



Washington  
Department of  
**FISH and  
WILDLIFE**

# Marine Mammal Commission Workshop

May 30, 2018

Pinnipeds and Salmon and Steelhead Marine  
Survival in Puget Sound

Erik Neatherlin  
WDFW

# Take Aways

- Pinnipeds have increased in Puget Sound
- Pinniped predation on salmon and steelhead has increased (Chasco et al., 2017)
- Predation is just one of many factors impacting salmon and steelhead in Puget Sound
- Need an integrated program to address predation and other factors in Puget Sound

# Outline

- Pinniped Status
- Brief Review of Chasco et al. (2017)
- Salish Sea Early Marine Survival Project
- Planned Work to Localize Pinniped Predation Estimates in Puget Sound



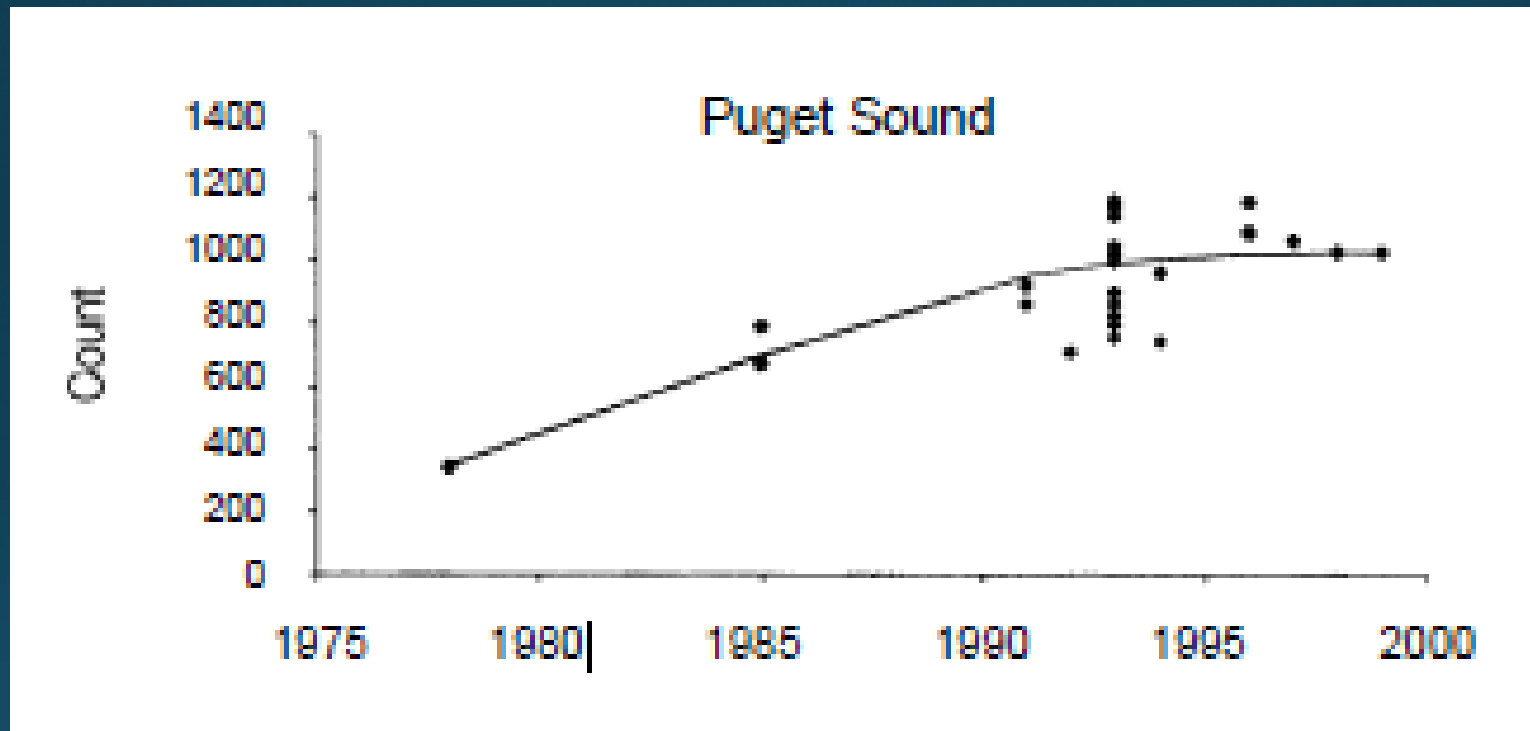
# Harbor Seal



Steve Jeffries



# Trends in Abundance



# Harbor seals have increased and reached carrying capacity

British  
Columbia  
91-119,000

WA  
Inland Stocks  
14-16,000

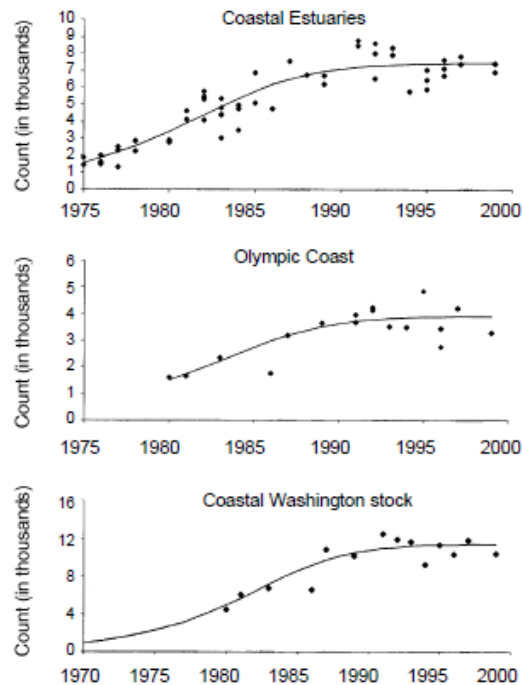


Fig. 3. Generalized logistic growth curves of harbor seals in Washington, USA, portion of the coastal stock for coastal estuaries and outer Olympic Peninsula coast regions and their sum.

