

**Juvenile Salmon Occurrence in the Lower Columbia Estuary:
Ecosystem Monitoring Program Findings
in an Unusual Weather Year**

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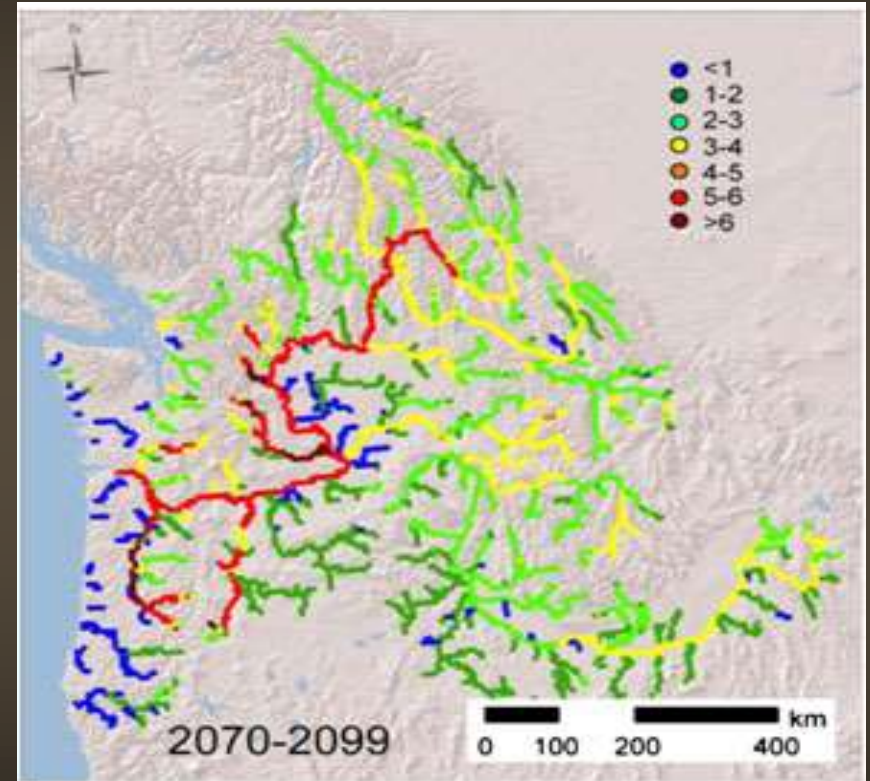
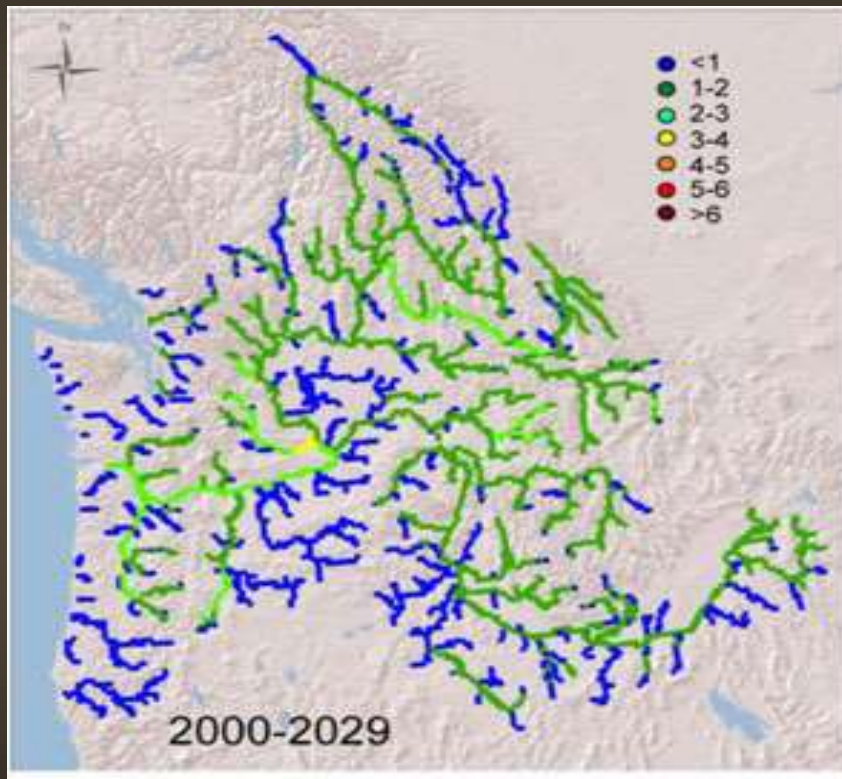
**2016 Columbia River Ecosystem Conference
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CLIMATE CHANGE

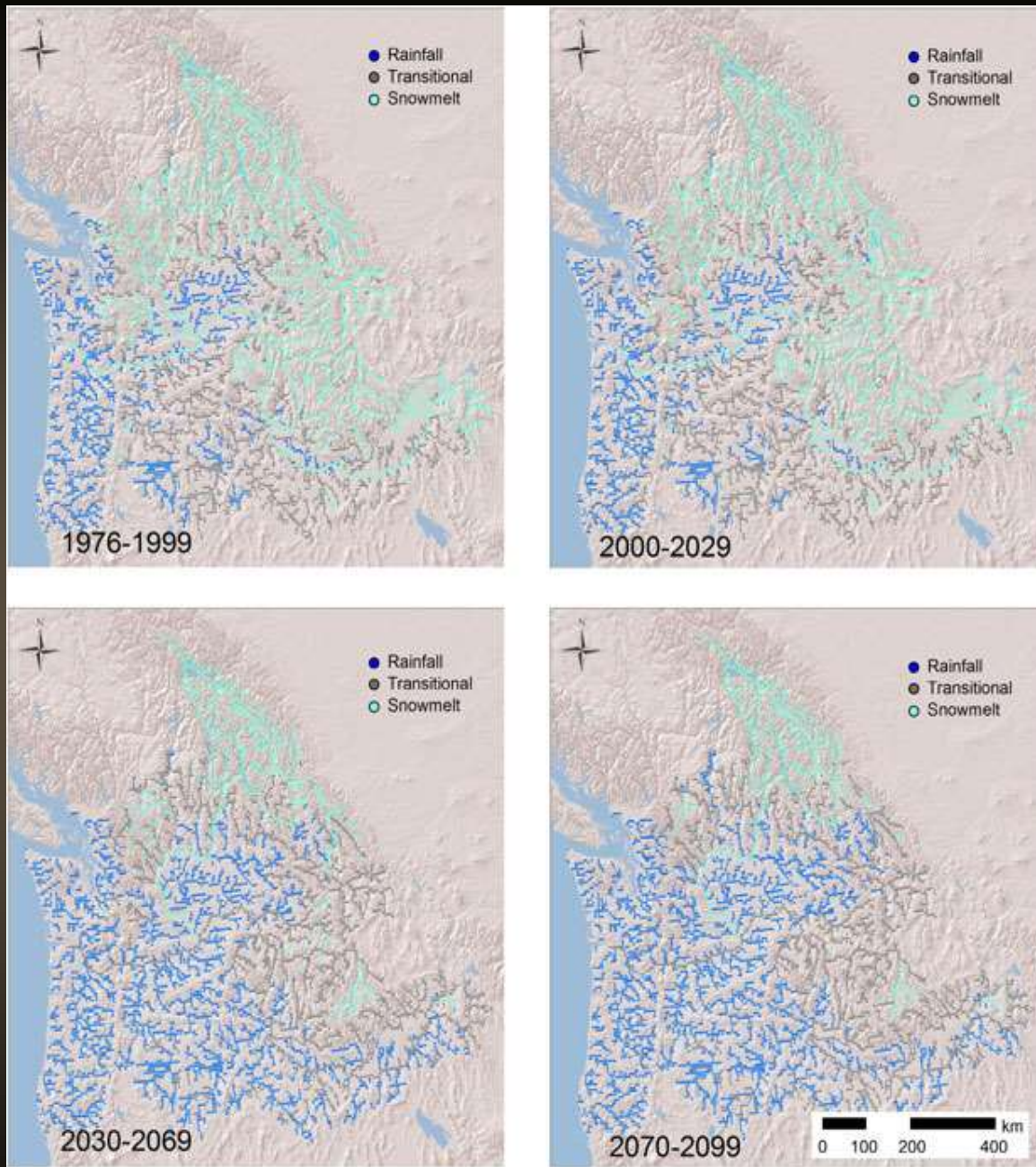
Climate Change in PNW

Higher temperatures, especially in summer



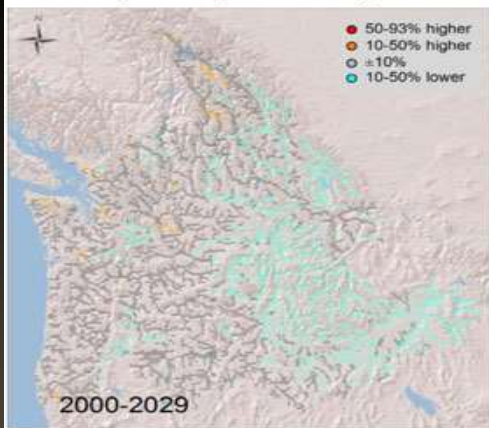
Climate Change in the PNW

Lower snow pack and a transition from snow-melt dominated watersheds to rainfall dominated watersheds

