Evaluation of Adult Salmon Passage Behavior and Success in Relation to Fishway Modifications at Bonneville Dam, 2014

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Year 2 Objectives

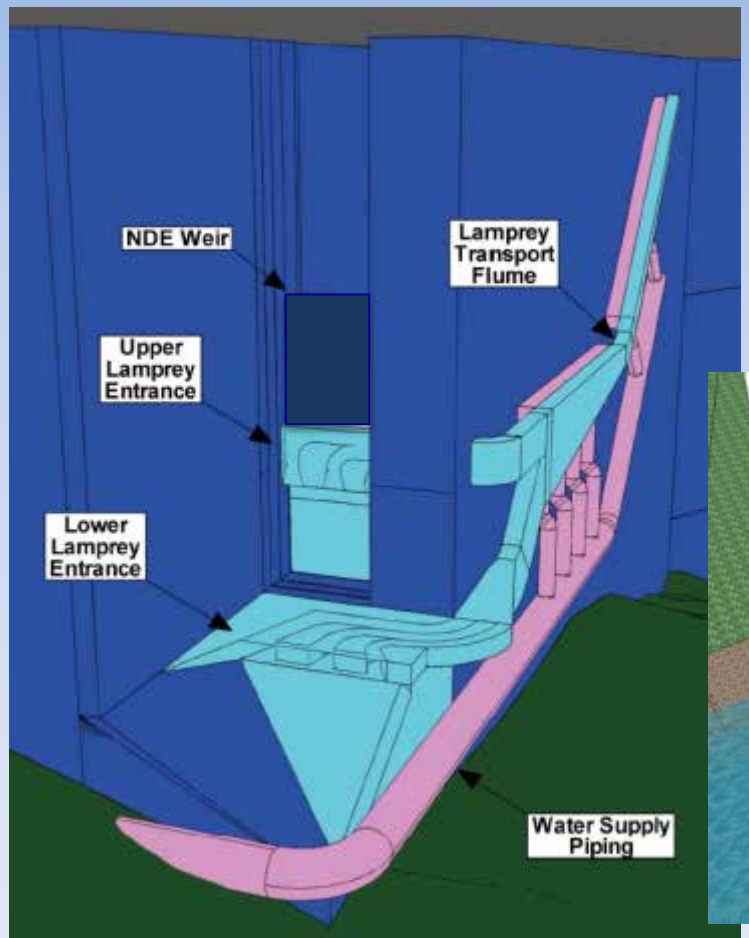
- **Do lamprey modifications impede adult salmonids?**

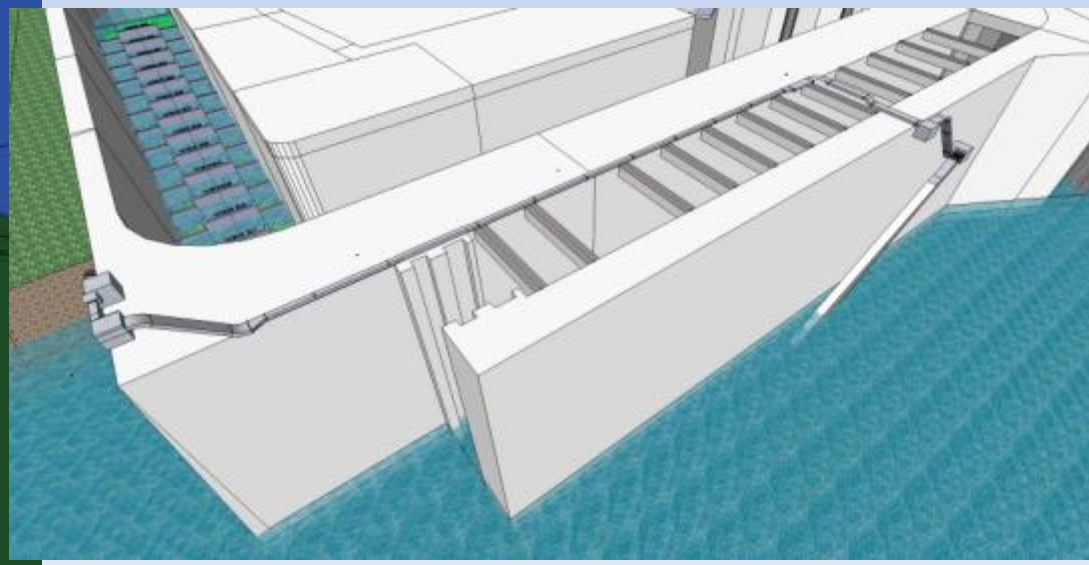
- Evaluate passage behaviors and metrics of Chinook and Sockeye salmon at the **Bonneville Dam PH2 LFS/LPS,** installed 2012-2013

- Evaluate entrance use and passage efficiency at the **Cascades Island fishway entrance,** modified 2008-2009

