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Salish Sea Ecosystem Conference

2018 Salish Sea Ecosystem Conference  
(Seattle, Wash.)

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Apr 6th, 9:15 AM - 9:30 AM

## **Interannual variation in early marine survival patterns of Puget Sound steelhead smolts indicates shifting predation pressures**

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Berejikian, Barry A.; Moore, Megan; and Jeffries, Steve, "Interannual variation in early marine survival patterns of Puget Sound steelhead smolts indicates shifting predation pressures" (2018). *Salish Sea Ecosystem Conference*. 465.

<https://cedar.wwu.edu/ssec/2018ssec/allsessions/465>

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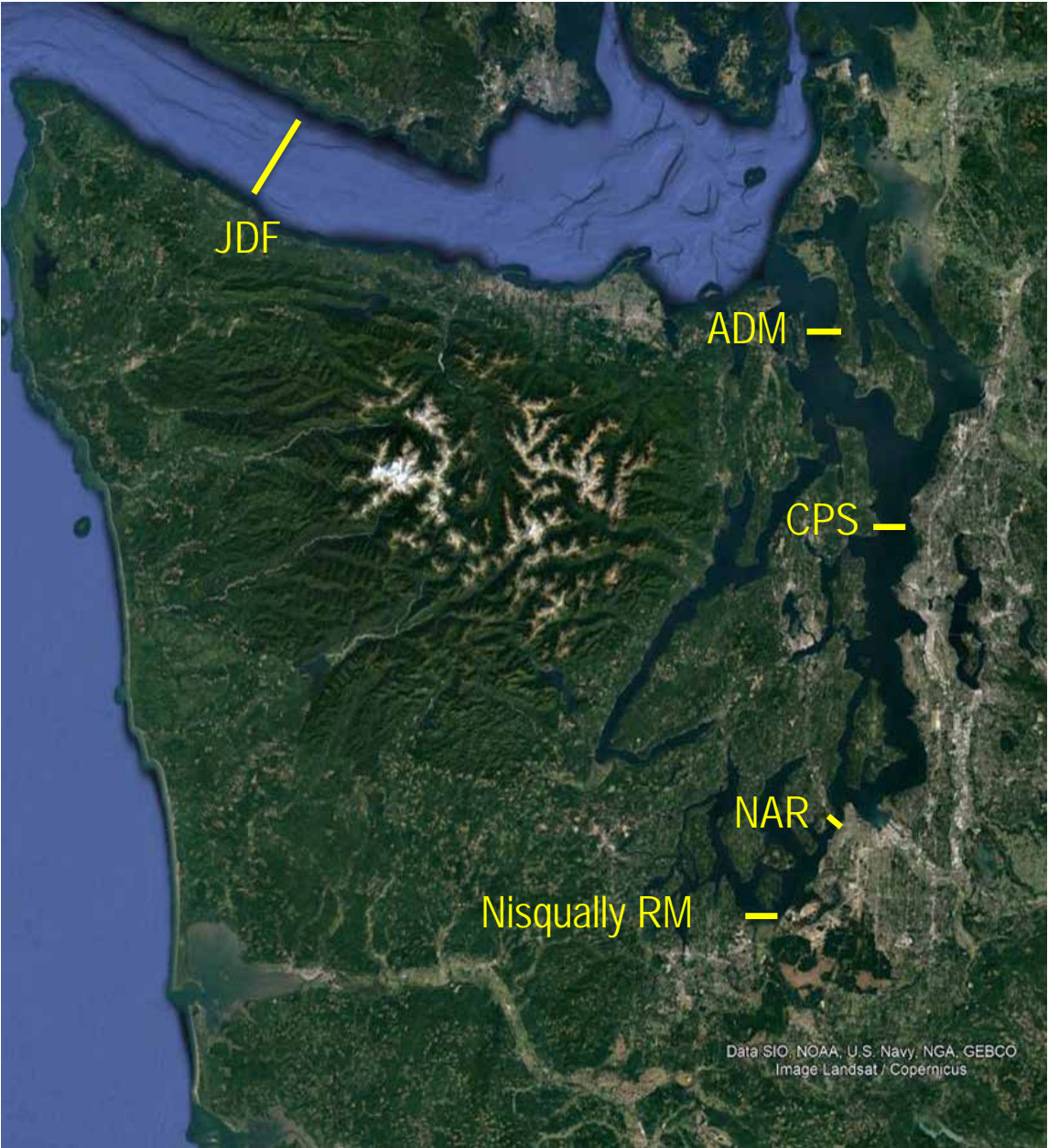
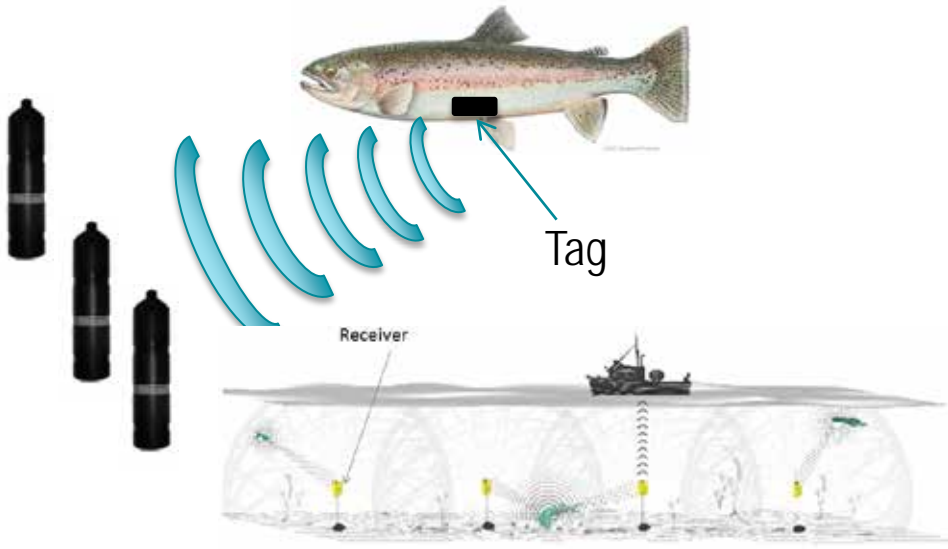
# Interannual variation in early marine survival patterns of Puget Sound steelhead smolts indicates shifting predation pressures