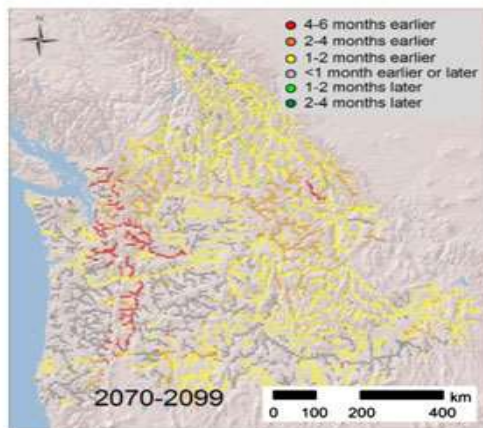
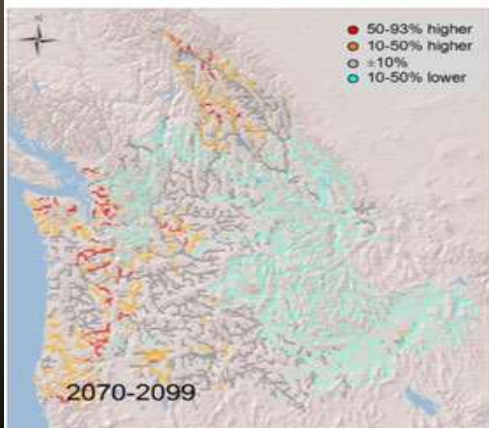
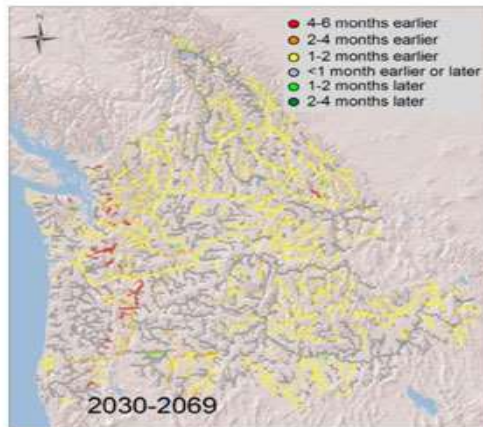
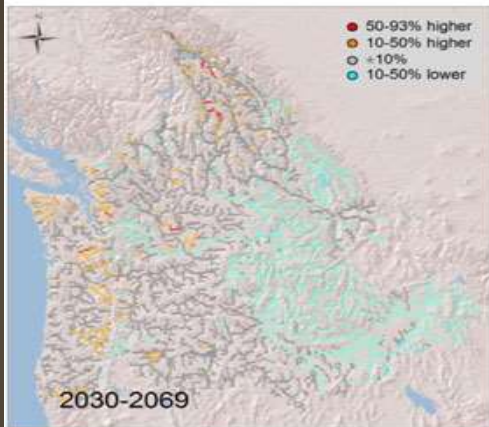
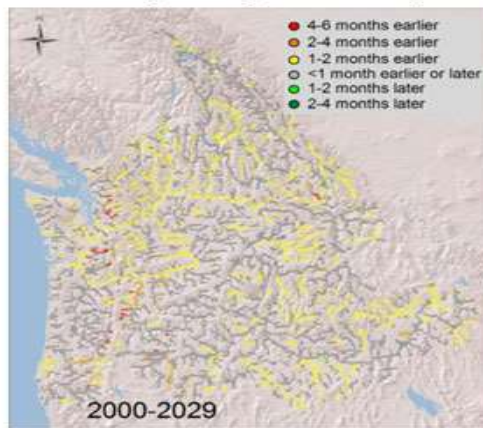


Figures from
Beechie et al. River
Res. Applic. 29:
939–960 (2013)

Change in high flow magnitude



Change in high flow timing



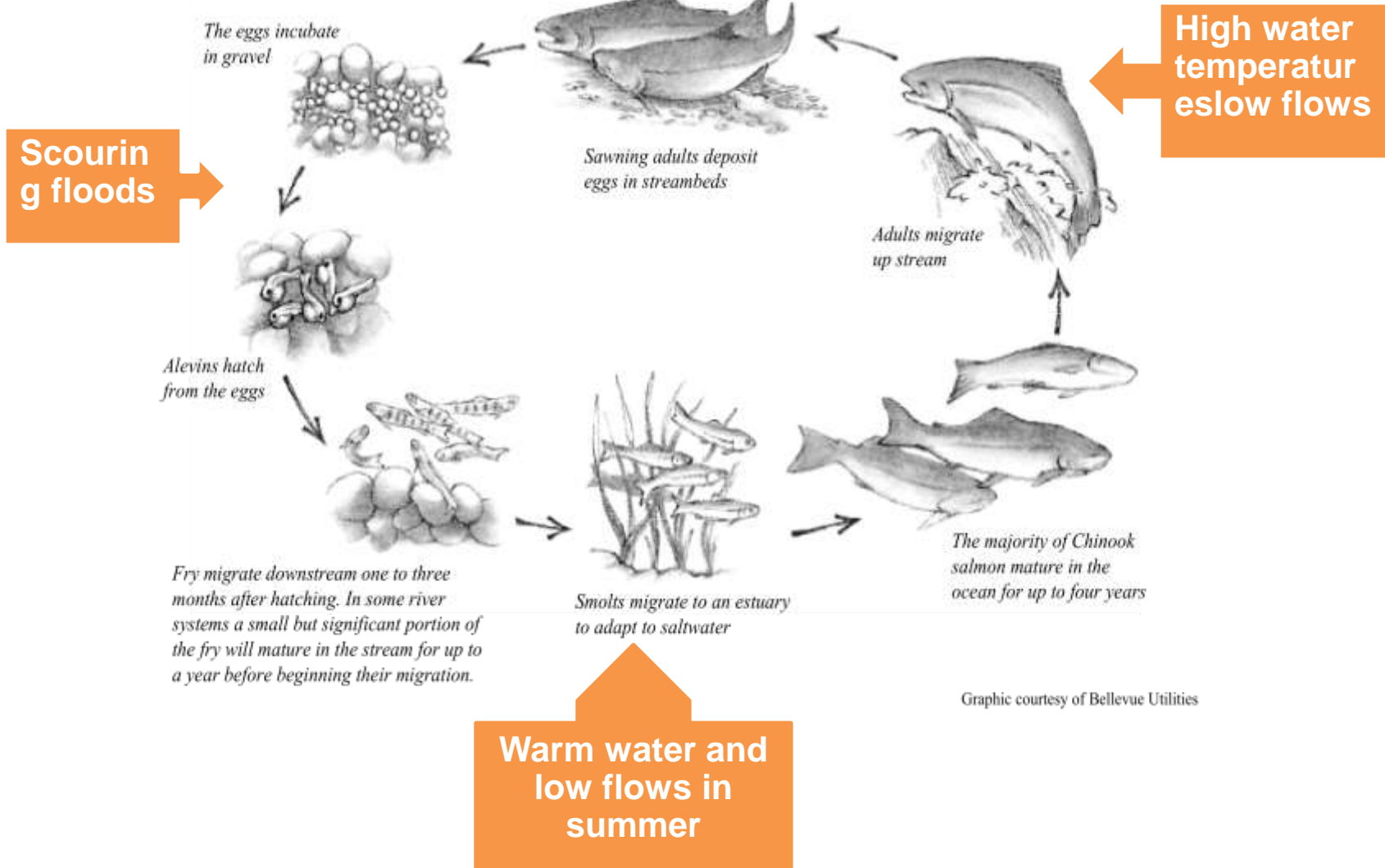
Climate Change in PNW

Changes in flow timing and magnitude:

- Earlier spring freshet
- Higher winter/spring flows, flooding and scouring in some areas
- Lower maximum flows in other areas
- Lower summer flows

Figures from Beechie et al. River Res. Applic. 29: 939–960 (2013)

Chinook Salmon Life Cycle



Graphic courtesy of Bellevue Utilities

Predicted Effects of Climate Change on Salmon*

• Temperature

- Impaired growth, increased mortality, risks to quality and quantity of rearing habitat in areas where summer temperatures are already high
- Increased growth in areas where temperatures are especially low; might improve productivity, but could lead to earlier juvenile migration to the ocean, so timing it out of alignment with ocean prey abundance and predators presence.
- Encourage warm water predators, such as smallmouth bass (*Micropterus dolomieu*).

• Altered Flow

- Increased scour of eggs and displacement of juveniles from slow-water rearing habitats due to increased winter flooding and higher peak winter flows.
- Summer low water flow may contribute to increased temperatures and decrease rearing habitat capacity for juvenile salmonids.

• Loss of Spring Snowmelt

- Reduced survival of eggs or emergent fry and reduced migration success from formerly snowmelt dominant streams where seaward migration timing has evolved to match the timing of the freshet.

*Mantua et al. 2010. Climatic Change 102:187–223 Beechie et al. 2013. River Res. Applic. 29: 939–960.

2015 conditions

- Warm winter temperatures; rain rather than snow
- Record low snowpack in mountains
- Earlier snowmelt
- Reduced and early spring freshet (Feb or March rather than May to June)
- High summer temperatures; little rain
- Unusually low summer flows

Similar to Predicted Effects of Climate Change

So . . . were weird things going on with the fish?