PH2 North Downstream Entrance

2013 – Powerhouse 2 (PH2) Lamprey Flume System (LFS) Entrance Modification

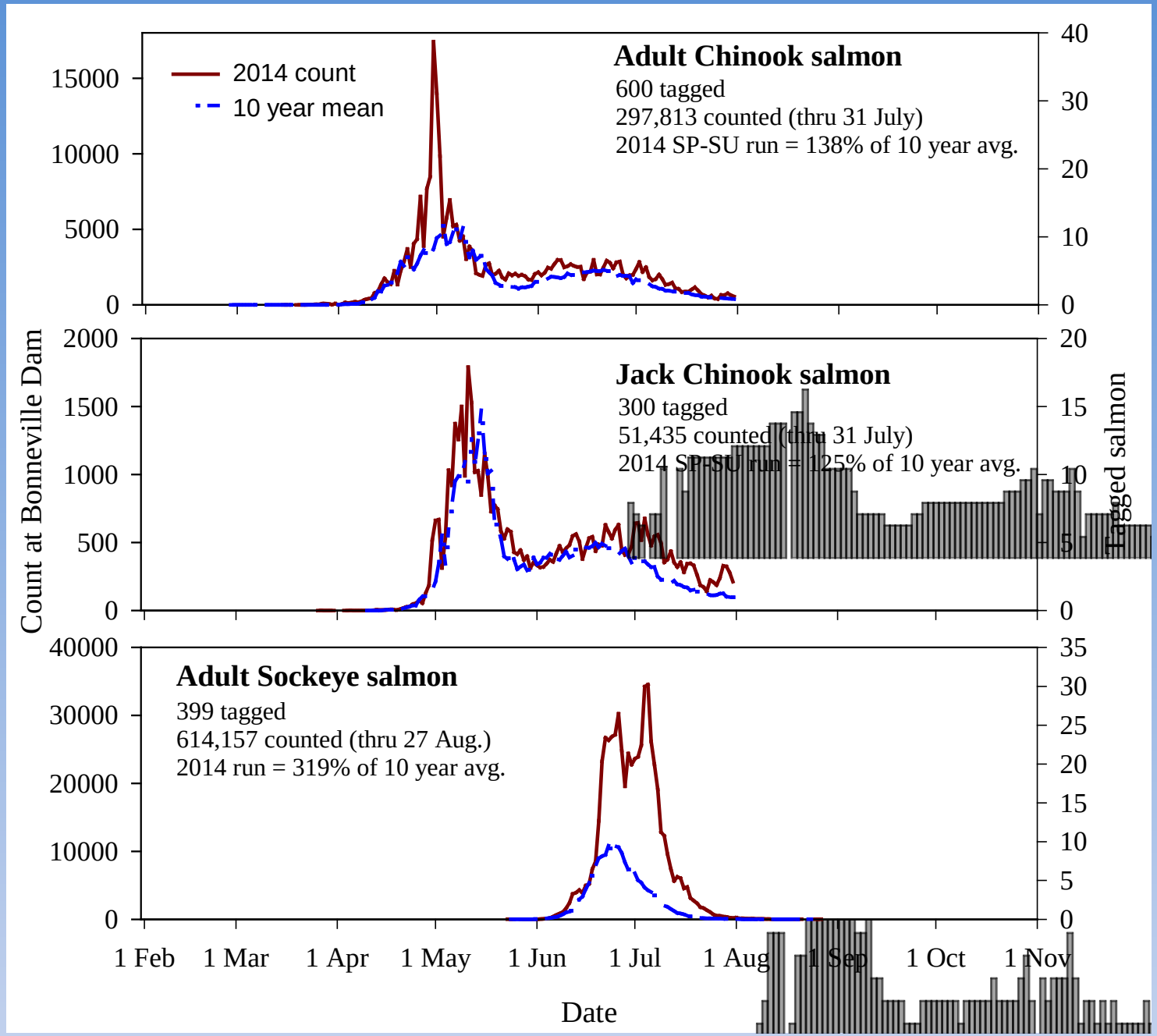




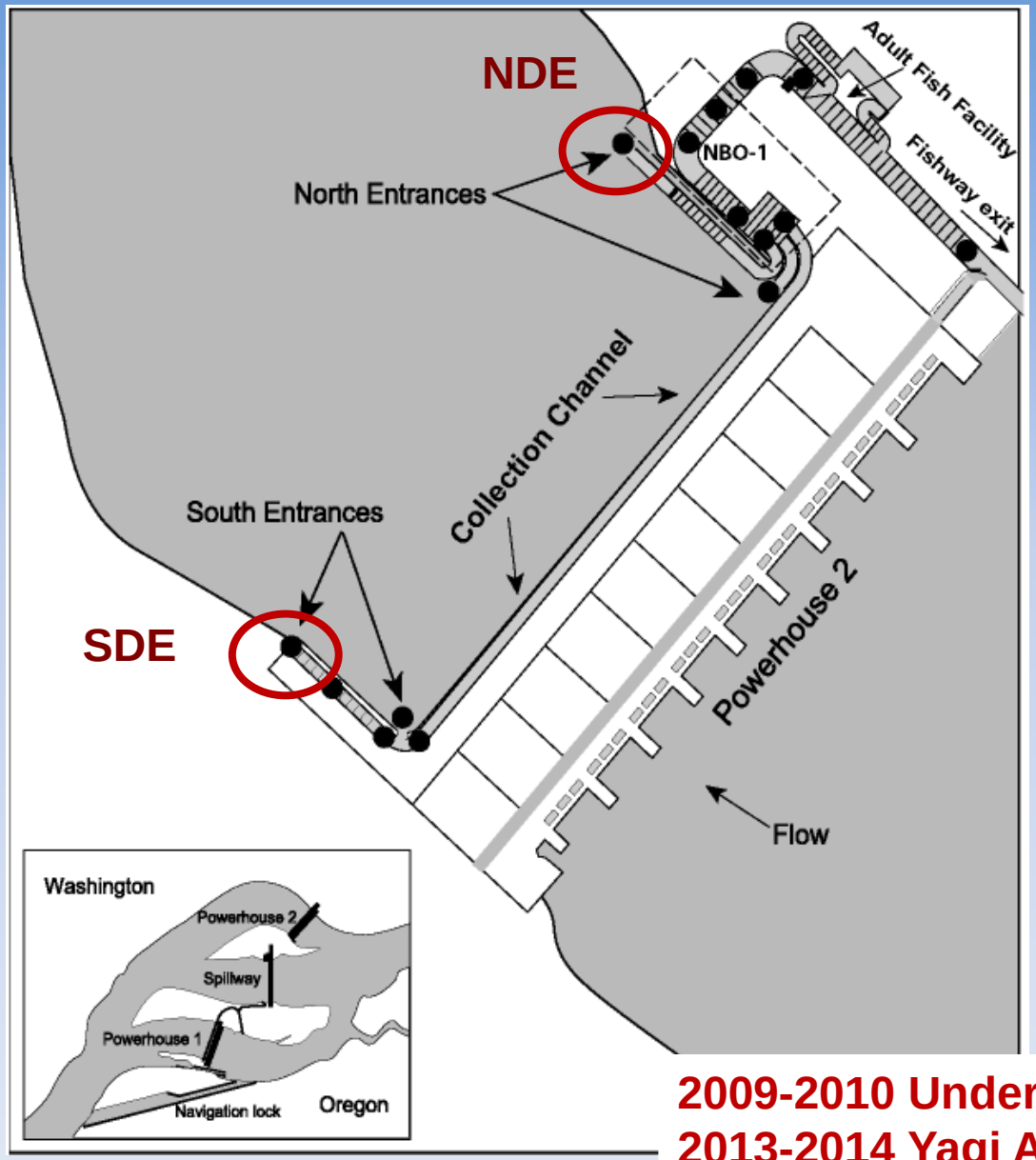
Bonneville Dam Radio-Tagged Salmon and Steelhead

Species	2013	2014
Spring Chinook	328	384
Summer Chinook	272	216
Jack Chinook	300	300
Sockeye Salmon	399	399
Steelhead	789	800

