May 1st, 1:30 PM - 3:00 PM

Early marine survival of steelhead smolts in Puget Sound

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Survival of steelhead in Puget Sound and Hood Canal

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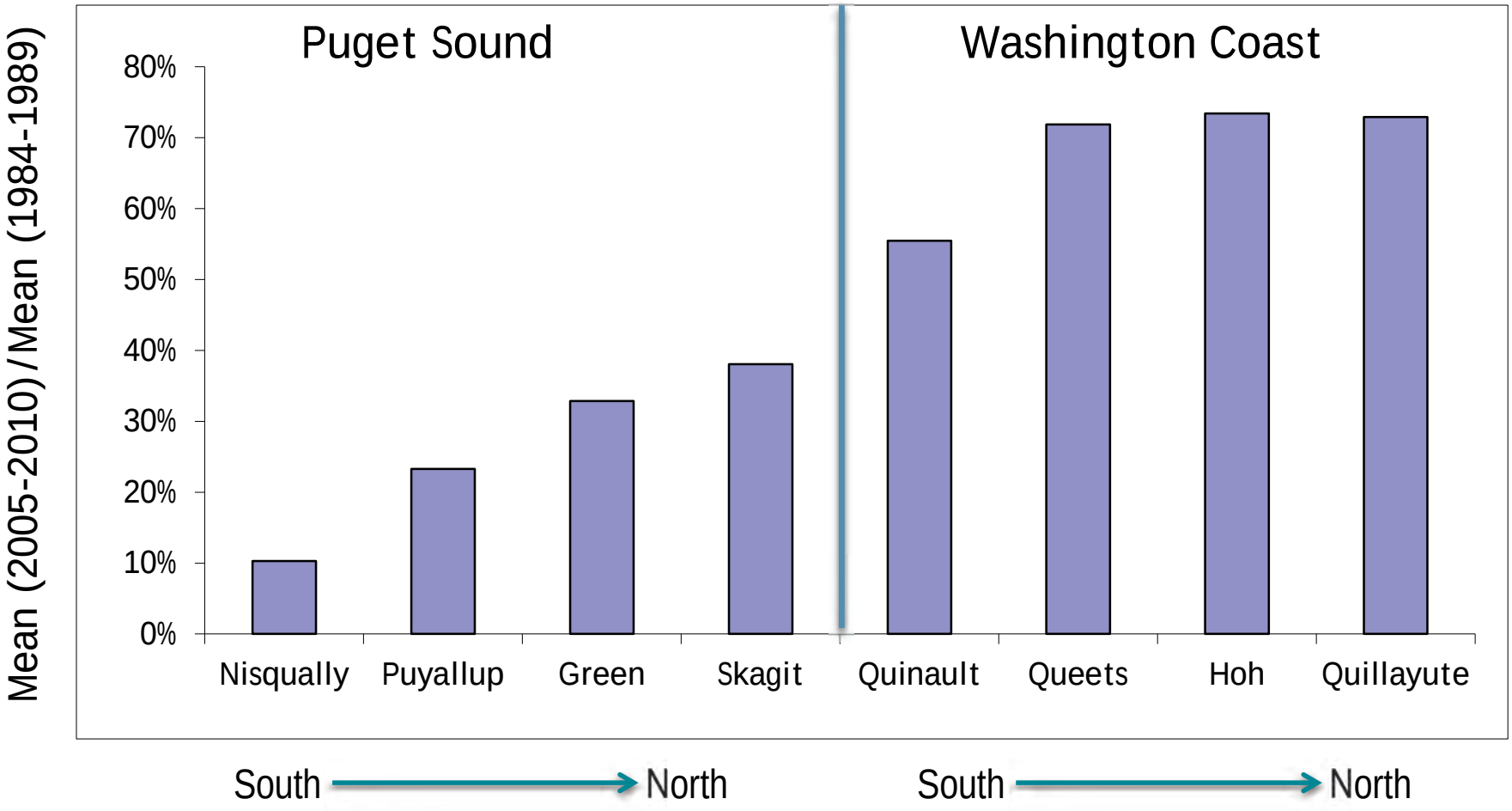
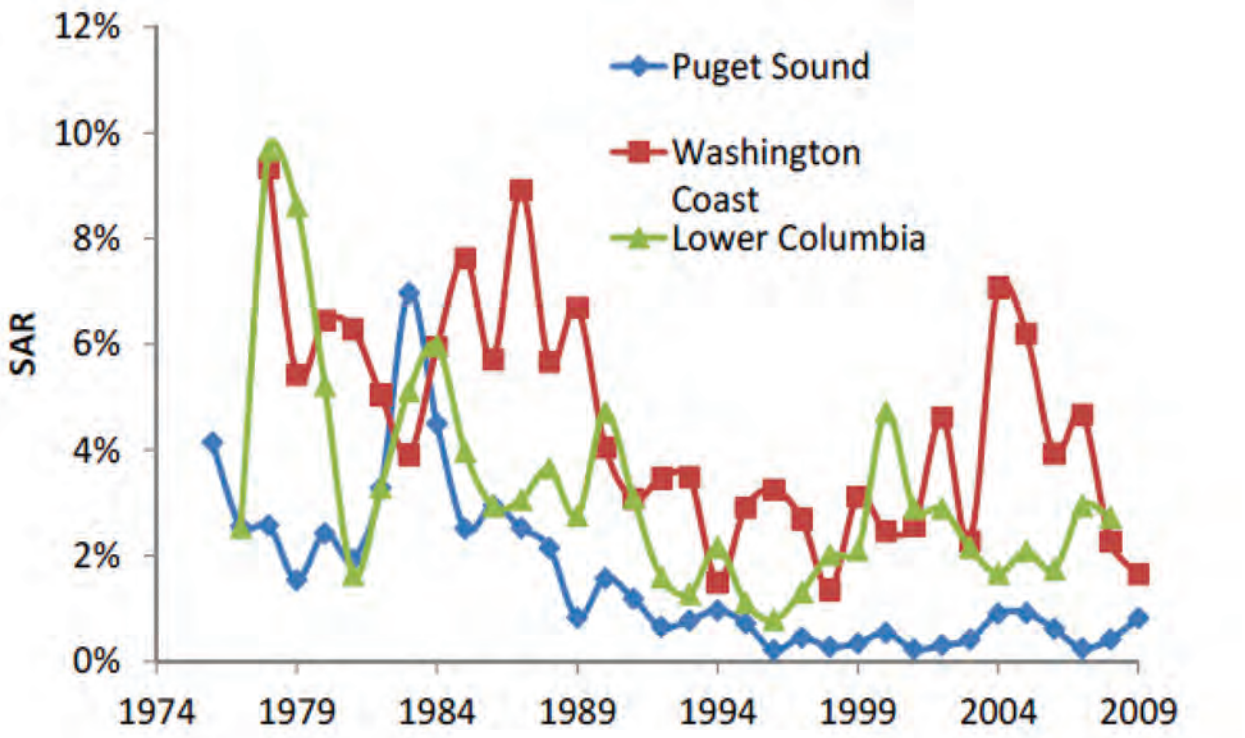
and
Salish Sea Marine Survival Project
Steelhead Workgroup