Barry Berejikian, Megan Moore,  
Steve Jeffries<sup>1</sup>

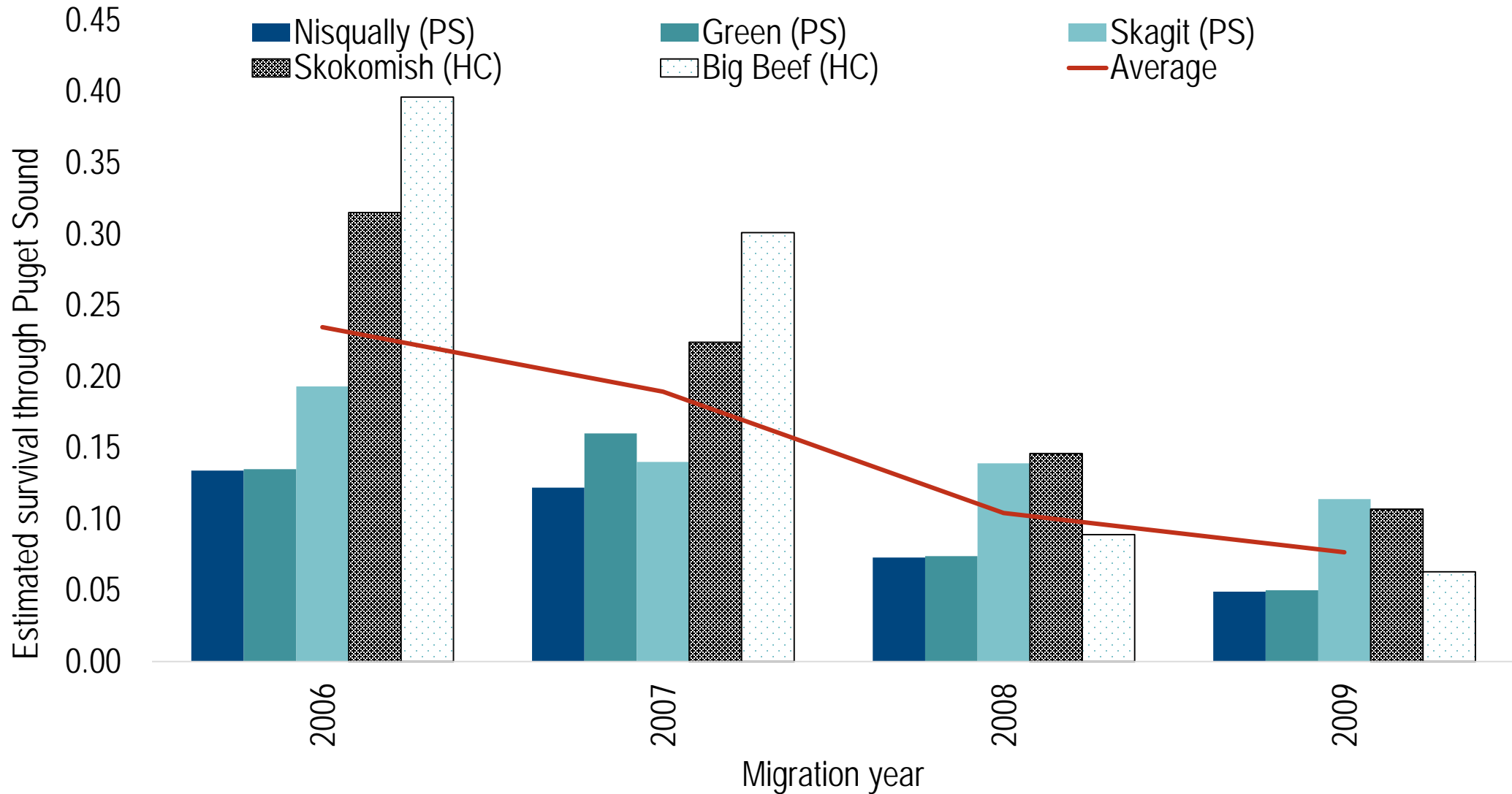
April 6 , 2018

1/ Washington Department of Fish and Wildlife

# Quantifying steelhead smolt survival



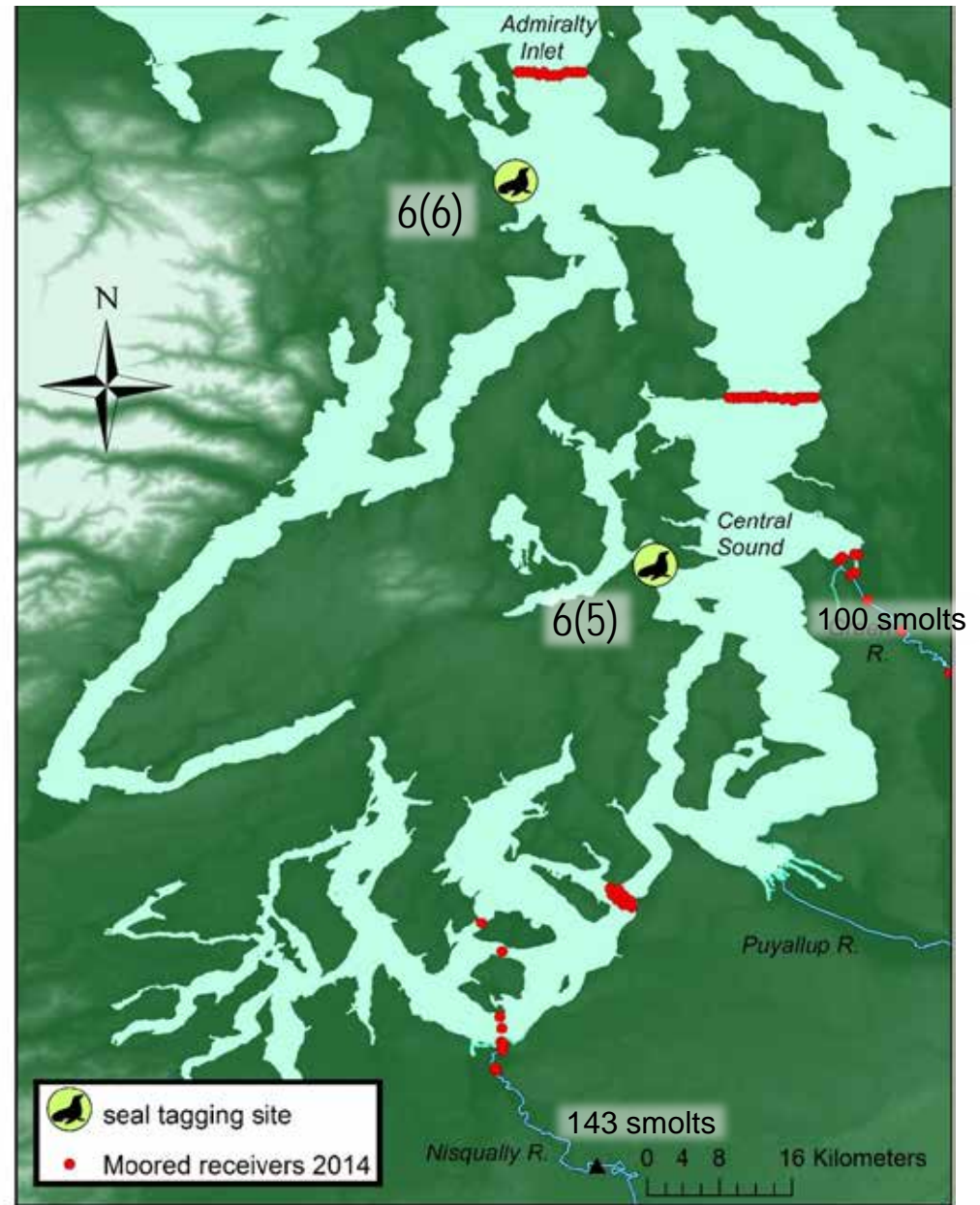
# Low and decreasing steelhead smolt survival in Puget Sound (2-week migration)