WA Coast  
16-19,000

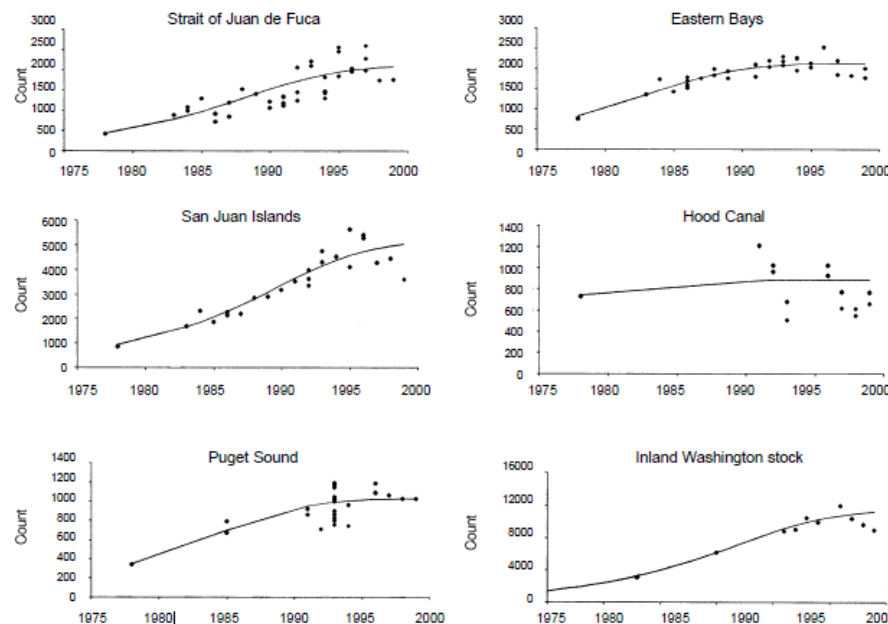
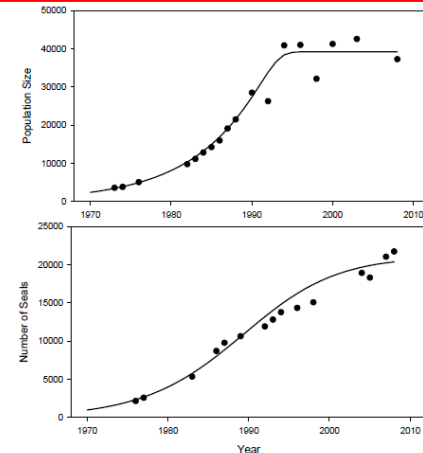


Fig. 4. Generalized logistic growth curves of harbor seals in the Washington, USA, inland stock for Strait of Juan de Fuca, Eastern Bays, San Juan Islands, Hood Canal, and Puget Sound regions and their sums.



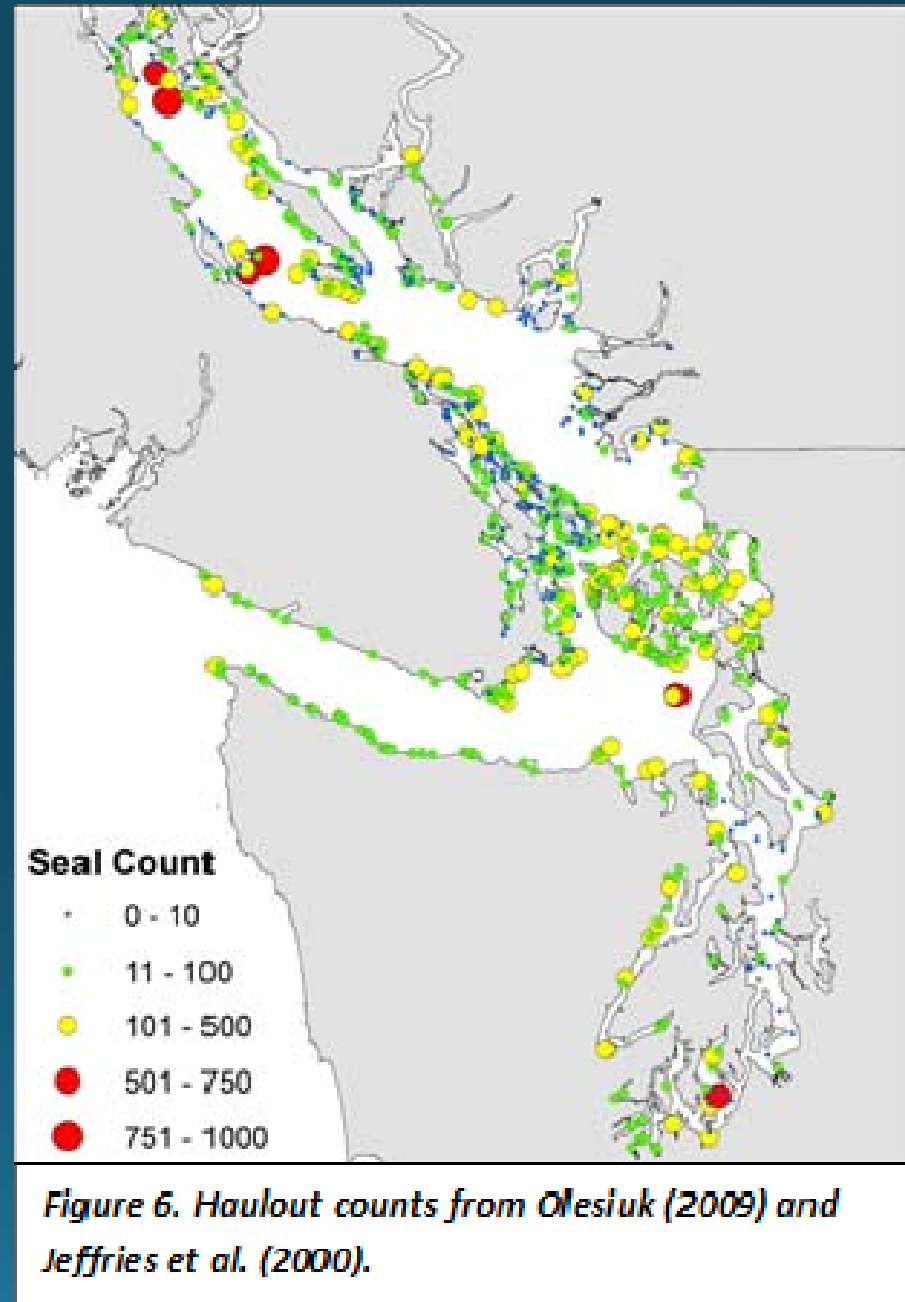
Seal abundance in the Strait of Georgia (top panel) and in Index (bottom panel). The Index Areas are widely distributed throughout the Strait of Georgia, most of the Queen Charlotte Islands, Queen Charlotte Strait and the west coast of Vancouver Island. The trend lines represent maximum likelihood methods.



