Estuary Partnership's Restoration Effectiveness Monitoring

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Lower Columbia River Estuary Partnership

Researchers and Funders

Contributing Researchers

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- Janelle St. Pierre, Scappoose Bay Watershed Council
- Chris Collins and Steve Pilson, Estuary Partnership
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- Lyndal Johnson, Sean Sol, Paul Olson, Kate Macneale National Oceanic and Atmospheric Administration, Northwest Science Center

Funding

- Bonneville Power Administration

Salmon in the Columbia River Basin

13 different evolutionarily significant units (ESUs) of anadromous salmonids that reproduce in the Columbia River basin listed as threatened and endangered under the Endangered Species Act

- steelhead (*Oncorhynchus mykiss*)
- chum salmon (*O. keta*)
- Chinook salmon (*O. tshawytscha*)
- lower Columbia River coho salmon (*O. kisutch*)
- Sockeye salmon (*O. nerka*)

Function of Estuaries for Juvenile Salmon

- Estuaries offer 4 opportunities to juvenile salmon in their transition from freshwater to saltwater environments
  1) Productive feeding area capable of sustaining increased growth rates
  2) Migratory corridor
  3) Temporary refuge from marine predators
  4) Physiological transition zone where fish can gradually acclimate to saltwater
- Estuary and ocean dynamics help control salmon productivity, biodiversity and reduce impacts from changing ocean and other conditions

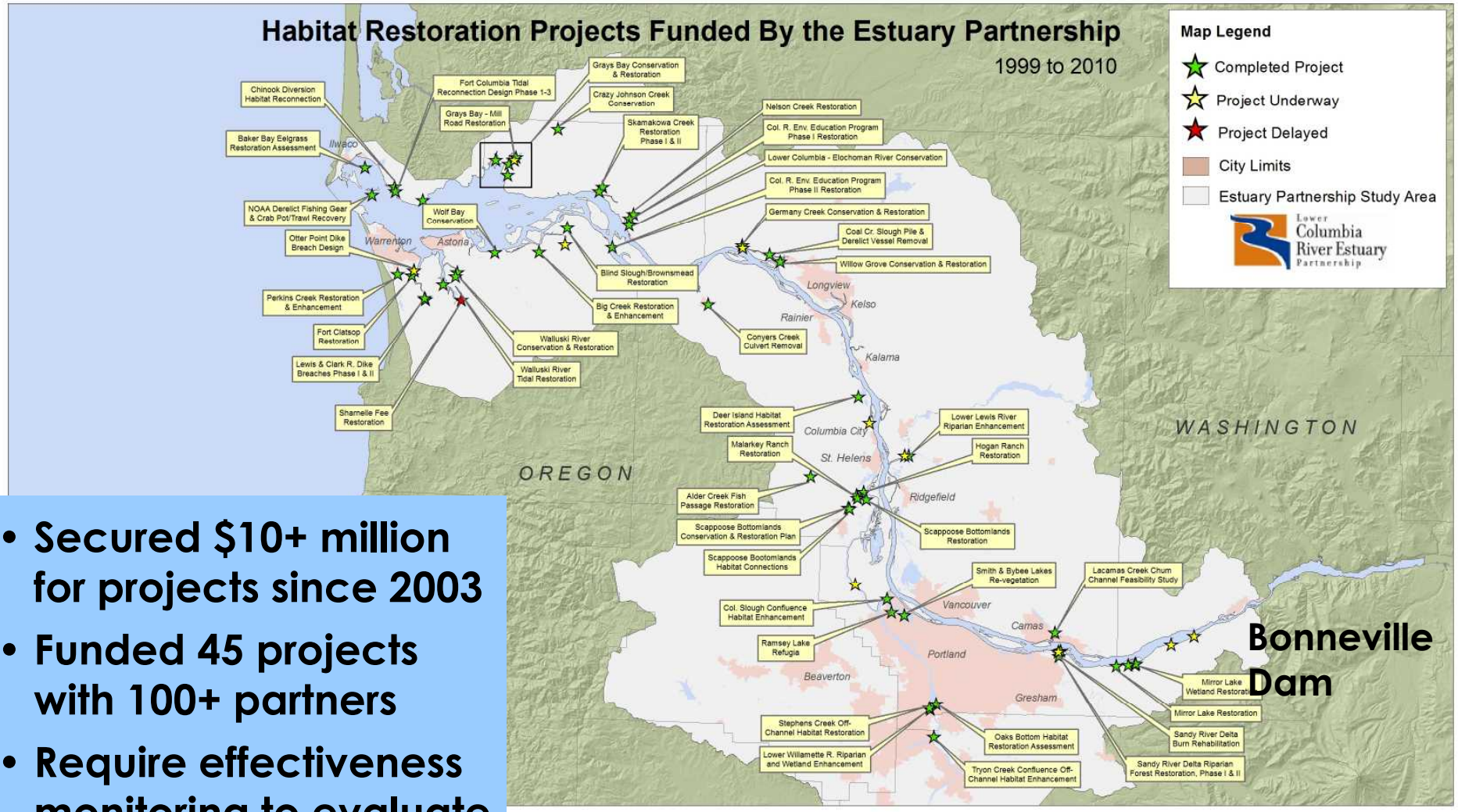
Importance of Lower Columbia River and Estuary to Juvenile Salmon

- Extensive use of shallow water and vegetated habitats within the estuary by juvenile Chinook and to a lesser degree chum and coho
- Growing awareness of the importance of the Columbia River estuary within salmonid life cycles
- Protection and restoration of important salmonid habitats within the estuary has been identified as a priority for salmon recovery

Lower Columbia Estuary Partnership

- Lower Columbia river and estuary is part of National Estuary Program (NEP)
- Lower Columbia River Estuary Partnership (non-profit) established in 1995 by the governors of Washington and Oregon and EPA
  - Lack of focus on the lower river and estuary
  - Bi State findings documented degradation of lower river
- Through our guiding management strategy, we work to fund and implement restoration projects to improve habitat conditions for salmon and other wildlife.

Restoration Investment in the Lower Columbia



- **Secured $10+ million for projects since 2003**
- **Funded 45 projects with 100+ partners**
- **Require effectiveness monitoring to evaluate investment**

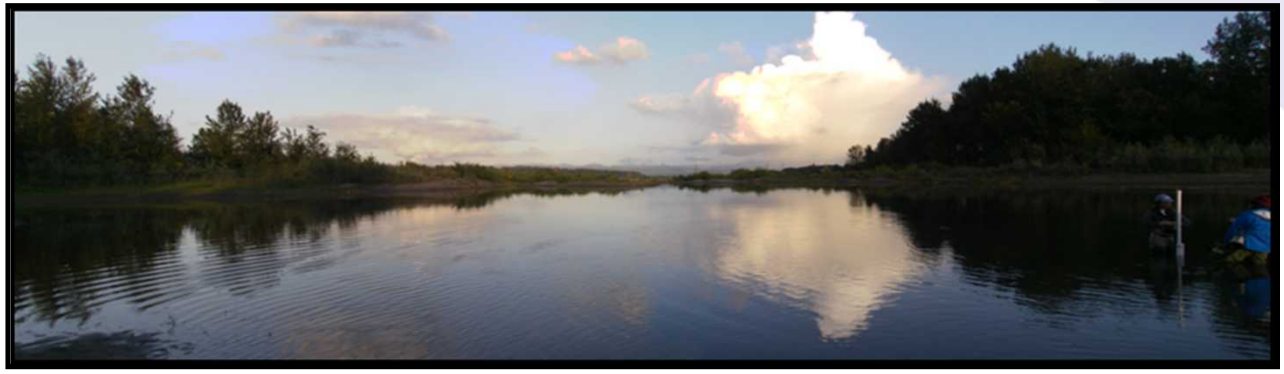
Estuary Partnership's Effectiveness Monitoring (AEM)

