Ecosystem factors affecting the early marine survival of Puget Sound steelhead

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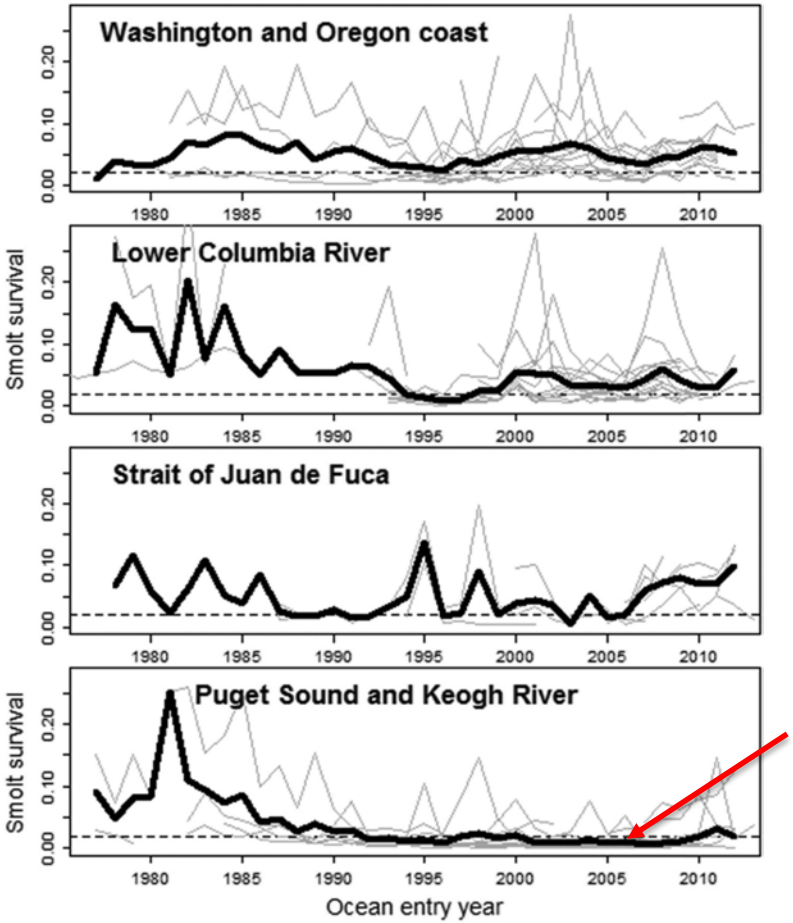


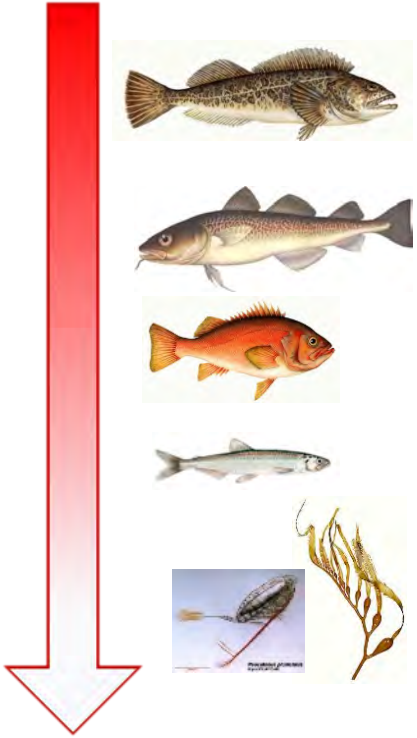
Steelhead trout
(*Oncorhynchus mykiss*)

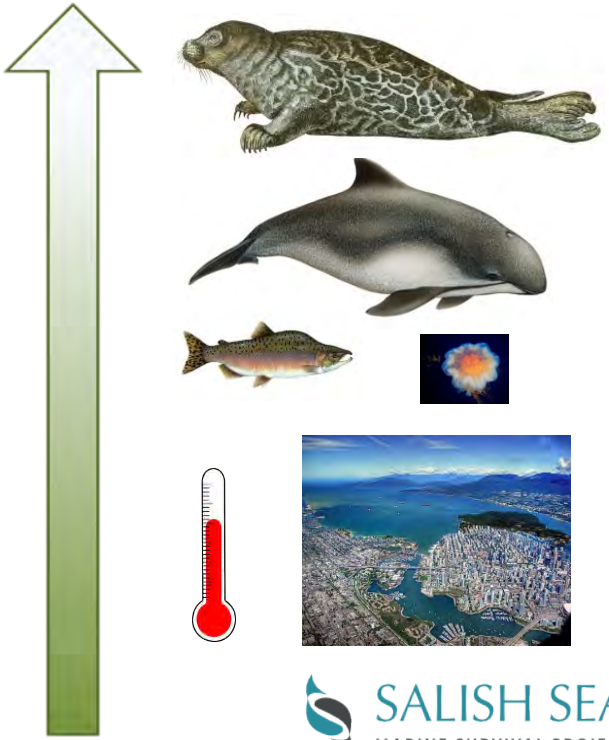
Puget Sound Distinct Population Segment

2007 ESA listing: “Threatened”

Kendall et al. 2017. Can. J. Fish. Aquat. Sci.

