult survival, is there a shift in the size of individuals that survive? Fish released in 2002 tended to be bigger, and 2002 was a good year for marine survival.

Lessons Learned:

- Low PDO readings, indicating cold ocean conditions and upwelling, tend to produce high levels of salmon survival, due to the abundance of copepods and food sources as well as predators such as the Humboldt squid. Timing is critical. Salmon evolve to reach to the ocean at specific times. How salmon evolve in relation to changing ocean conditions will be a critical aspect of survival.

- Research into ocean productivity has become extremely useful to wildlife management. Studying ocean conditions gives a good idea of what smolts migrating to the ocean will experience.

D. Fish. Paul Wagner (NOAA), Cindy LeFleur (Washington) and Brandon Chockley (FPC) reviewed the 2009 migration of juveniles and adults, as well as adult run timing.

Juveniles: High flows in April, coupled with an abundance of copepods and herring, aided yearling steelhead passage, Wagner reported. At McNary and Lower Granite, there was a bump in steelhead passage in early April, and again in May. Steelhead passage at McNary brought higher numbers than usual, perhaps the result of no transportation at Lower Granite, Little Goose and Lower Monumental this year. Steelhead passage at Bonneville Dam followed a similar pattern, with an early migration and a big peak in May.

Passage rates for Chinook yearlings of various species were average in 2009. Sockeye subyearling passage at Lower Granite Dam was close to the 10-year average. The passage index for upper Columbia sockeye in 2009 was significantly lower than normal at both Rock Island and McNary dams. Sockeye passage at Bonneville followed the typical shape, but numbers were on the low side. Subyearling Chinook passage at Lower Granite and McNary was close to the 10-year average, peaking near transportation times at McNary.

Adults: As of June 15, 2009,169,000 upriver spring Chinook adults were counted, LeFleur said. Spring Chinook jack numbers for 2009 were off the charts. The upriver spring jack count of more than 81,000 is the highest since 2000, when 24,000 jacks produced 400,000 age-4 fish the following year.

In recent years, the spring Chinook adult migration has been occurring later than usual, a shift that complicates fishery management and has led to over-prediction of adult runs. The 2010 spring Chinook forecast for Bonneville is 470,000 adults, which would set a record since 1938. The 2009 count of spring and summer Chinook passing Lower Granite was 64,000 adults. Some 54,000 summer Chinook adults spawned in the Wenatchee basin in 2009. The Rock Island Dam count was almost 13,000. The prediction for 2010 is 88,800 summer Chinook adults, a significant jump due to the record numbers of summer Chinook jacks in 2009.

The sockeye count for 2009 was 179,000 adults. The prediction for 2010 is 125,000 adults. Sockeye counts at Lower Granite were strong this year. The fall Chinook count (upriver bright, Hanford reach, Snake River wild Chinook, and Deschutes River fish) was almost 200,000. Jack counts in 2009 were high across the board for listed species. The fall Chinook jack count at Lower Granite Dam was 41,000, more than 4 times the 2008 count of 10,000 jacks.

Of the 1,200 adult sockeye that passed Lower Granite Dam, Jim Litchfield (Montana) asked, how many made it to the upper lakes? That count was approximately 826 fish, which set a record, Russ Kiefer (Idaho) replied.

Summer steelhead had a strong 2009 return at Bonneville similar to that of 2001, LeFleur reported. Very high numbers of summer steelhead were counted on the Snake River in 2009.

Lamprey populations, however, hit a record low in 2009, with only a dozen passing Lower Granite Dam, Dave Statler (Nez Perce Tribe) said. The significant decline of lamprey affects species diversity across the basin, impacting ecosystem health and the productivity of listed and unlisted salmon.

<u>Adult run timing:</u> FPAC had asked the Fish Passage Center to investigate whether spring Chinook adult run timing in recent years is occurring later than in the past. Brandon Chockley (FPC) reported the findings.

Prior to 2001, counts at Bonneville Dam occurred from March 15 to November 15; since then counts have occurred year-round. Video counts at Bonneville occur from November 1 to March 31, and direct counts from April 1 to October 31. The Fish Passage Center defines spring Chinook as those passing Bonneville Dam from January 1 through May 31. Fish longer than 22 inches are considered adults, while those less than 22 inches are considered jacks.