## Past Harbor Seal Distribution in Puget Sound and the Strait of Georgia

Most of the animals are  
found in the Strait of  
Georgia and the San Juan  
Island area.

Inland Stock = 14 – 16,000



# Harbor Seal Diet



- Strait of Georgia (1990's)
  - Salmon = 1.3-8.6% salmon (Olesiuk 1993)
  - Chinook = 6% of salmon
- Strait of Georgia (2017)
  - Juvenile Chinook = 3%
  - Adult Chinook = 7% (Thomas et al. 2017)
- San Juan Island
  - Chinook 2% (Bromaghin et al. 2013)

Olesiuk, P.F. 1993. Annual prey consumption by harbor seals (*Phoca vitulina*) in the Strait of Georgia, British Columbia. Fishery Bulletin 91:491-515

Lance, M.M., W.Y. Chang, S.J. Jeffries, S.F. Pearson, A. Acevedo-Gutiérrez. 2012. Marine Ecology Progress Series 460: in press



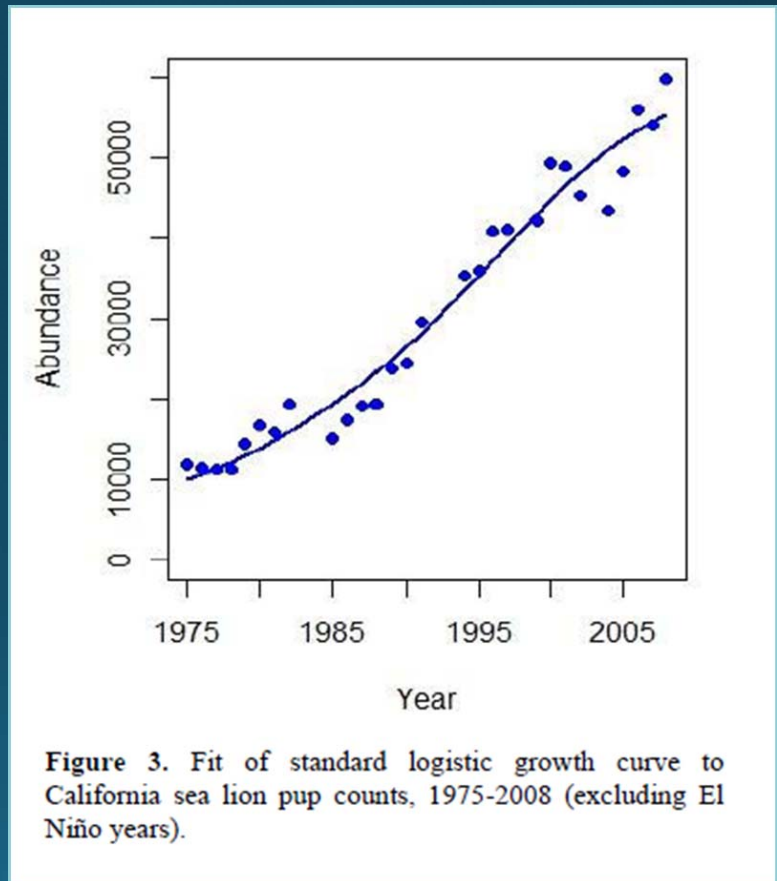
# California Sea Lion



Steve Jeffries

# California Sea Population Trends

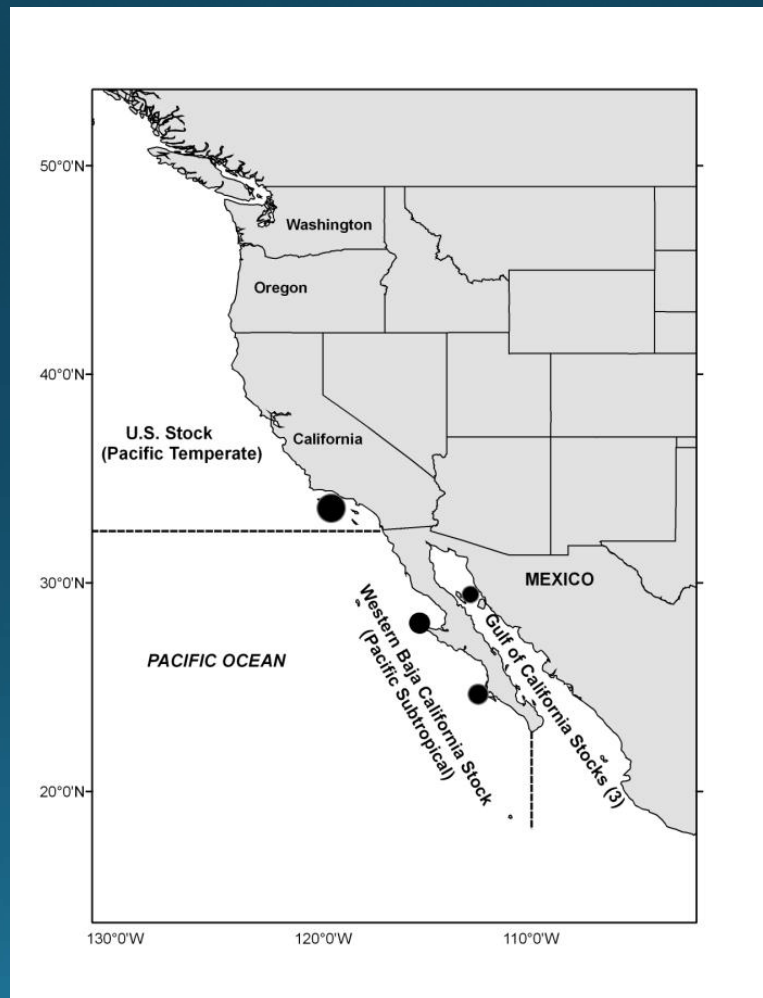
- California sea lion population growth rate =  $5.4\% \text{ yr}^{-1}$
- Lack recent range wide data on abundance and distribution