Photograph from Allegheny Front

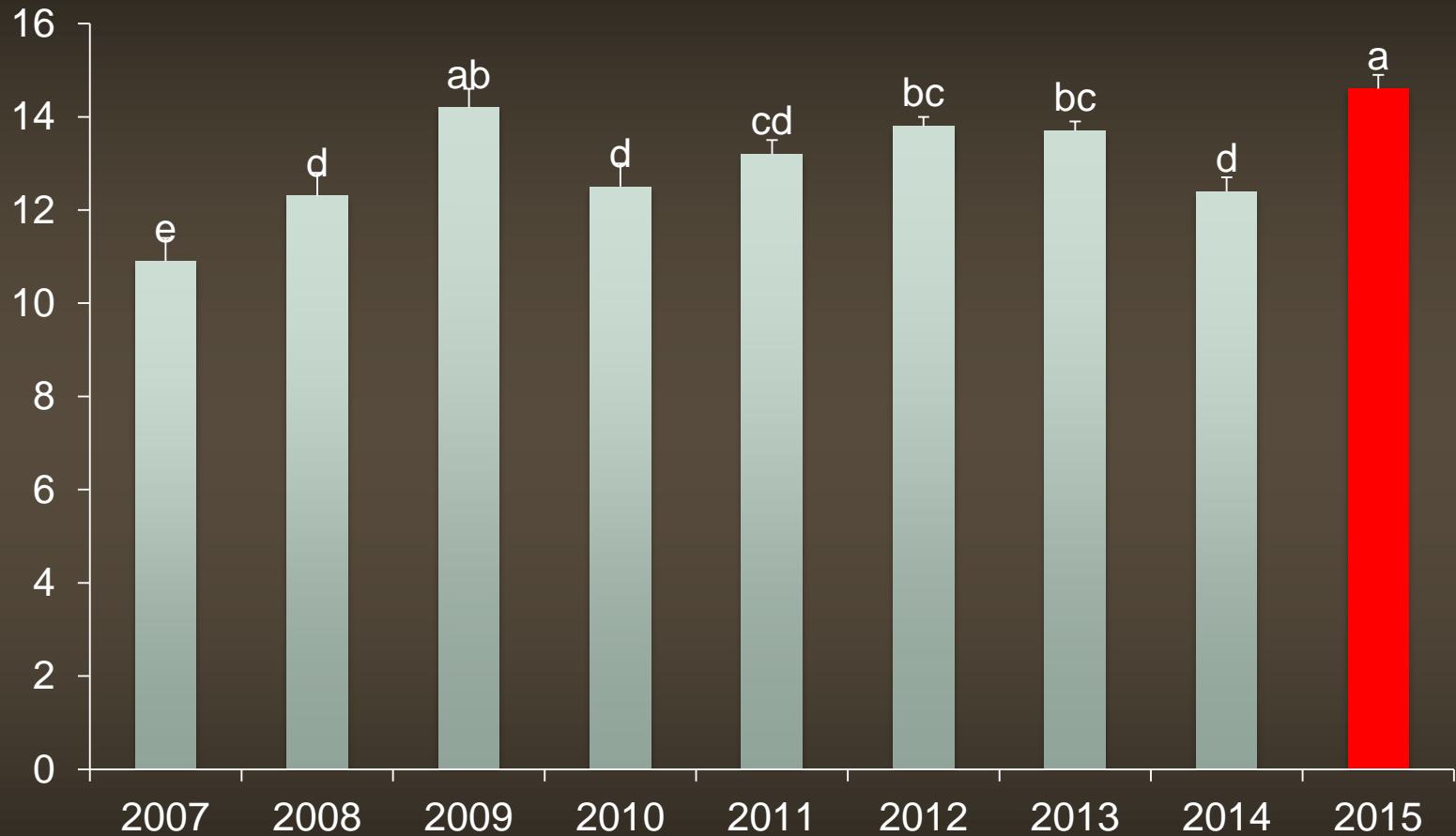
2015 EMP Fish Sampling Sites



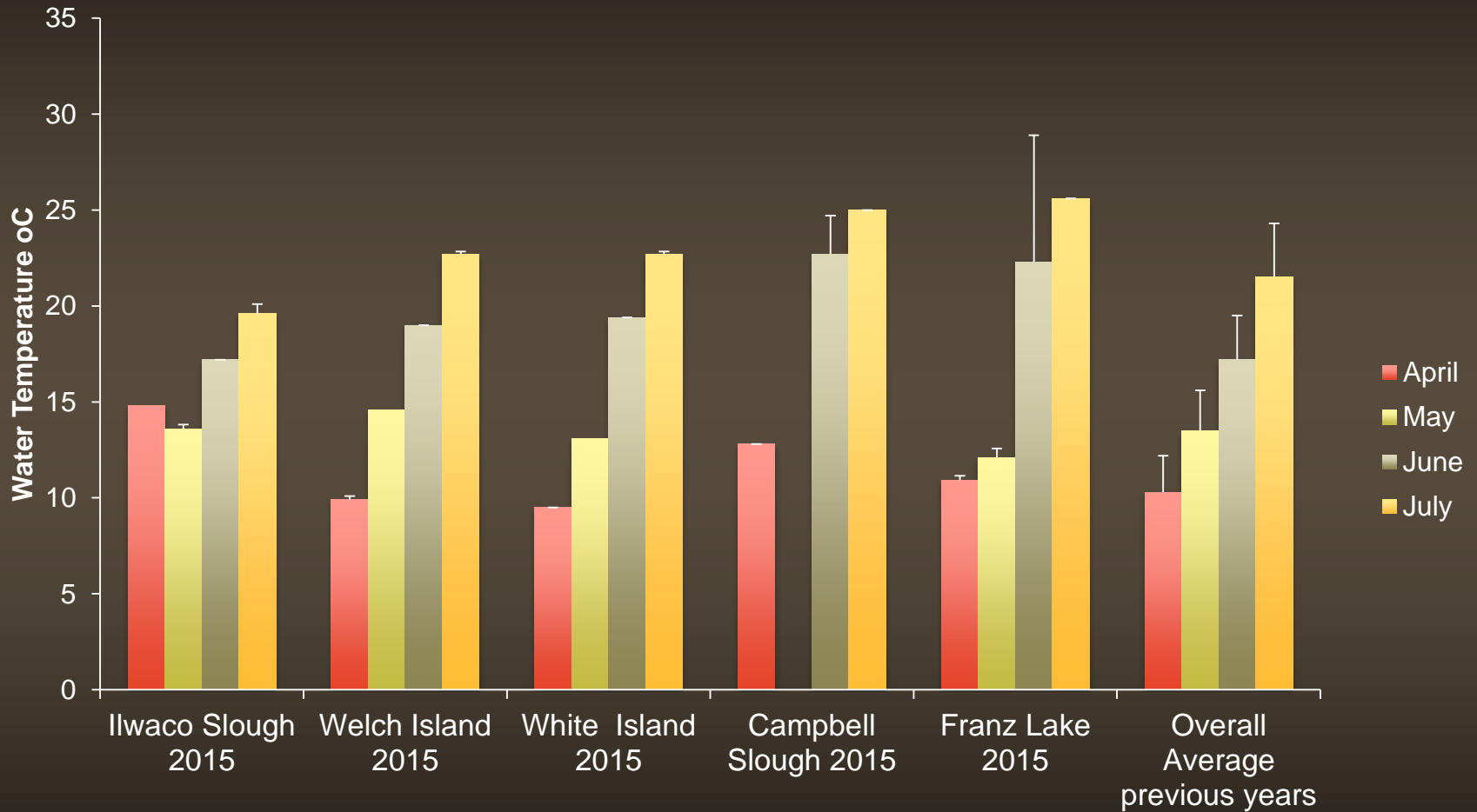
Methods

- Fish collected by beach seine
- Sampling occurred once a month (Feb-Dec); but suspended from August-October in 2015 due to high water temperatures
- 3 beach seine sets per site per sampling time
- Counts and species ID for all fish; lengths and weights, hatchery marking for salmon
- Fish “density” estimated as number of fish per area swept by beach seine; adjusted to fish per 1000 m²
- Otoliths, genetic samples, bodies for lipid content and contaminants, diets for Chinook salmon