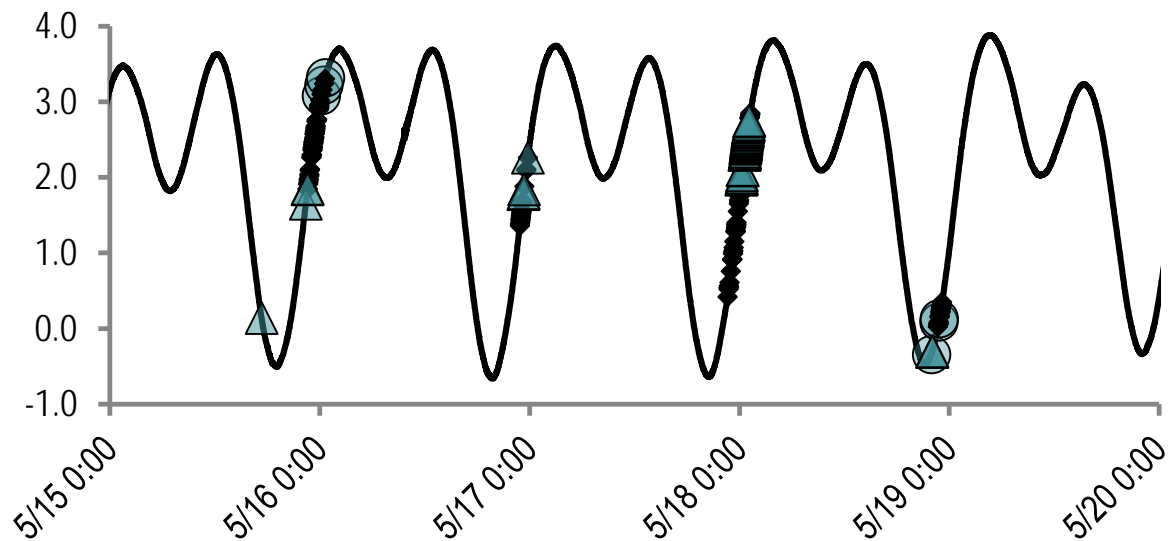
# 2014

- VMT hydrophone
- GPS/archival tag
- VHF transmitter



# 2014 - Evidence of predation in Puget Sound

- Stationary steelhead tags detected by seals at haulouts in Puget Sound
- Tag detection patterns consistent with harbor seal movements in Puget Sound (Welch et al. 2007; Berejikian et al, unpublished) and estuaries (N = 12)



- Higher proportions of stationary tags and total seal-detected tags in Central Puget Sound where mortality was greatest