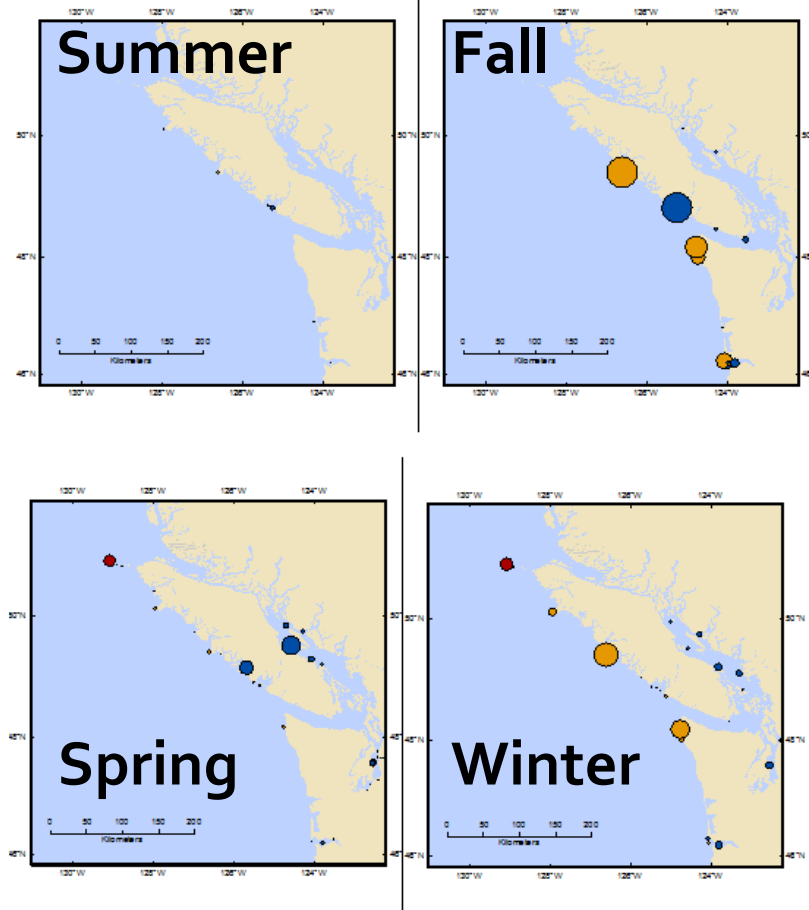


# California Sea Lion Distribution

- Note that they breed in the spring on islands off California and Mexico as a result their abundance changes dramatically throughout the year.



# California Sea Lion PNW Seasonal Distribution



**Figure 16.** Maps showing seasonal changes in distribution of California sea lions counted during the summer (top left), fall (top right), winter (bottom right) and spring (bottom right) surveys. Symbol sizes are drawn proportional to the average site counts. Red symbols denote rookeries, orange symbols year-round haulout sites, and blue symbols winter haulout sites and swimming animals.



# California Sea Lion Diet

- Salmon = 5-25% frequency of occurrence  
(diet dominated by whiting and pollock)
- Shilshole Bay, WA (1987) = 25% frequency of occurrence
- Puget Sound, WA (1988) = 21 % frequency of occurrence
- Everett, WA
  - April (1986) < 5%
  - May (1979) = 5%
  - Feb, May (1987) = 6%

National Marine Fisheries Service (NMFS). 1997. Investigation of Scientific Information on the Impacts of California Sea Lions and Pacific Harbor Seals on Salmonids and on the Coastal Ecosystems of Washington, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-28, 172 p.

# Steller Sea Lion

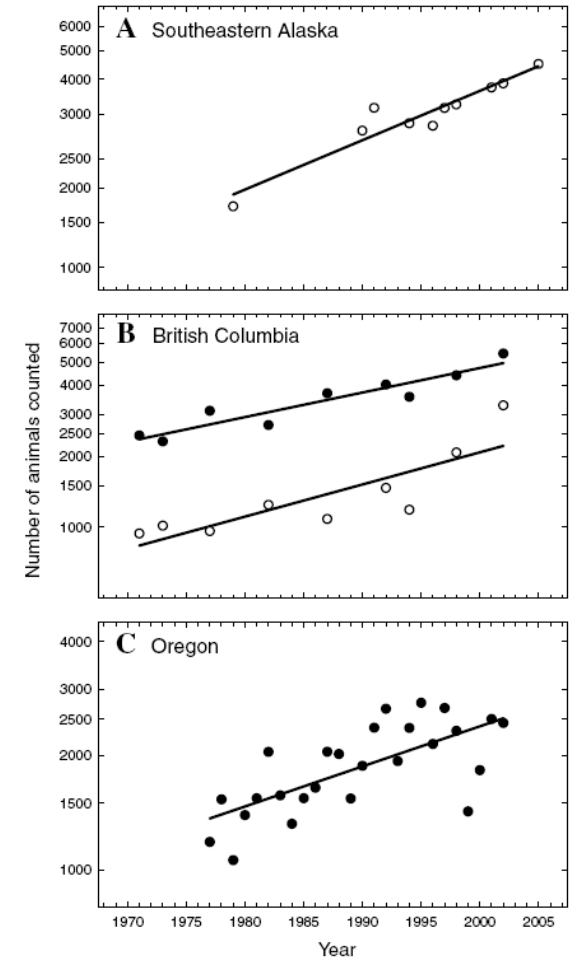


Peter Hodum

# Steller Sea Lion Population Trends

- Increased off Oregon, northern California, and Washington (Brown and Riemer 1997; Brown et al. 2002; Pitcher et al. 2007, Jeffries pers. comm.).
- Increased between 2.3 and 3.5% per year for Oregon (Pitcher et al. 2007) and BC non-pup numbers have increased by 3.5%/year since the 1970s (National Marine Fisheries Service 2012).

Pitcher et al. 2007. Abundance and distribution of the eastern North Pacific Steller sea lion (*Eumetopias jubatus*) population. Fish. Bull. 107:102-115.