- AEM Program began in 2008 with 4 pilot sites to assess uncertainties affecting restoration success
- Provide data to improve restoration strategies (via adaptive management)
- Funded by Bonneville Power Administration (BPA) to address RPA 60 in the 2008 FCRPS Draft Biological Opinion

  "Evaluate the effects of selected individual habitat restoration actions at project sites relative to reference sites and evaluate post-restoration trajectories based on project-specific goals and objectives"

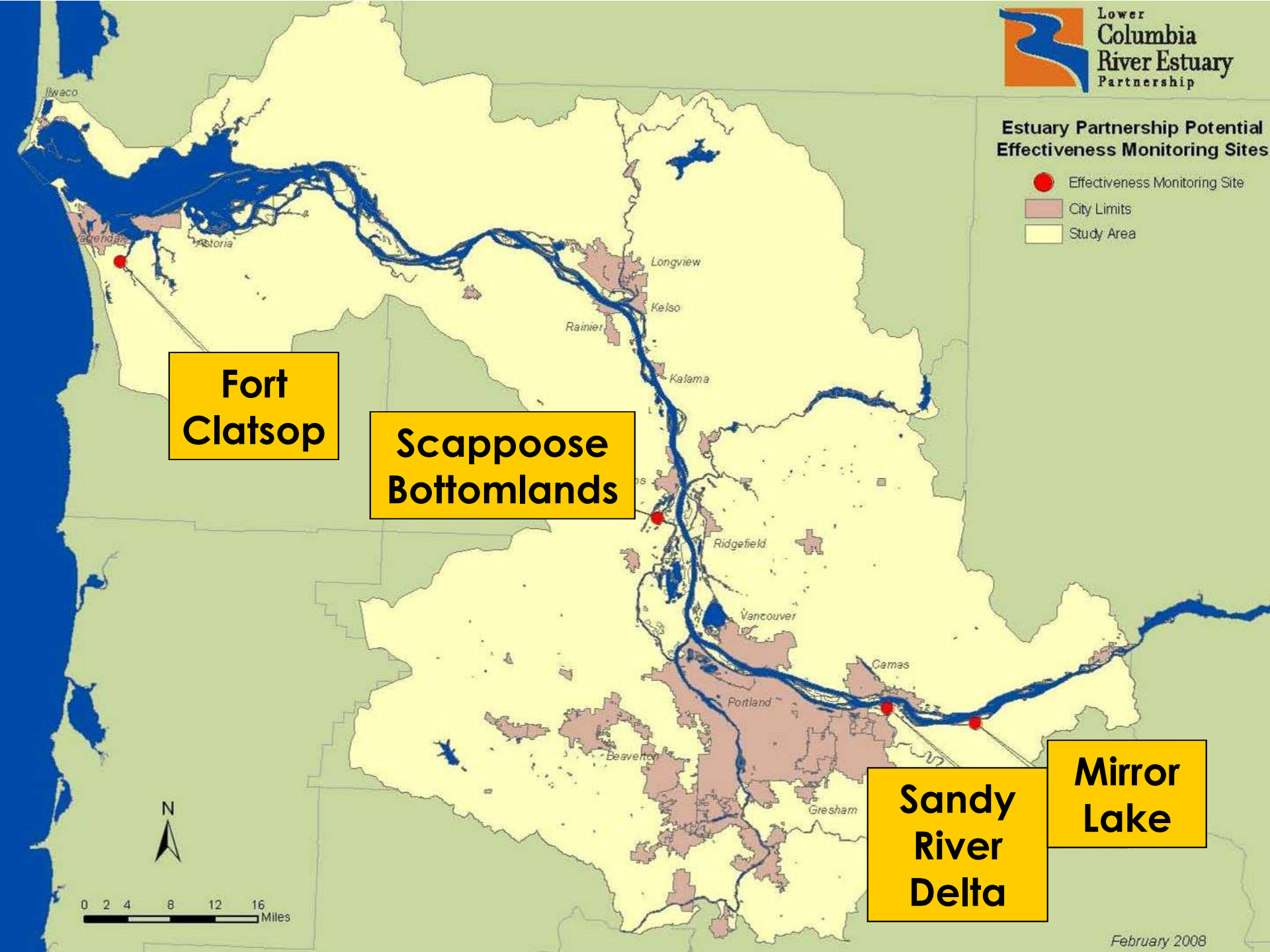
Water Quality Methods

- Each AEM site has a Monitoring Plan with objectives for the site, data collection methods and analysis
- Standardized water quality methods for monitoring the effects of habitat restoration projects in the lower Columbia River and estuary
- **Protocols for Monitoring Habitat Restoration Projects in the Lower Columbia River and Estuary. 2009.** Roegner, G.C., H.L. Diefenderfer, A.B. Borde, R.M. Thom, E.M. Dawley, A.H. Whiting, S.A. Zimmerman, and G.E. Johnson. 2009. Protocols for monitoring habitat restoration projects in the lower Columbia River and estuary. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-97, 63 p.
- Monitoring controlling factors, structure and function of tidal wetlands
- Hydrology & Water Quality focus of this talk



Site Selection Process

- Estuary and Oceanic Subgroup (EOS; BPA, USACE, NOAA, PNNL, EP) reviewed 12 candidate sites
- Criteria:
  - tidally influenced wetlands
  - funded by BPA and USACE
  - included baseline monitoring
  - and restored over multiple years
- Recommendations:
  - Include different actions, habitats, and river reaches
  - Pair with reference sites where possible
  - Fewer sites, more intensively monitored


Lower Columbia River Estuary Partnership
Estuary Partnership Potential Effectiveness Monitoring Sites
Effectiveness Monitoring Site
City Limits
Study Area
Ilwaco
Astoria
Longview
Kelso
Rainier
Kalama
Ridgefield
Vancouver
Camas
Portland
Beaverton
Gresham
Fort Clatsop
Scappoose Bottomlands
Sandy River Delta
Mirror Lake
N
0 2 4 8 12 16 Miles
February 2008