Threatened steelhead

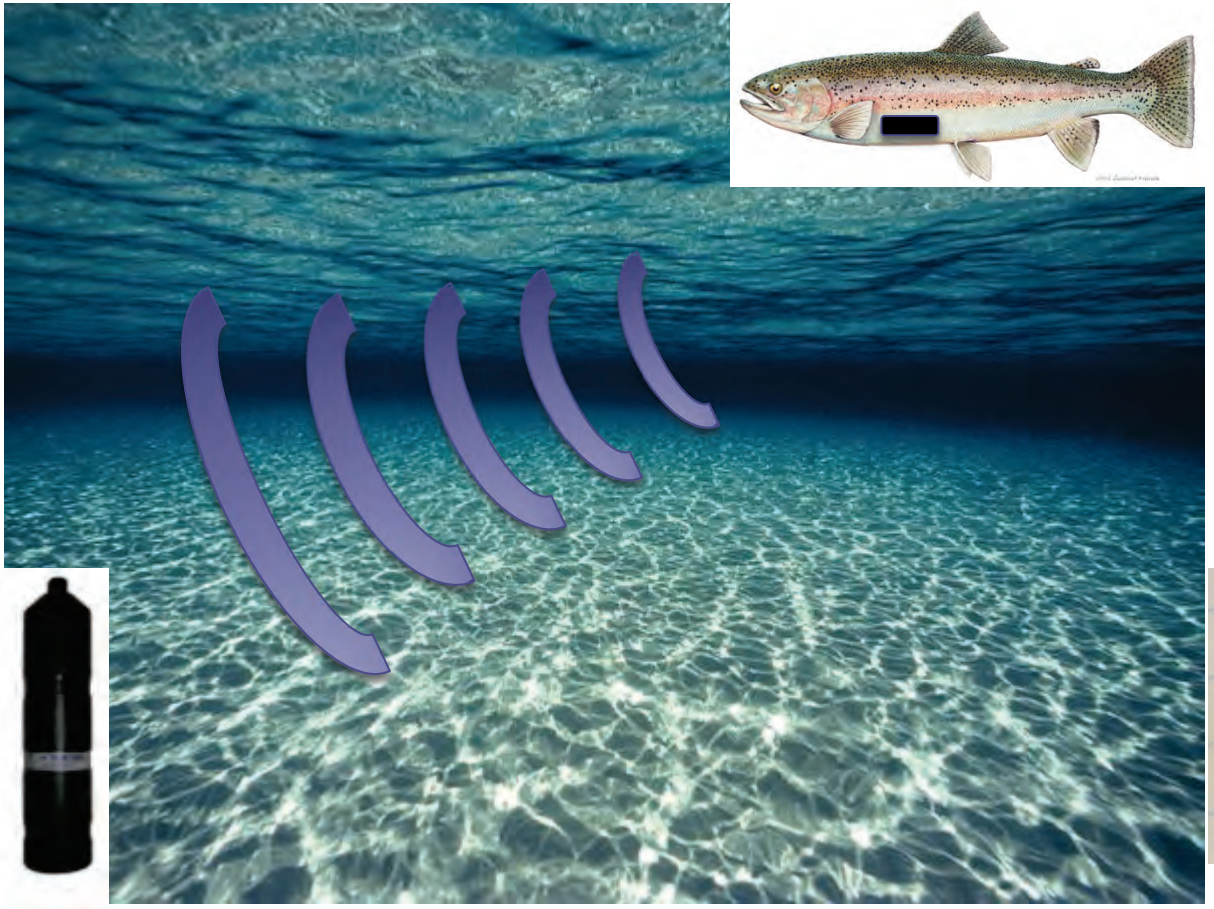


Marine survival trends



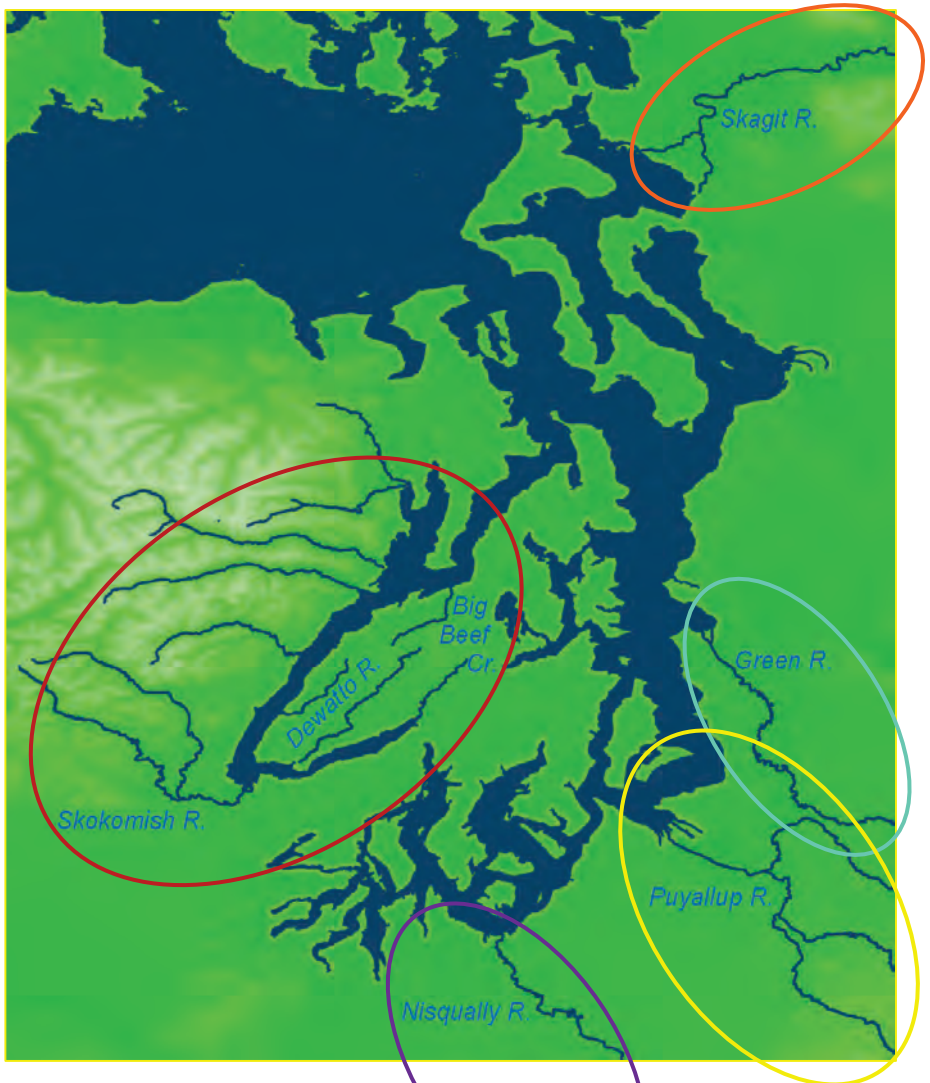
- Marine survival rates have declined dramatically over the last 25-30 years
- Puget Sound populations have not rebounded in recent years as have coastal and Columbia populations