Bonneville Dam Salmon Counts

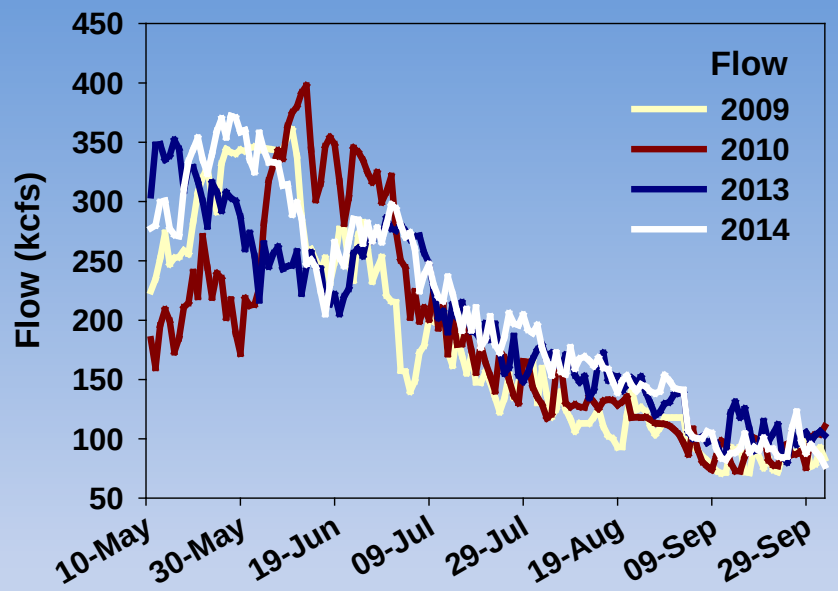


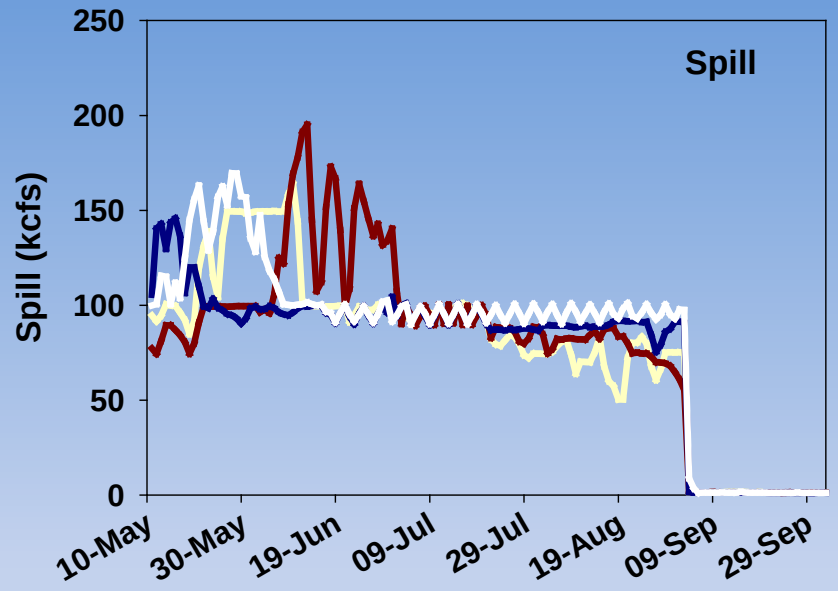
PH2 Monitoring

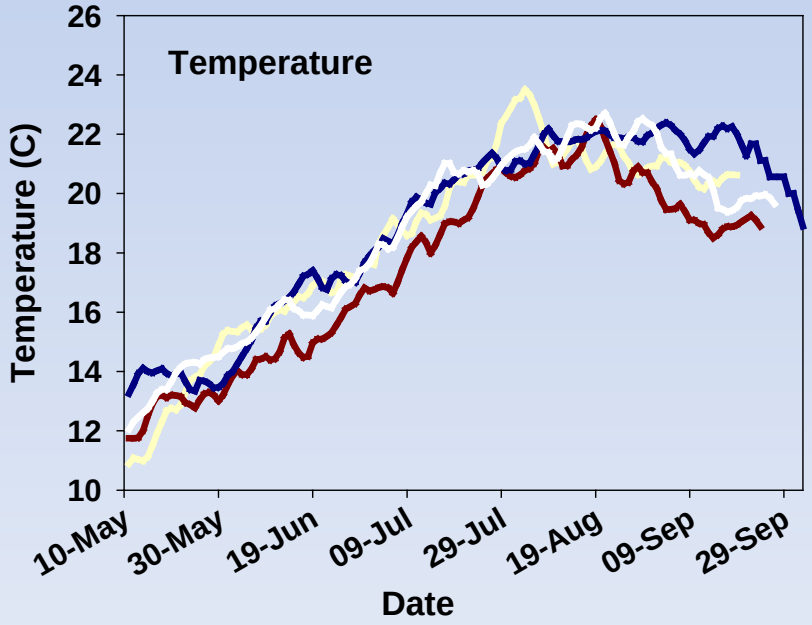


2009-2010 Underwater Antennas
2013-2014 Yagi Antennas

Bonneville Dam

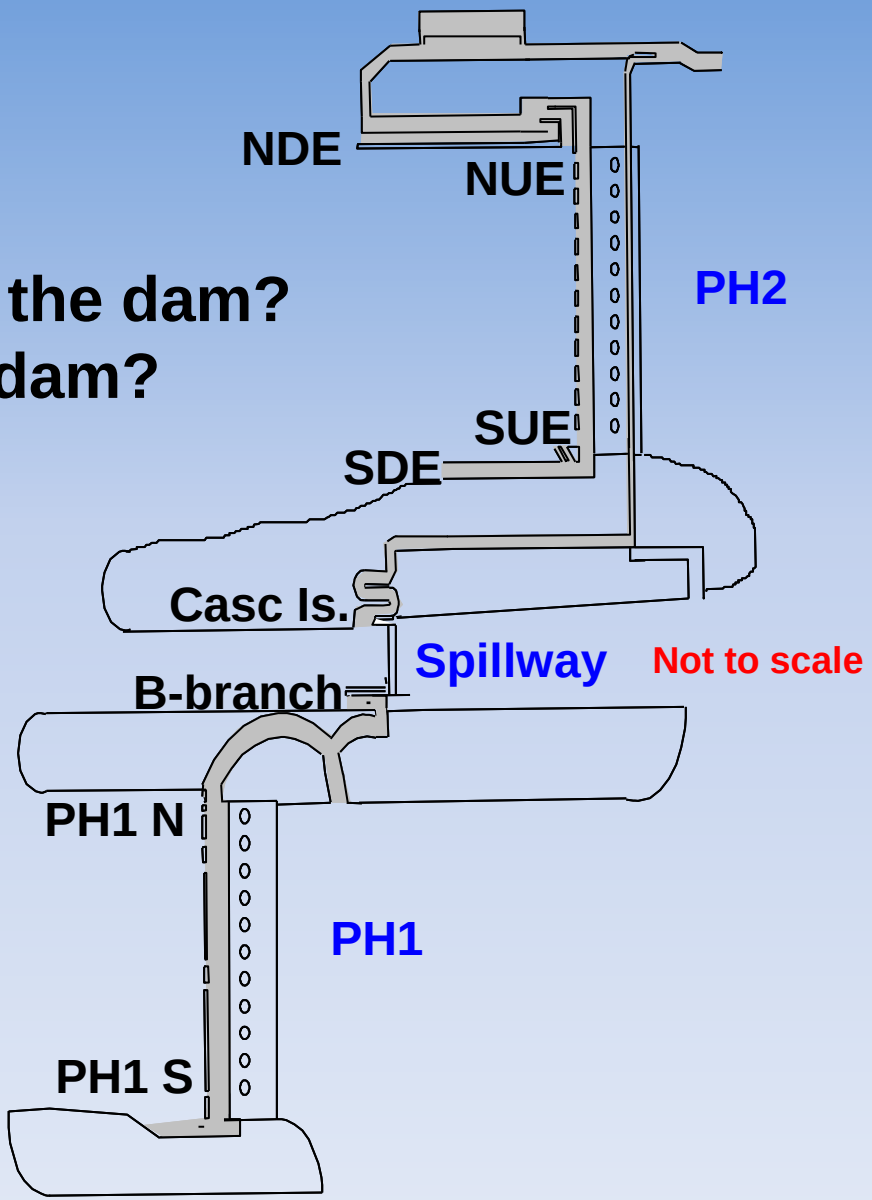




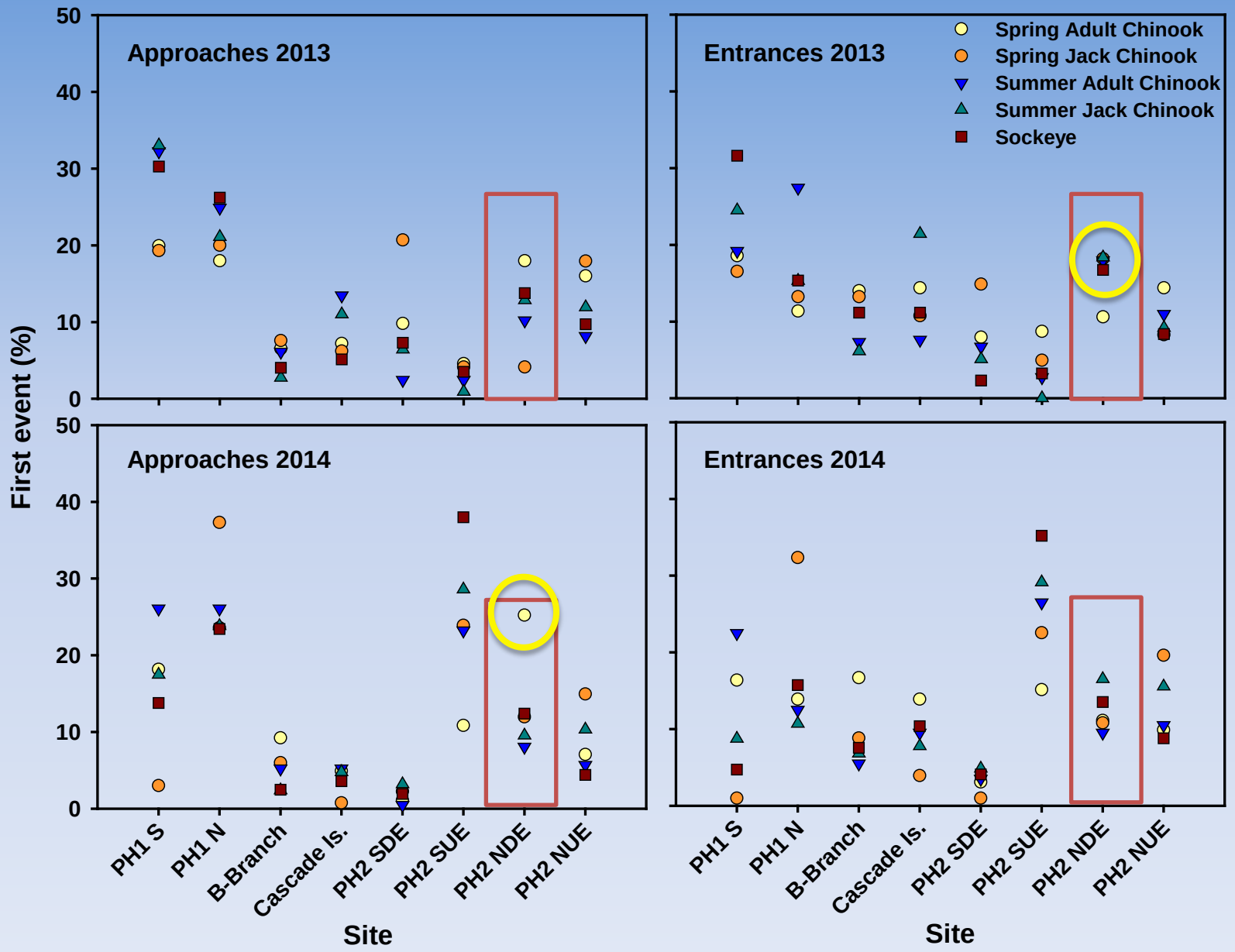


Entrance Use

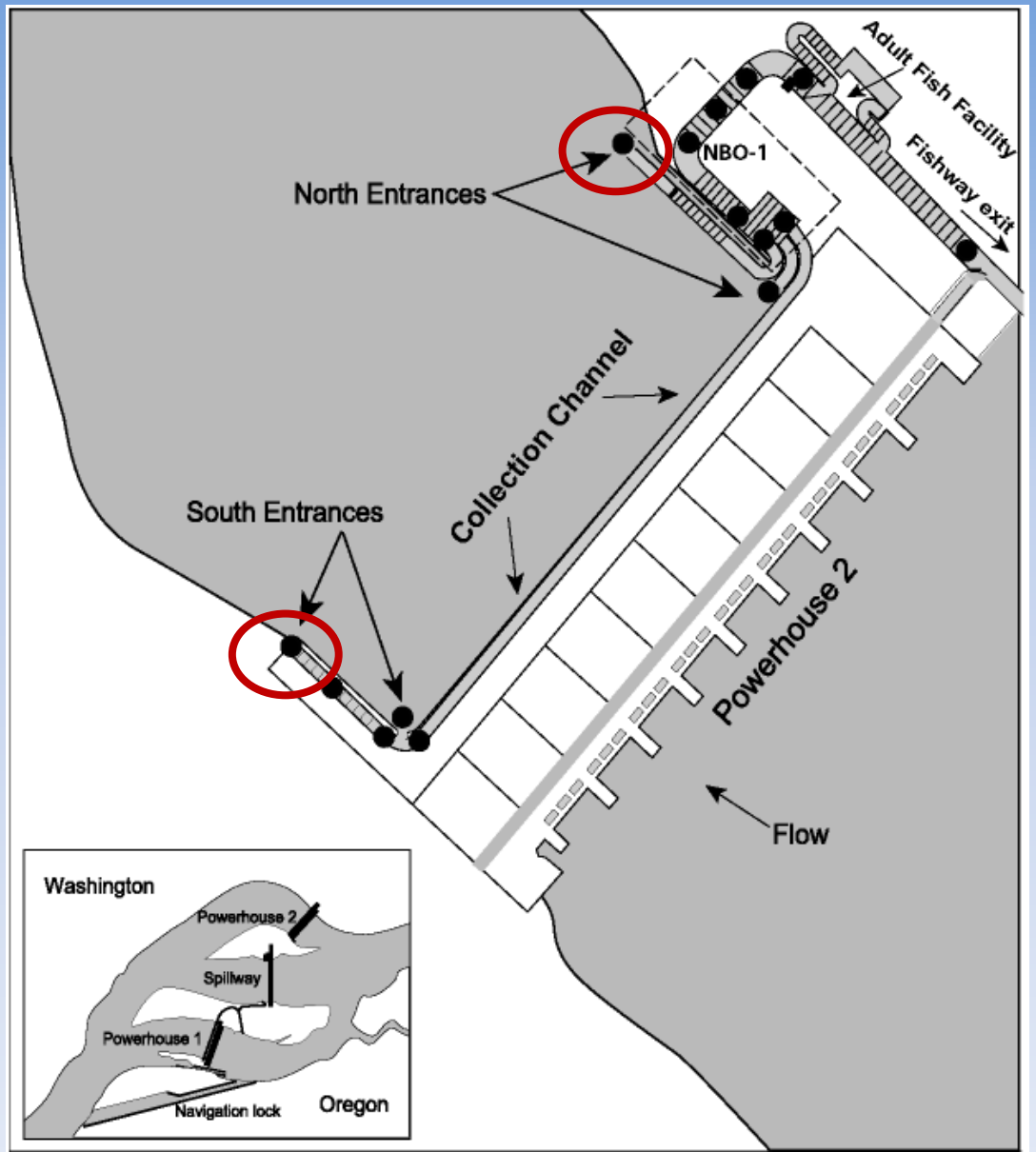
Where did fish first approach the dam?
Where did fish first enter the dam?



Entrance Use



PH2 NDE Metrics: Did Modifications Impede Passage?



NDE Passage Metrics

1) **Entrance Efficiency** $_{(unique)}$ = Ratio of unique fish entering to number that approached **(NDE unique** $_{entrances}$**/NDE**$_{unique\ approaches}$**)**