The FPC's database of daily counts at Bonneville going back to 1977 has been invaluable in terms of estimating run timing. Using these data, Chockley estimated the 10%, 50% and 90% passage dates for 2000-2009 as compared to 1977-99, using only the counts for March 15-May 31.

Run timing was found to be highly variable among all the years studied. The 10% passage dates for spring Chinook adults in recent years occurred later than in earlier years, a difference of 6 days (April 10 vs. April 16). The 50% passage date historically was around April 25, but in the past decade was April 29, a difference of 5 days. The same pattern was true for the 90% passage date, which historically was May 14, but in the past decade was May 19.

Spring Chinook jacks generally migrate later than adults. Nevertheless, the same pattern applies to jack timing. The 10% passage date was 7 days later in the recent decade than historically (April 23 vs. May 1). The earliest 10% passage date was in 2003. The 50% passage date historically was May 8; now it's May 12. The 90% passage date is only 2 days later now than it was historically (May 22 vs. May 24).

Another data request FPAC made of the FPC was to investigate the environmental factors influencing spring Chinook adult run timing. To do so, the FPC looked at temperature and TDG data that were recorded at the Warrendale guage 6 miles downstream of Bonneville Dam. Data from the Warrendale guage goes back to 1994. To establish conditions at the beginning of each run, Chockley compared average temperatures and flows from March 15-April 1 for each of the years studied.

Lessons Learned:

- There's a significant correlation between water temperatures and the 10% passage date for adult spring chinook. Cooler temperatures are associated with a later 10% passage date.

- Spring Chinook adults and jacks are indeed arriving at Bonneville Dam later now than they have in past decades. Generally the discrepancy is 4-8 days for adults and 2-8 days for jacks. For the past 4 years, the 50% passage date was the latest seen on record. Temperature seems to affect the timing of spring Chinook adult and jack runs significantly. Flows, however, have no measurable effect on run timing.

E. Sea Lion Predation in the Bonneville Tailrace. Robert Stansell (COE) gave a report on sea lion predation control efforts in the Bonneville Dam area, noting that sea lion predation occurs elsewhere as well. In 2009 sea lions ate an estimated 4,489 salmon, or 2.4% of the run.

California sea lions: Since January 2009 when the sea lion exclusion devices and floating orifice gates were installed at the entrance to the Bonneville fishway, no sea lions have gotten in like C404 did in recent years. However, acoustic devices installed near the ladder entrances seem to be ineffective. Hazing by states and the U.S. Department of Agriculture continues with limited effectiveness during daylight hours only. The sea lions have responded by taking more fish during morning and evening hours when there are no boats present. Sea lions took an estimated 200-250 additional fish during off-duty hours in 2009.

Stansell reviewed charts, attached to today's agenda, showing sea lion predation counts over time. In 2009, 4 California sea lions were trapped and sent to zoos; 11 failed health exams and were euthanized; and 5 were branded, tagged and released because they were not on a list of known predators. Since the program began, 26 animals have been removed. All 26 were on a list of 87 known salmon predators. Catch data indicate that they had been consuming a large number of salmon, which demonstrates that the removal program has been effective. Approximately 30 California sea lions are expected to return to the Bonneville Dam area in 2010.

Stellers: Unfortunately, the presence of Steller sea lions, a protected species, is on the rise. They arrive earlier every year and hang out along the Columbia River all the way to Astoria, feeding on white sturgeon and salmon. Four years of deterrence hasn't decreased this pattern. In fact the Stellers are becoming more aggressive, arriving as early as January and increasing their take. Stellers take approximately 90% sturgeon, while California sea lions take approximately 90% Chinook.

Predation impacts: The percentage of sea lion take this year was slightly smaller due to large run sizes, although more fish were taken this year than in the past, indicating that actual predation has increased. Salmonid catch counts for the past 3 years show that sea lion predation begins earlier now than previously. Sea lions are heavily targeting the early spring runs, with Chinook and sturgeon most at risk. Over the past 6 years the lamprey take has dropped, probably due to the decline in lamprey populations.