2015 Water Temperatures



2015 Water Temperatures

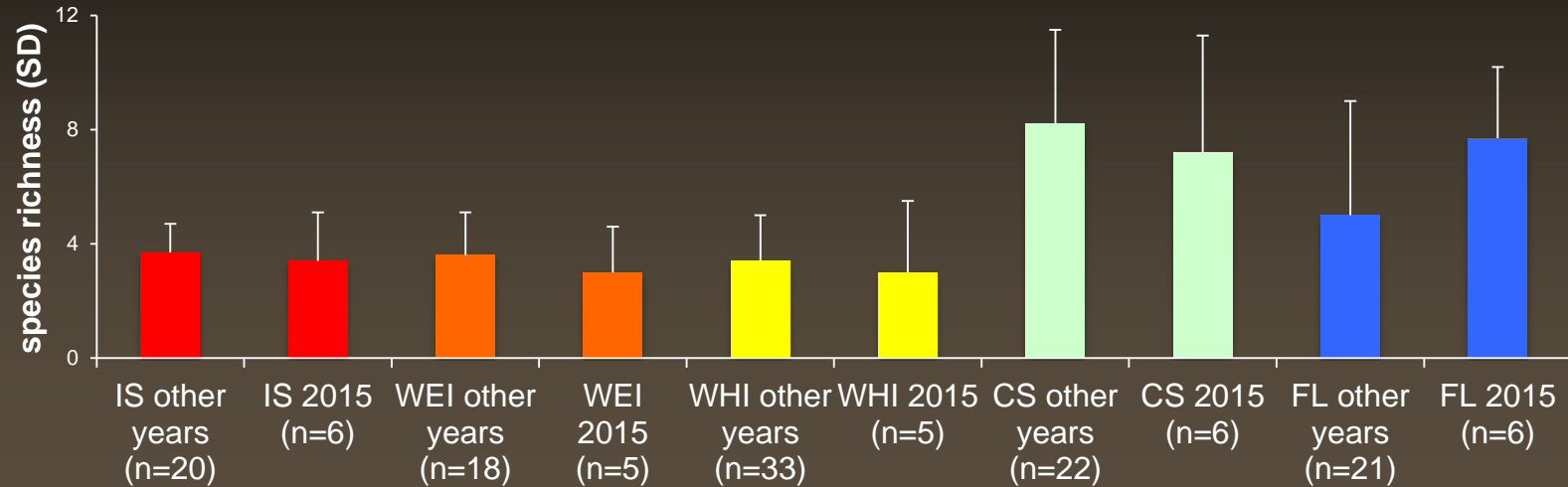




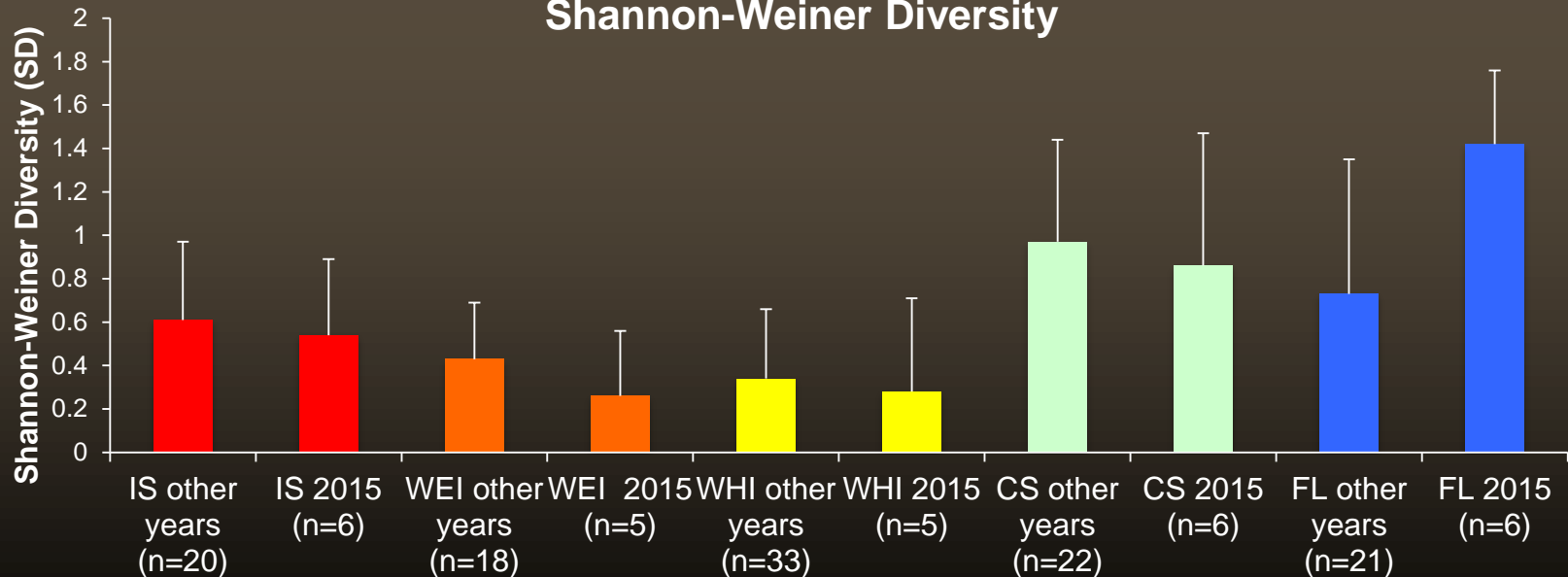
Fish community
composition

Species diversity and richness – 2015 vs. other years

Species richness

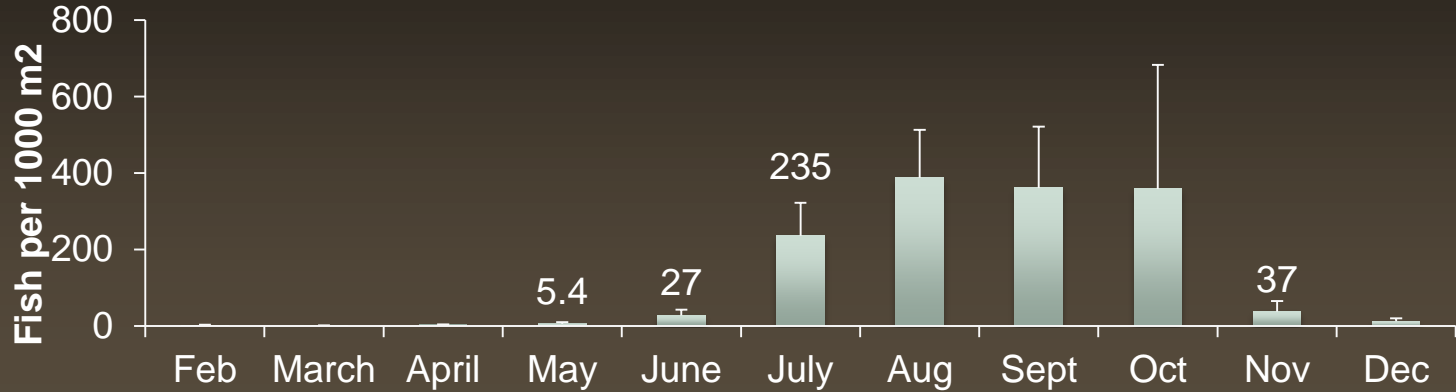


Shannon-Weiner Diversity

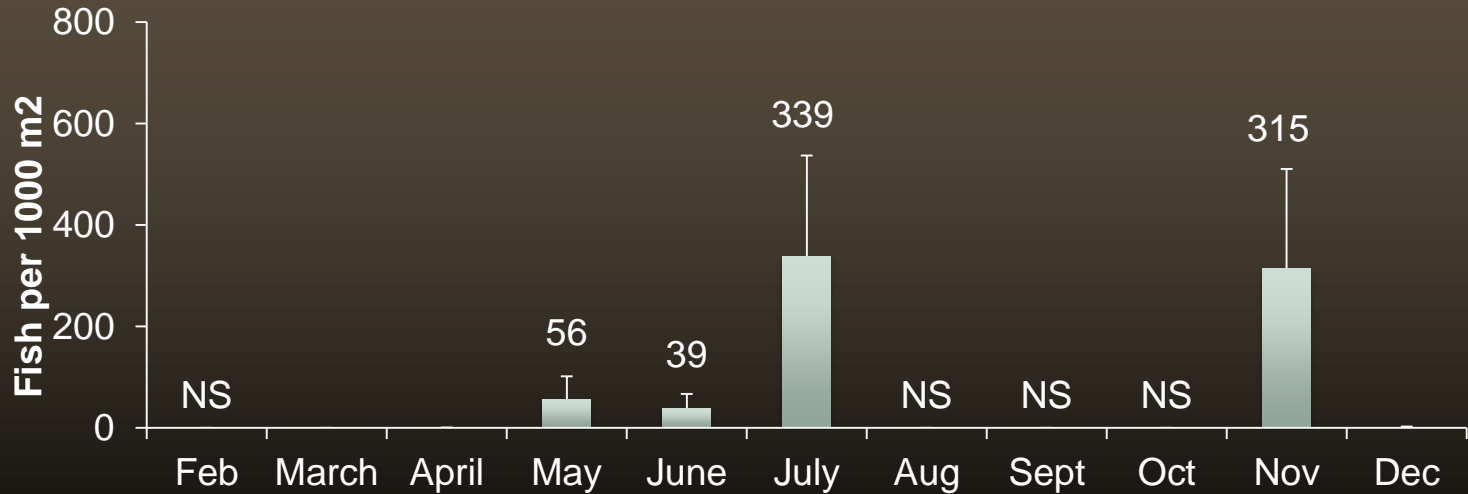


Seasonal occurrence of non-native fish species

2008-2014