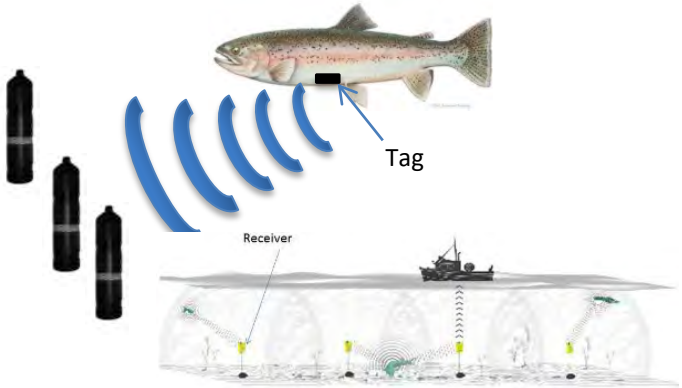
Significant ecosystem shift in the Salish Sea beginning late 1980's



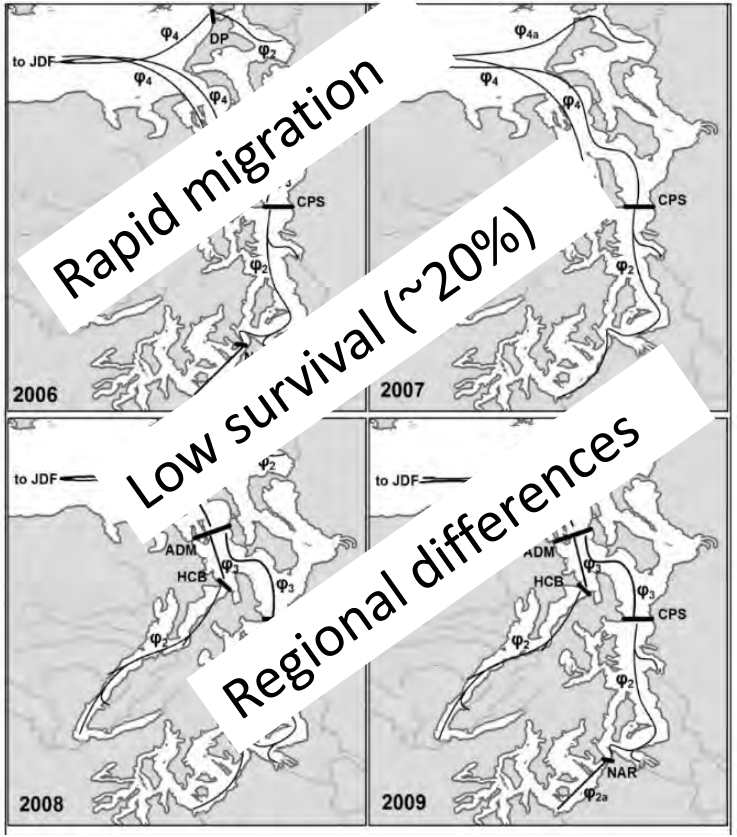


SALISH SEA
MARINE SURVIVAL PROJECT