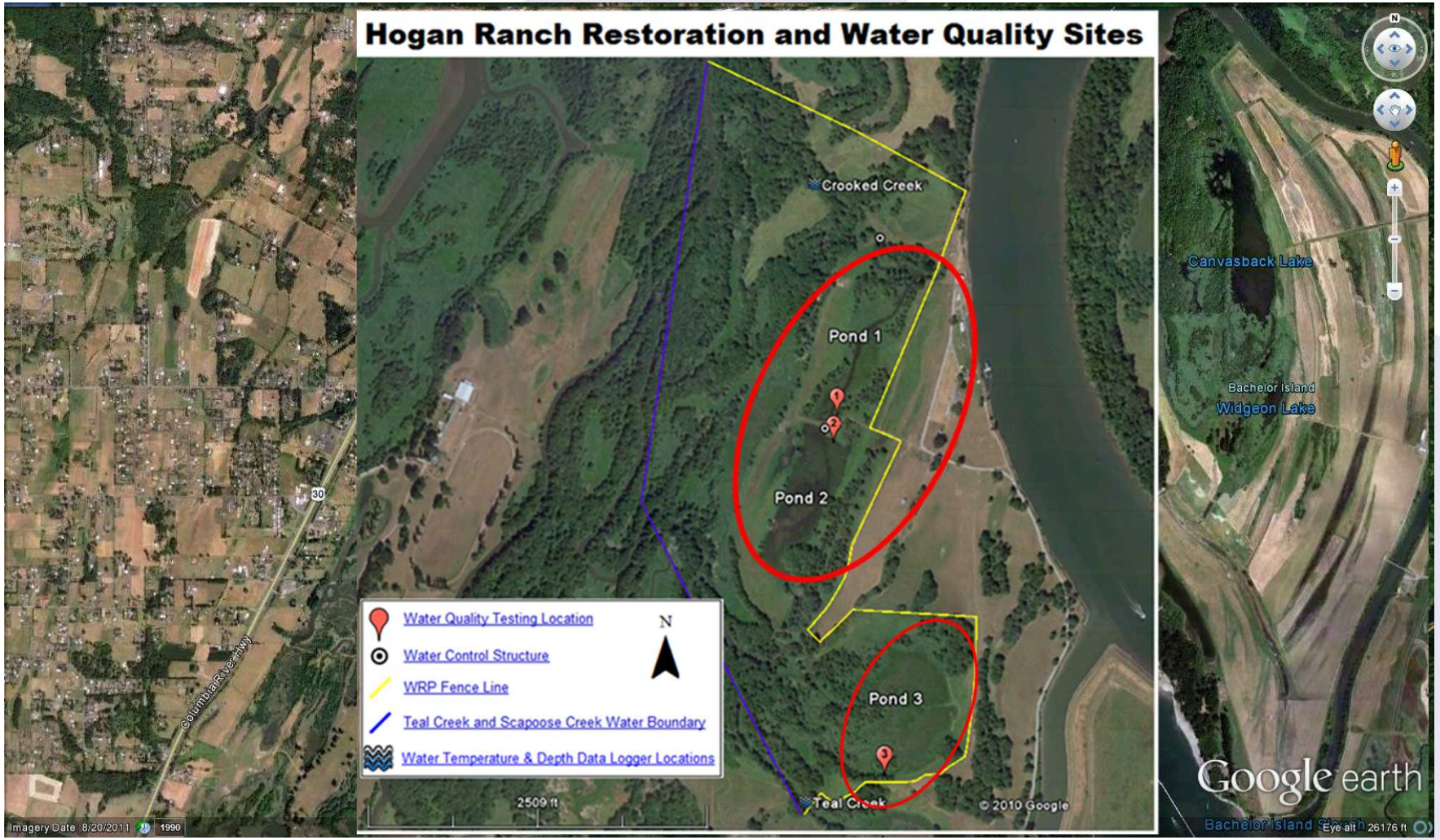
Type of Data Collected
…varied by restoration action

Site	Mirror Lake	Scappoose Bottomlands	Fort Clatsop
Habitat	Bottomland Forest; stream and wetland complexes	Tidally-influenced emergent wetlands; streams	Brackish wetland
Restoration Action	Invasive species removal & plantings; culvert passage improvement; LWD	Invasive species removal & plantings; cattle exclusion	Culvert replaced with bridge to improve tidal connectivity
Temperature*	X	X	X
DO*		X	X
pH*		X	X
Bacteria and E. coli*		X	
Conductivity*		X	X
Depth*		X	X

*Water Quality parameters that may be limiting factors for juvenile salmon

Scappoose Bottomlands

Scappoose Bay Site Location



Water Quality Methods

- Invasive species removal, native plantings, cattle fencing
- Three tidally influenced ponds
- Continuous (hourly) full-year water quality data collection
- Pre-restoration data (2004-2007), post-restoration (2008-2011)

WATER QUALITY PARAMETER	EQUIPMENT	ACCURACY
Water Temperature	HOBO Data Logger and YSI 30 Conductivity Meter	(+/-) 0.5 °C
Air Temperature	NIST Digital Thermometer	(+/-) 0.5 °C
Dissolved Oxygen	Hach Dissolved Oxygen Titration Kit	(+/-) 0.3mg/l (ppm)
pH	Orion pH meter	(+/-) 0.2 pH
Turbidity	Hach Turbidity Meter	(+/-) 5% of standard value (NTU)
Conductivity	YSI 30 Conductivity Meter	(+/-) 7% of standard value (µS/cm)
Depth	HOBO Data Logger	(+/-) 0.5 cm water
Bacteria and E. Coli Counts	IDEXX Quanti-Tray 2000® MPN	(+/-) 0.5 log (MNP/100ml)

Years and Months of Water Quality Data Collection at Hogan Ranch Ponds 1-3, Teal Creek and Crooked Creek

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004												
2005												
2007												
2008							T	T	T	T	T	T
2009	T	T/C	T/C	T/C	T/C	T/C	T/C	T/C	T/C	T/C	T/C	T/C
2010	T/C	T/C	T/C	T/C	T/C	T/C	T/C	T/C				
2011												

Grab Sample Water Quality Collected

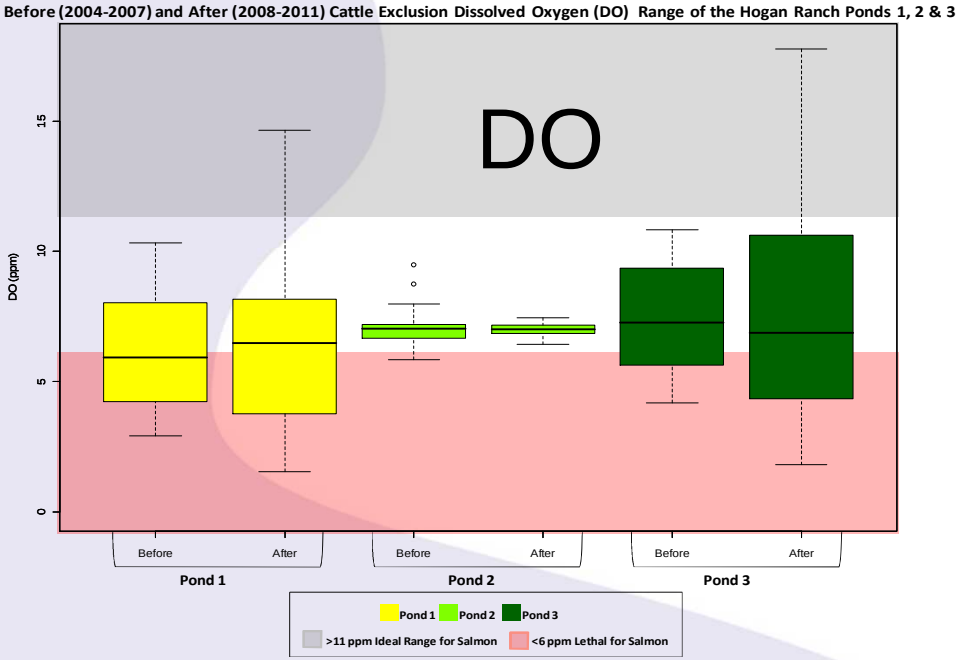
Data Loggers Collecting Temperature Data:

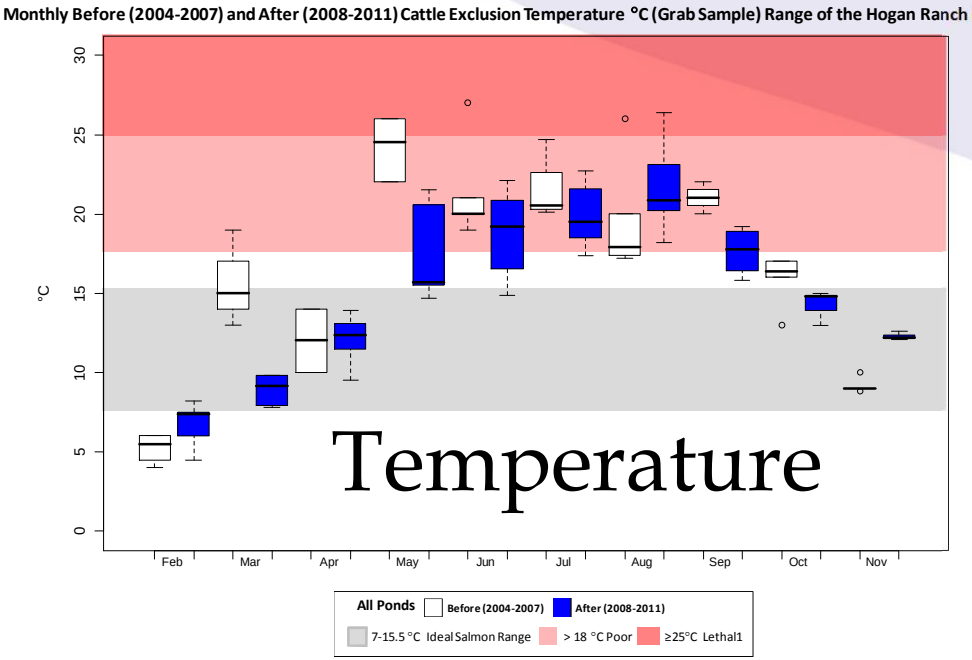
TTeal Creek

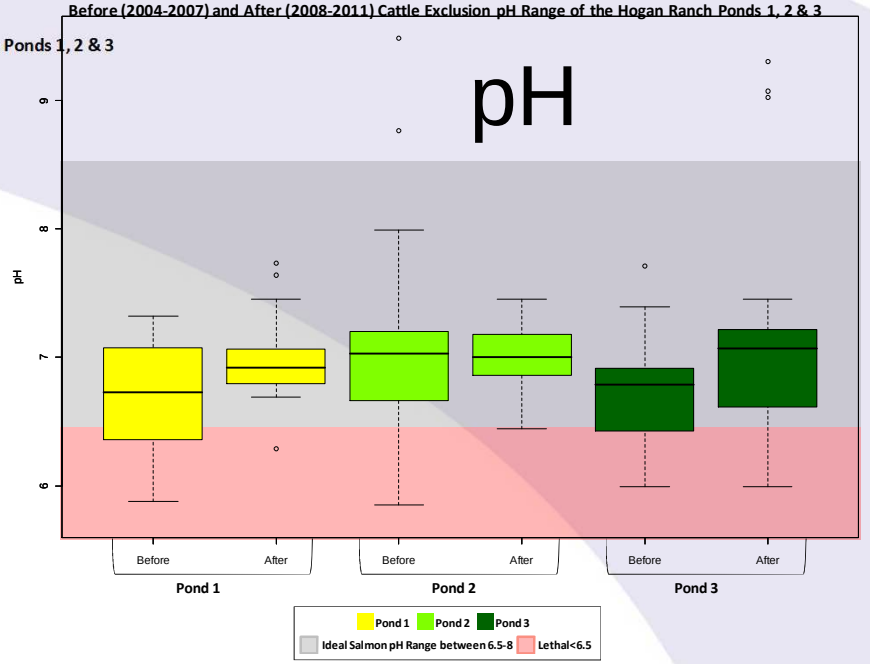
CCrooked Creek

Monitoring Results

- Grey=ideal for salmon, pink=poor, red=lethal
- Continuous temperature, DO and pH, similar before and after cattle exclusion
- Too soon to see effects of native plantings/invasive species removal