Wagner asked whether sea lions can consume their take underwater and unobserved. For the most part, California sea lions have to surface to consume salmon. Stellers come up to the surface to swallow steelhead whole. They can also take lamprey underwater, but lamprey are harder to swallow whole. Cindy LeFleur asked whether it's possible to distinguish between adults and jacks taken. No, but it's possible to distinguish between Chinook and steelhead at close range, Stansell said.

Jim Ruff (NPCC) wondered how the presence of sea lions in the Bonneville tailrace earlier in the year is affecting run timing. Fish probably don't sense the presence of sea lions and wait to migrate, but the sea lions could be taking a higher proportion of early run fish than in previous years. It's unknown whether the sea lion program at Bonneville is displacing sea lions downstream.

Lessons Learned:

- Physical barriers keep sea lions out of fishways, but acoustic devices are ineffective.

- Trapping and removal of California sea lions is helping to keep predation numbers down. ODFW estimates that 800-1,700 salmon have been preserved so far, but full effects won't be known for 5 years.

- The biggest problem now is the increasing numbers of Steller sea lions.

3. Reservoir Operations. *How effective were the proposed actions (SORs) at achieving desired results? What changes might be necessary to enhance results in the future? How did this year compare to others?*

A. Libby Summer Operations. Libby Dam drafted to elevation 2,411 feet at the end of December 2008, Joel Fenolio (COE) recalled. On January 1, 2009, it went to minimum flows until April 28. During that time, 8 feet of water were drafted out of the reservoir, and inflows were only 60% of average.

The Libby refill operation began on April 28. This year inflows matched outflows until early May, when the operation went to full VARQ flows of 13.4 kcfs. That operation continued until VARQ flows changed slightly to 13.5 kcfs on June 06. The sturgeon pulse began on June 10th. The temperature trigger for the sturgeon pulse of 1.5 degrees C also occurred on June 10, when Libby outflows ramped up to full powerhouse for 7 days. On June 17, the slow ramp-down of outflows began. The later timing of the sturgeon pulse affected refill, with less overlap between sturgeon and VARQ flows. The sturgeon pulse ended on July 11 and Libby went to bull trout minimums for the rest of the summer.

On August 31, Libby reached a maximum elevation of 2443.4 feet, missing its refill target by almost 16 feet. Russ Kiefer (Idaho) asked whether the 2,411-foot elevation target at the end of December 2008 took into account bull trout minimum flows that would continue to lower the reservoir elevation throughout winter. Dave Wills (USFWS) raised a similar question regarding the sturgeon pulse and draft flood control limits for winter. These releases could buy some amount of elevation for storage on a sliding scale. Fenolio explained that the end of December flood control elevation is contingent on the capacity of Libby Dam to release full flood control storage between January 9th and March 31st, and is independent of spring and summer fish flows.

Meanwhile, inflows at Libby steadily declined. The May 2009 water supply forecast for Libby was 5,205 kaf, or 82% of average. Actual inflows in May were 4,334 kaf, 68% of average. Libby inflows in June were only 60% of average.

Libby is one of the most difficult dams to operate, Brian Marotz (Montana) observed. Initial work on VARQ flows attempted to offset impacts of the sturgeon release by reducing the draft target and therefore improving refill probability. The original intent of VARQ was to reduce the maximum drawdown and improve the refill operation by releasing flat flows in a gradual ramp down. Marotz expressed interest in learning more about the COE process of setting January 1 draft targets. He suggested reducing the size of releases early in the year because there's still plenty of time to react if inflow forecasts don't follow early predictions.

Montana is doing IFYM modeling work that could show it's possible to lower the bull trout minimum flat flows of 3.5 kcfs in summer and still maintain sufficient riffle habitat for bull trout. This would increase operational flexibility at both Libby and Hungry Horse dams. Bull trout minimums are typically released from May 15 to September 30. Possibly Montana will revise the Columbia Falls minimum flow requirement as a result of this modeling work. If so, that would probably involve a revision of the 2008 BiOp requirements. The region will collaboratively participate in the decision.

Lessons Learned:

- Use the deviation request process and adaptive management via the TMT collaborative process to manage and improve Libby refill.

- Review the Libby water supply forecasting process.