Steelhead smolt migratory behavior and survival

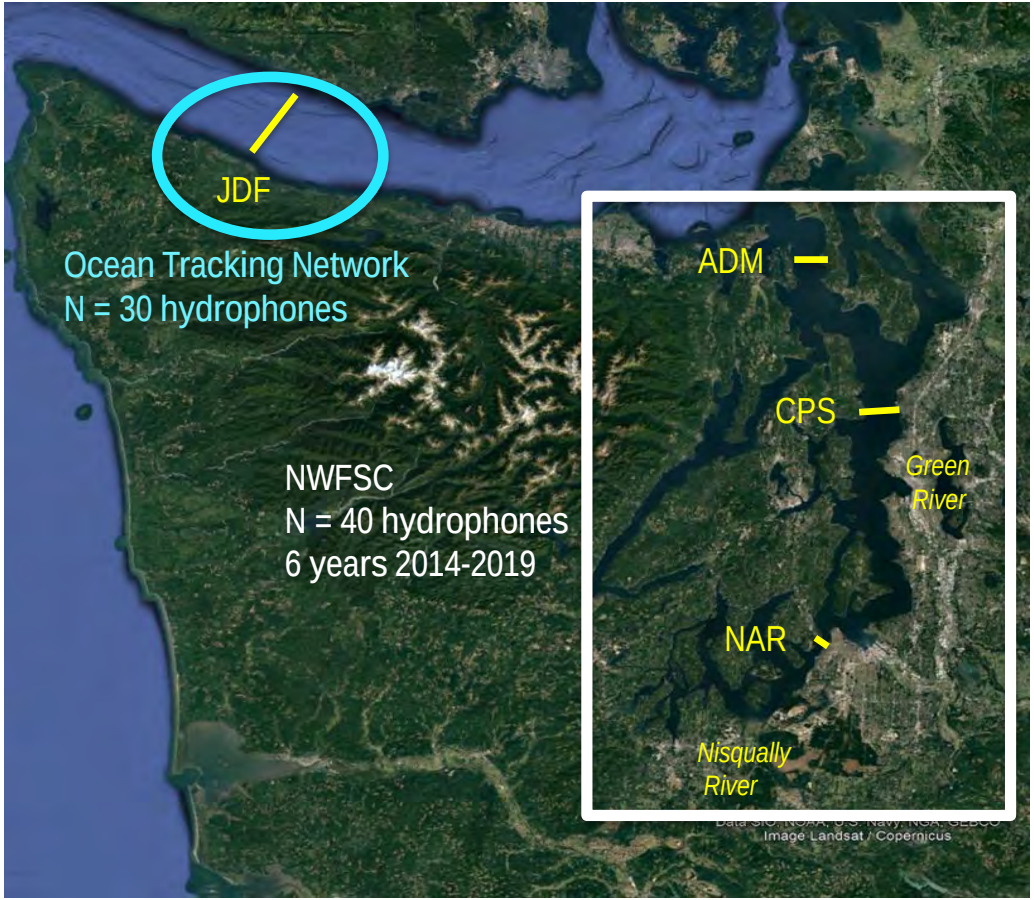


2014 Hydrophone deployments



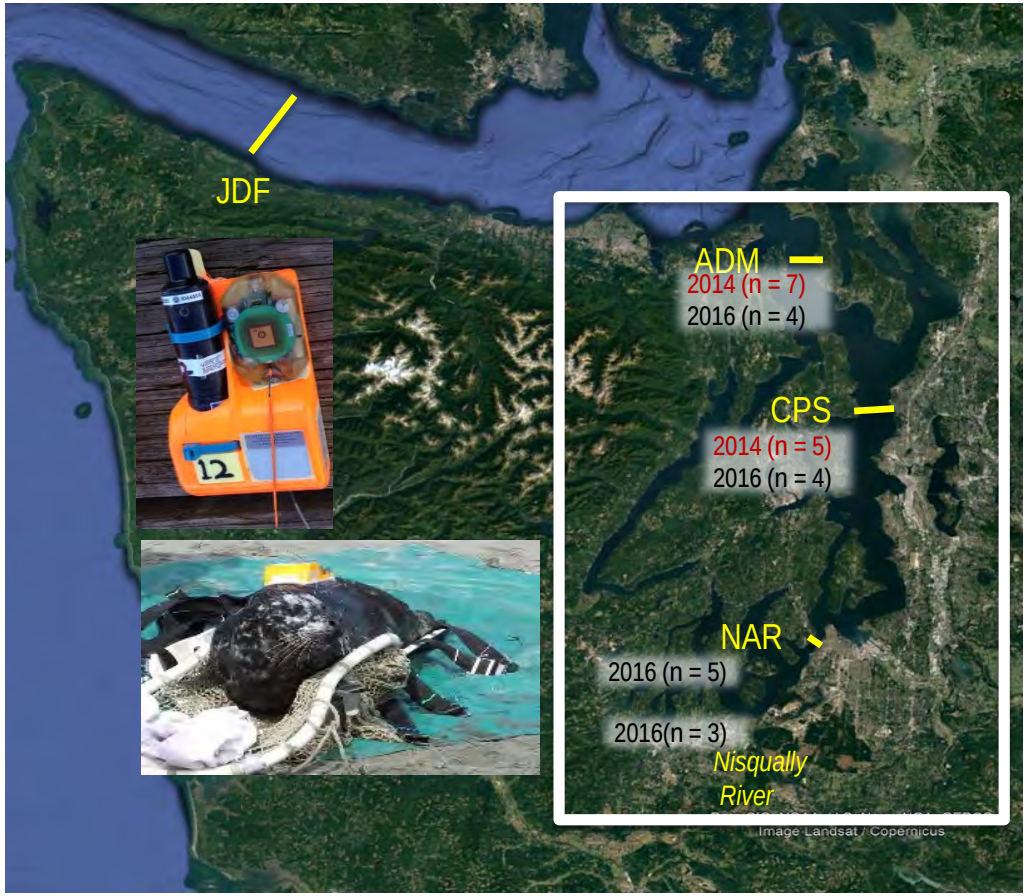
Moore et al. 2015. Mar. Ecol. Prog. Ser.