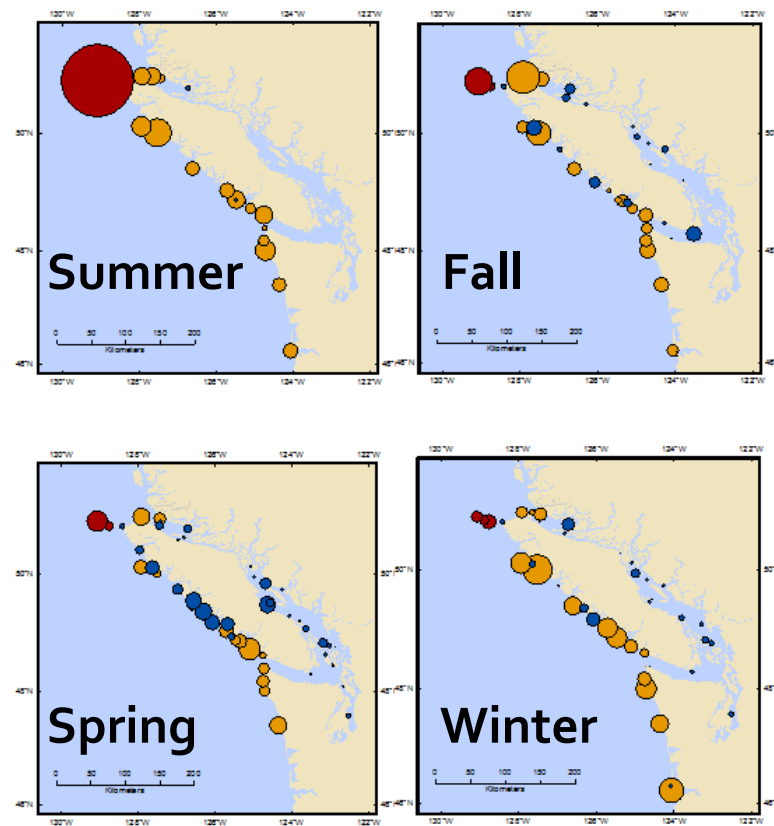


**Figure 3**

Recent trends in counts of Steller sea lion (*Eumetopias jubatus*) pups (○) and nonpups (●) on rookeries in (A) Southeastern Alaska, (B) British Columbia, and (C) Oregon. These areas combined account for over 90% of pup production in the eastern population. Survey techniques were standardized within each region, but differed among regions. The slopes are all statistically significant ( $P < 0.001$ ), and none differed significantly from the overall rate of increase of 3.1%.



# Steller Sea Lion PNW Seasonal Distribution



**Figure 13.** Maps showing seasonal changes in distribution of Steller sea lions counted during the summer (top left), fall (top right), winter (bottom right) and spring (bottom right) surveys. Symbol sizes are drawn proportional to the average site counts. Red symbols denote rookeries, orange symbols year-round haulout sites, and blue symbols winter haulout sites and swimming animals.

Olesiuk, P.F., Jeffries, S.J., Lance, M.M., Trites, A.W., Gearin, P.J., Miller-Saunders, K., Tabata, A., Riemer, S.D., and Lambourn, D.M., and 2010. Prey requirements and salmon consumption by Steller Sea Lion (*Eumetopias jubatus*) in southern British Columbia and Washington State. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/nnn. vi + xx p.

# Steller Sea Lion Diet

- Salmon = 10% of overall diet (range = 7% in spring to 15% in fall)
- Chinook composed about 18% of the Salmon identified genetically (% salmon in diet ranges from 7-15%)