2) **Exit Ratio** = Ratio of fish exiting to the tailrace to the number that entered **(NDE**$_{exits}$**/NDE**$_{entrances}$**)**

3) **Passage Time** = Time between approach at NDE to entry at NDE **(NDE**$_{approaches}$ **– NDE**$_{entrances}$**)**

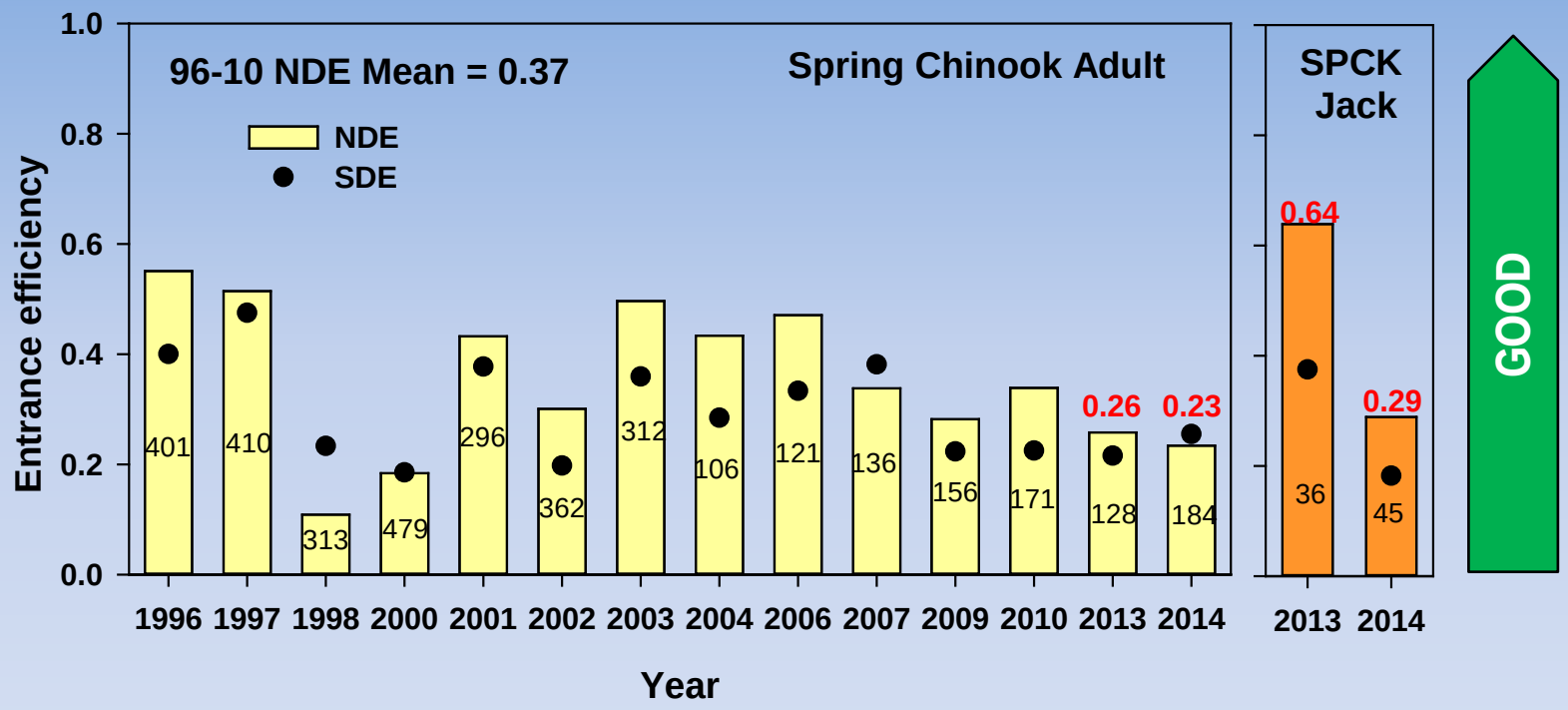
4) **Extended Passage Time =** Percentage of fish that require > 1h between approach at NDE to entry at NDE

5) Entrance to Base of Ladder = Passage time from entrance antenna to the antenna located in the transition pool at the base of the ladder.

6) PH2 entry locations of successful dam passages (PH2 NDE only). Percentage of last pool events that were preceded by an entry at NDE.