From survival monitoring to mechanistic studies

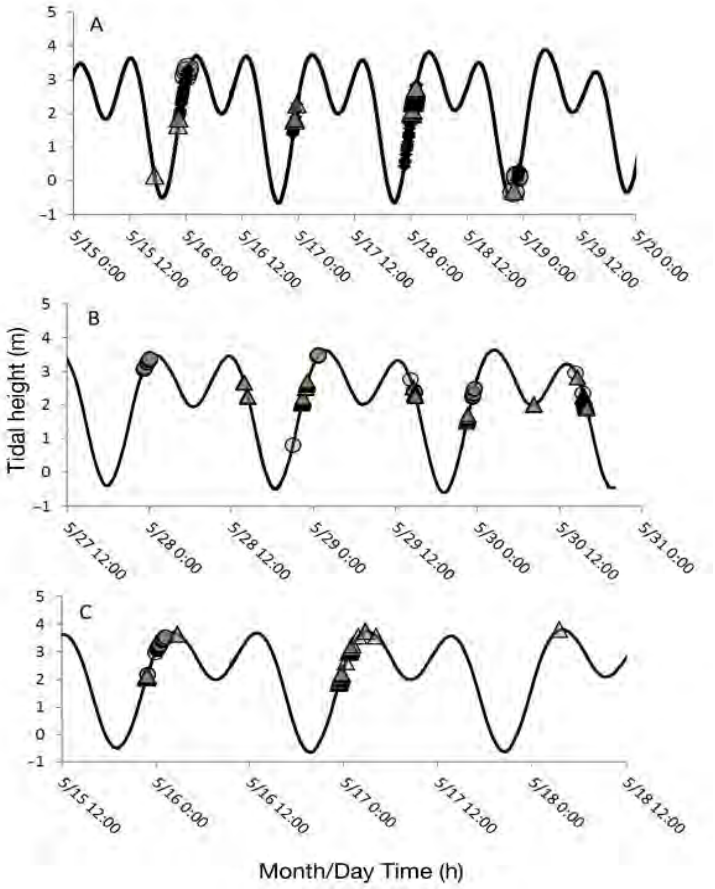


Moore et al. 2017. Ecosphere

Harbor seal – steelhead interactions

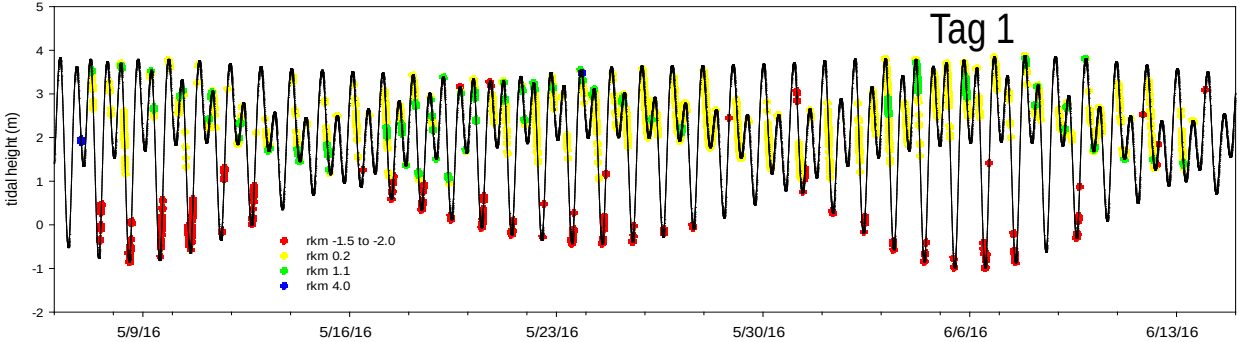


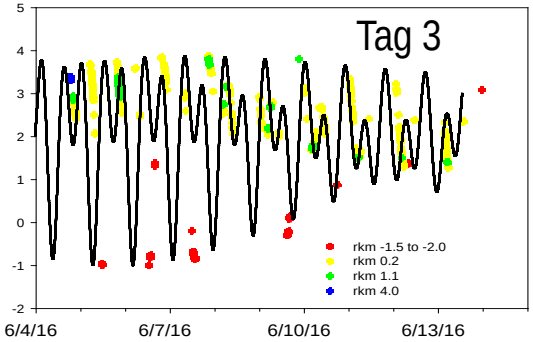
Seal predation on tagged steelhead in Puget Sound

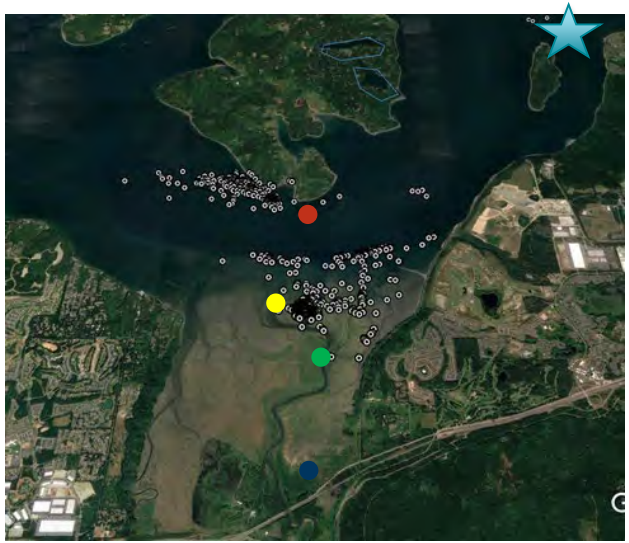


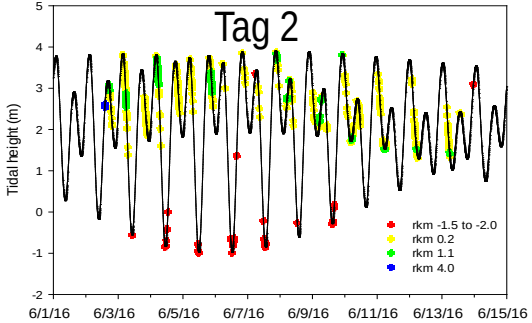
Berejikian et al. 2016. Mar. Ecol. Prog. Ser.

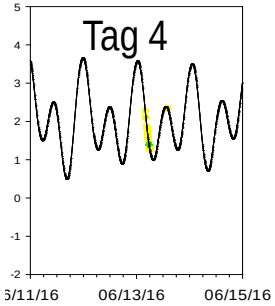
Seal predation on tagged steelhead in estuaries