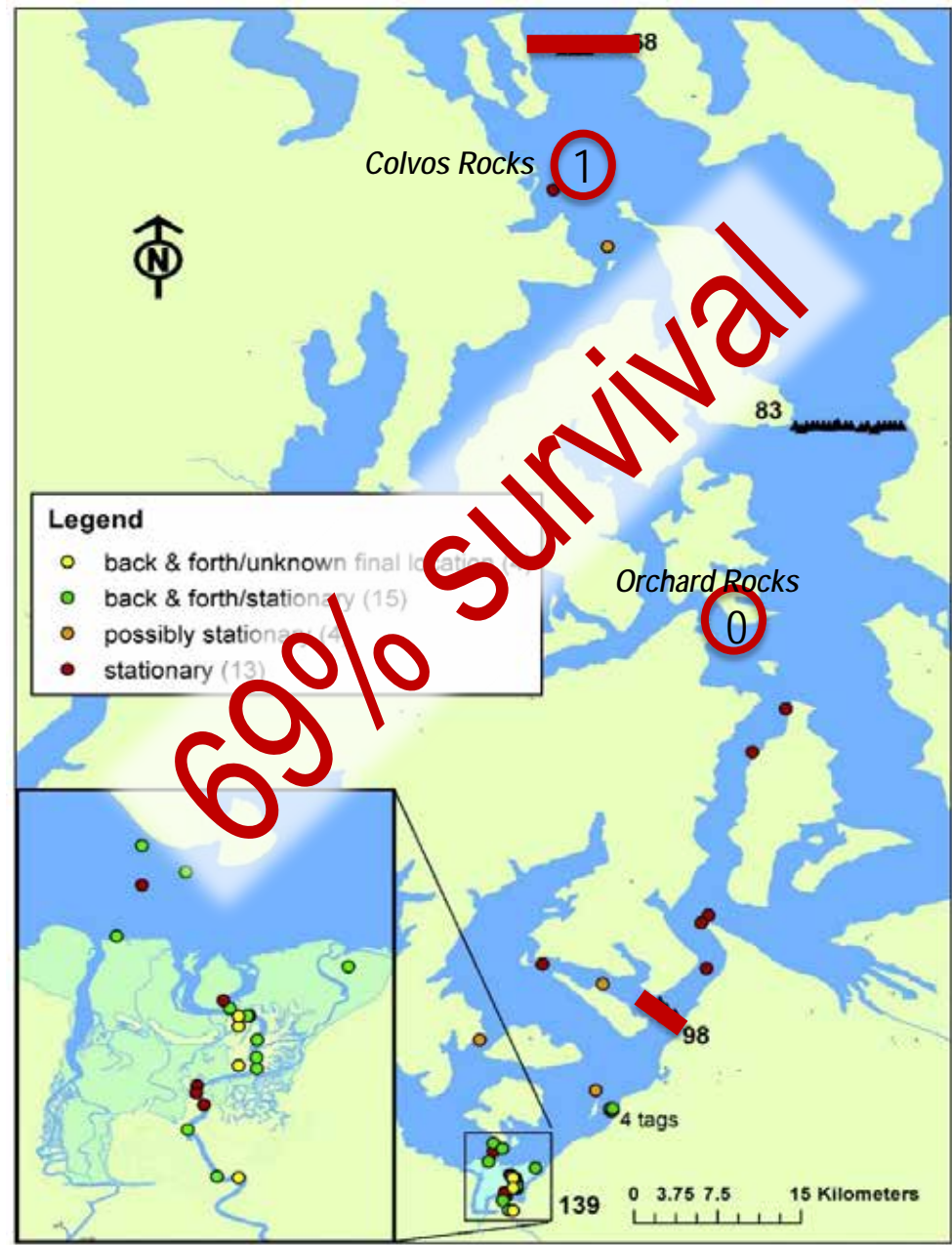
# 2016

- Similar approach 2014
- 16 seals
- Include South Puget Sound



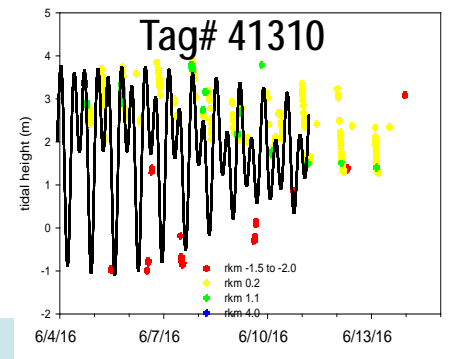
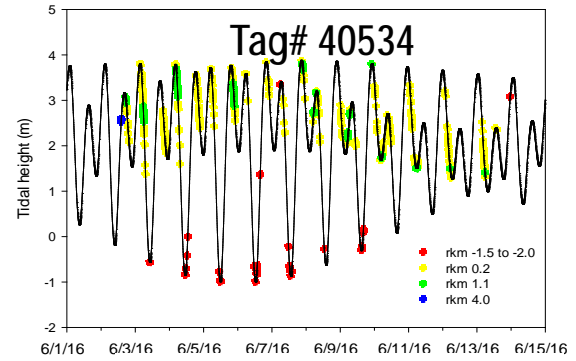
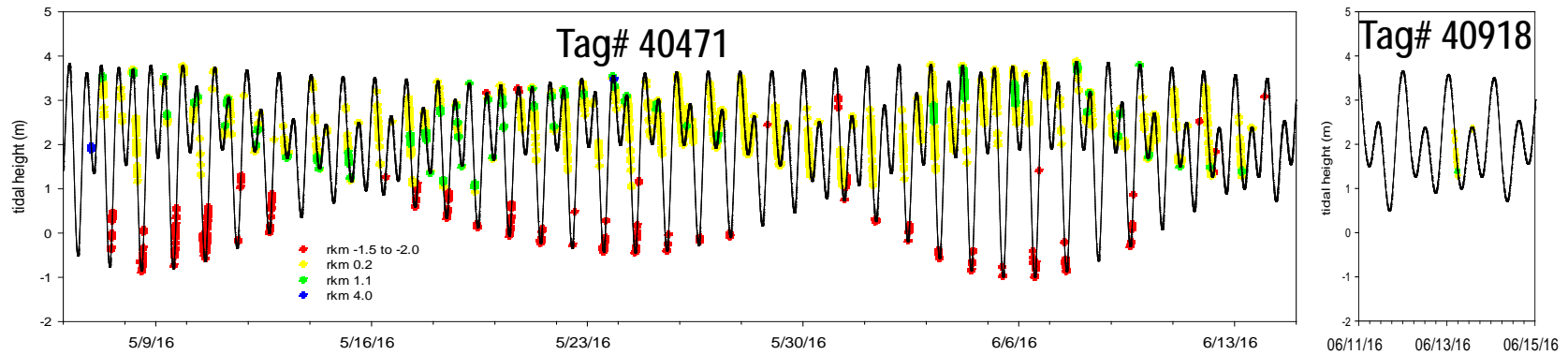
# 2016 – Little evidence of predation by harbor seals in Puget Sound

- Tags less frequently detected at haul-outs in Puget Sound
- High survival
- Lots of tags detected in and around the Nisqually Estuary