- Marine migration through Puget Sound seems to be a major limiting factor

Acoustic telemetry



7mm and 9 mm transmitters
@ 69kHz, 136 db

Puget Sound Telemetry Project



Hood Canal Rivers: 2006-2010
362 tagged smolts
NOAA Fisheries

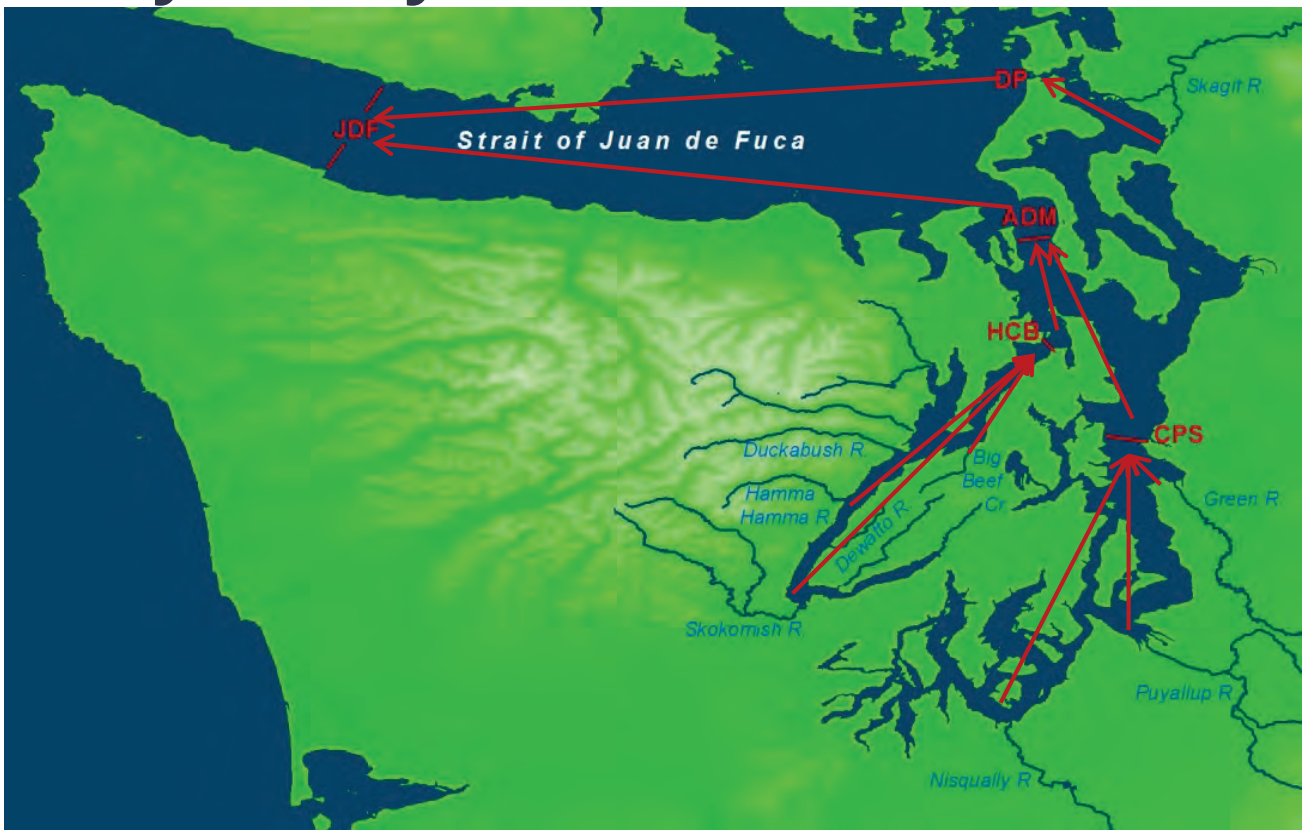
Green River: 2006-2009
337 tagged smolts
Fred Goetz, Tom Quinn/UW