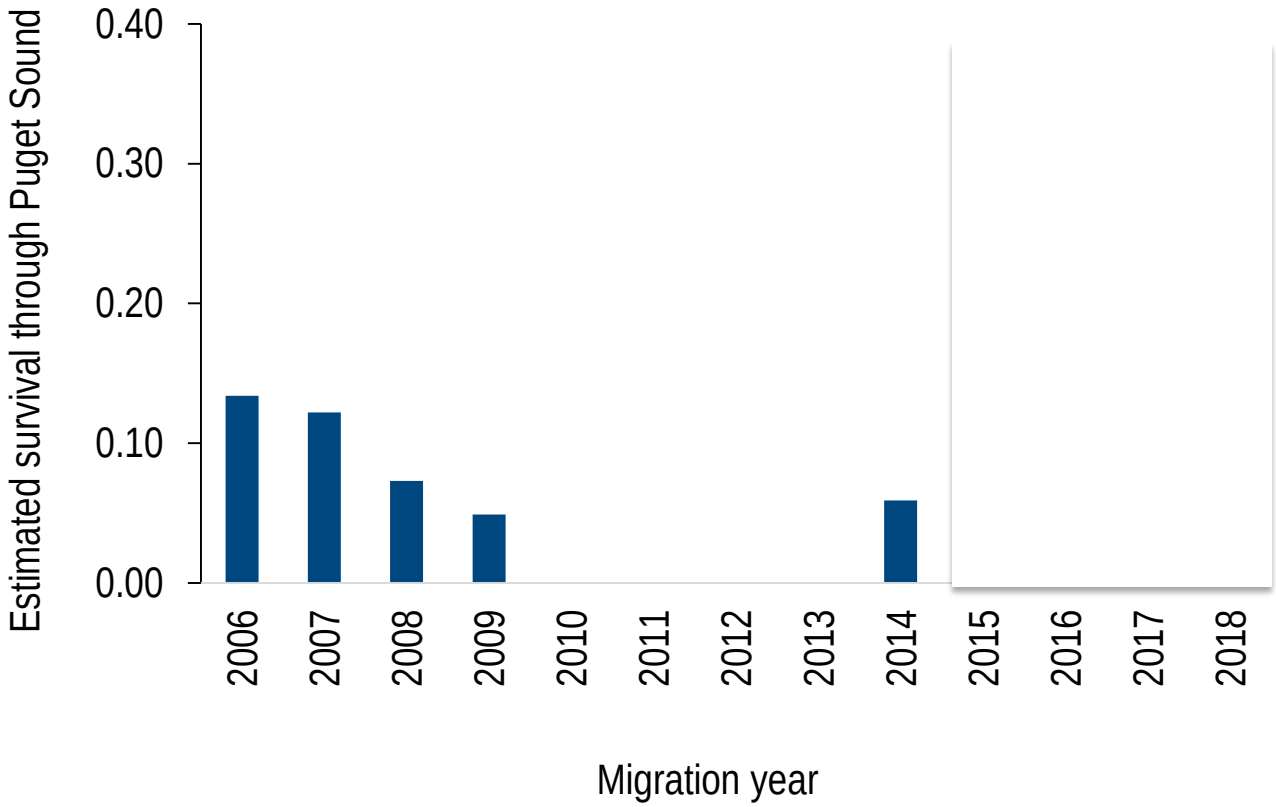




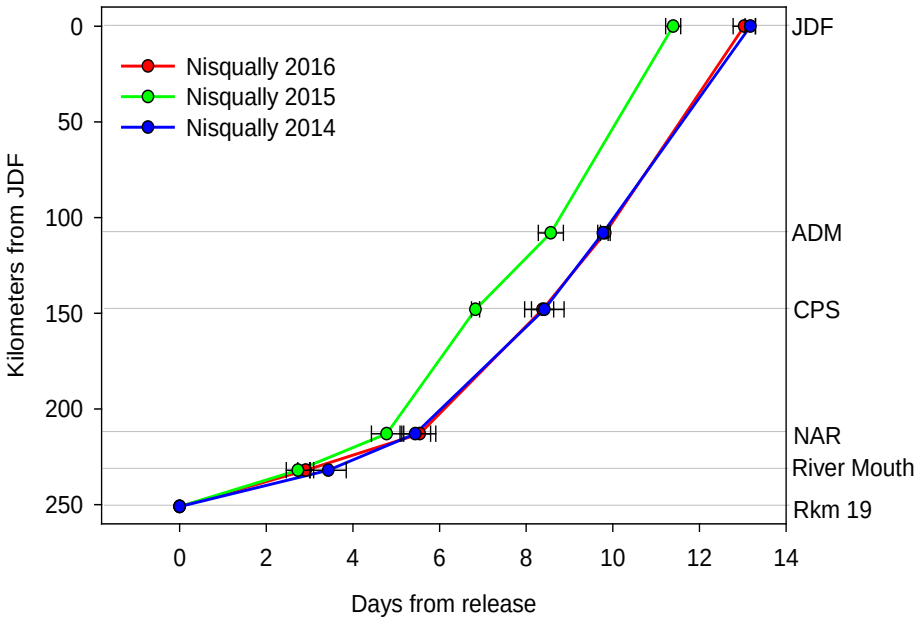


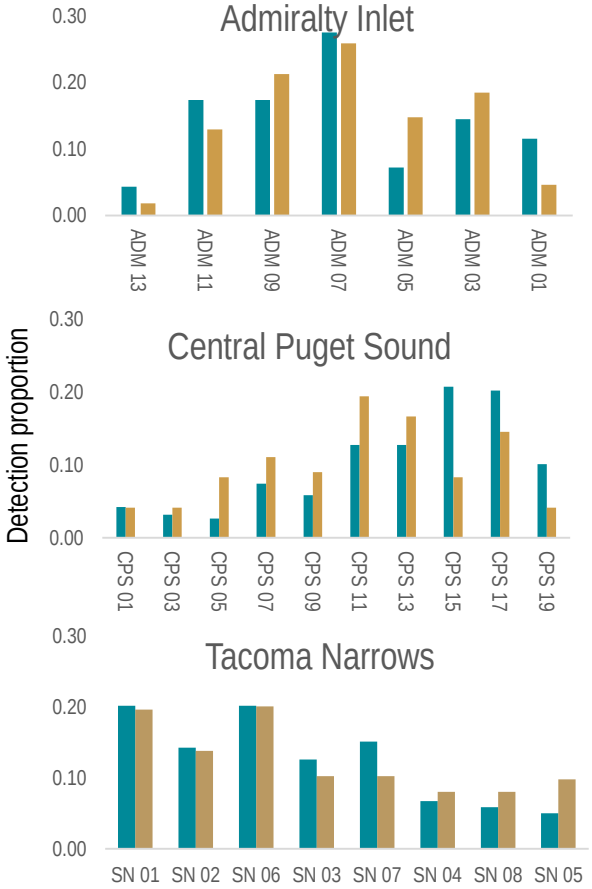


Recent shifts in Nisqually River steelhead survival through Puget Sound

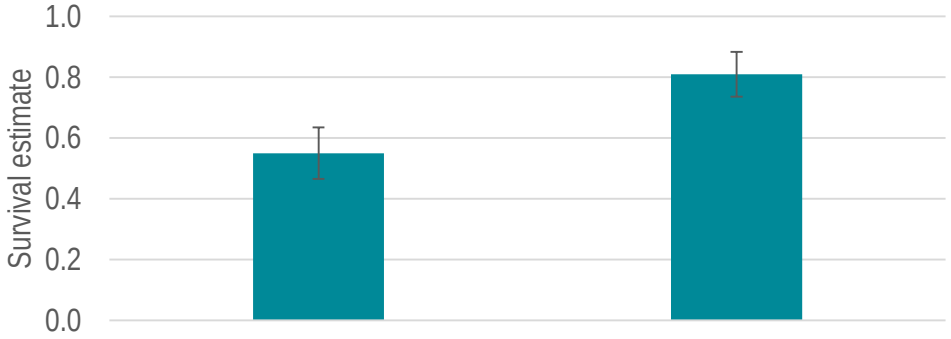