- Review the variable January 1 draft target methodology. There was strong interest in addressing how sturgeon and bull trout flows impact winter storage and the "2,411 rock," the established flood control elevation for December 31. Managed releases for bull trout and sturgeon could be included in the modeling of VARQ flows for the variable January 1 draft target.

B. Hungry Horse Operations. Fall and winter operations were typical at Hungry Horse, John Roache (BOR) reported. The dam released minimum flows through April. Inflow volume for January to July was 91% of normal, after forecasts in January of 100% (average) inflows. Starting on May 1, the operation ramped up to VARQ flows of 6 kcfs based on an inflow forecast of 99.1% of normal.

Precipitation declined in June and the project ramped down, targeting flat flows, in the effort to conserve water for refill. The June operation is challenging because the dam can't spill much before exceeding the 110% water quality standard for TDG saturation.

On July 19, Hungry Horse reservoir hit a maximum elevation of 3,551.15 feet and drafted slowly toward elevation 3,550 feet by September 30. Outflows remained around 2.5 kcfs during this period. Once the end of September elevation was achieved, the minimum flow requirement was 2.5 kcfs, so the same operation continued.

Hungry Horse powerhouse capacity is approximately 12 kcfs with 4 units running. The normal winter flood control elevation of Hungry Horse reservoir is approximately 3,546 feet. The purpose of VARQ flows at Horse is to shift volume from winter to the spring spill period.

C. Grand Coulee Operations. Grand Coulee operation in 2009 was also typical, Roache said. The reservoir reached elevation 1,283 feet in October for kokanee spawning, then rose to 1,288 feet by November 1 to support the chum operation at Bonneville. Grand Coulee was heavily drafted in March and April due to changes in the March inflows forecast at The Dalles. Grand Coulee flood control elevations are based on inflow forecasts at The Dalles. The March forecast at The Dalles was 80% of normal and increased to 90% of normal in April. That meant a huge increase in flood control releases at Grand Coulee in order to draft 24 feet, or 1,727 kaf, out of the reservoir. Grand Coulee reached elevation 1,277.5 feet on August 31, 2009.

Most of the 2008-09 winter operation at Grand Coulee was driven by Bonneville tailwater elevation requirements. The springtime operation took the reservoir from elevation 1,281 feet to 1,257.7 feet on April 30, which helped to smooth out 7-day average inflows at McNary Dam downstream. The Grand Coulee reservoir was at 1,290 feet on July 6 and began drafting toward the end of August target elevation of 1,278 feet. The goal was to keep the elevation below 1,277.8 feet, which was met.

D. Upper Snake Flow Augmentation. The year 2008-09 was a low water year. Roache showed TMT a graph on flow augmentation in the upper Snake River. The BOR released 487 kaf of flow augmentation in the upper Snake above Milner Dam between June 19 and August 28. This was the first year BOR followed the 2008 BiOp, which calls for earlier water releases than the typical July-August releases of past years. The purpose of the change is to keep temperatures sufficiently cool at Lower Granite Dam throughout July and August. This goal was met in 2009.

Unexpected heavy precipitation in the upper Snake basin in June 2009 meant that flow augmentation turned into flood control releases as flows approached flood levels. The excess water was released from July 5 to July 31, mostly in the form of flat flows of 3-4 kcfs.

E. Canadian Operations and Impacts on Columbia River System. BPA stored 1 maf of flow augmentation in Canada during the heavy rains of January 2009 and released it in July, Tony Norris (BPA) reported.

F. Dworshak Spring/Summer Operations Review. Steve Hall reviewed Dworshak 2009 summer temperature operations, final refill, and the flood control shift from Dworshak to Grand Coulee. The water supply forecast for Dworshak this year started out rosy and slid to average. On April 1, the COE shifted 134 kaf of flood control space from Dworshak to Grand Coulee. When the April 7 flood control forecast showed that Grand Coulee needed to draft 24 feet of water, it meant Grand Coulee couldn't absorb the flood control shift volume scheduled to begin at the end of April. The Dworshak operation therefore went immediately to maximum discharges, which caused brief exceedances of TDG saturation levels. The flood control shift was designed to protect fish flows in low water years like 2009, but the increasing inflow forecast of April made it difficult to implement.