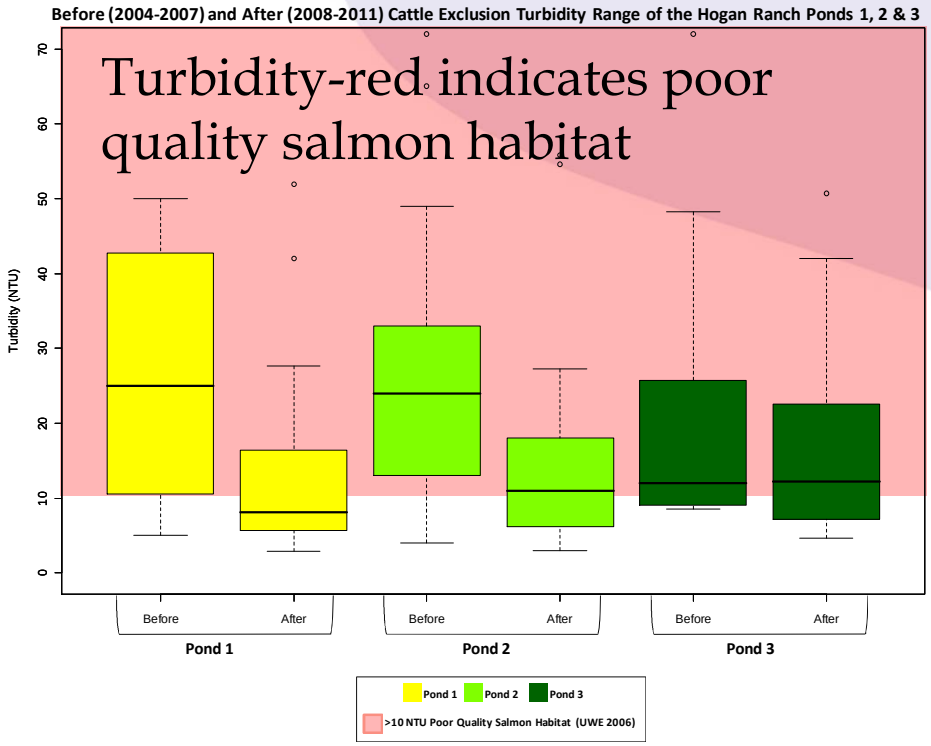


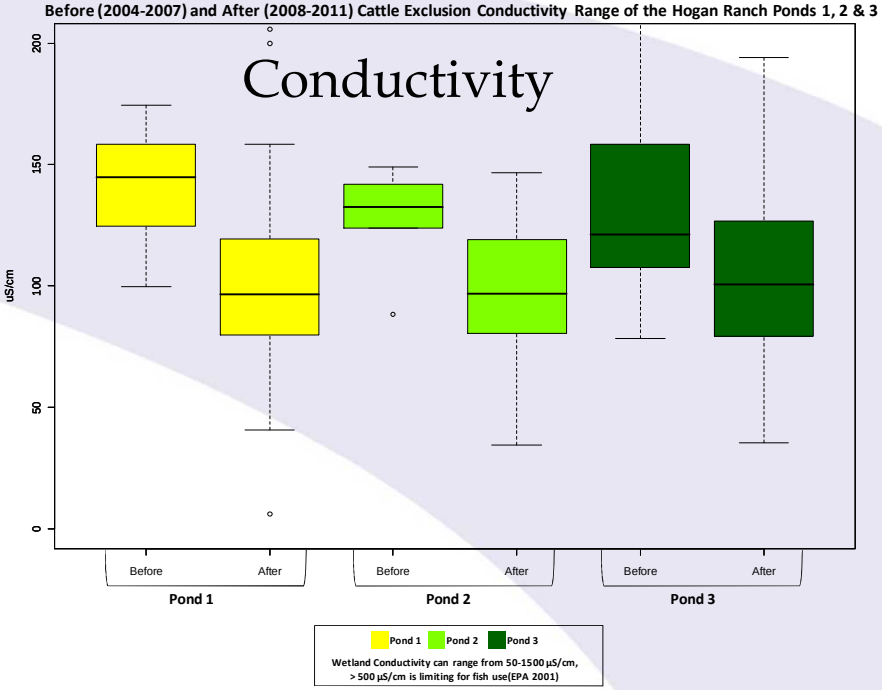




Turbidity and Conductivity

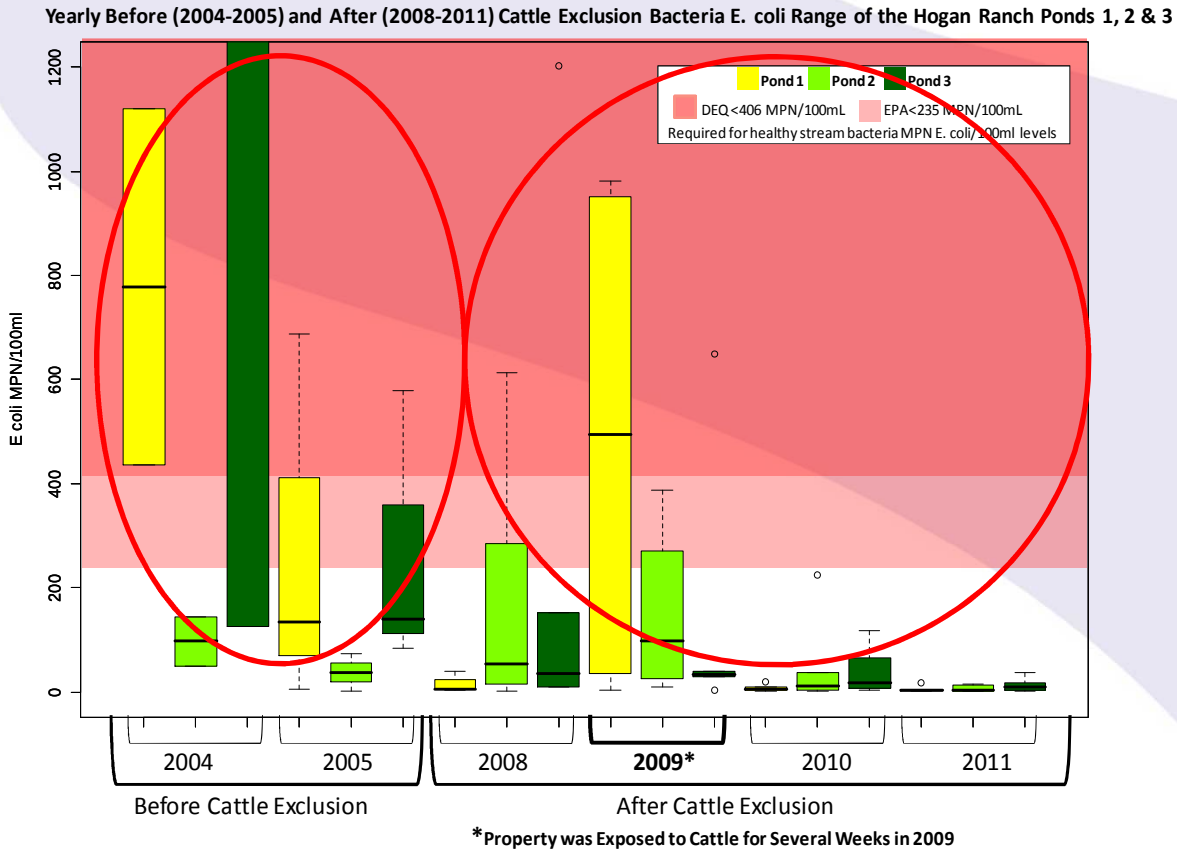
- Slight decrease in turbidity before and after restoration
- Slight decrease in conductivity—which can indicate decreased turbidity and bacteria levels





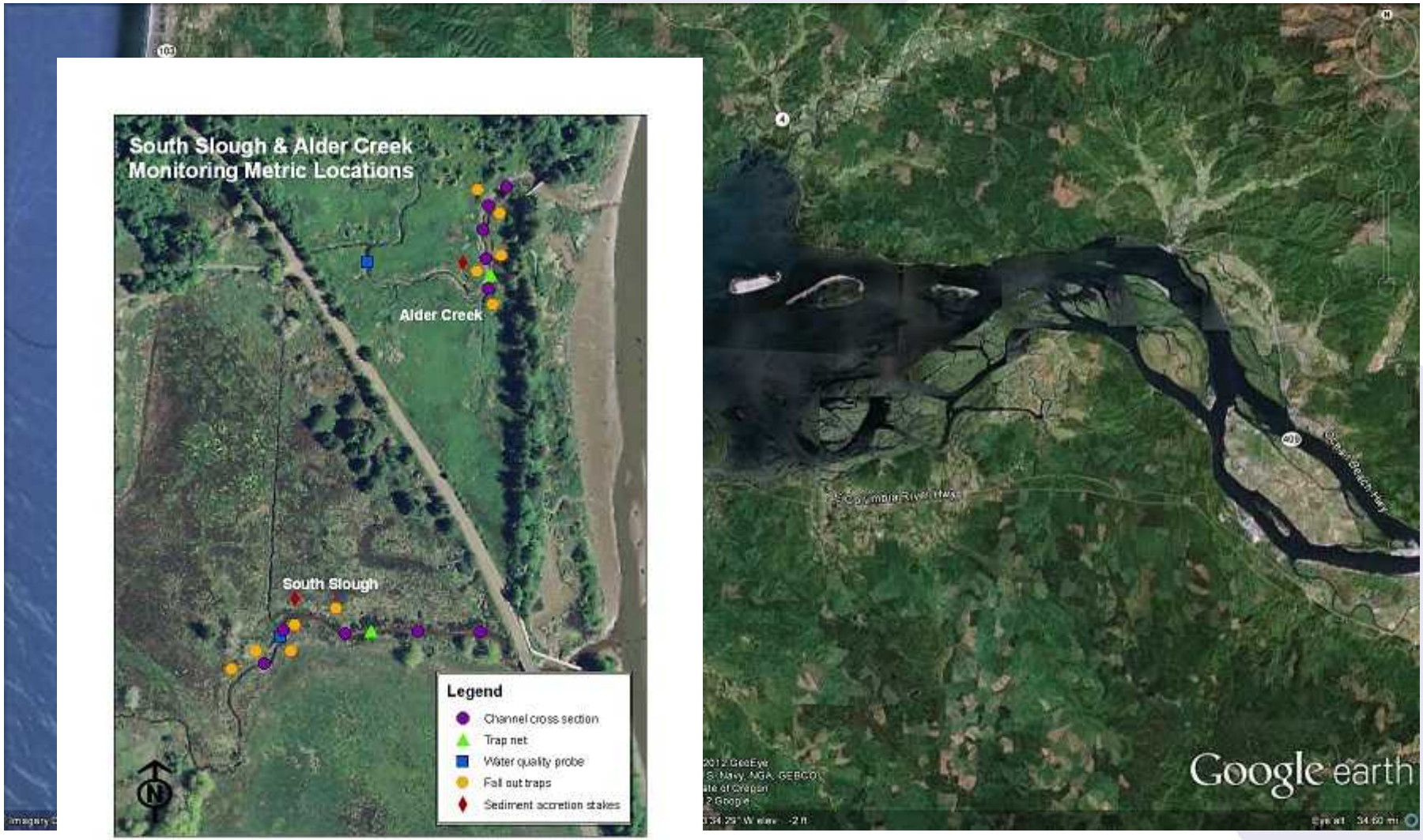
Monthly E. coli Bacteria Sampling

- Prior to cattle exclusion E. coli levels were higher than ODEQ (red) and EPA (pink) recommendations (>235 MPN/100ml)
- Significantly lower E. coli in all ponds, post-cattle exclusion (< 40 MPN/100ml)