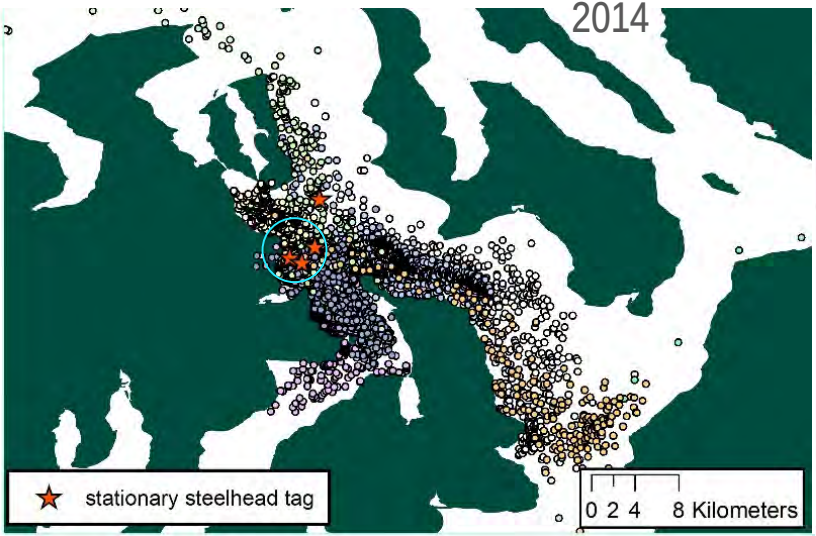
Steelhead behavior is similar in high and low survival years

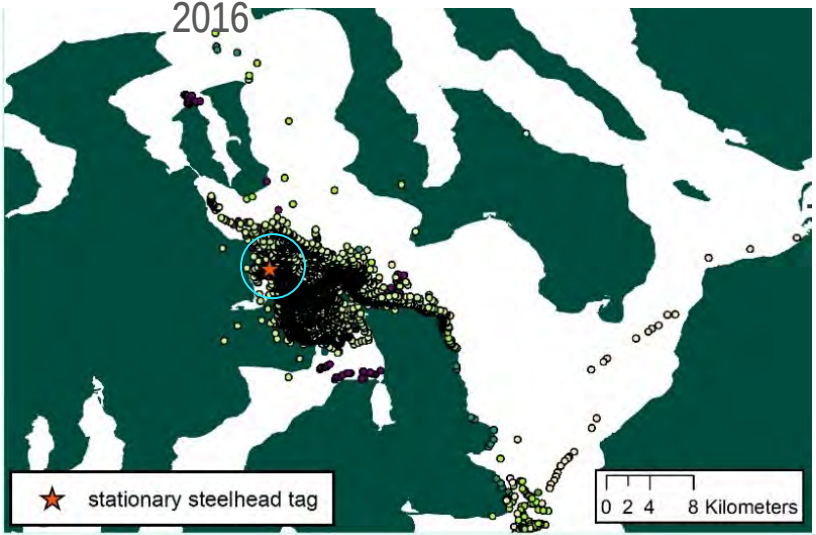




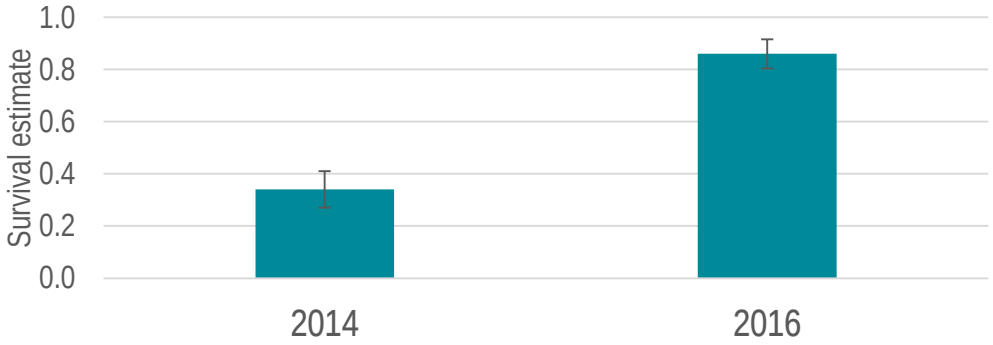
Stationary tags near harbor seal haulouts – Admiralty Inlet