Refill at Dworshak caused confusion in 2009. The COE refills Dworshak by operating the project to certain criteria, timing final refill when the inflow hydrograph drops below the powerhouse maximum of 10 kcfs. It's a difficult balancing act every year, and in 2009 the risk of not refilling was especially high. On June 10 the COE did a snow flight of Dworshak basin and was surprised to see ripe snowpack, with only 5-6% of runoff remaining. On June 22 the reservoir refilled based on the falling hydrograph, which caused some concern. The operation intercepted the falling hydrograph by 7 kcfs, which supports the assumption that waiting much longer could have resulted in failure to refill.

Temperature operations went well this year, with only 2 exceedances at Lower Granite tailwater. Both were due to circumstances beyond Action Agency control, occurring when Dworshak was releasing maximum discharges of the coldest water available. The 2009 temperature operation helped moderate Lower Granite pool temperatures at the beginning of summer passage season.

Lessons Learned:

- If it's typical for Dworshak inflow forecasts to deteriorate as the season progresses, that should be built into forecasting procedures. To whatever extent that can be foreseen, it could be factored into the operation. Early forecasts are the most subject to error. Even by April 2009, there was a $\pm$ range of 400 kaf, or 800 kaf of possible variability in the inflow forecast.

4. Review of Specific Operations. *What was learned about specific operations that were requested by TMT members or other regional entities? How effective were these operations in achieving the intended goal? Should they be continued or modified in future years? Why or why not?*

A. Dworshak Head Seal Repair and SOR 2009-2. The temporary head seal repair at Dworshak unit #3 took the unit out of service from late May to early June

2009, Hall recalled. The repair was completed in time for summer fish operations and lasted through summer, but the leakage continued all summer long, requiring additional pumping. In fall 2009, the seal was repaired a second time. That repair is expected to last for a few years, maybe longer. The seal was last repaired in 1991-92. Unit #3 is now functioning well.

Dworshak SOR 2009-2 dealt with the transition from drafting to refill. A period of high flows in April was followed by a cold spell that caused inflows to decline. SOR 2009-2 requested full powerhouse discharges from May 12-17 to achieve 100 kcfs inflows at Lower Granite. Due to the risk of not refilling, the COE responded with a compromise operation.

At the April 22 TMT meeting, the COE agreed to boost Lower Granite inflows as requested. During this period, the COE followed protocol for a 95% confidence level of refilling the reservoir based on when inflows intersect the flood control refill curve. That intersection occurred on April 18, which is when the COE normally would have transitioned to refill mode. On April 29, TMT met again and the COE approved a second request for additional discharges from Dworshak. On May 6, TMT agreed collectively to reduce Dworshak discharges to minimum flows and begin actively refilling Dworshak reservoir.

On May 12, the COE received SOR 2009-2 requesting full powerhouse discharges out of Dworshak from May 12-17 to maintain 100 kcfs inflows at Lower Granite. TMT discussed the SOR on May 13 and the COE responded with a compromise operation based on ESP inflow forecasts and the flood control refill curve. At the time, there was a $\pm$ 400 kaf variability in the Grand Coulee inflow forecast, and the reservoir elevation was 20 feet below the FCRC, which the COE defined as an unacceptable risk of not refilling. This risk was underscored by snowpack data that showed, in 4 of 12 years with similar inflow volumes, the reservoir would not refill.

Margaret Filardo (FPC) asked how far the refill target would have been missed if the SOR had been fully implemented. Hall estimated the maximum risk was 6-7 feet below the target elevation, which represents a substantial volume of water lost, according to the worst 4 years covered by the modeling exercise.

Dave Wills asked, did the COE account for lower elevation snow pack in planning the 2009 Dworshak operation? In 2008 Dworshak had an inverted snow pack, with more snow at low than high elevations, Hall said.

Lessons Learned:

- Balancing refill and spring flow augmentation at Dworshak is challenging. An important piece of the puzzle will be evaluation of anomalous factors in the basin that traditional forecasts don’t take into account. The main difference between the 2009 and 2008 Dworshak operations was how much riper the snow pack was this year than predicted.

- The region could benefit from better historical information and more clarity regarding forecasting tools and uncertainty. Regional discussion is needed of acceptable levels of risk involved in the balancing act that drives Dworshak operations.