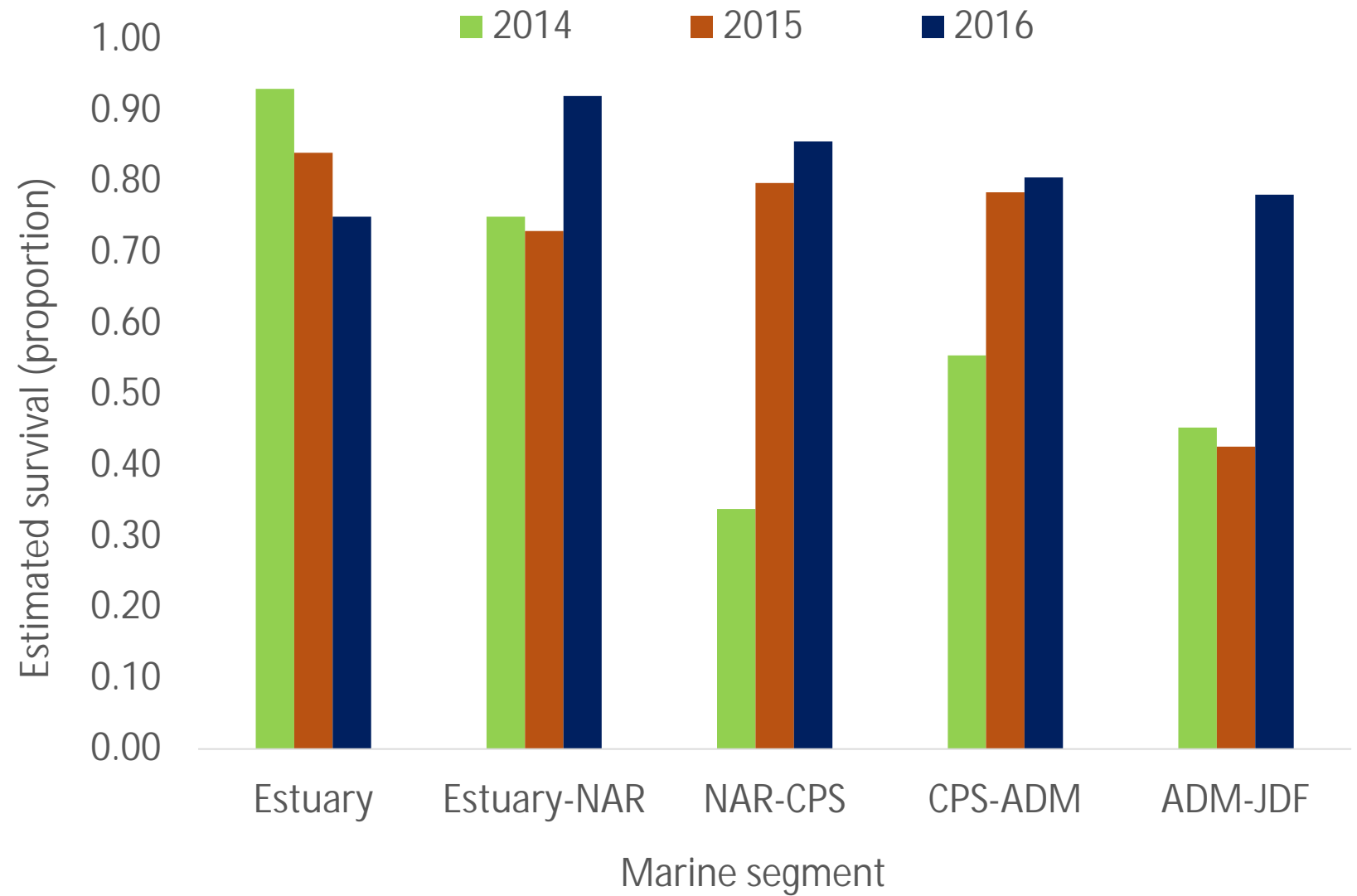
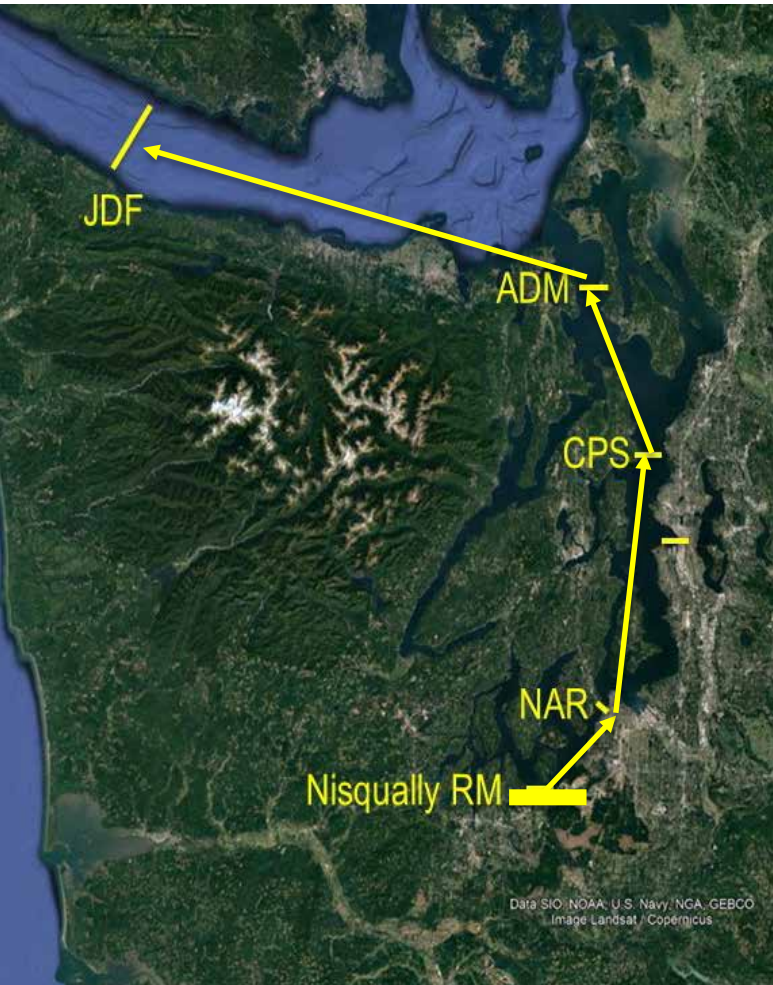