Puyallup River: 2006, 2008-2009
206 tagged smolts
Puyallup Tribe

Nisqually River: 2006-2009
187 smolts tagged
Nisqually Tribe

Skagit River: 2006-2009
250 smolts tagged
Seattle City Light

Telemetry array



Migration Segments		
Hood Canal	**Puget Sound**	**Skagit**
River Mouth - HCB	River Mouth - CPS	River Mouth - DP
HCB – ADM	CPS – ADM	
ADM – JDF	ADM – JDF	DP - JDF

Mark-Recapture Model: Cormack-Jolly-Seber

Population	N_{2006}	N_{2007}	N_{2008}	N_{2009}
Hood canal	106	170	109	78
Green	100	89	98	50
Nisqually	55	49	14	69
Puyallup	50	0	90	66
Skagit	23	47	100	80
TOTAL	**334**	**355**	**411**	**293**

N=1393

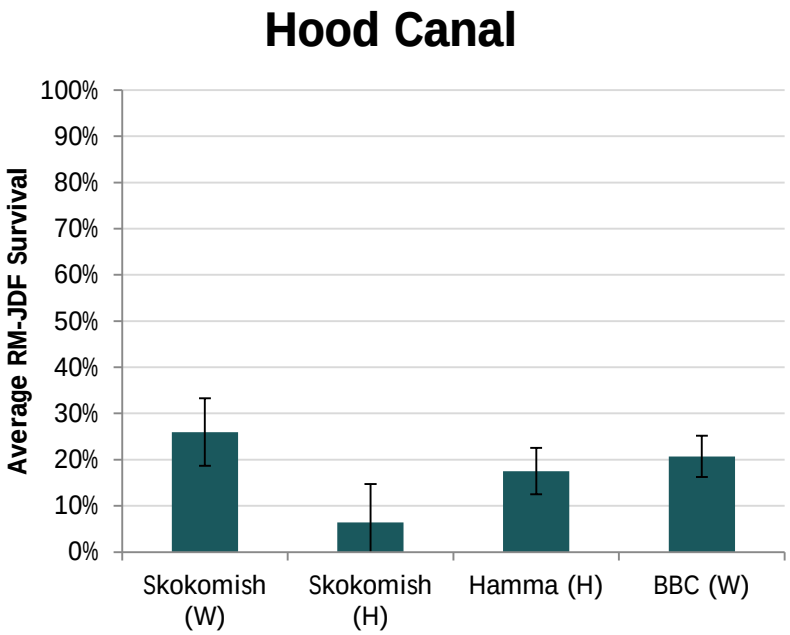
Variables included in the survival analysis

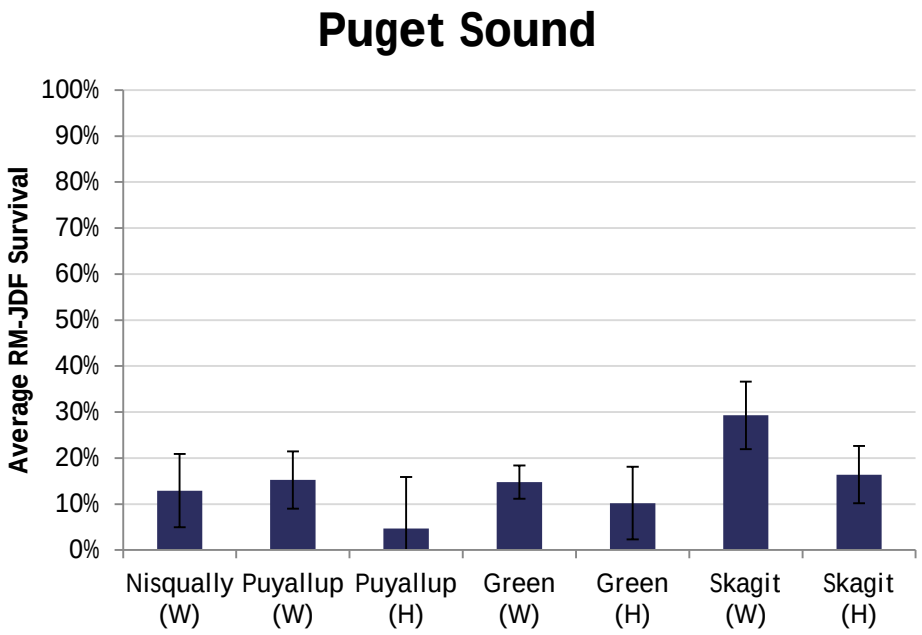
Factors: Population
Region (HC, SS, Skagit)
Rear type
Migration Segment
Year
Tag Type

Covariates: Distance
Body Length

Model with lowest AICc = ~Segment:population+year+reartype

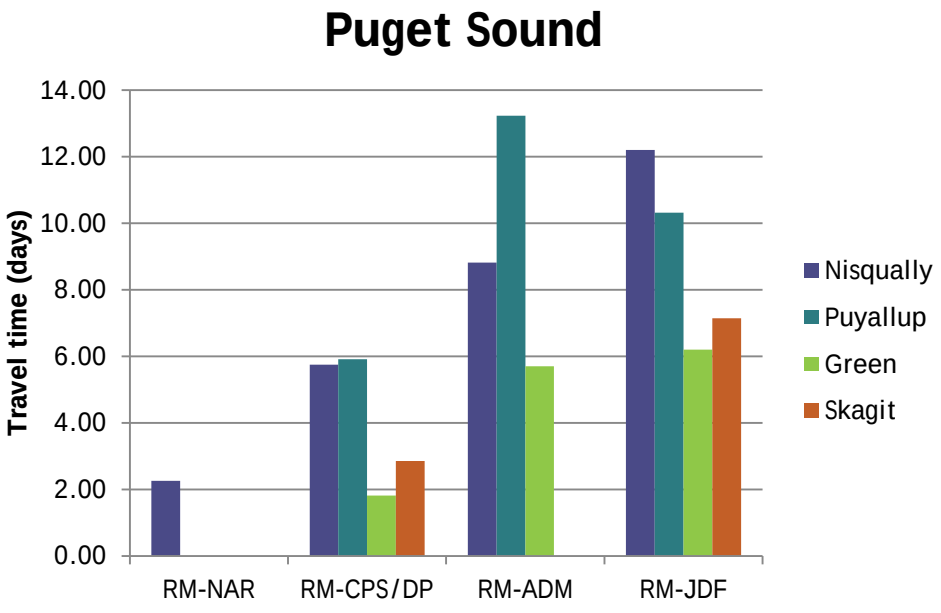
Marine survival is low in Hood Canal and Puget Sound