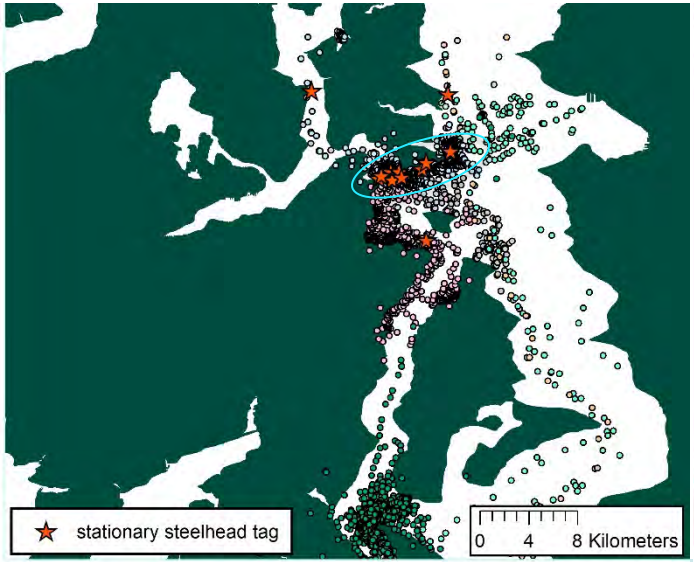


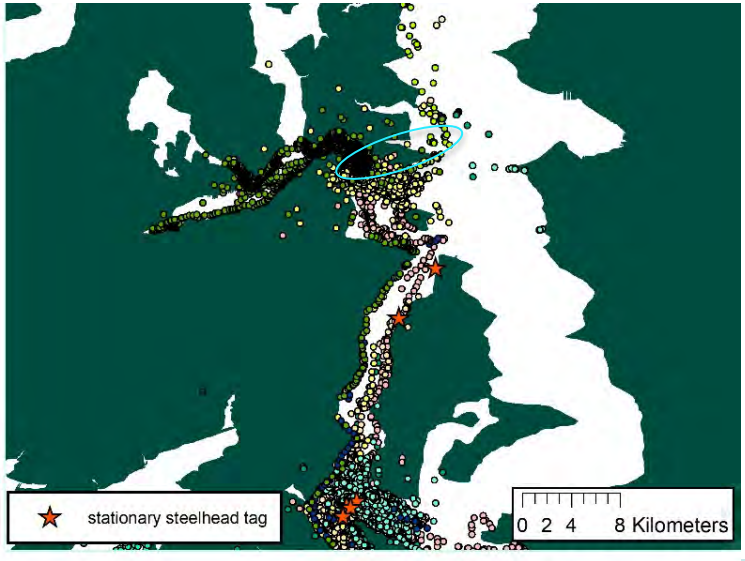




Stationary tags near harbor seal haulouts – Central Puget Sound



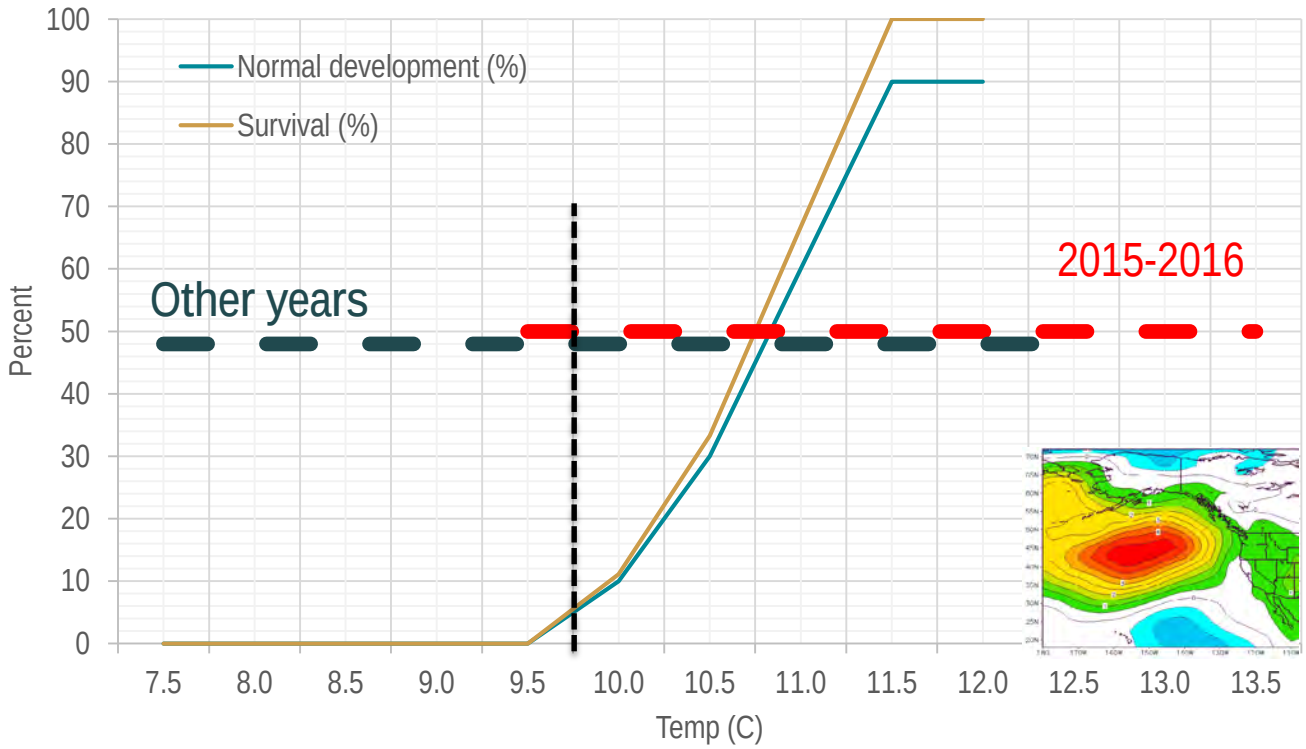




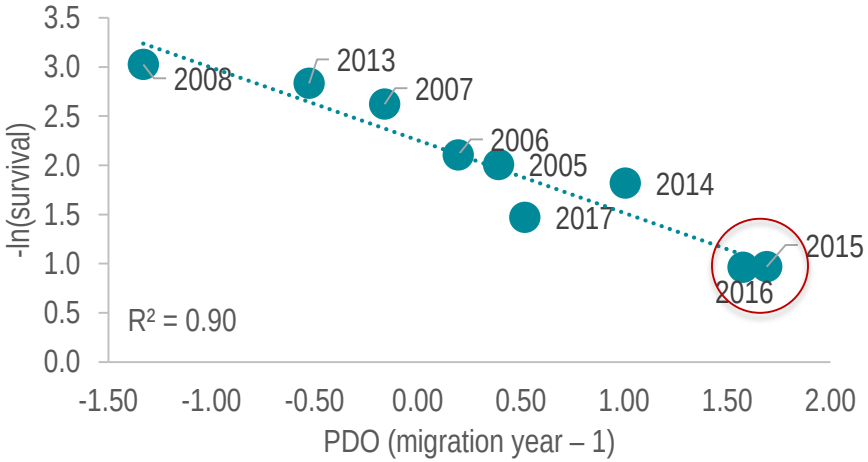
Why the recent increase in early marine survival and decrease in evidence of harbor seal predation?