B. Chief Joseph Spill Deflectors. When Grand Coulee had to draft 24 feet of flood control space in April 2009, the situation presented the COE with an opportunity to test the new deflectors at Chief Joseph Dam. Amy Reese (COE Seattle) presented results of 12 spill tests. Deflector installation at all 19 spill bays has led to successful TDG abatement at Chief Joseph Dam, based on 1999 study results compared with results from the 2009 spill test.

The new deflectors almost tripled the amount of flow that could pass through the bays while maintaining a 120% TDG saturation limit in the tailrace. The uniform spill pattern consistently produced lower TDG levels than the bulk spill pattern. Tailwater elevations also impacted TDG production. Spillway flows, powerhouse flows, and spill patterns were all tested at spillway volumes ranging from 18 to142 kcfs. Submergence of the flow deflector crest at 5, 10 and 15 feet was tested at flow rates of 18, 58, 98, and 142 kcfs, or 3-7 kcfs per bay. All tests were done within the range of a skimming jet or surface jet. A fixed monitoring station downstream of Chief Joseph was found to be unreliable and has been successfully repaired.

TDG readings at Chief Joseph have important implications for downstream operations (there is no fish passage at Chief Joseph itself). The current spill cap for 120% TDG is 100 kcfs, but will be adjusted real-time based on data from the fixed monitoring station downstream of the project. In 2009 the Chief Joseph spill cap for 120% was originally set to 100 kcfs, but was then lowered to 80 kcfs based on real-time data from the fixed monitoring station.

Lessons Learned:

- Now that the region is satisfied the flow deflectors work, Chief Joseph's ranking on the spill priority list needs to be revisited.

C. Libby 2008 End of December Variable Draft Methodology and 2009 SOR. Joel Fenolio (COE) described the process the COE uses to establish end of December variable draft targets for Libby Dam. If the December 1 inflow forecast is over 5,900 kaf, the project is drafted to elevation 2,411 feet. If the forecast is less than 5,500 kaf, the project is drafted to 2,426.7 feet. Forecasts of 5,500 to 5,900 kaf are interpolated between the two elevations, which creates a less rigorous draft requirement than drafting to elevation 2,411 feet. This interpolation process is spelled out in the Water Management Plan. It translates to approximately 2,420 feet elevation.

The December 1, 2008, Libby inflow forecast was 5,937 kaf, 94% of average. That resulted in an interpolation between 2,426 feet and 2,411 feet. If actual inflows had been 94% of average, it would have meant 1.8 maf of space in the reservoir was needed, a relaxation of 116 kaf of required draft. So the COE reran the model with the reservoir at 2,408 feet at the start of refill instead of the actual elevation of 2,405.3 feet. Language in the WMP has been changed to reflect the 2009 operation.

The Libby 2009 SOR called for a 0.8 maf sturgeon pulse, heavily weighted on river temperature, and a full-powerhouse operation of 7 days (as opposed to the previous request for 14 days), then dropping to 20 kcfs for 5 days, 17 kcfs for 5 days, and 15 kcfs for 5 days. When precipitation deteriorated, TMT decided at its June 24 meeting to reshape the sturgeon pulse. In recent years the sturgeon pulse has been starting later, which impacts the FCRC.

Lessons Learned:

- The region needs further discussion of Libby operations in light of lower river flows, upper river flows, refill and forecasting trends.

- There's strong interest in having more flexibility around strict VARQ flows when conditions are dry. The COE plans to look at this more closely in spring 2010. Perhaps the best value can be found in evaluating associated risks in potential deviations to the VARQ FC procedures. It might be possible to get a deviation request for Libby operations in dry years.

D. Steelhead and Spring Chinook Juvenile Survival in 2009. Bill Muir (NOAA Science Center) presented information on juvenile travel time and survival rates for spring Chinook, steelhead, sockeye, and fall Chinook salmon. He discussed percentages of fish transported in 2009 in relation to previous years, and gave estimates of the number of fish that pass through the hydro system undetected.

The year 2009 was a normal flow year in the Snake Basin, close to average for the past decade in Little Goose, Lower Monumental and Lower Granite reaches. Average weekly spill in 2009 was a bit high but not exceptional, while temperatures throughout the Snake basin stayed cool.