Ft. Clatsop

Ft. Clatsop Site Location



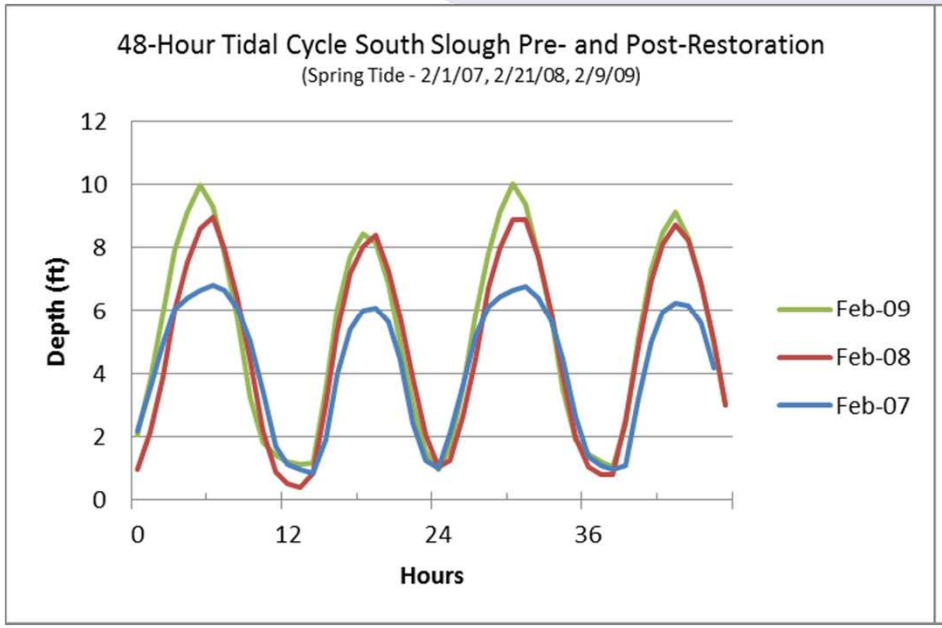
Ft. Clatsop Tidal Reconnection

- Replacement of culvert with bridge for tidal reconnection
- Monitoring of tidal slough (and reference site)
- Continuous (hourly) full-year water quality data collection
- Pre-restoration data (2007), post-restoration (2008-2011)

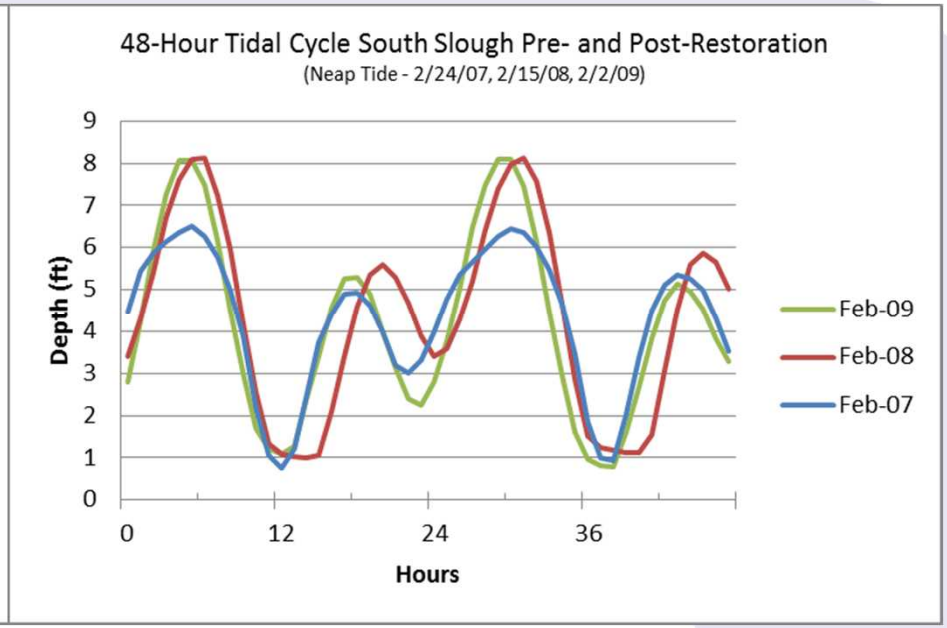
Ft. Clatsop Reconnection Results

- Tidal depth greater after reconnection

February spring tides pre- vs. post-restoration

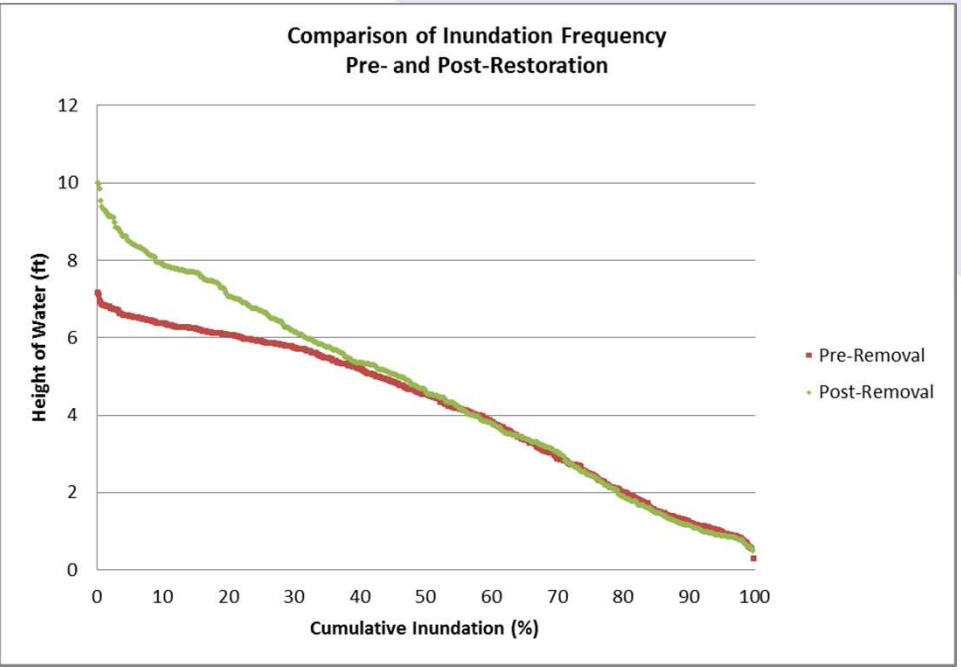


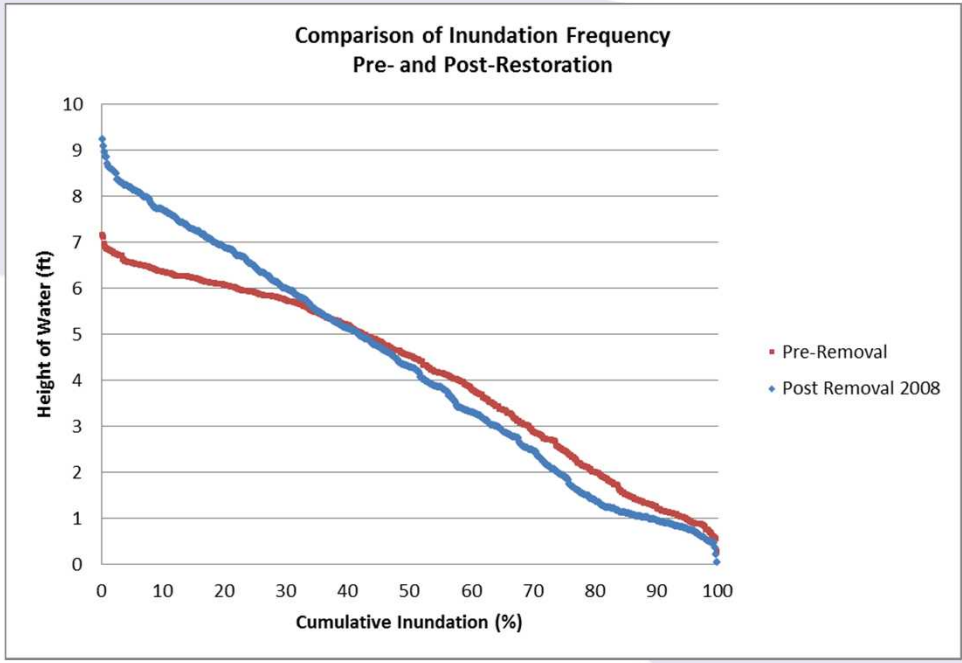
February neep tides pre- vs. post-restoration