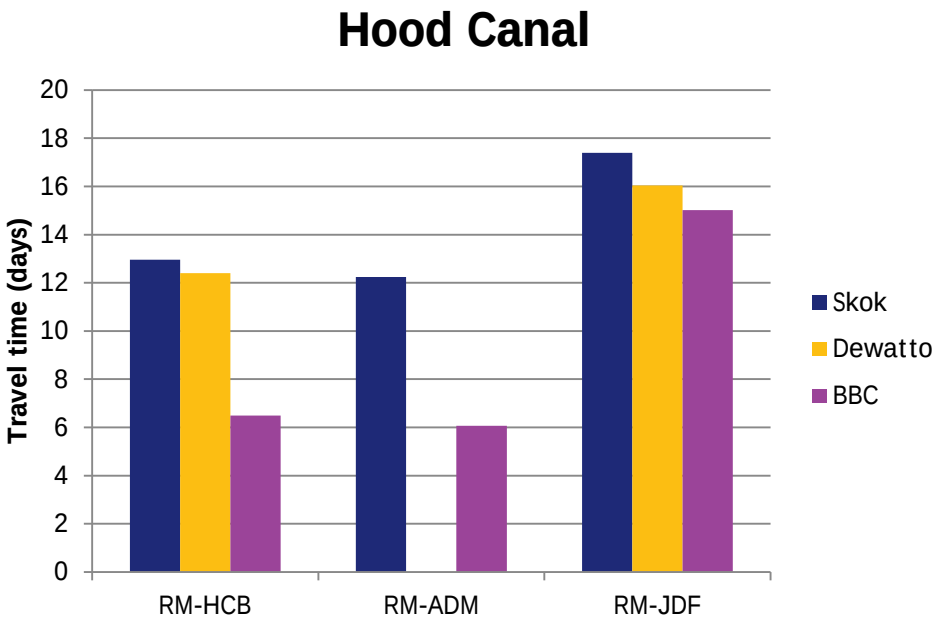




Combined early marine survival estimate = 17% (hatchery = 12% , wild = 20%)

Travel Times





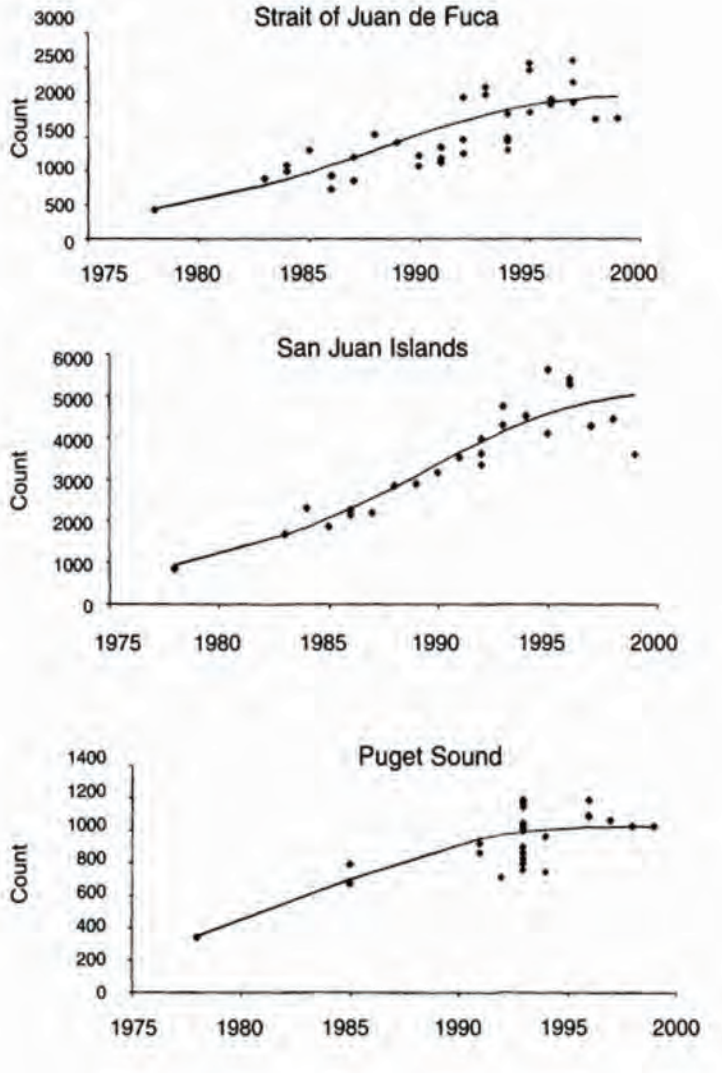
Potential factors affecting marine survival (why do so many steelhead die so quickly)

- Freshwater influences
  - Reduced diversity ('Portfolio effect': e.g., *Schindler et al. 2012. Nature*)
  - Hatcheries (genetic or ecological)
  - Water quality (toxic contaminants)
  - Disease-causing pathogens (nanophyetus)

- Changes in the Puget Sound ecosystem that have influenced predator-prey dynamics
  - Avian predators: cormorants, Caspian terns, common mergansers, and loons
  - Mammalian predators: harbor seals, harbor porpoise

Predator-prey interactions (harbor seals)