Snake River survival estimates were based on fish tagged at Lower Granite specifically for the study, as well as all other tagged fish in the basin. Most PIT tag detection is in the Snake, with not much detection capacity in the upper and mid Columbia.

A review of hatchery survival rates in the Snake basin found a significant inverse relationship between survival and distance traveled. The average survival rate for all Snake River hatcheries combined was 59% in 2009, compared to a long-term average survival rate of 61%. Early migrants in 2009 took about 3-4 weeks to travel all the way through the hydro system from Lower Granite to Bonneville Dam.

Steelhead travel time stands out in 2009. Apparently they were not delayed by the low flow conditions toward the end of the year. Steelhead survival was almost 20% higher than the long-term average throughout all reaches.

Spring Chinook survival from Lower Granite tailrace of McNary Dam was 79%, a little higher than the long-term average but similar to rates of the past 3-4 years. Survival from the Lower Granite reservoir to Bonneville tailwater was 53.2% for spring Chinook, about 5% higher than the long-term average. For the upper Columbia reach from McNary to Bonneville, yearling Chinook had an 84% survival rate. Hatchery steelhead in the upper Columbia reach had a 72.5% survival rate.

Snake River sockeye survival from Lower Granite to McNary was a little less than 45% in 2009, which is low. That's considered a solid survival estimate because it's based on larger numbers of fish than in past years. Snake River steelhead survival rates from Lower Granite and McNary to Bonneville were 60-70% in 2009 – the highest survival rate on record, as was the 86.4% survival rate in the upper Columbia. For the Snake and Columbia basins, the combined steelhead and Chinook survival rate was 62% from Lower Granite to Bonneville.

These are all spring survival estimates. Fall survival estimates were lower, ranging from 10-37% for the same areas, which is similar to past years.

Transportation: This year there were big changes in the proportions of fish transported. Only 5-10% of wild Chinook were transported in 2009 compared to 70% of wild Chinook in 2007. In some years, close to 100% of fish were transported.

Muir showed TMT data, linked to today's agenda, on proportions of fish detected, not detected, and transported. He also discussed piscivorous bird colonies at the confluence of the Snake and Columbia whose favorite meal is steelhead. In recent years the COE has been transporting fewer fish, putting more nontagged fish back in the river, and diluting the PIT tagged population.

Lessons Learned:

- Direct or indirect effects of increased spill may not improve smolt to adult survival rates.
- Steelhead survival rates can be increased by collecting fewer of them and keeping more in the river.
- Steelhead survival was high in 2009 due to an earlier migration of both wild and hatchery steelhead than in previous years. This was partly the result of new hatchery practices.
- Steelhead travel times were short in 2009 despite low flow conditions, which helped to boost survival rates. Steelhead had an increased

migration rate of about 1.8 kilometers per day over previous years. This wasn't the case for spring Chinook. Early in the season, fixed structures reduced steelhead travel time by about 10 days, an effect that diminished as flows increased.

- Juvenile steelhead survival was the highest in 2009, with a number of contributing factors including high flow and spill rates.

- In the past, steelhead have suffered from a tendency to residualize, delaying migration until water temperatures were on the rise. Surface passage structures now in place help to move steelhead through the hydro system more quickly, increasing survival rates.

E. Fall Chinook Survival in 2009. Jerry McCann (FPC) presented survival estimates for PIT tagged fall Chinook released in the Snake and Columbia basins during May 20-July 15, 2009.

Fall Chinook survival rates in 2009 were in the 70% range, similar to 2008. Transit times from Lower Granite to McNary were notably shorter in 2009, reflecting good flow conditions. Temperatures seem to be the factor least correlated with hatchery subyearling Chinook survival rates.

Transport rates for Chinook were similar in 2008 and 2009. This year, a wild subyearling Chinook arriving at Lower Granite Dam had about a 41% chance of being transported (or about a 51% chance for all Chinook). The study found a strong relationship between subyearling Chinook survival, spill proportion, and water transit time. Chinook survival in 2009 was high thanks to good flows and high spill proportions during the fall passage season.