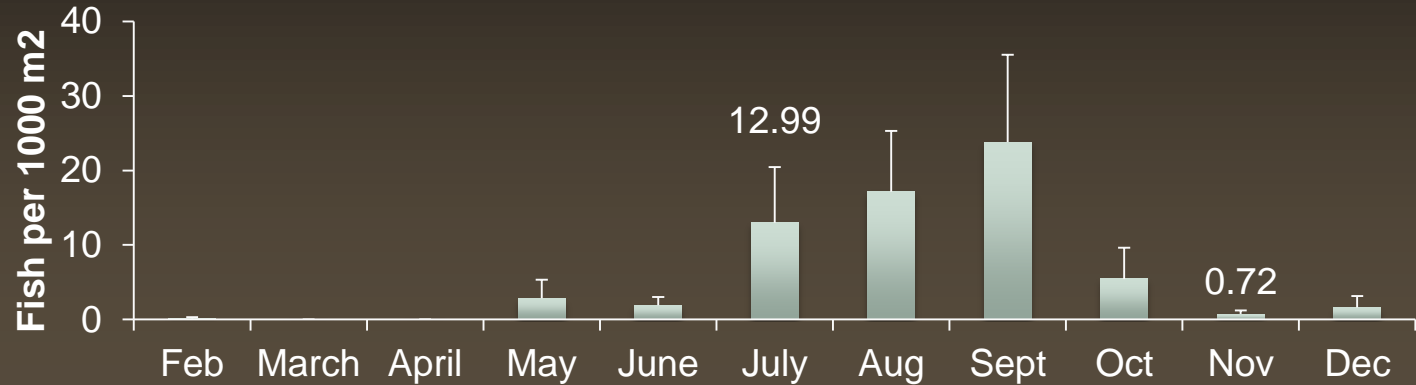


2015

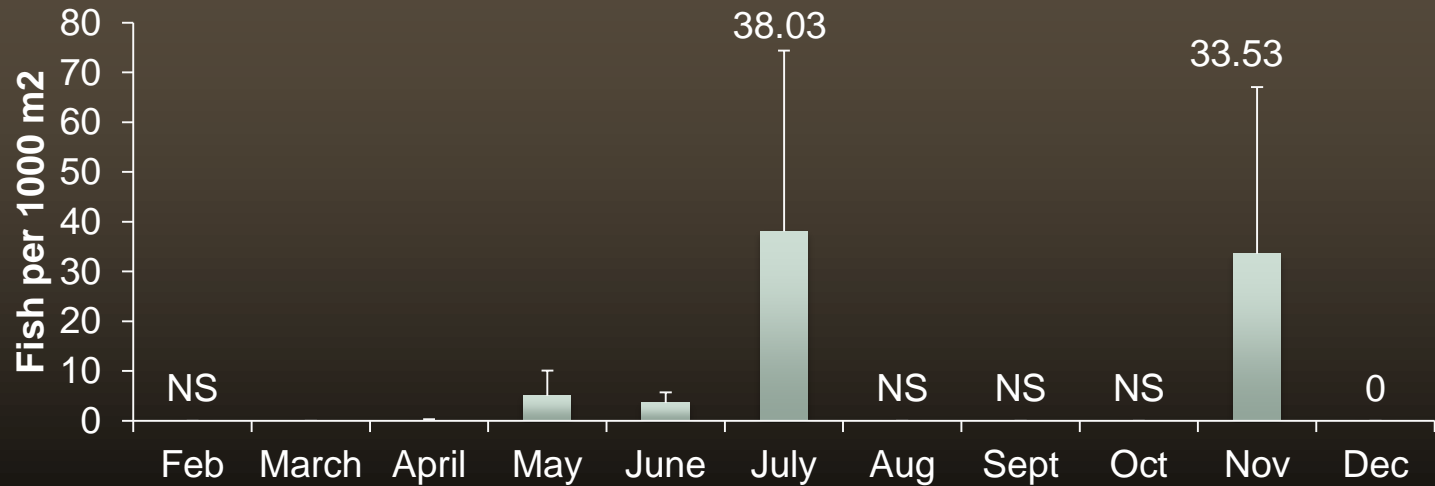


Seasonal occurrence of predatory fish species

2008-2014



2015



Non-native and predatory density – 2015 vs. other years

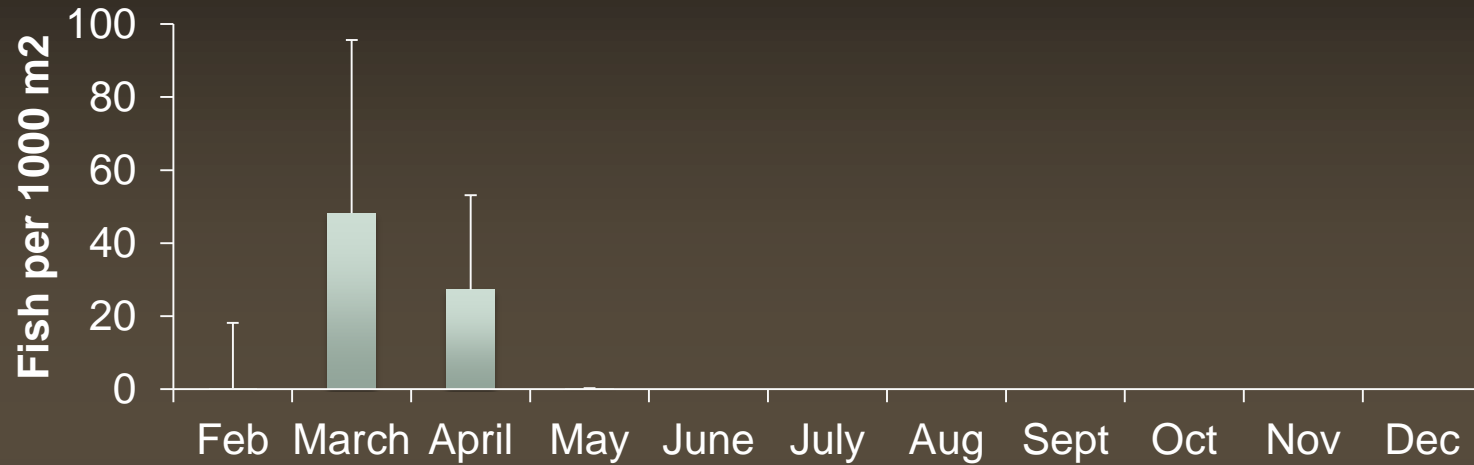




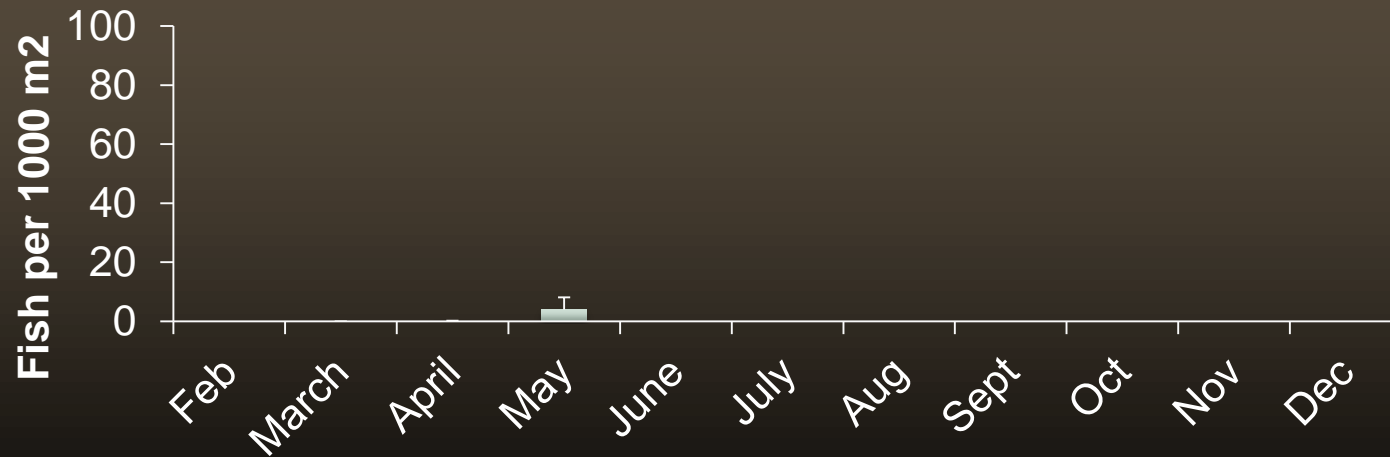
Salmon Habitat Occurrence

Season salmon occurrence-Chum salmon

2008-2014

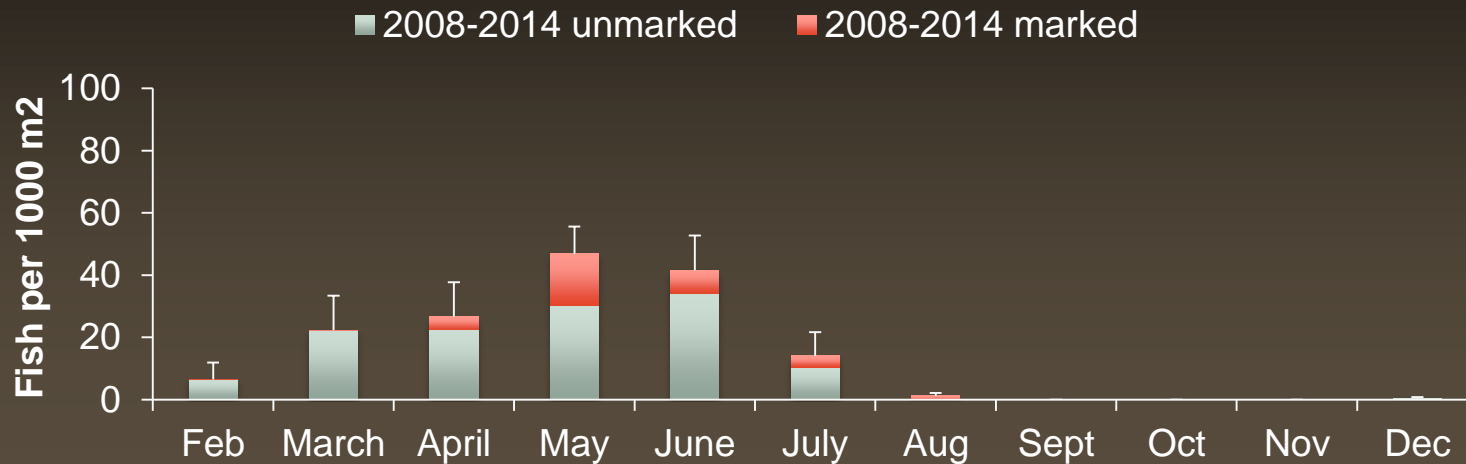