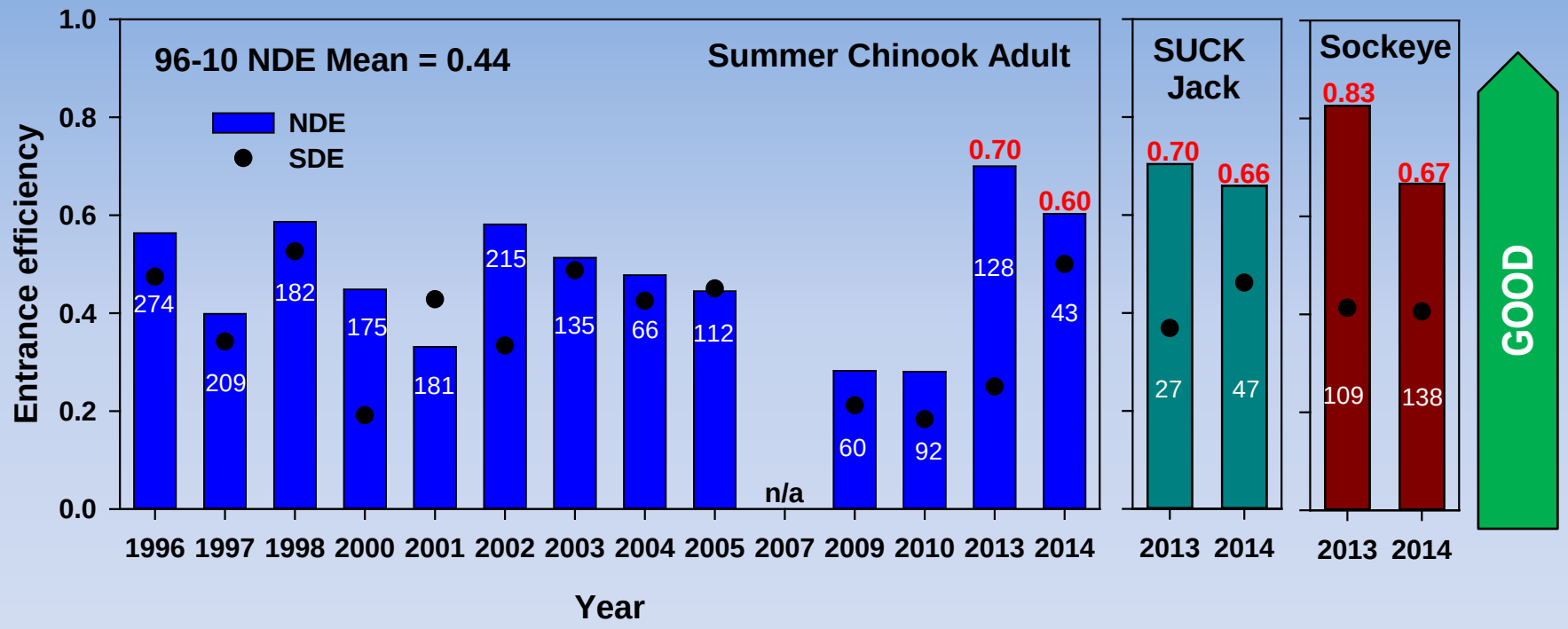
7) Percentage of PH2 NDE approaches and entries in relation to SDE. Percent = NDE/ (NDE + SDE)

NDE Unique Entrance Efficiency Spring



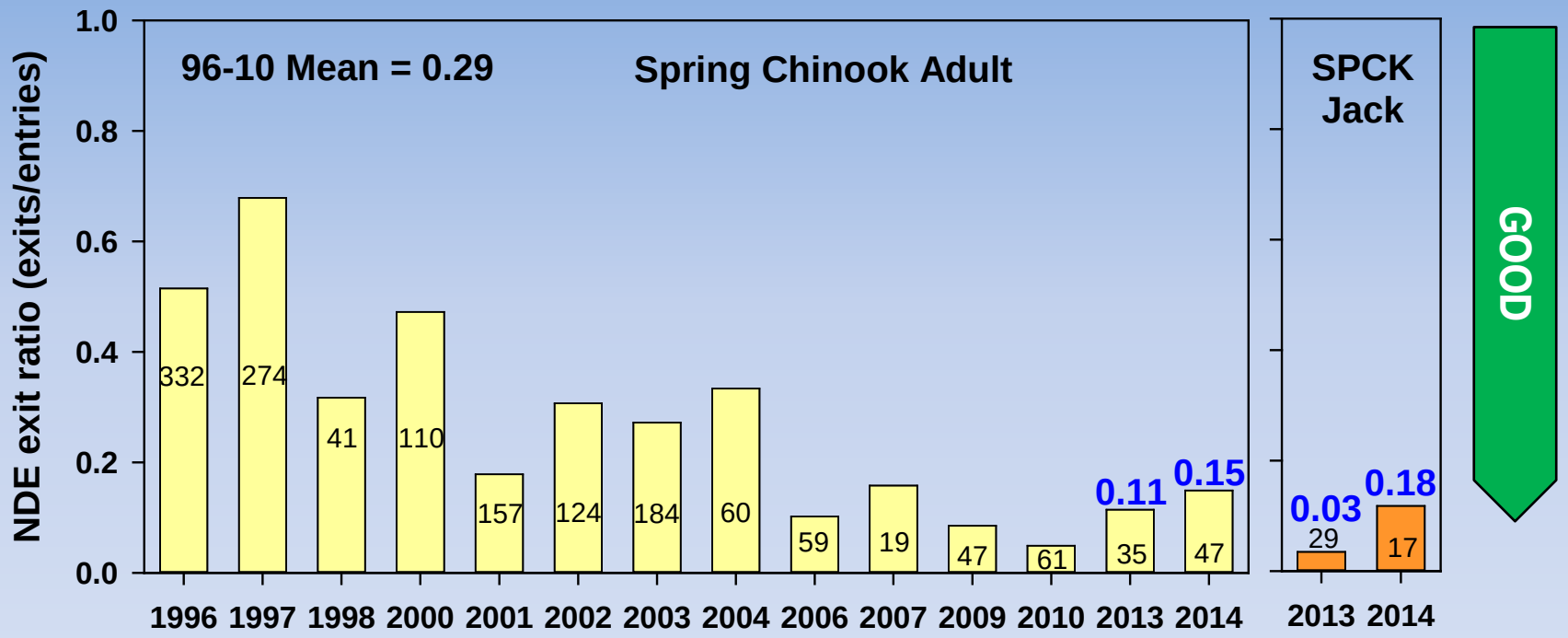
Entrance Efficiency $_{\text{(unique)}}$ = Ratio of unique fish entering to number that approached **(NDE unique** $_{\text{entrances}}$**/NDE**$_{\text{unique approaches}}$**)**

NDE Unique Entrance Efficiency Summer



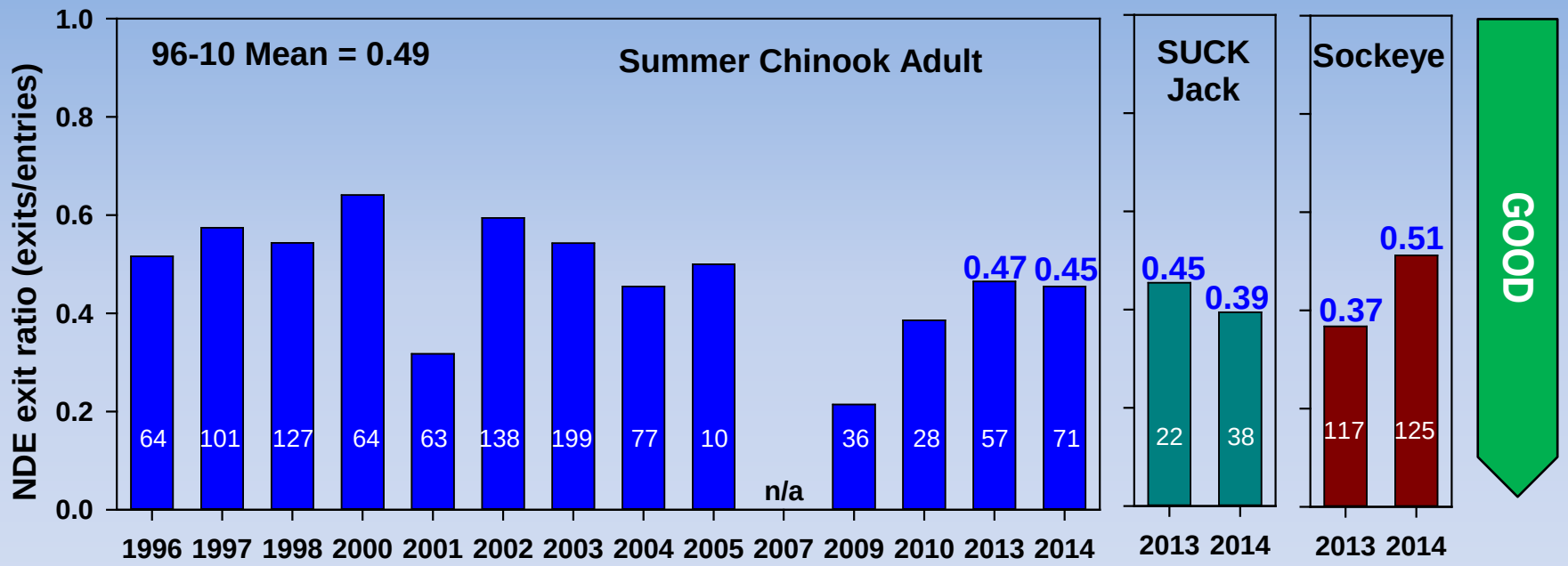
Exit Ratio = Ratio of fish exiting to the tailrace to the number that entered **($NDE_{exits}/NDE_{entrances}$)**