Ft. Clatsop Reconnection Results

- Maximum amplitudes increased from 7 ft to 10 ft
- For approximately 50% of the time there is no difference in height of water, but from 10-50% of time there is greater inundation post-restoration

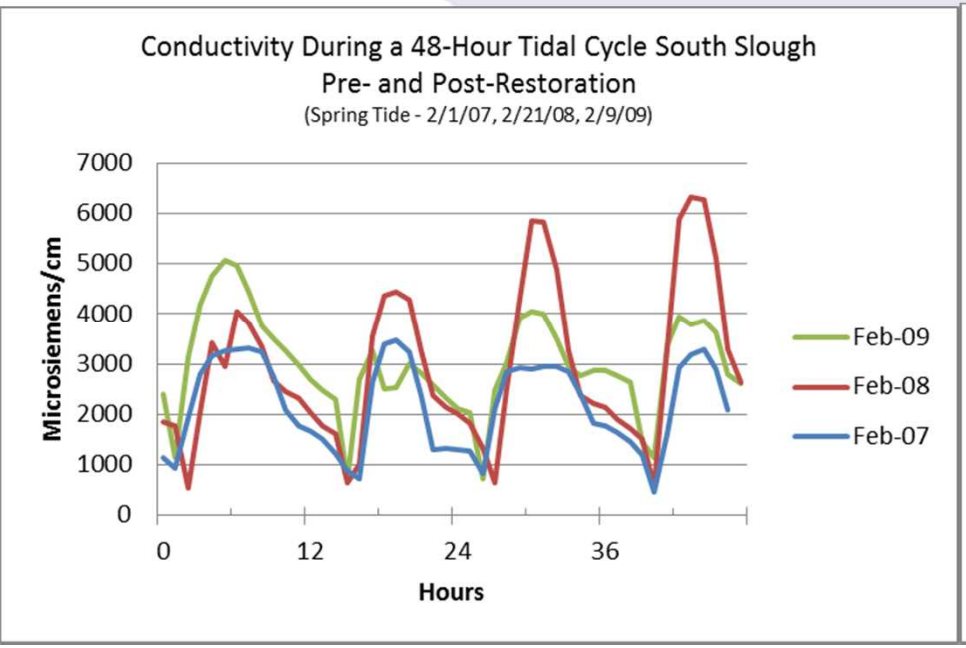




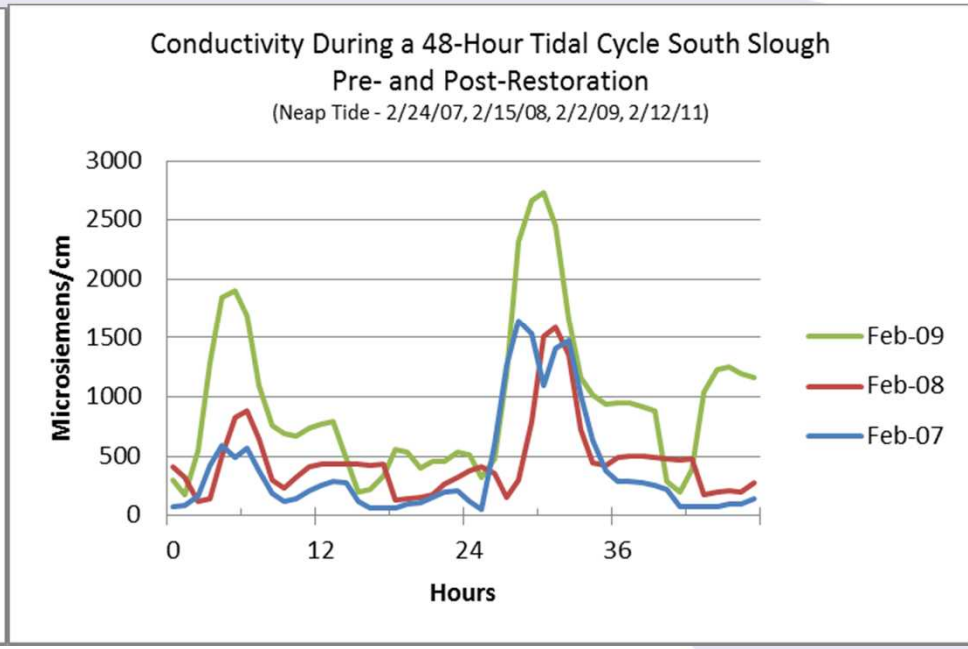
Ft. Clatsop Reconnection Results

- Restoration of higher salinity intrusion as shown in conductivity levels

February spring tides pre- vs. post-restoration

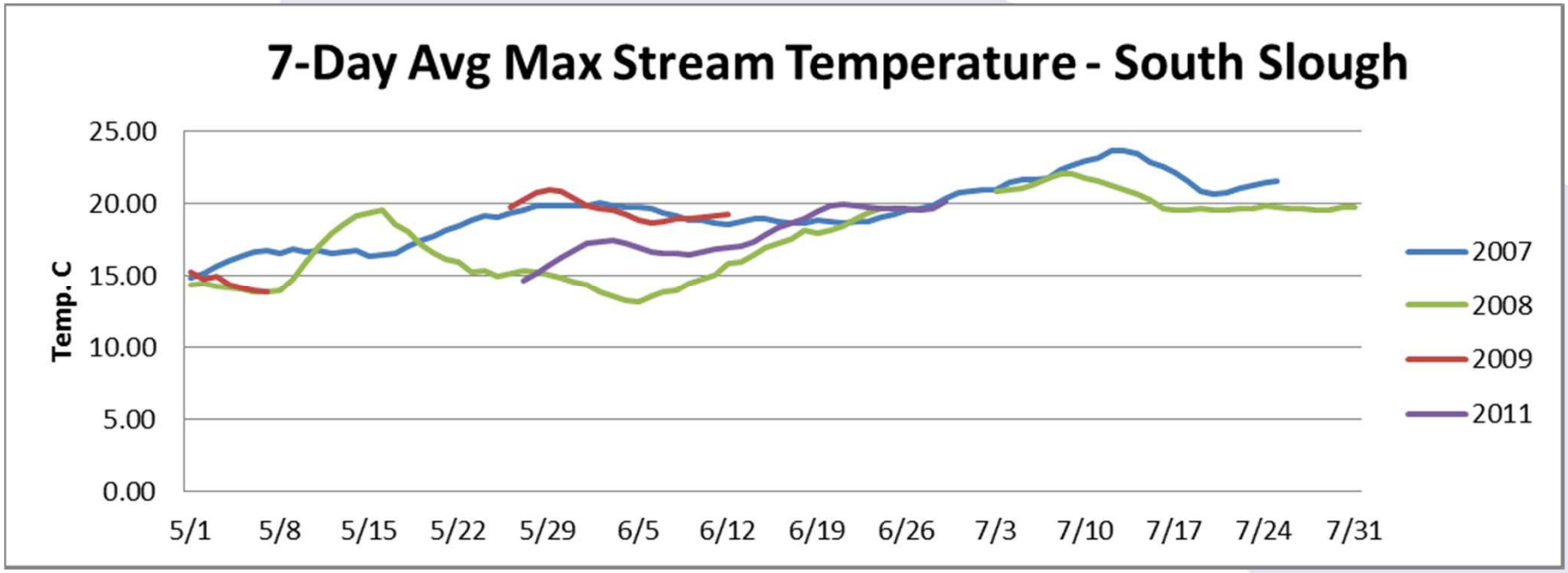


February neep tides pre- vs. post-restoration



Ft. Clatsop Reconnection Results

- No clear temperature results for the temperature limiting period for salmonids pre- versus post-restoration