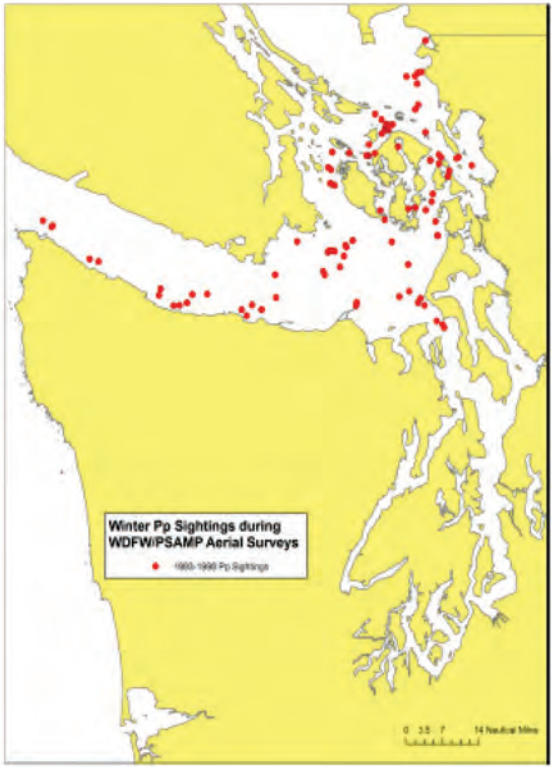
Harbor seal counts



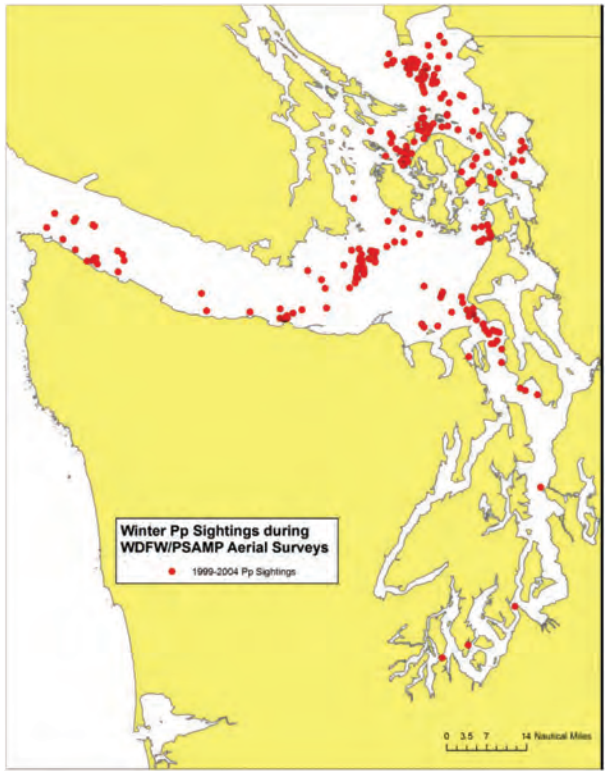
Jeffries et al. 2003 J. Wildlife Manage.

Predator-prey interactions (harbor porpoise)

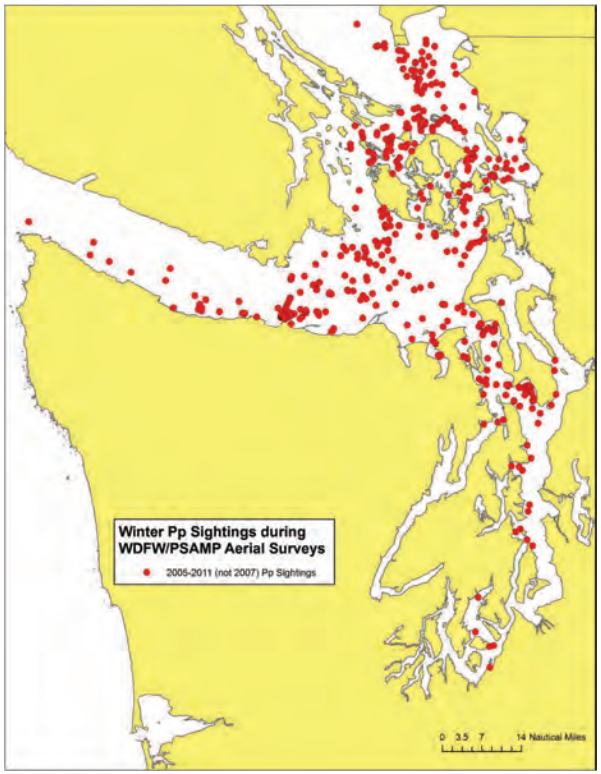
1993-1998



1999-2004



2005-2011



(J. Evenson, WDFW, 2013, unpublished data)