NDE Exit Ratios
Spring

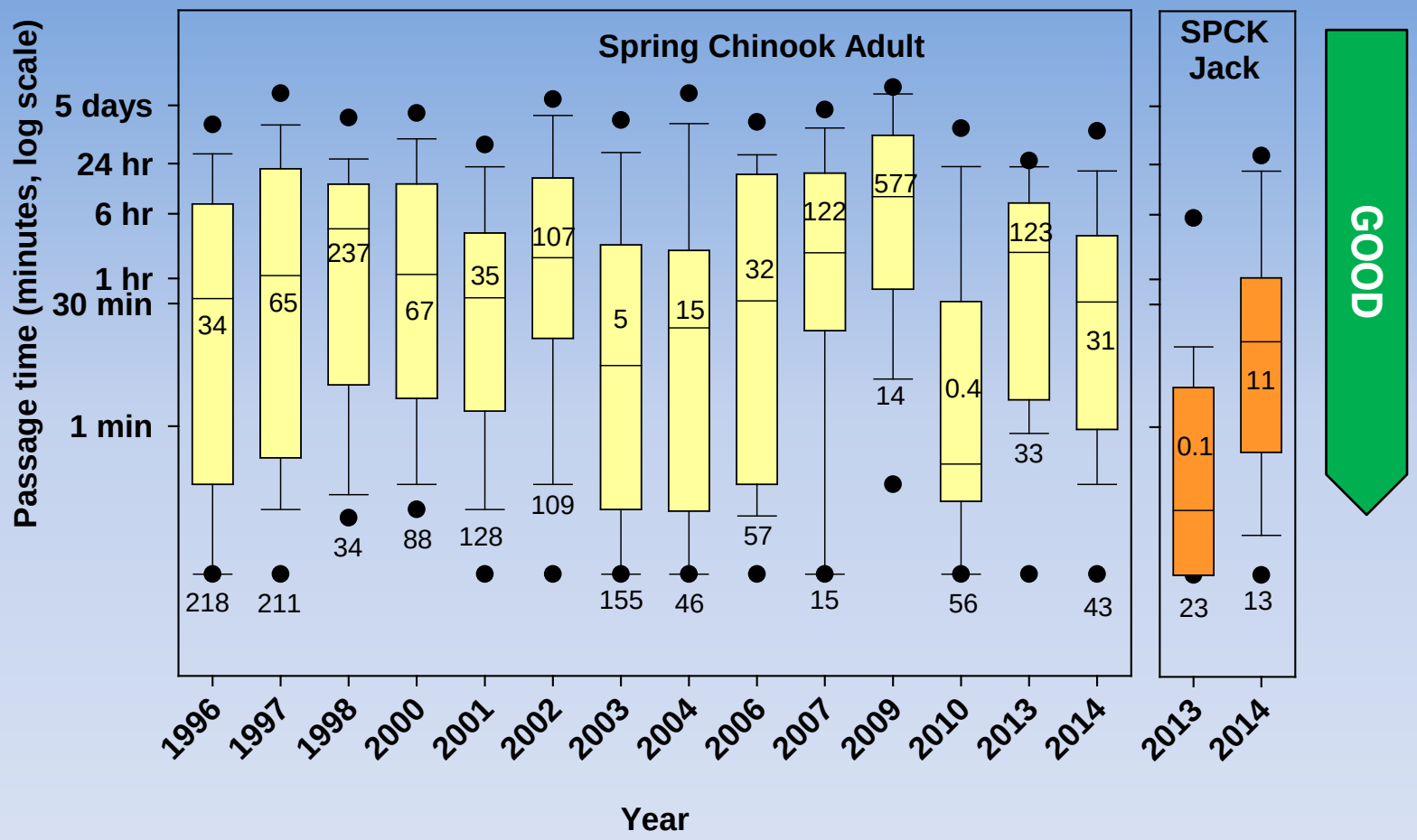


Exit Ratio = Ratio of fish exiting to the tailrace to the number that entered **($NDE_{exits}/NDE_{entrances}$)**