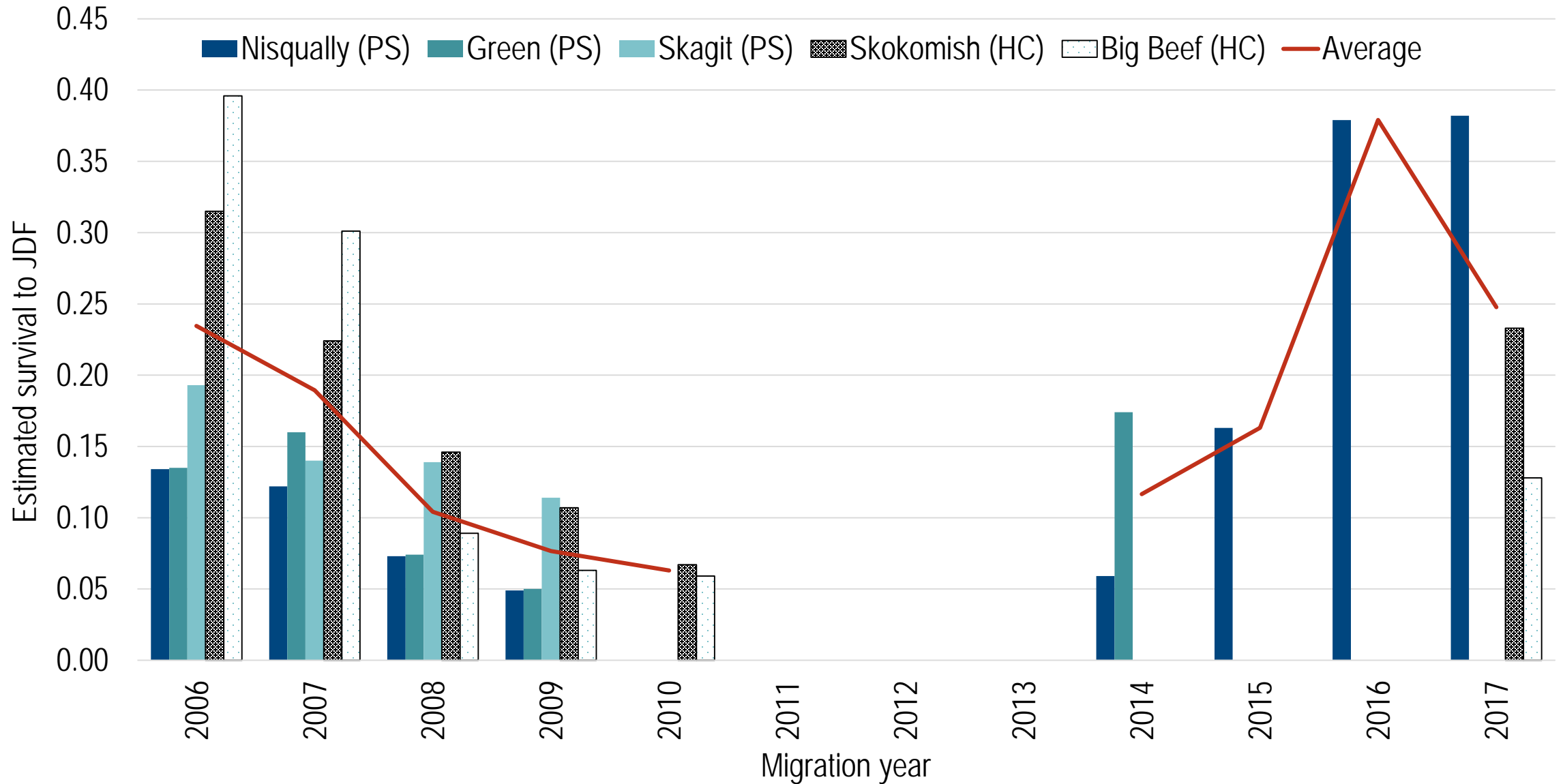
# Back and forth (i.e., upstream-downstream) tag movement



# Recent shifts in Nisqually steelhead early marine survival



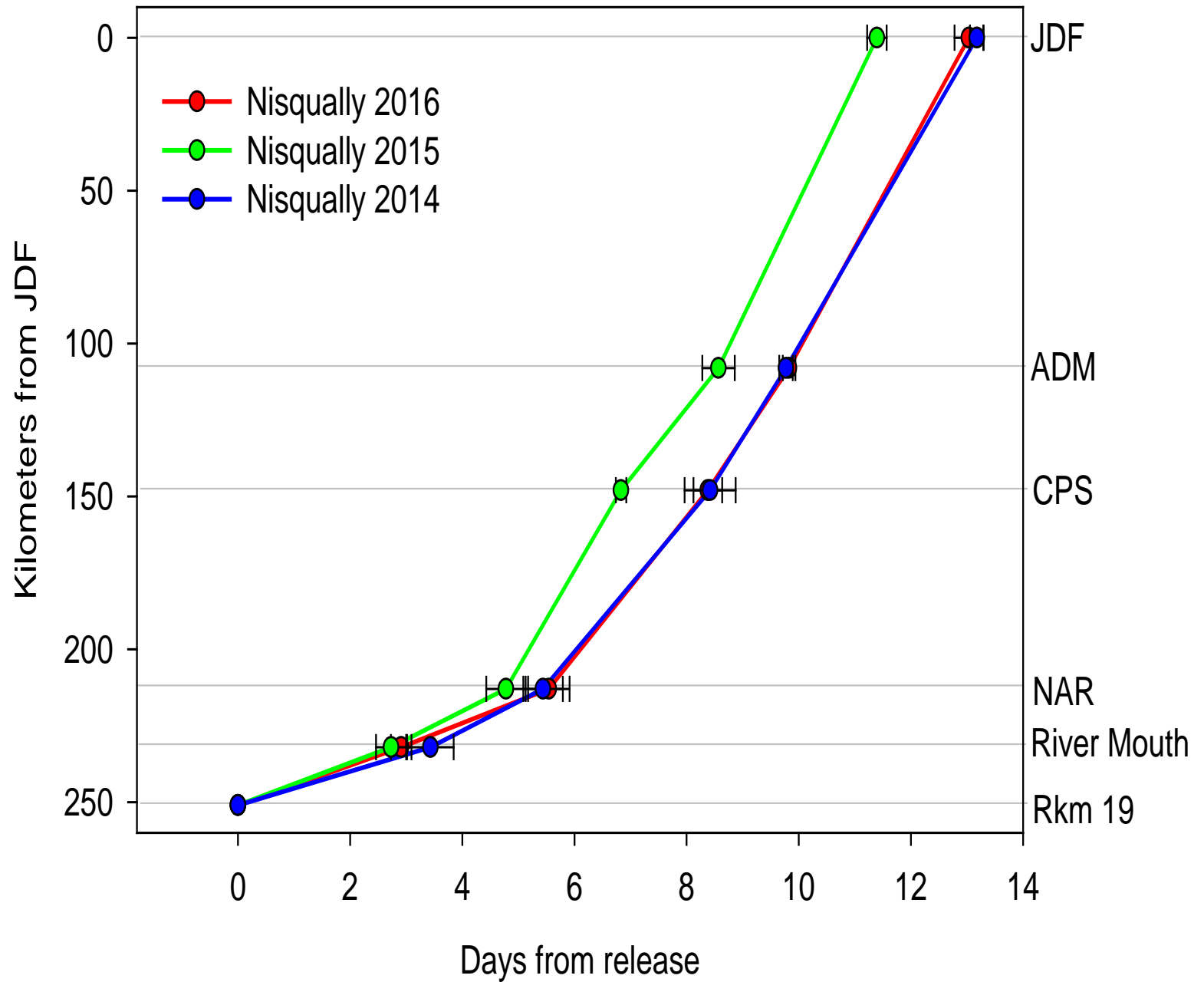
# Recent shifts in PS and HC steelhead early marine survival



# What has caused the shift in steelhead smolt survival and apparent predation?

- Change in steelhead smolt behavior
- Change in predator behavior/predation pressure