Source: https://www.eopugetsound.org/magazine/ssec2018/marine-survival-3, A harbor seal hunting anchovies. From Howe Sound Ballet video by Bob Turner: https://youtu.be/Ycx1hvrPAqc

Effects of temperature on larval anchovies

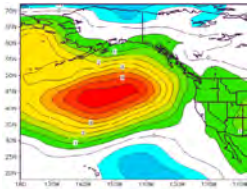


Anchovy data: Brewer et al. FISHERY BULLETIN: VOL. 74, NO. 2, 1976
Temperature data: Courtesy King County

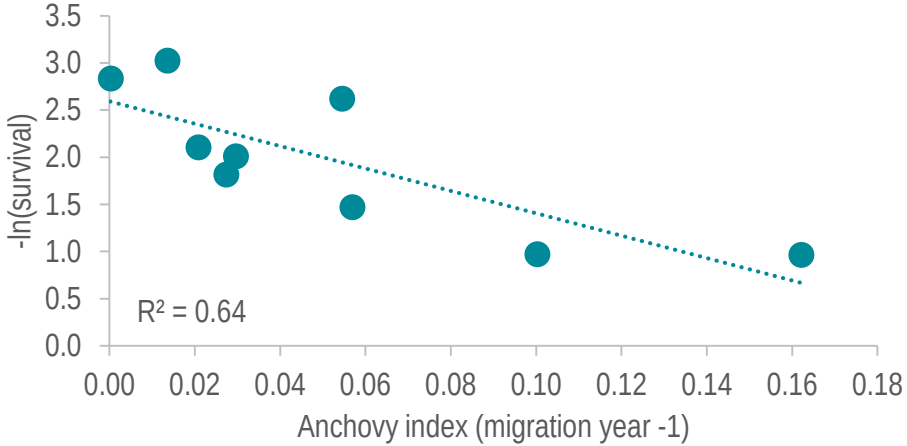


Harbor seal diet shift

Anchovy abundance



Temperature



Anchovy data: C. Greene et al., NWFSC

Transient killer whale presence in Puget sound

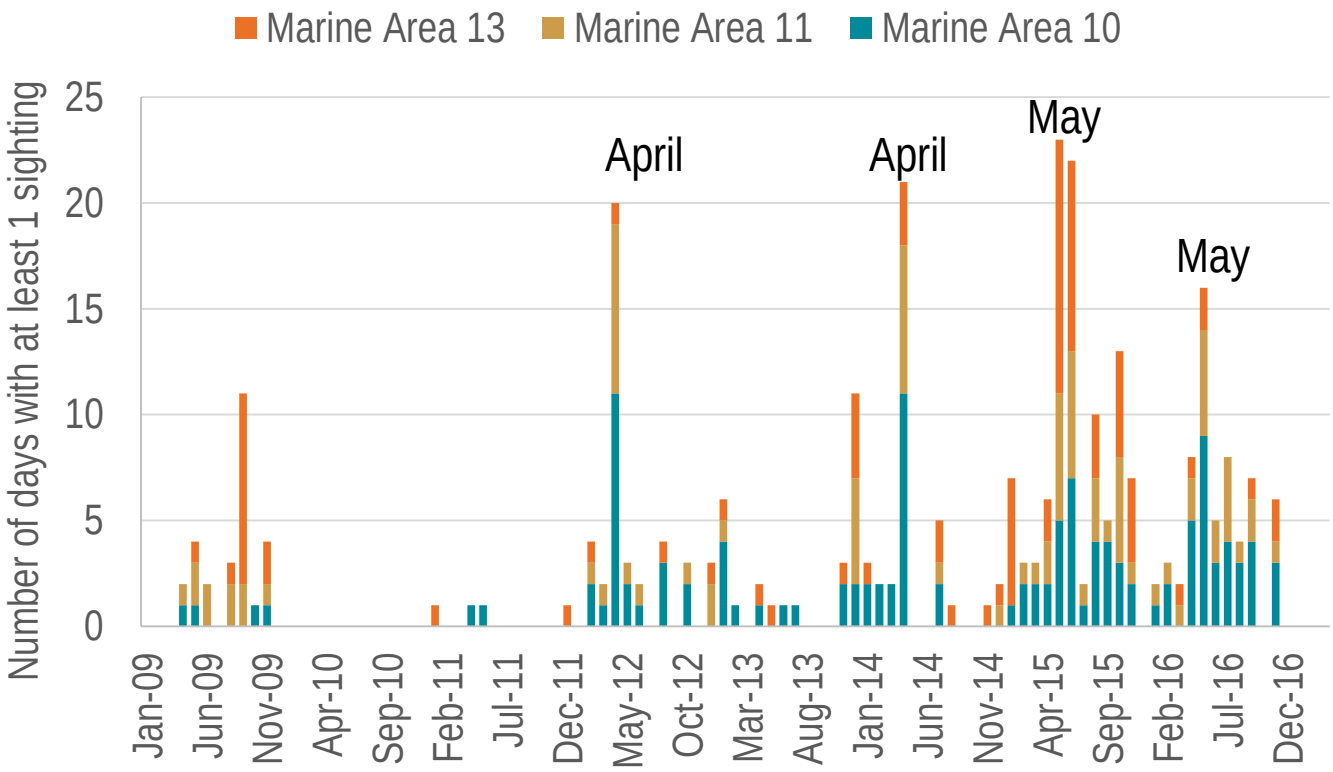
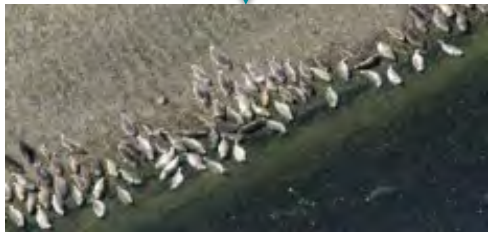


Photo: Robin Baird

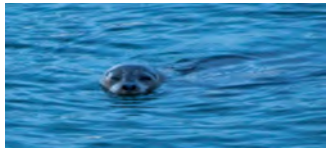


Data source: The Whale Museum

Summary

- Substantial interannual variability in survival
- Warm phases are conducive to anchovy recruitment and steelhead survival *within* Puget sound
- Unclear whether warm ocean conditions have a positive or negative effect on steelhead after they leave Puget Sound
- Harbor seals steelhead mortality, it appears to be additive, but magnitude is not yet clear
- Presence of alternative, preferred prey may lessen predation impacts on steelhead
- Abundant and diverse prey base for harbor seals and other predators may improve Puget Sound steelhead early marine survival

Acknowledgements



Salish Sea Marine Survival Project (Steelhead Workgoup)
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James Hackett
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Chris Ellings
Rob Endicott
Michael Schmidt
Erik Neatherlin

Many others!