Mirror Lake

Mirror Lake Site Location

Figure 5.
Locations of Restoration Activities

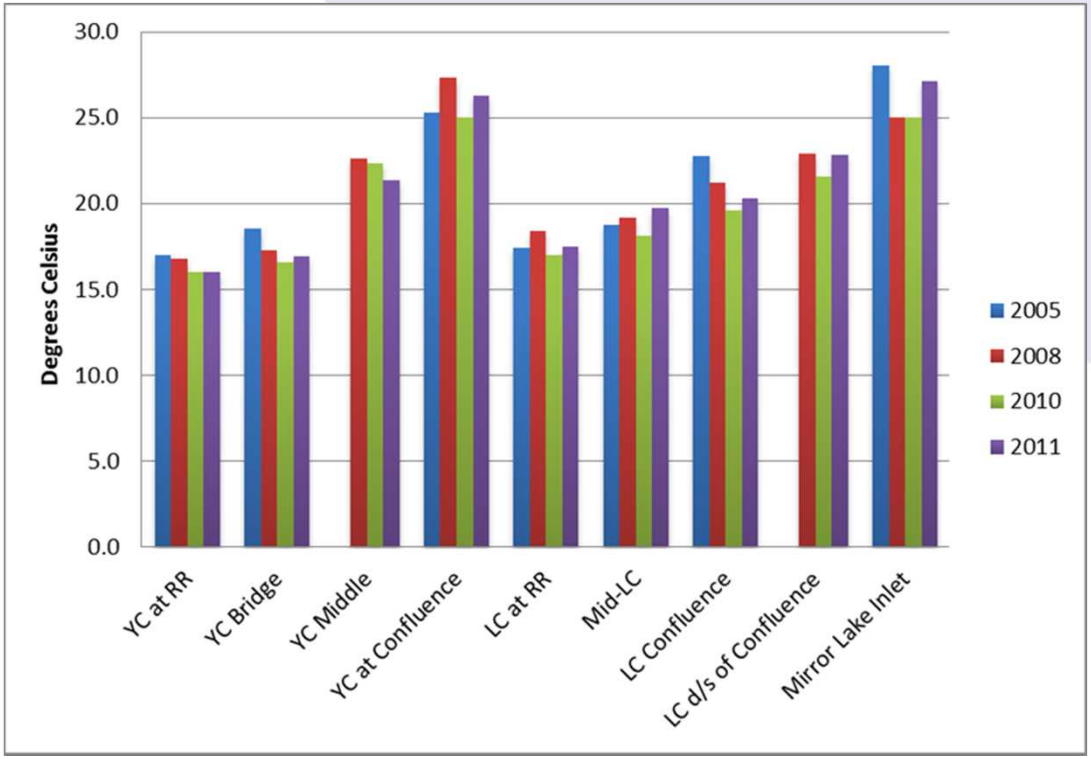
Mirror Lake Temperature Methods

- Connection to Columbia River is I-84 culvert
- Vegetation restoration, Large Woody Debris inputs
- Hourly monitoring between July and September

- Inter-annual temperature variation and habitat suitability for juvenile salmon
- Use of the seven-day moving average maximum (7DMA) temperatures to monitor stream condition

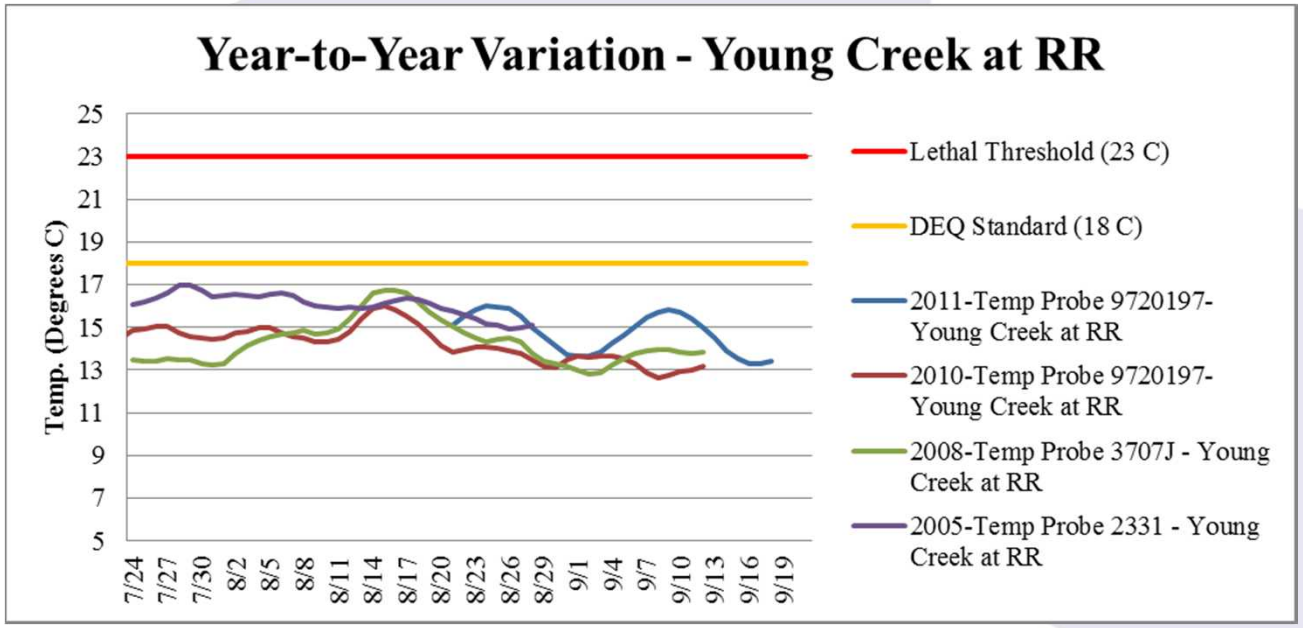
Mirror Lake Temperature Results

- Low temperature in upper reaches (14°-18° 7DMA), high downstream temperatures (>23° 7DMA)
- Range of 7-day maximums 16° to 28° (on average 16.4° -26.3°) across length of study area



Year-to-Year Variation by Site

- Variation between years is 1º -2º , however, downstream locations up to 3º of variation between years



- In most years, approximately 41% of site has sustained high temperatures in lethal range for salmon
- Little year-to-year variation in habitat suitability

Conclusions

- Some restoration measures can show results within the first few years after construction, some may take longer
- Sources of unforeseen variation, such as landowner changing water level at site, cattle breaking through fencing can complicate results
- Difficult to tease out restoration effects in an inherently very complex system (Bonneville Dam water releases, tidal influences and differences in hydrology from upstream to downstream in the estuary)
- Important to set out objectives of the restoration project and methods and analysis for the monitoring to tie the two together
- Need to conduct periodic checks and synthesis of data to make sure monitoring is on track and to adaptively manage site

Questions?