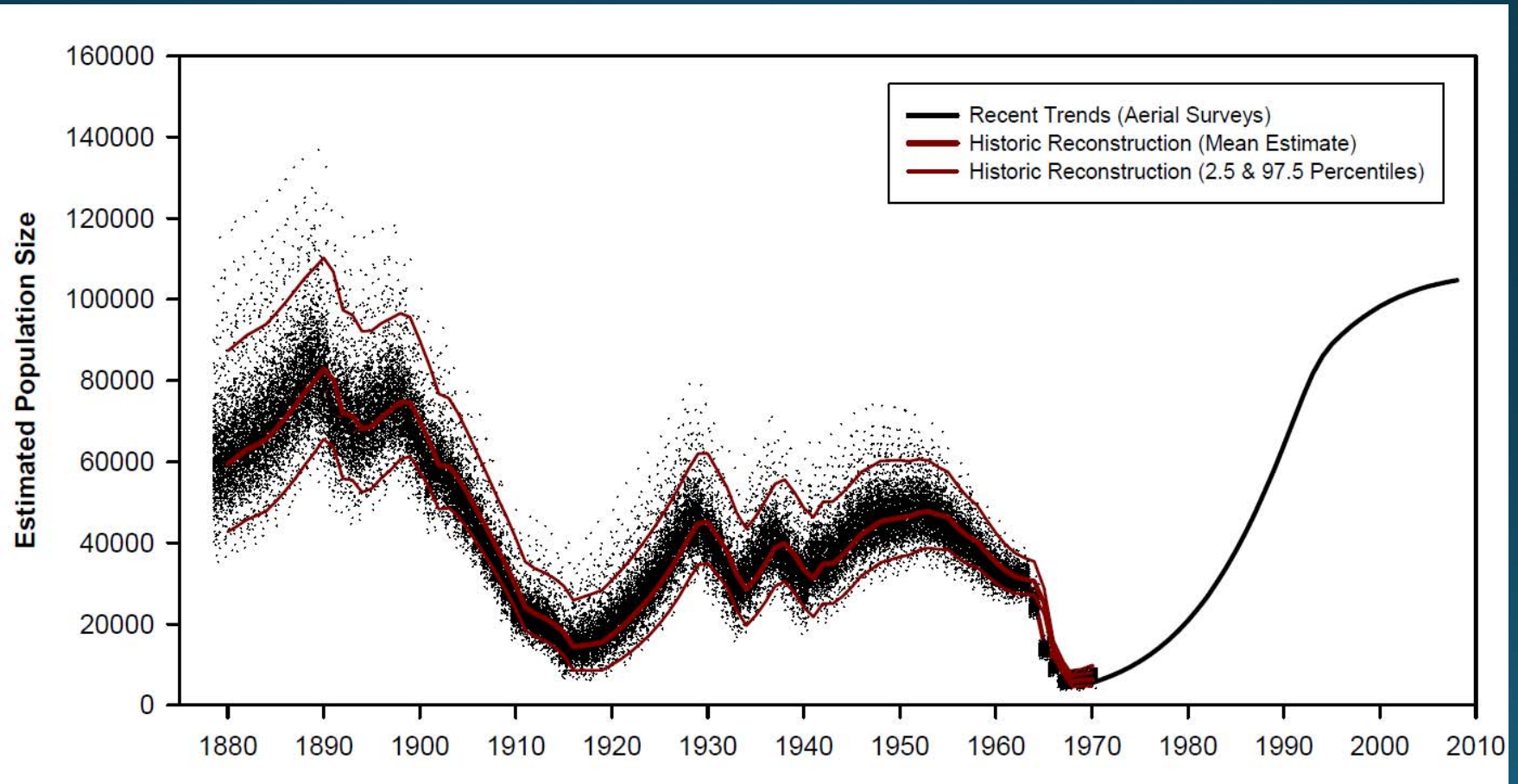
# Pinniped Summary



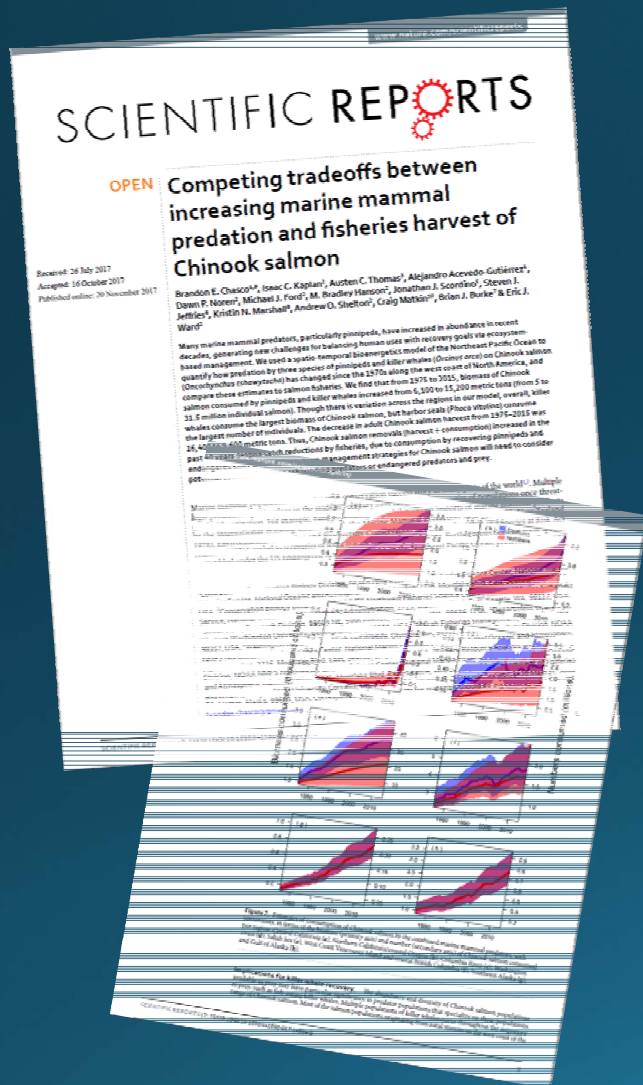
- Pinnipeds increasing but some stocks or populations may be at carrying capacity
- Salmon important but relatively small proportion of diet in most areas (2 – 25%)
- Evidence that pinniped distributions are changing
- Need updated information on abundance, distribution, and diet



# Department of Fisheries and Oceans Canada (DFO) Reconstruction of Historical Harbor Seal Abundance in British Columbia

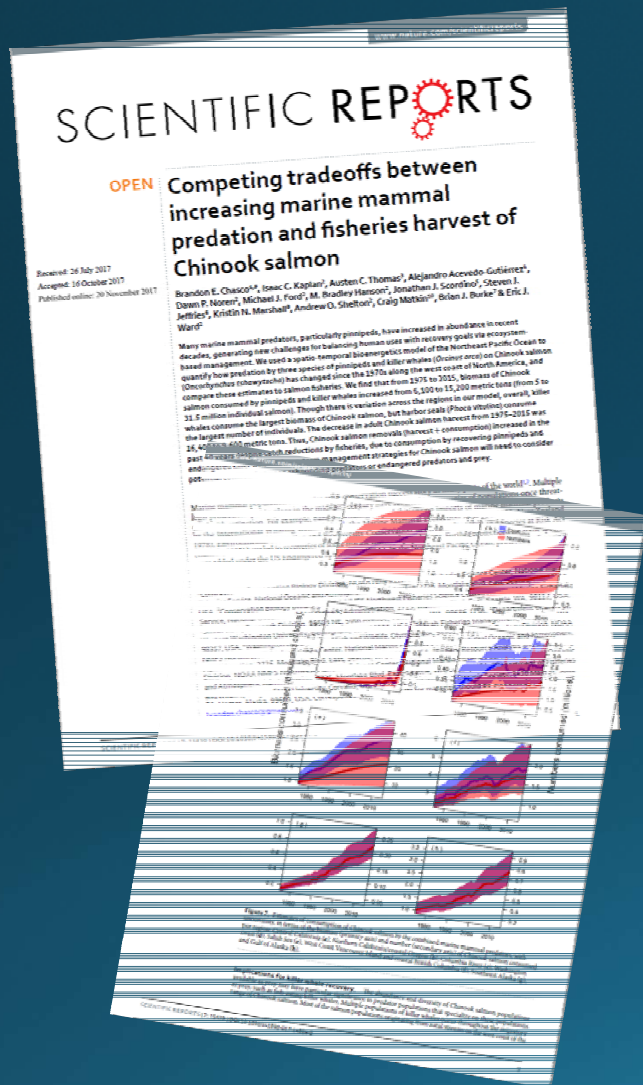


# Review of Chasco et al., 2017



- Coastwide spatio-temporal bioenergetics model
- Estimated consumption of Chinook salmon from 1970-2015
- Modeled energetic costs/demands for killer whales, California sea lions, Steller sea lions, and harbor seals compared with Chinook abundance
- Compared Chinook abundance with and without predation