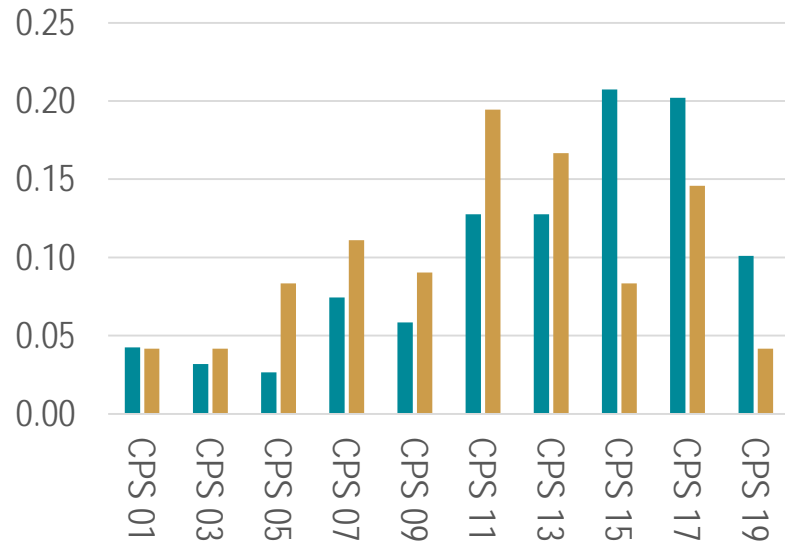
# Travel time



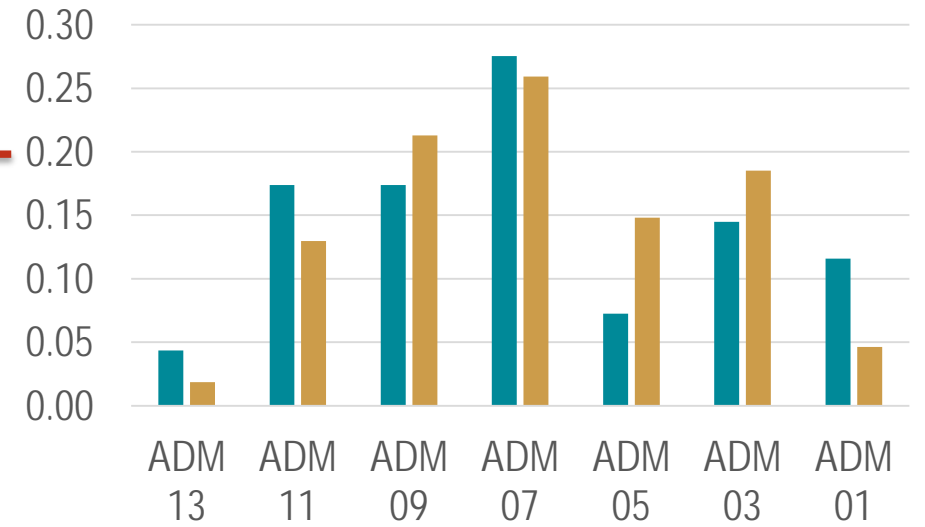
# Migratory paths



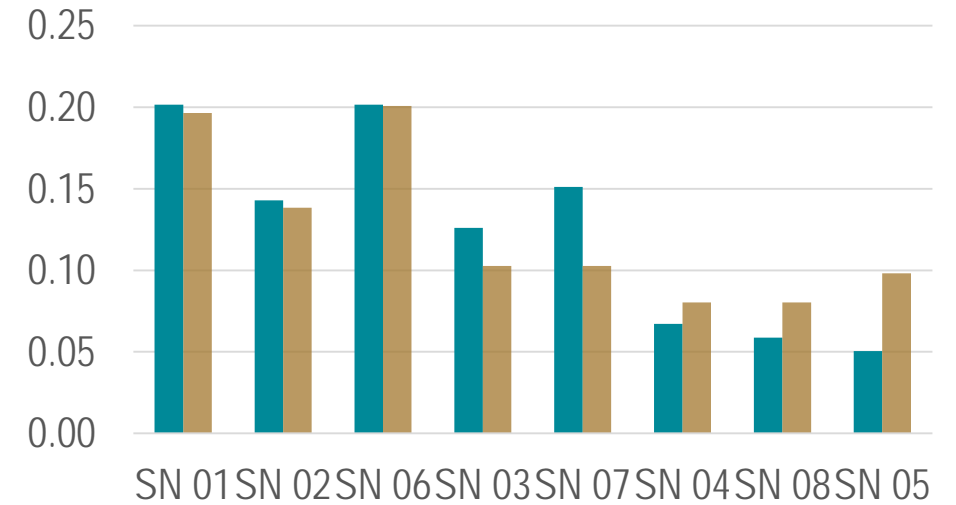
Central Puget Sound



Admiralty Inlet



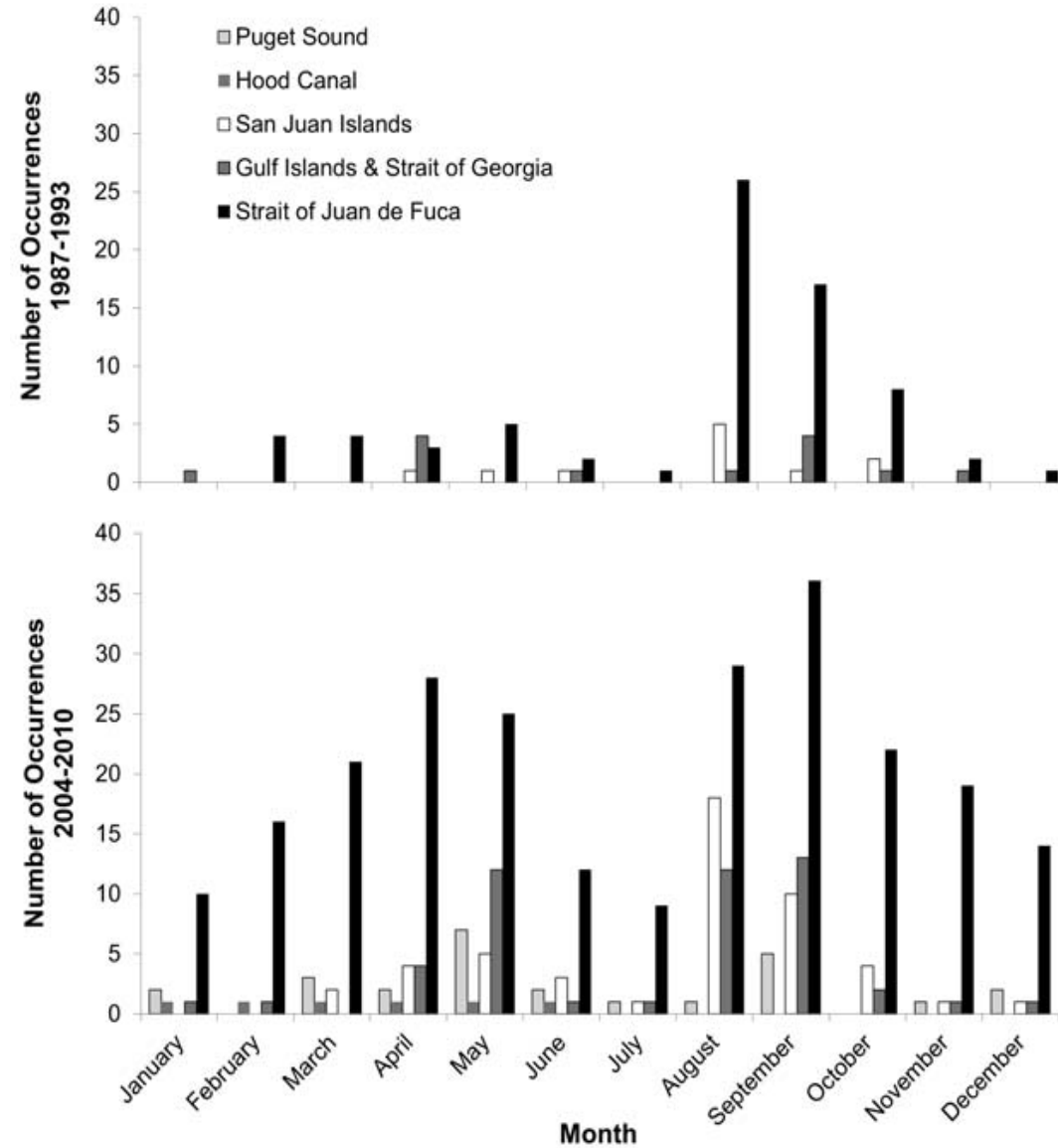
Tacoma Narrows



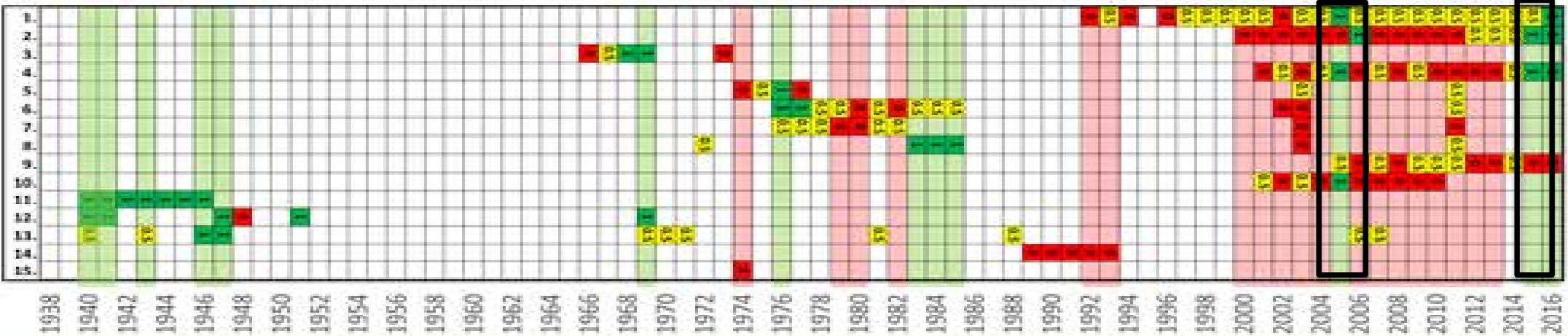
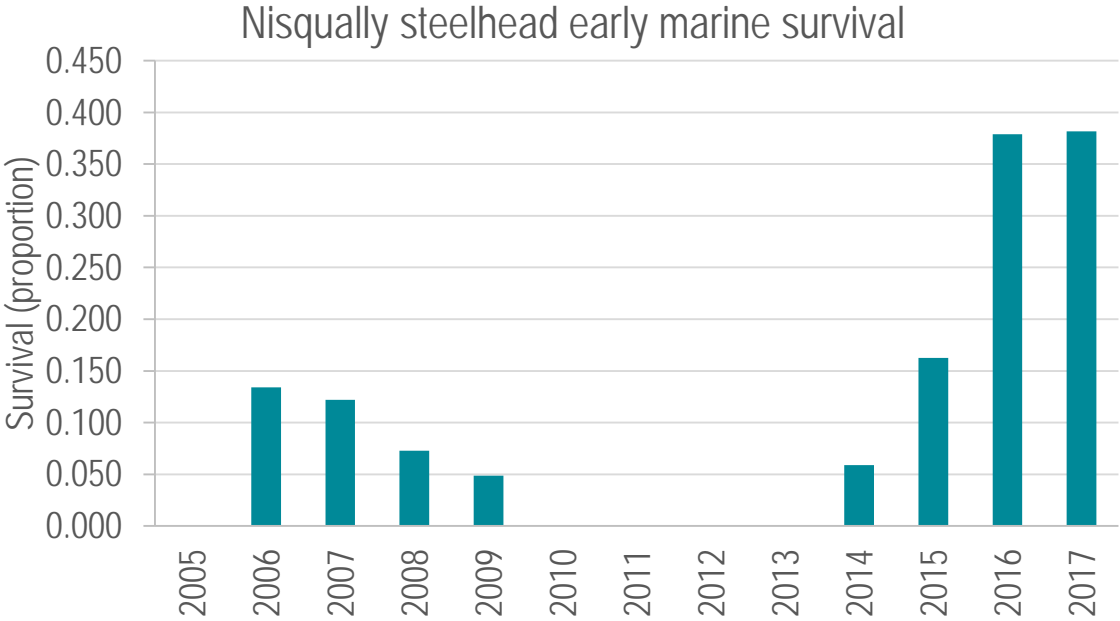
# Top-down effects?



Transient (Biggs) Killer Whales



# Alternative prey hypothesis





# Summary

1. Significant changes in early marine survival
2. Smolt behavior similar among years
3. Evidence for predation by harbor seals in Puget Sound inversely related to marine survival rates
4. Changes in mortality in the estuary
5. May be associated with increased transient killer whale activity and anchovy pulses

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