2015

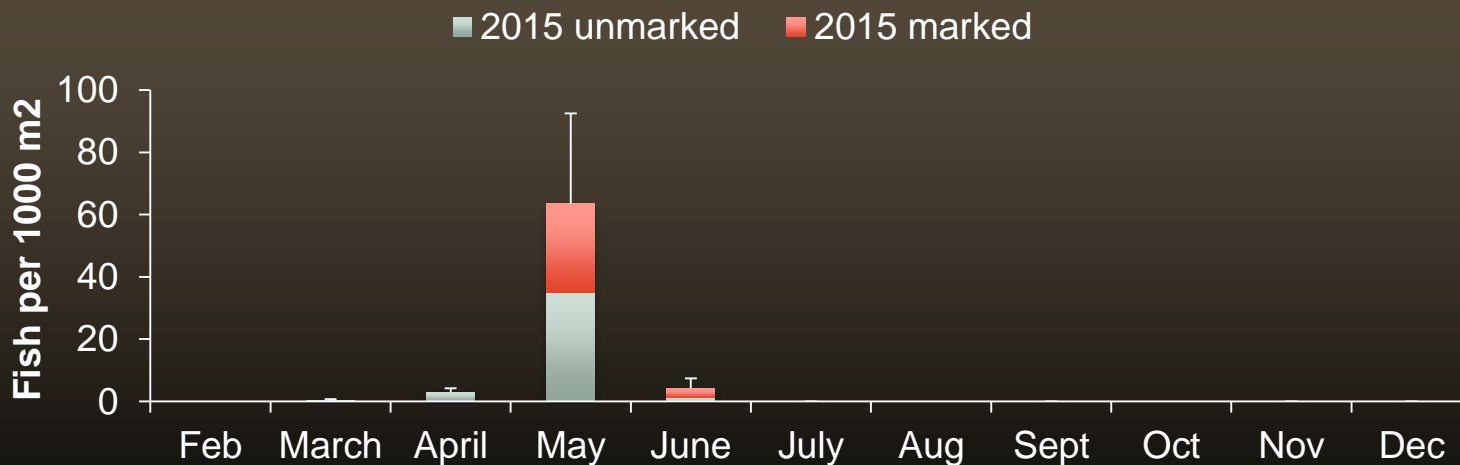


Season salmon occurrence-Chinook salmon

2008-2014

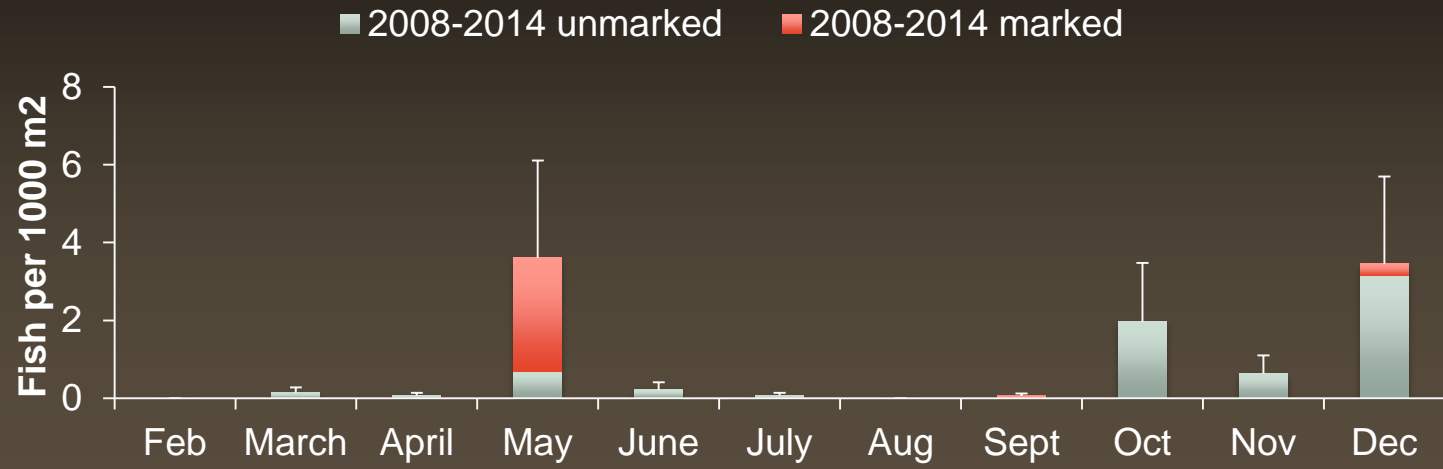


2015

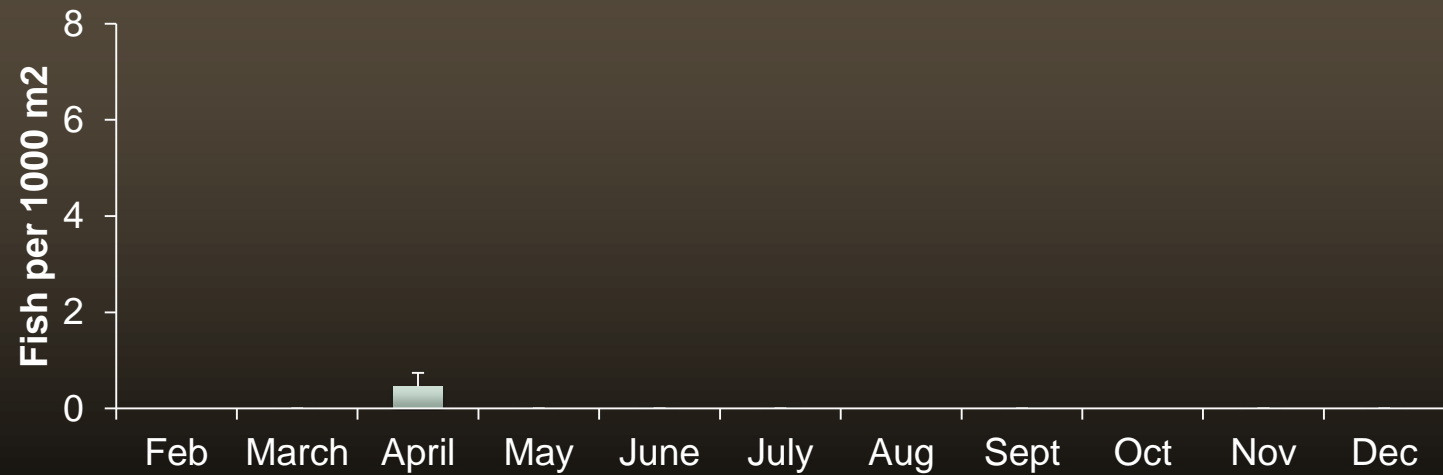


Season salmon occurrence-Coho salmon

2008-2014

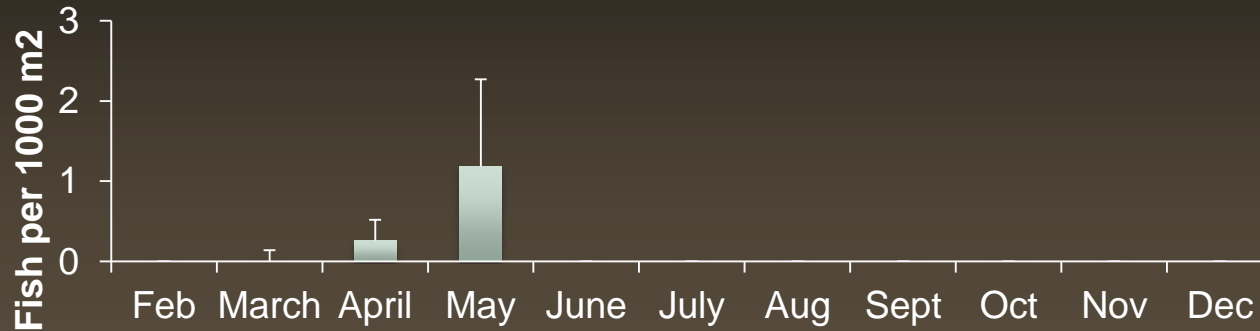


2015

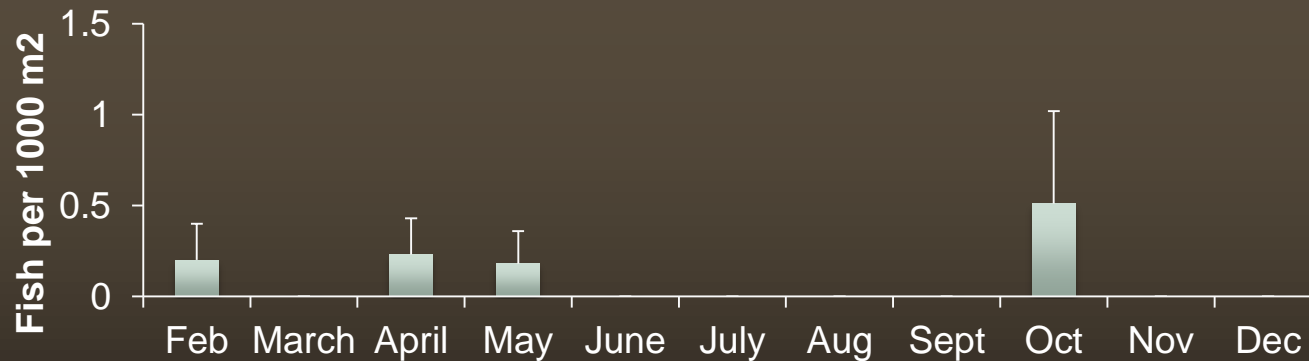


Season salmon occurrence-sockeye salmon and trout spp.