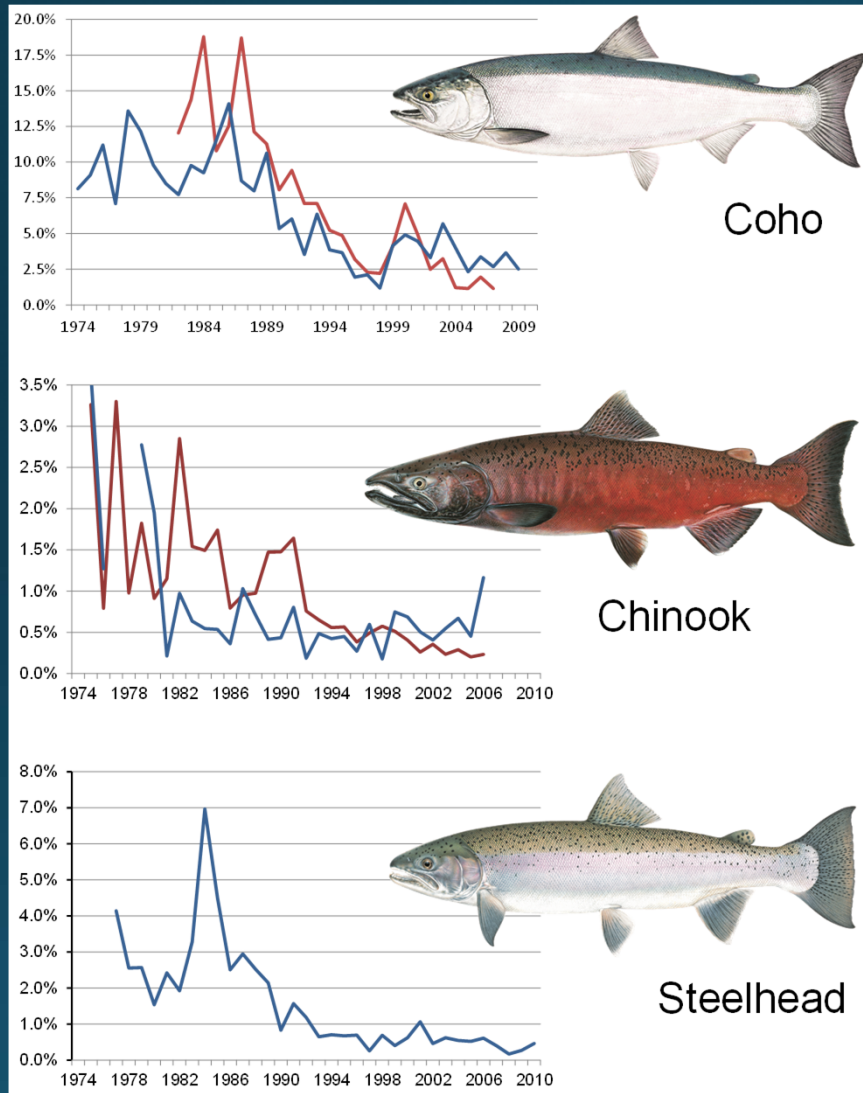
# Review of Chasco et al., 2017



- Chinook consumed by killer whales and pinnipeds has increased from 6 to 15k metric tons (or 5 to 32M individuals)
- Killer whales consume the largest biomass, harbor seals consume the most individuals
- Commercial and recreational fishing declined from 16 to 10 metric tons (or from 3.6 – 2.1M individuals)
- Suggested predation could be masking the benefits of recovery as increases from recovery could be offset by predators
- These are coastwide estimates, need localized modeling to determine localized effects



# Marine Survival in the Salish Sea



- Up to 10-fold decline since the 1980s
- Has remained low, a trend not shared by coastal populations
- Juvenile steelhead and coho dying while they traverse the Salish Sea on their way to the ocean



# Other known significant changes in the Salish Sea







# SALISH SEA

MARINE SURVIVAL PROJECT

**International Collaborative Research**

Top-Down Drivers

Bottom up / Food Web Drivers

Integrated Ecosystem Modeling

Pacific Ocean

Strait of Georgia

Juan de Fuca Strait

Puget Sound



**LONG LIVE  
THE KINGS**

# The Salish Sea



# Many Factors at Play for Salmon and Steelhead Marine Survival



- Climate Change and Population Growth
  - Increased nutrients disrupting base food webs
- Estuary habitat and Food in the Nearshore
  - Estuary rearing is a critical growth period for Chinook – linked to an increase in adult survival
  - Energy rich food linked with growth and survival and adult survival
- Contaminants and parasites
  - High levels of flame retardants in Chinook and parasite loads for steelhead linked with poor survival
- Forage fish abundance in PS (acting as buffer prey)
  - In years with high abundance of herring and/or anchovies see increased survival of steelhead from 6% to over 40%
- Predation
  - Increased pinnipeds impacting salmon

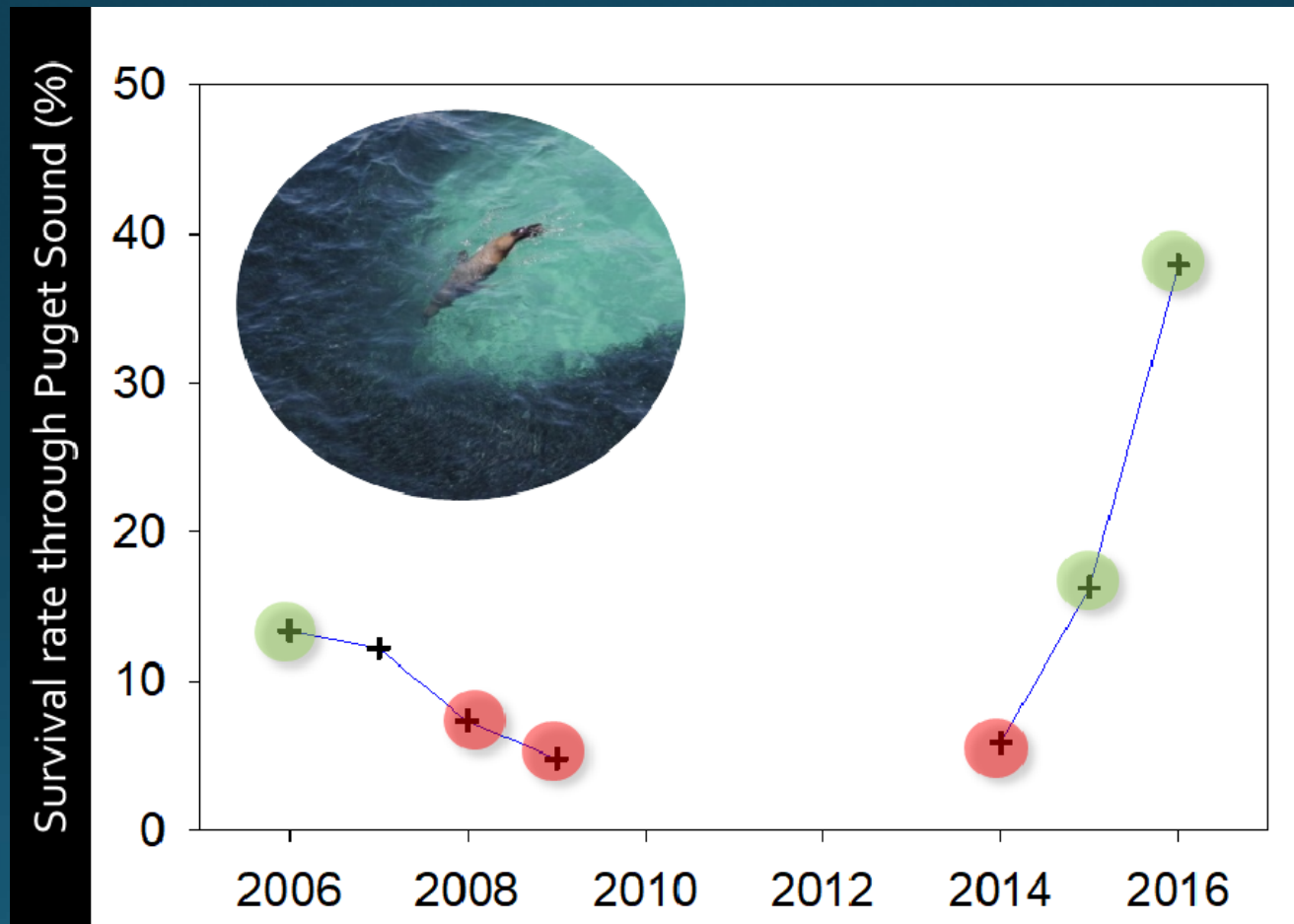
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# Anchovies Buffering Predation on Steelhead?