NDE Exit Ratios
Summer

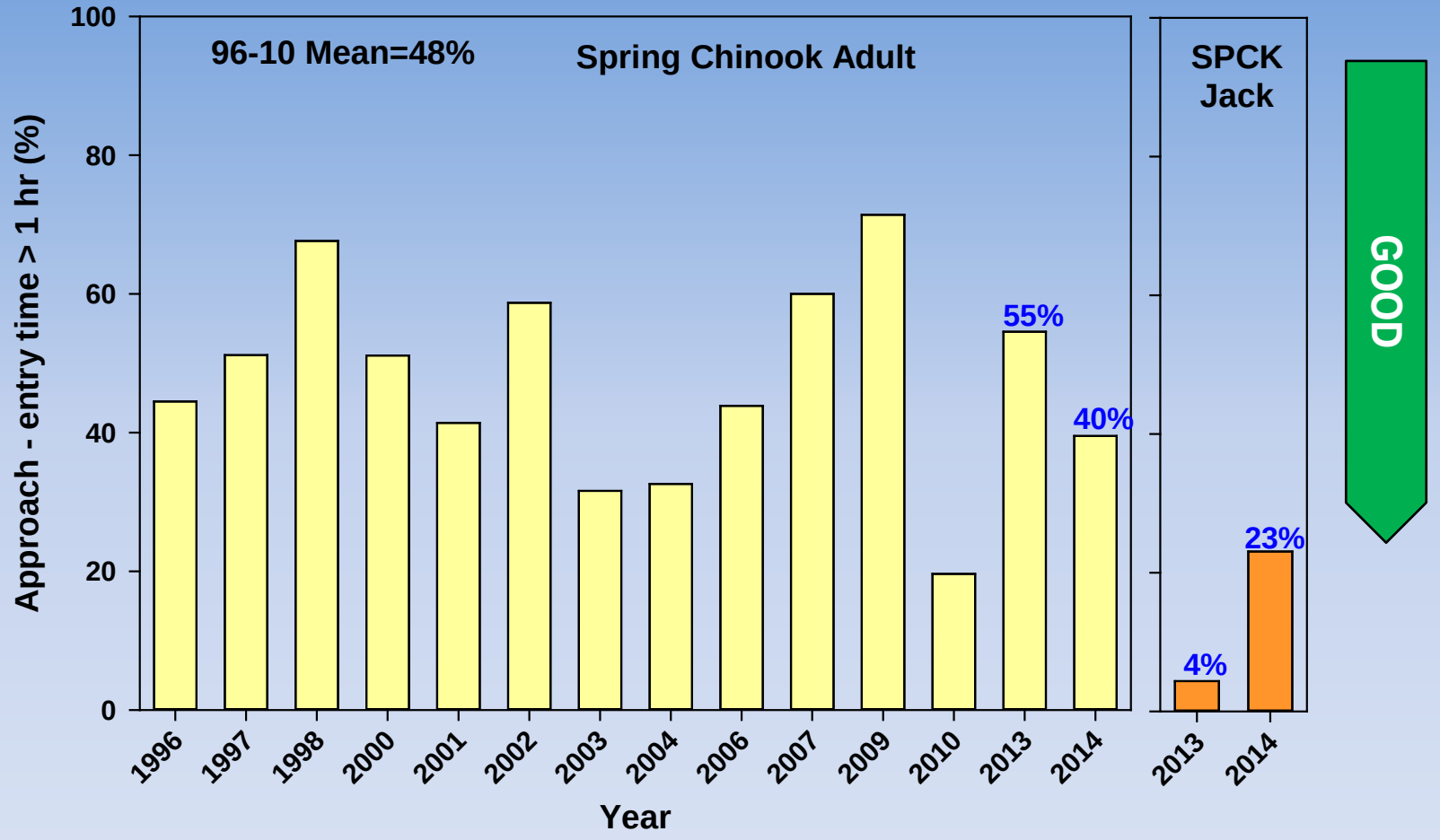


NDE Passage Times
Spring



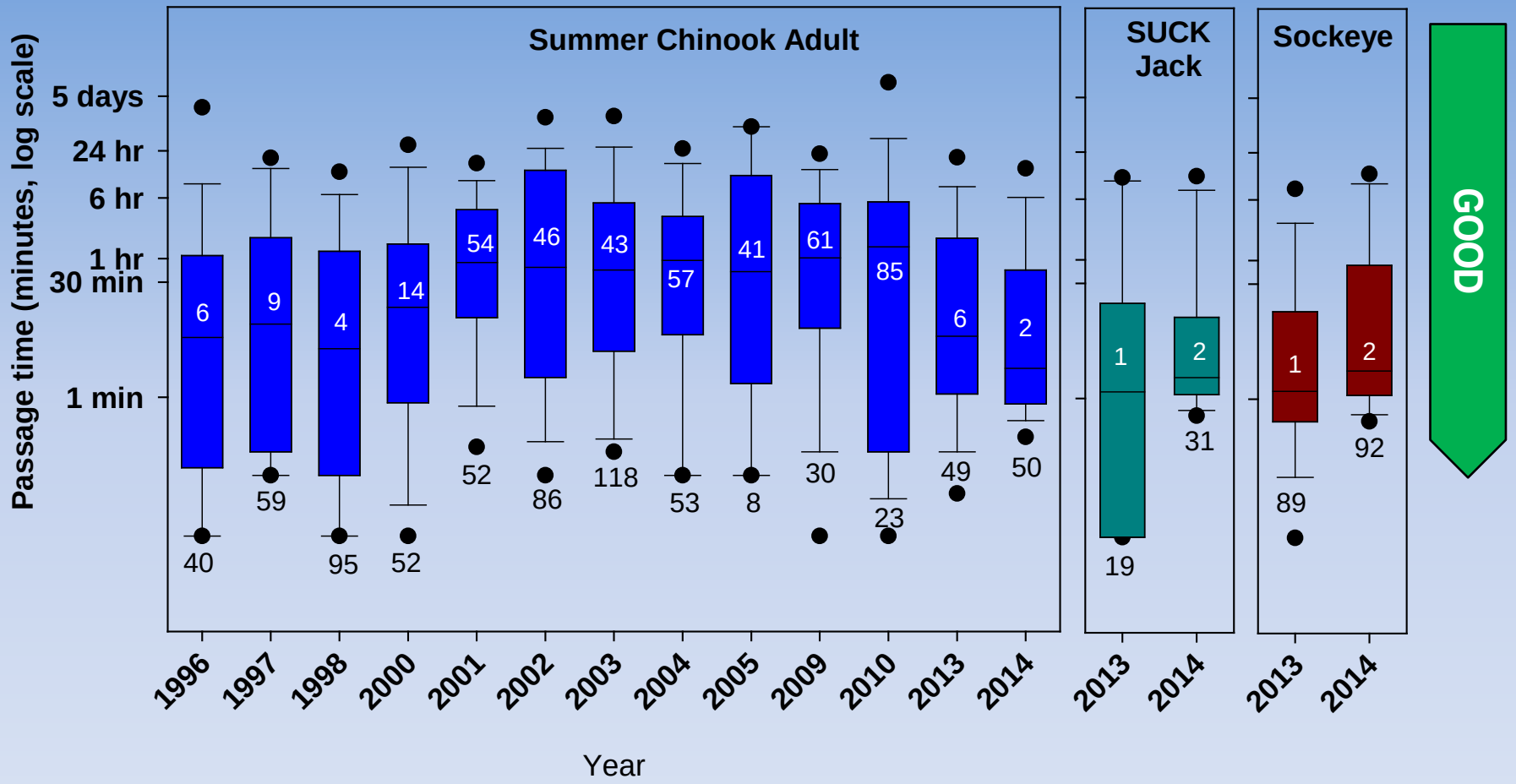
Passage Time = Time between approach at NDE to entry at NDE
($NDE_{approaches}$ – $NDE_{entrances}$)

NDE Extended Passage Times Spring



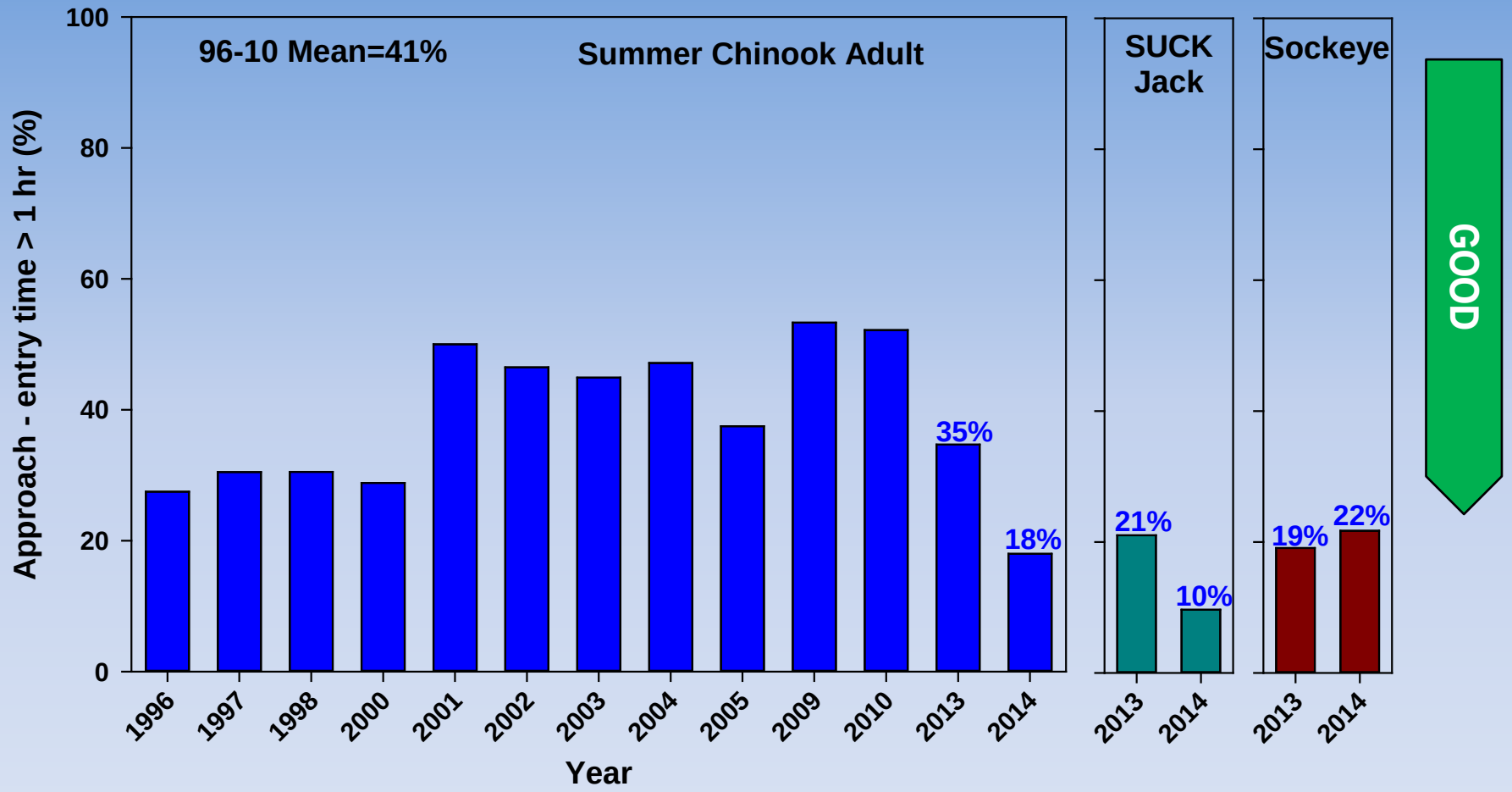
Extended Passage Time = Percentage of fish that require > 1h between approach at NDE to entry at NDE

NDE Passage Times Summer



Passage Time = Time between approach at NDE to entry at NDE
($NDE_{approaches}$ – $NDE_{entrances}$)

NDE Extended Passage Times Summer



Extended Passage Time = Percentage of fish that require > 1h between approach at NDE to entry at NDE

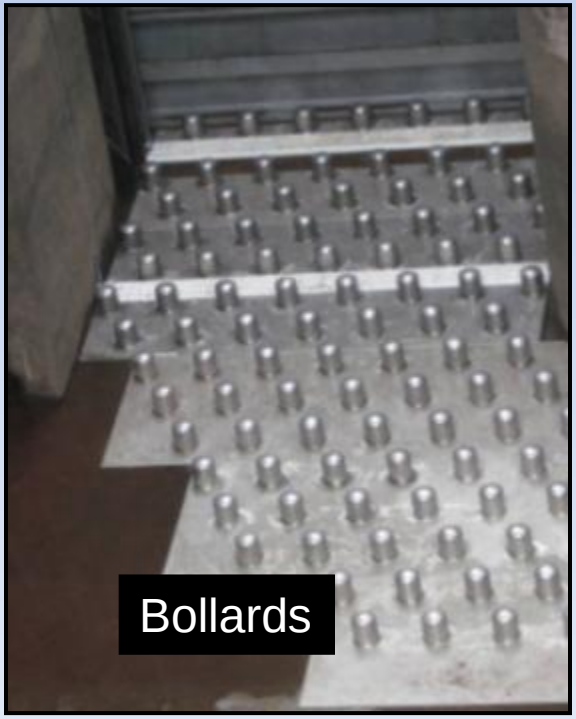
NDE Conclusions

- Passage metrics within historical range or indicated better passage in 2014 for all five groups
- Additional analyses pending