Russ Kiefer asked whether the rate of 52% of fish transported in 2009 accounts for higher mortality rates in the in-river group. The proportion of transported fish that survived was around 40-45%, McCann said.

F. Chum Spawning Operation. TMT has been vigilant regarding the chum operation in recent years, Tony Norris (BPA) recalled. Because Bonneville Dam is at the end of the hydro system, a lot of factors have to come together to make the chum operation a success. Inflows, tidal cycles, lack of storage space in Bonneville pool, operational limits, construction of The Dalles spill wall, power system needs, even operation of Brownlee Dam all have enormous influence on the ability to keep the Bonneville tailwater elevation around 11.5 feet while limiting risk to spring flows. It takes extra flows to provide a higher daytime tailwater operating range, which can raise the risk to spring flows. The need to move excess water out of Bonneville at night is limited by a recent finding that tailwater elevations higher than 18 feet can disrupt spawning activity. If flows are too high to pass the excess without exceeding 18 feet, the daytime tailwater elevation can be raised to 12.5 feet.

Russ Kiefer asked whether the chum operation would work at a regular tailwater elevation of 12 or 12.5 feet instead of 11.5 feet, which is harder to maintain. The range of 11.3-11.7 feet was quite manageable in 2009, Norris said. It's difficult to know how the chum operation will impact refill in a given year until the third week of February. A number of variables can impact the chum operation. There are times when an 11.5 foot tailwater elevation isn't sufficient to accommodate the chum run, Wills said.

Lessons Learned:

- The 2009 chum spawning operation was highly successful despite limits on the Bonneville tailwater elevation imposed by spill wall construction at The Dalles.

5. Further Observations. TMT members ended this annual review with some closing thoughts on 2009 operations.

- Deviations from flood control elevation requirements could be helpful.

- Integration of bull trout minimums and the sturgeon pulse with the modeling of VARQ flows is needed.

- Temperature operations went well in 2009.

- Better communication of risk management is needed. The region needs to clarify acceptable levels of risk.

- The court-mandated rollover limited some 2009 operations such as spill priorities, refill targets, and flood control. Decisions made at higher levels have limited the issues TMT can debate. More discussion of spill is needed to better understand what's possible.

- Stakeholders have learned the art of compromise. The chum operation and Libby operation are two examples of issues that generate significantly less controversy now than in the past, thanks to regional collaboration.

- The Action Agencies are more flexible and receptive to operational requests than in past years.

- More data are available to support TMT's observations.

- Frustration can result when people don't understand the basis of decisions. The Dworshak 2009 operation was a classic example.

- More explanation is needed of the COE's methodology for managing December draft targets.

- The region needs to discuss how low flows affect Libby operations.

- The facilitation team has been beneficial to the TMT process.

- TMT is a higher functioning group that it used to be, resolving issues more readily.

- TMT members appreciate the complexity of the issues they're dealing with and are willing to work together on finding the right answers.

6. Next TMT Meeting

The next regular TMT meeting is December 23. This meeting summary prepared by consultant and writer Pat Vivian.

Name	***Affiliation***
Amy Reese	COE Seattle
Bill Muir	NOAA Science Center
Brandon Chockley	FPC
Brian Marotz	Montana
Jim Ruff	NPCC
Cindy LeFleur	Washington
Jim Litchfield	Montana
Dave Benner	FPC
Dave Statler	Nez Perce Tribe
David Wills	USFWS
Don Faulkner	COE
Doug Baus	COE
Jason Sweet	BPA
Jeremy Giovando	COE
Joel Fenolio	COE
Kim Johnson	COE
Kyle Dittmer	CRITFC
Laura Hamilton	COE
Margaret Filardo	FPC
Paul Wagner	NOAA
Tony Norris	BPA
John Roache	BOR
Pete Hassemer	Idaho
Richelle Beck	DRA
Rick Kruger	Oregon
Russ Kiefer	Idaho
Shane Scott	NPCC
Steve Barton	COE
Steve Hall	COE Walla Walla
Charles Morrill	WDFW
Robert Stansell	COE

Chris Nicholson	COE
Paul David	NOAA Science Center
Bill Peterson	NOAA Science Center
Jim Faulkner	NOAA
Bill Emmett	NOAA Science Center