2008-2014 sockeye

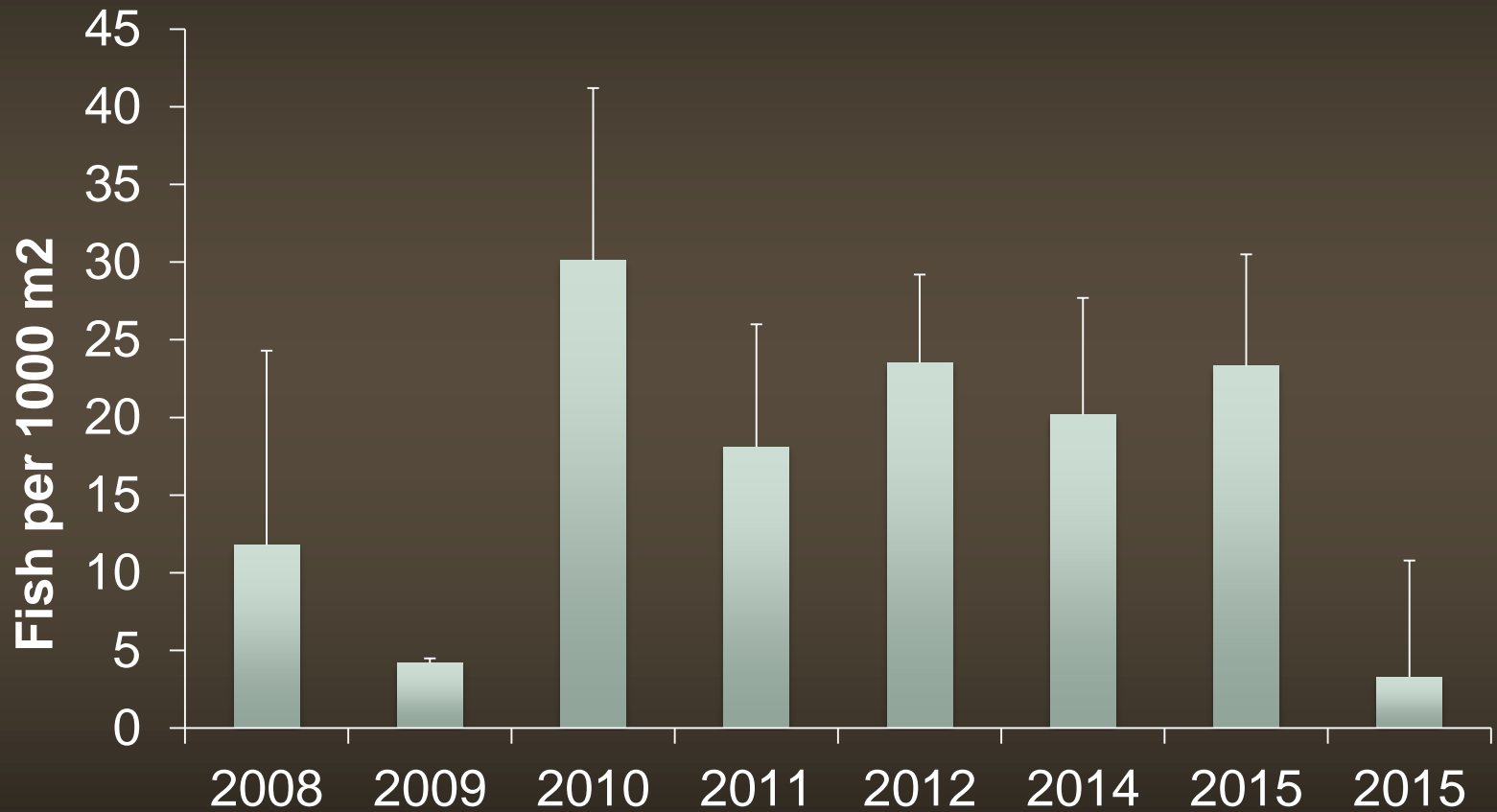


2008-2014 trout sp.



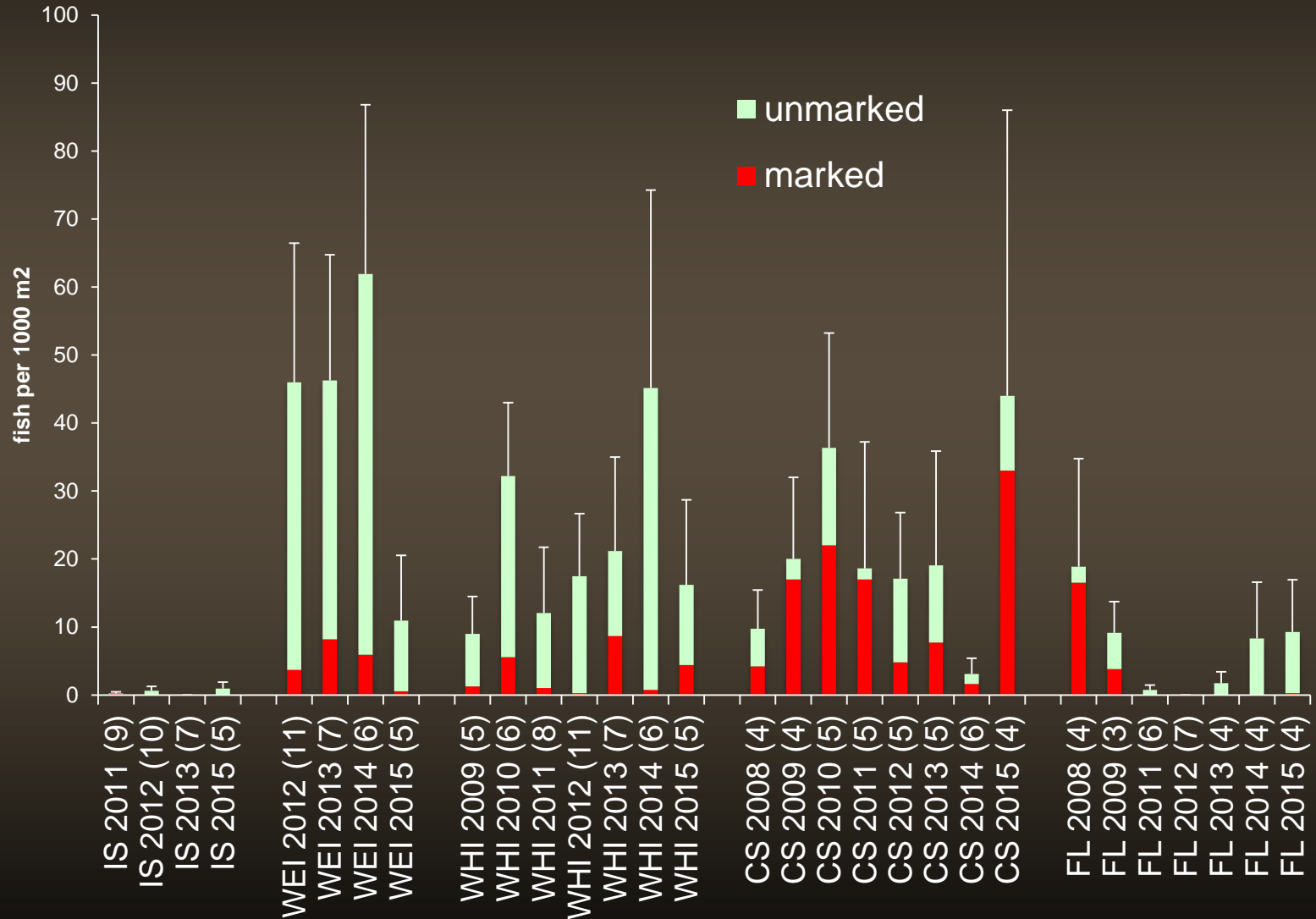
NO sockeye or trout caught in 2015

Salmonid catch in 2015



Least square mean adjusted for site and sampling month

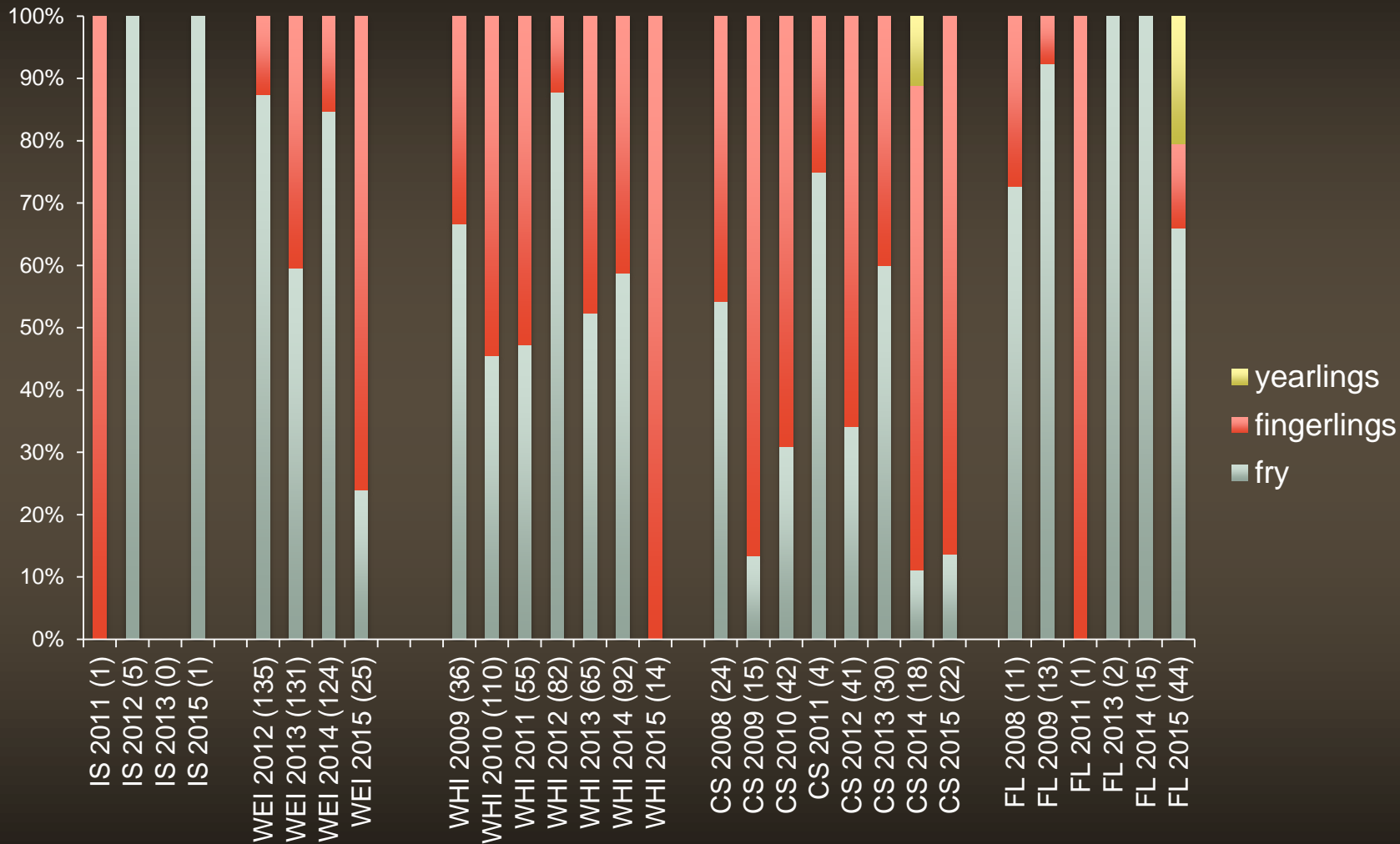
Chinook salmon catches - temporal trends