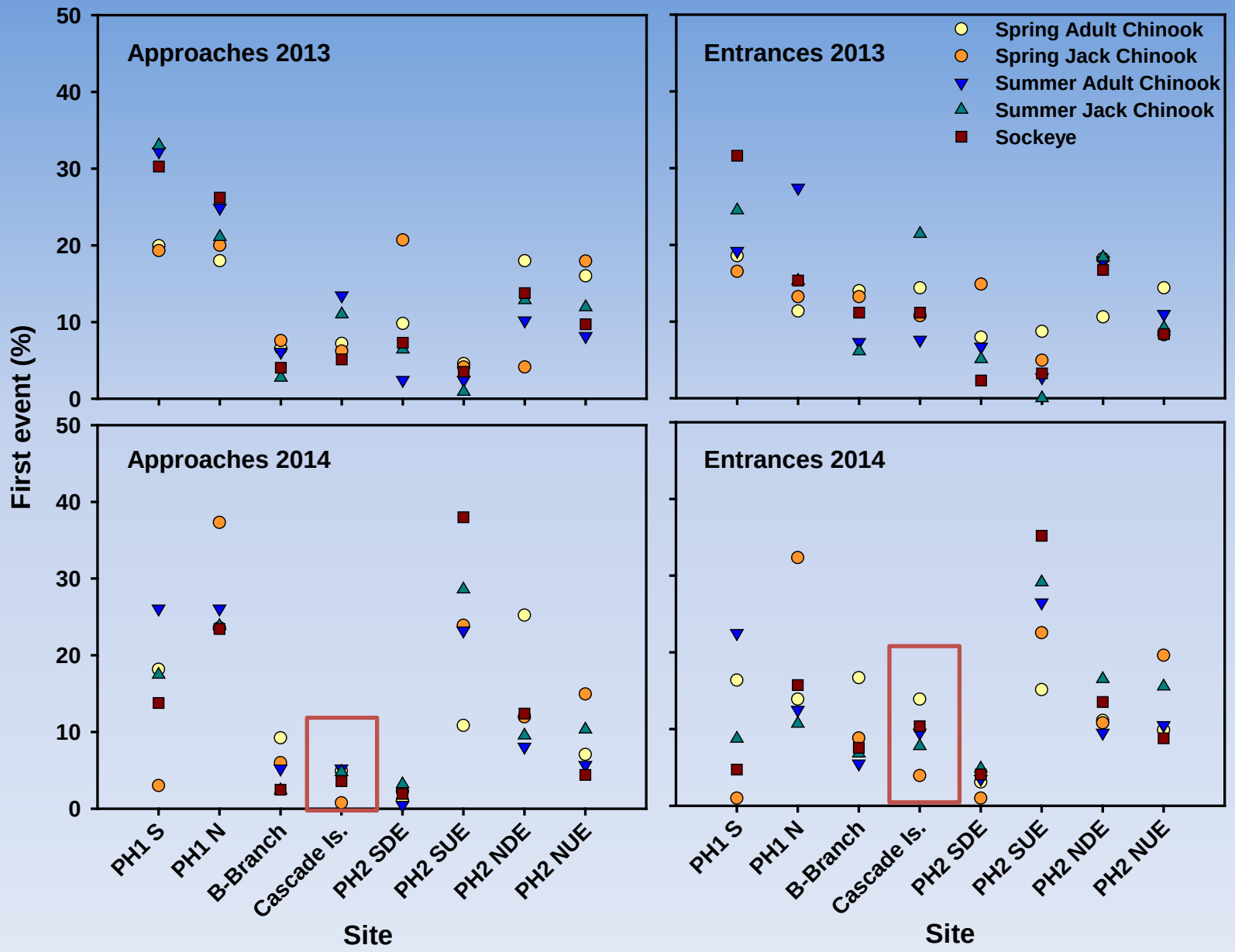
Cascades Island - Background

2008-2009 - Cascades Island Modifications

- Designed to reduce maintenance and improve entry rates for lamprey and salmonids
- Analyses in progress



Entrance Use



Cascades Island Metrics Spring

Metric	Adult Spring Chinook					Jack Spring Chinook	
	Pre-Mod. Range	2009	2010	2013	2014	2013	2014
1) Entrance Efficiency	0.56 – 0.98	0.59	0.89	0.67	0.68	0.74	0.50
2) Exit ratio	0 – 0.46	0	0.04	0.13	0.02	0.06	0.25
3) Approach - Entry time (min)	1 - 46	59	42	21	41	12	81
4) Entry - Ladder base time (min)	7 - 16	13	14	11	8	17	31
5) Approach - Entry > 1 h (%)	12 - 45	48	36	19	42	24	50
6) Entry - Ladder base time > 1 h (%)	0 - 14	7	1	4	2	0	0

Cascades Island Metrics Summer

Metric	Adult Summer Chinook					Jack Summer Chinook		Sockeye	
	Pre-Mod. Range	2009	2010	2013	2014	2013	2014	2013	2014
1) Entrance Efficiency	0.72 – 0.89	0.70	0.71	0.47	0.58	0.77	0.67	0.61	0.65
2) Exit ratio	0.35 – 0.77	0.63	0.26	0.20	0.29	0.13	0.14	0.21	0.27
3) Approach - Entry time (min)	6 -12	16	1	27	15	22	56	12	13
4) Entry - Ladder base time (min)	12 - 21	17	20	10	9	11	11	6	4
5) Approach - Entry > 1 h (%)	7 - 12	17	9	27	33	25	50	17	22

Cascades Island Conclusions

- Spring Chinook salmon:
  - Adults within historical range
  - Low entrance efficiency and long passage times for spring jacks
- Summer Chinook salmon:
  - Metrics mixed for adults and jacks
- Sockeye metrics similar between years
- Additional analyses pending

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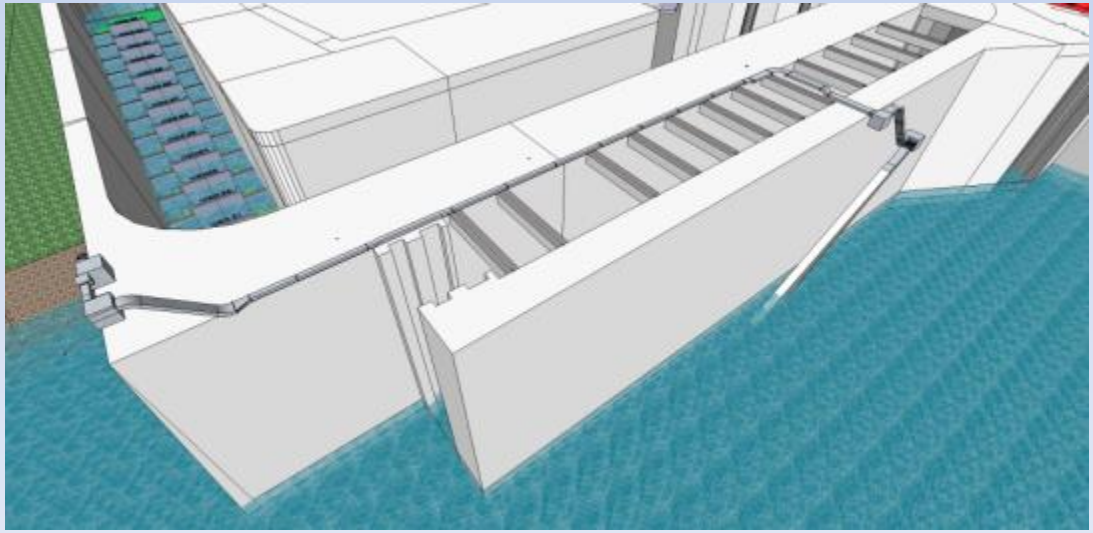

CI Conclusions

- Overall, adult spring Chinook salmon post modification year metrics were within the range of pre-modification values
- Adult summer Chinook salmon entrance efficiencies were lower in 2013 and 2014 but within in the pre-modification range in 2009 and 2010.
- Adult summer Chinook exit ratios were lower than or within the pre-modification year range
- Adult summer Chinook approach-entry times and % > 1 hr. were slightly higher than post modification years
- Adult summer Chinook entry-base of ladder and % > 1hr were lower than or within the pre-modification year range

NDE Conclusions

- Spring Chinook entrance efficiencies at NDE were similar to 2013 and overall within range of pre LFS years
- Jack spring Chinook entrance efficiencies at NDE were lower in 2014 compared to 2013 but similar declines in entrance efficiency were observed at SDE
- A similar pattern in entrance efficiency at SDE supports negligible effects of LFS on spring Chinook salmon.
- High entrance efficiencies for summer Chinook (including jacks) and sockeye but historically high.
- Chinook jacks and sockeye entered the fastest and had fewer > 1 hr. passage events
- Spring and summer Chinook entry times, including the proportion with extended passage times was comparable to pre LFS years.