**Marine** survival rate of steelhead through Puget Sound relative to years of high  vs. low  anchovy abundance



Moore, Duguid – NOAA, U. of Victoria

# Pinniped Predation Assessment

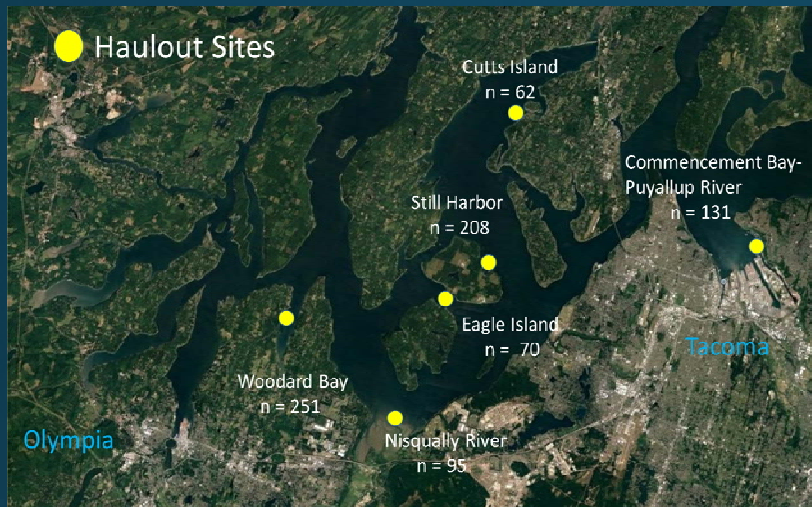
Partnership with Salish Sea Marine Survival Project, NOAA, and WDFW



- Update pinniped abundance by region and season
- Estimate diet by region/month
- Estimate daily energy demands and age-specific seasonal availability of H/W Chinook in each region

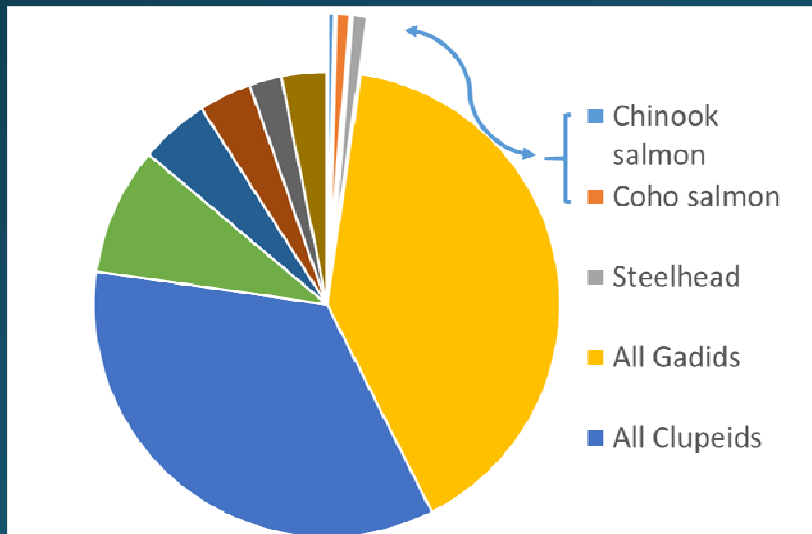
# Harbor Seal Diet (example)

Assessing diet in Puget Sound (from Salish Sea Marine Survival Project)



Reconstructing diet from scat

- Hard parts (bones, beaks, etc.)
- DNA



Preliminary results (2016 only)

- Salmon less than 5% of harbor seal diet
- Chinook less than 2% of diet

# Pinniped assessment next steps (in process)

- Use updated population estimates for all pinnipeds
  - WDFW estimates (in process)
  - Navy derived estimates (in process)
- Use new pinniped diet data from
  - South Sound (Early Marine Survival Project – 2016 & 2017)
  - Puget Sound diet data for California sea lions (samples in hand but need to be processed – partnership with Nisqually Tribe)
- Provide new Chinook smolt and adult consumption estimates
  - Include availability of hatchery / wild Chinook
  - Include uncertainty in pinniped diet
  - Include uncertainty in pinniped population estimates



# Take Aways

- Pinnipeds have increased in Puget Sound but appear to have leveled off (or may even be declining)
- Predation on salmon and steelhead has increased (Chasco et al., 2017)
- Predation is just one of many factors impacting salmon and steelhead in Puget Sound
- Need an integrated program to address predation and other factors in Puget Sound



# Thank You