Herring Biomass

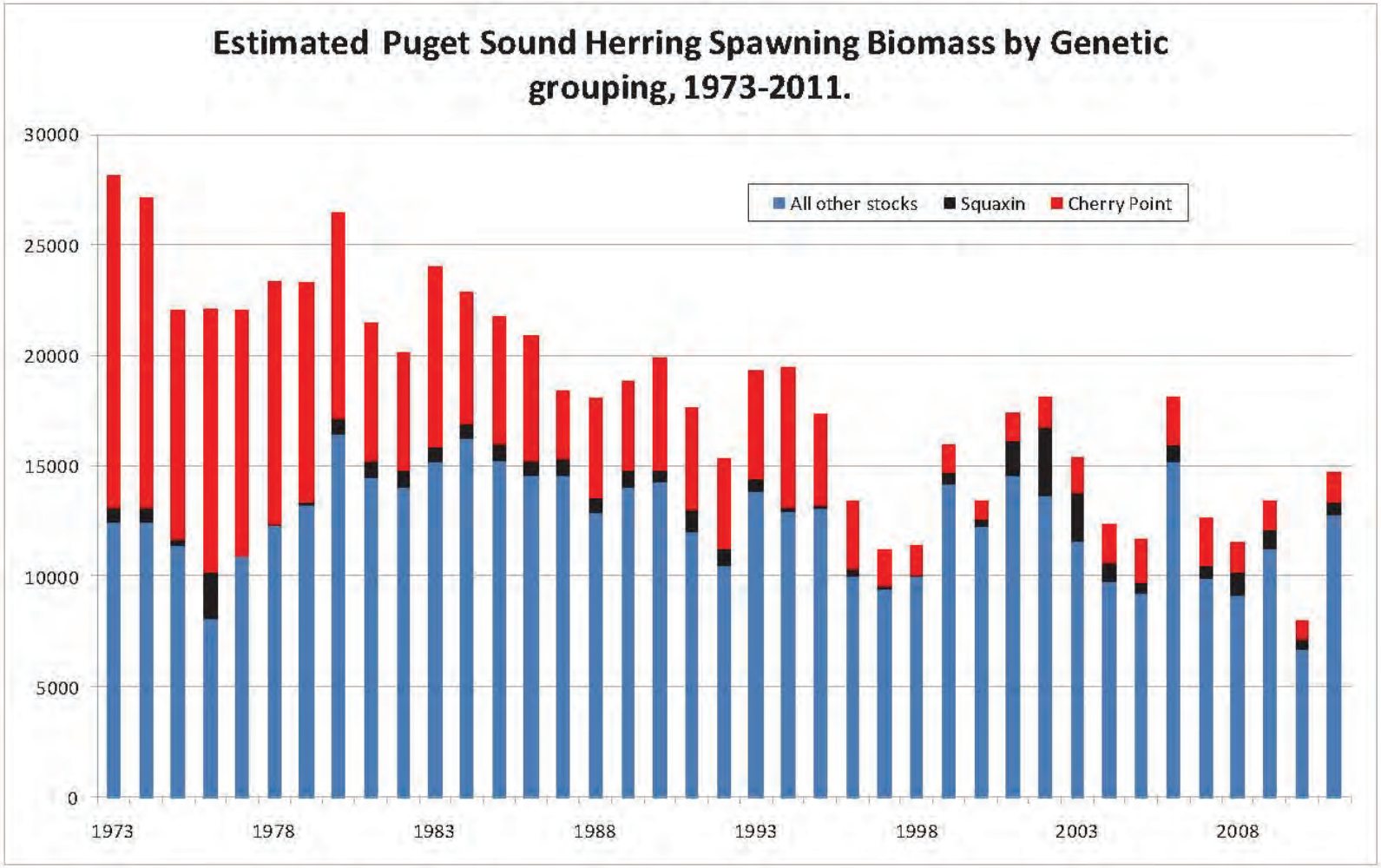
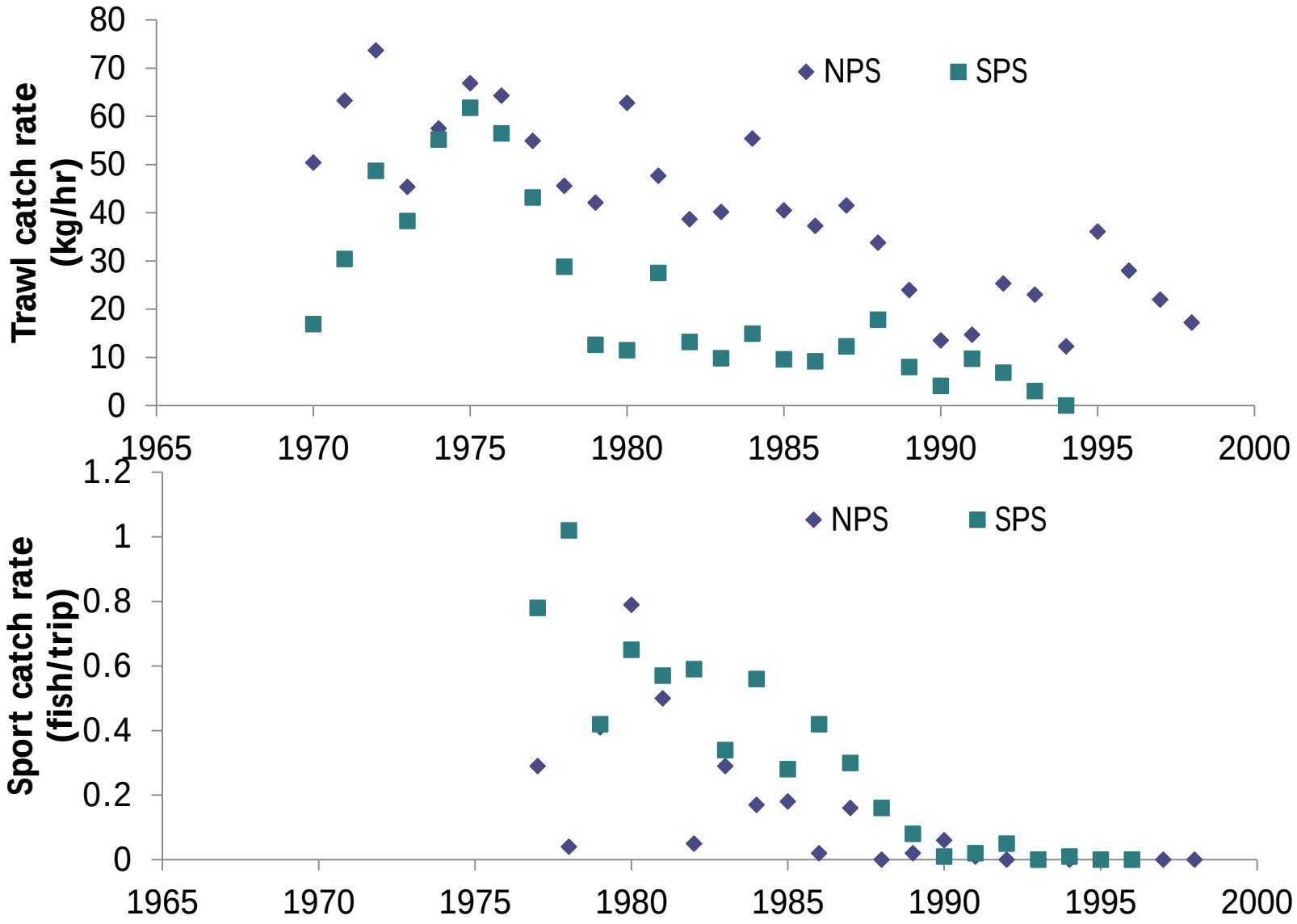


Figure 5. Estimated herring spawning biomass, 1973-2011.