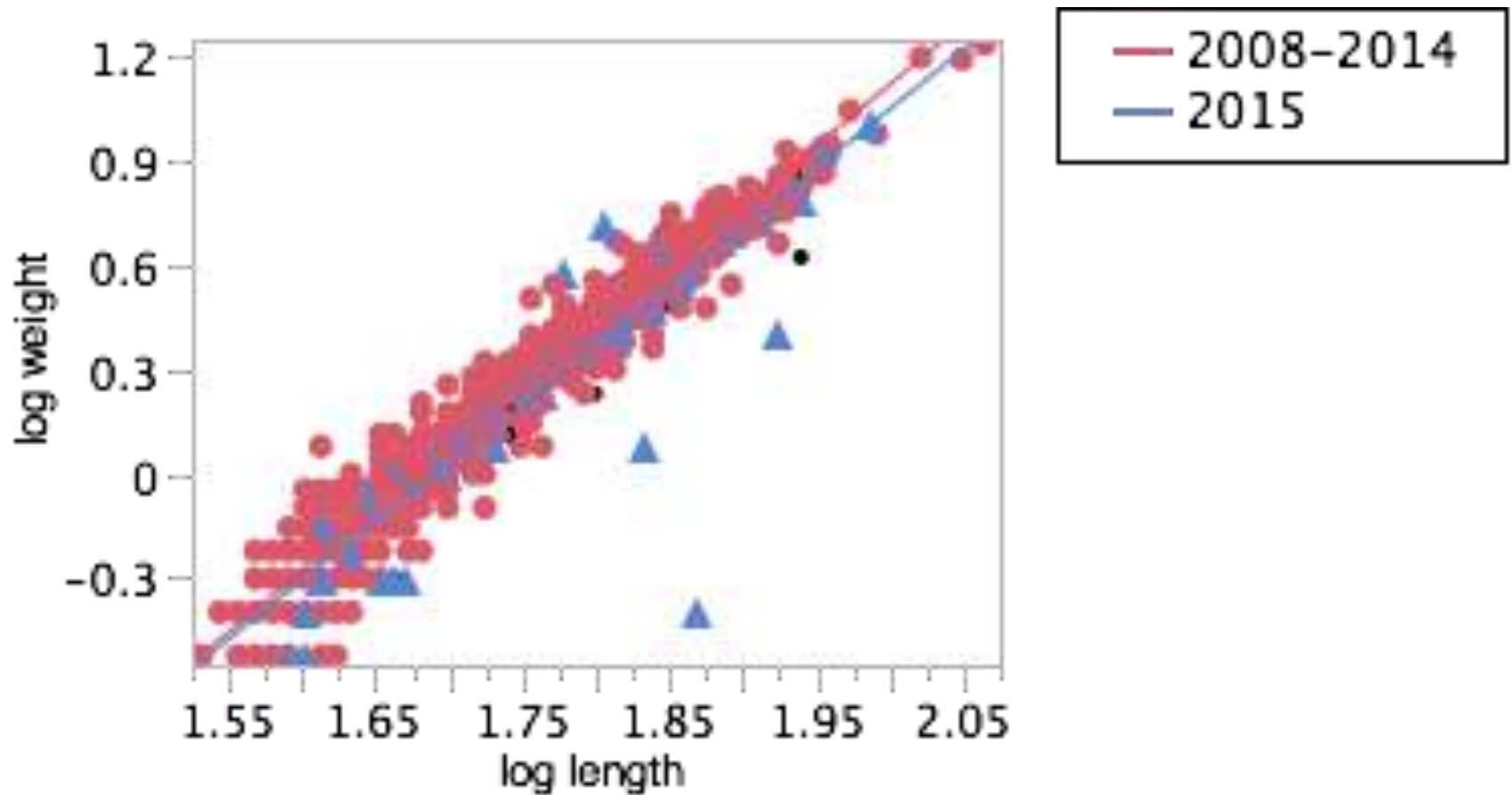


Salmon Health
and Condition

Unmarked Chinook size class distribution- temporal trends

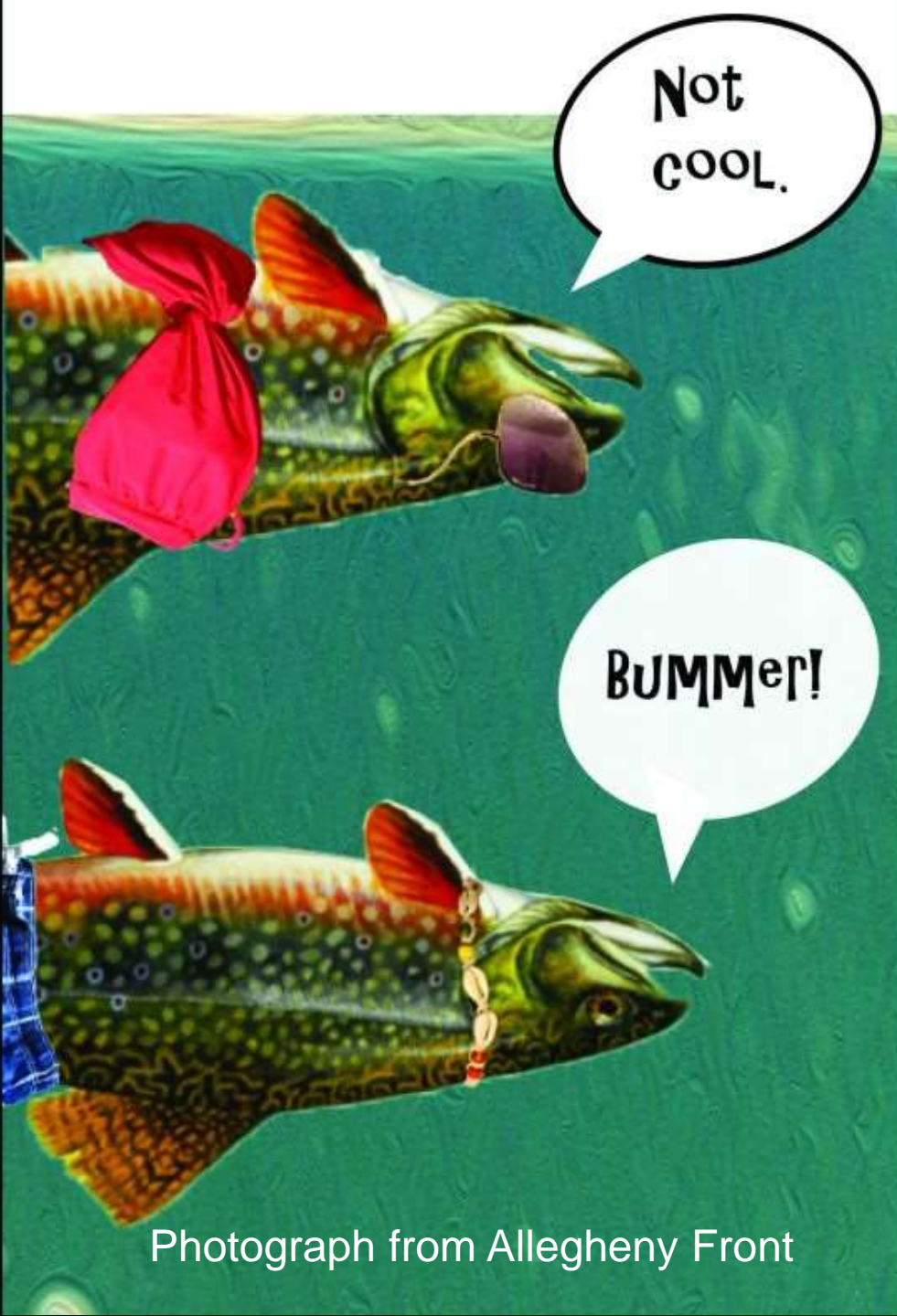


Length-weight relationship in unmarked Chinook



Summary and Conclusions

- In 2015, low summer flows and increased summer temperatures were associated with changes in rearing capacity of the tidal freshwater emergent marsh areas that we sample in the EMP.
 - By June temperatures at all trend sites above optimal levels for juvenile salmon
 - Low water levels reduced available habitat for juvenile salmon at some sites.
 - Shorter period of estuary occurrence and lower catches for Chinook salmon
 - Fewer fry at Welch and Whites Island, where they are usually abundant
 - Fewer outmigrating chum and coho salmon; no sockeye or trout
- Higher number of non-native species and predatory fish (e.g., bass species, pike minnow)
- Findings consistent with some predicted impacts of climate change.
- Our results suggest that climate change will not be favorable to salmon productivity in the Columbia River and will make recovery of listed salmon a greater challenge.



Questions?

Photograph from Allegheny Front