Pacific Cod Abundance



Data source: Palsson et al. via NMFS 2000 Status Review

Summary

- Early marine survival rates of Hood Canal and Puget Sound steelhead populations are low considering short observed travel times
- Travel times within the Puget Sound environment are very short, giving little time for long term sources of mortality to take effect
- Puget Sound has undergone a major ecosystem shift timed with the decline in steelhead abundance and SAR.
- Future studies: tag more steelhead smolts and harbor seals

SALISH SEA
MARINE SURVIVAL PROJECT
www.marinesurvivalproject.com

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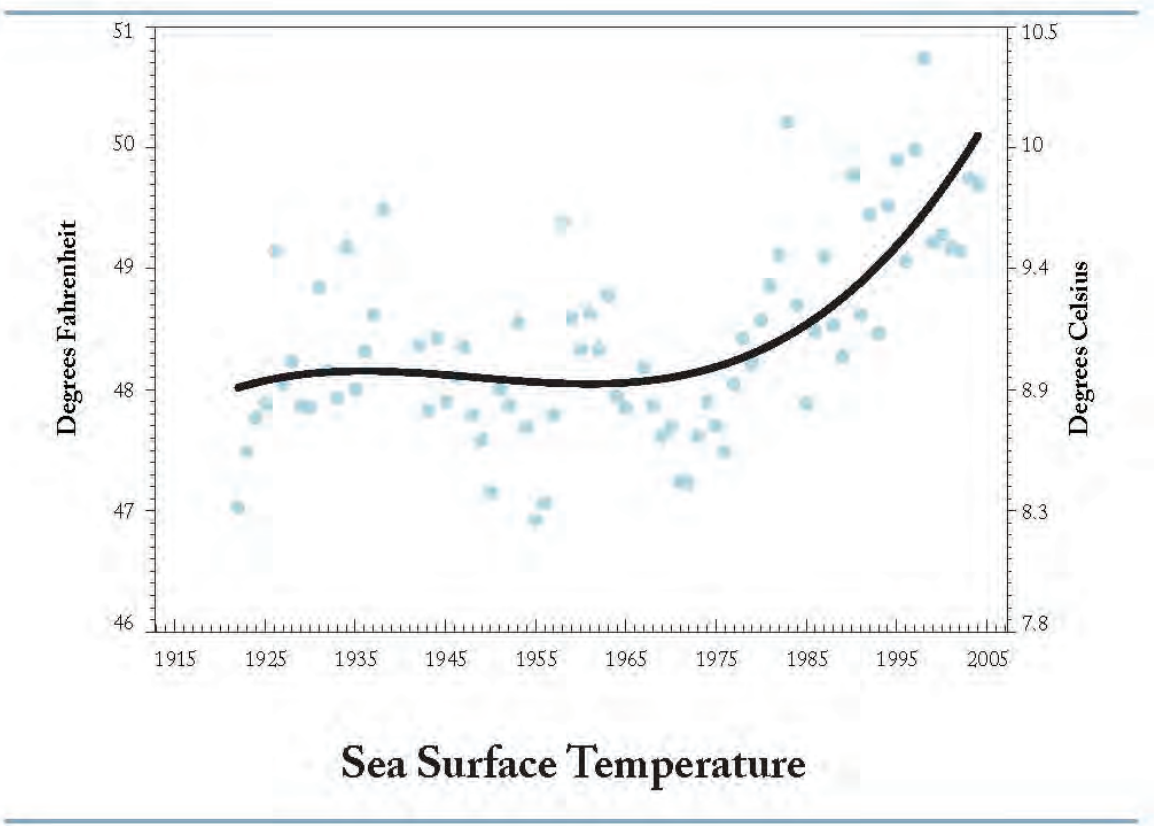
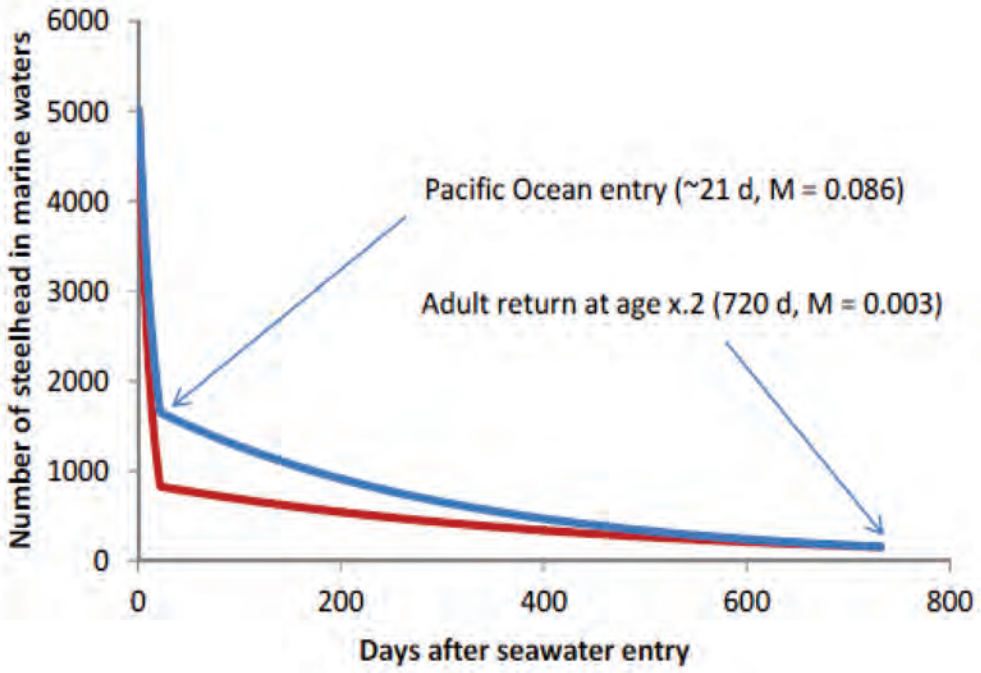
Temperature in Puget Sound (Strait of Juan de Fuca)



Snover, A. K., P. W. Mote, L. Whitely Binder, A.F. Hamlet, and N. J. Mantua. 2005. Uncertain Future: Climate Change and its Effects on Puget Sound. A report for the Puget Sound Action Team by the Climate Impacts Group.

Early Marine Mortality in Puget Sound makes up a substantial amount of overall marine mortality



Slope of the line = instantaneous mortality rate

Red line = estimates from previous telemetry work in Hood Canal

Blue Line = 2x Hood Canal estimates, providing for underestimation of early mortality rate

Assumed 3% Smolt to Adult return rate (SAR)

Where within Puget Sound is survival occurring?