Pinniped population trends and their diet and distribution overlap with Southern Resident Killer Whales

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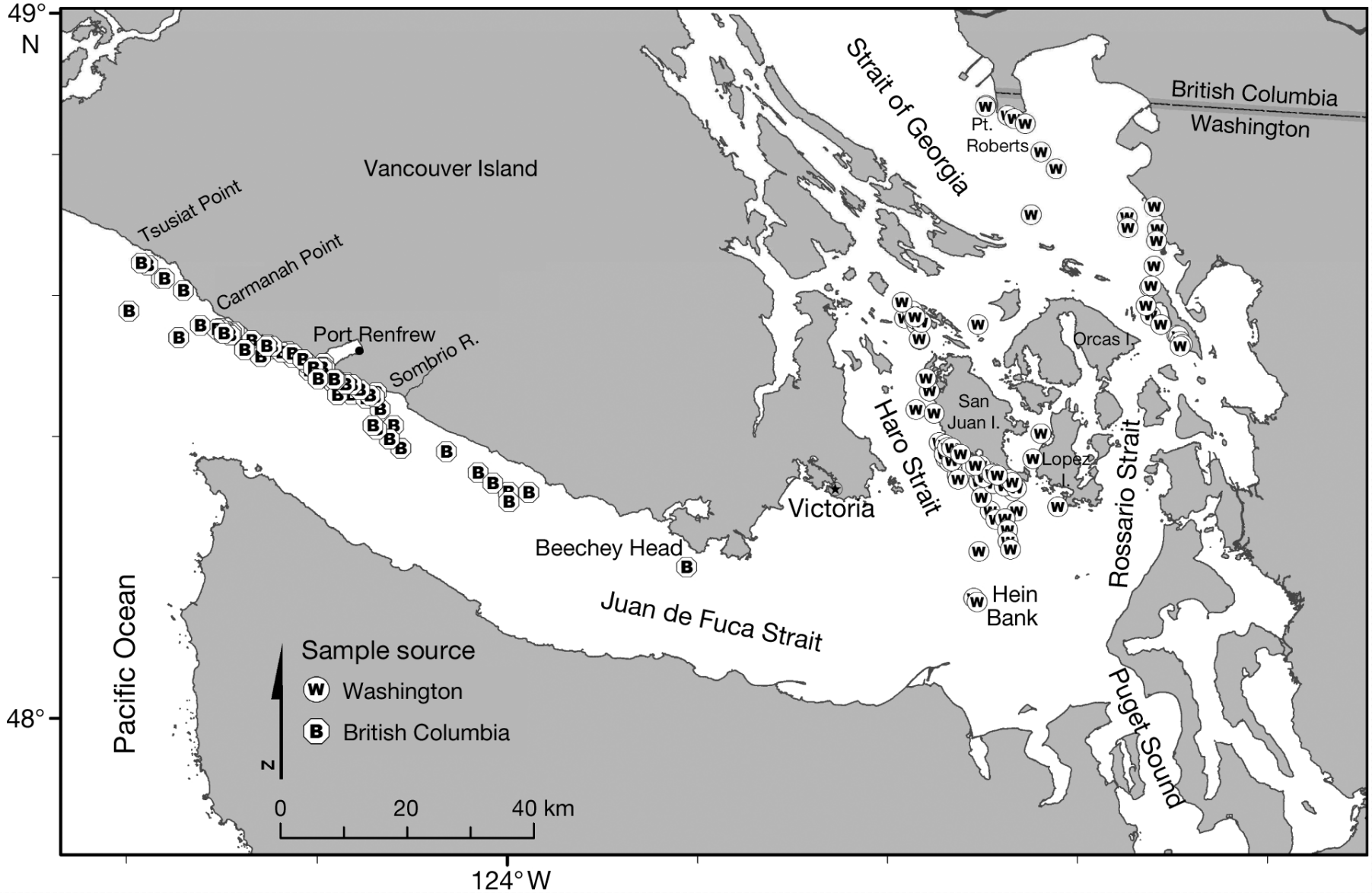
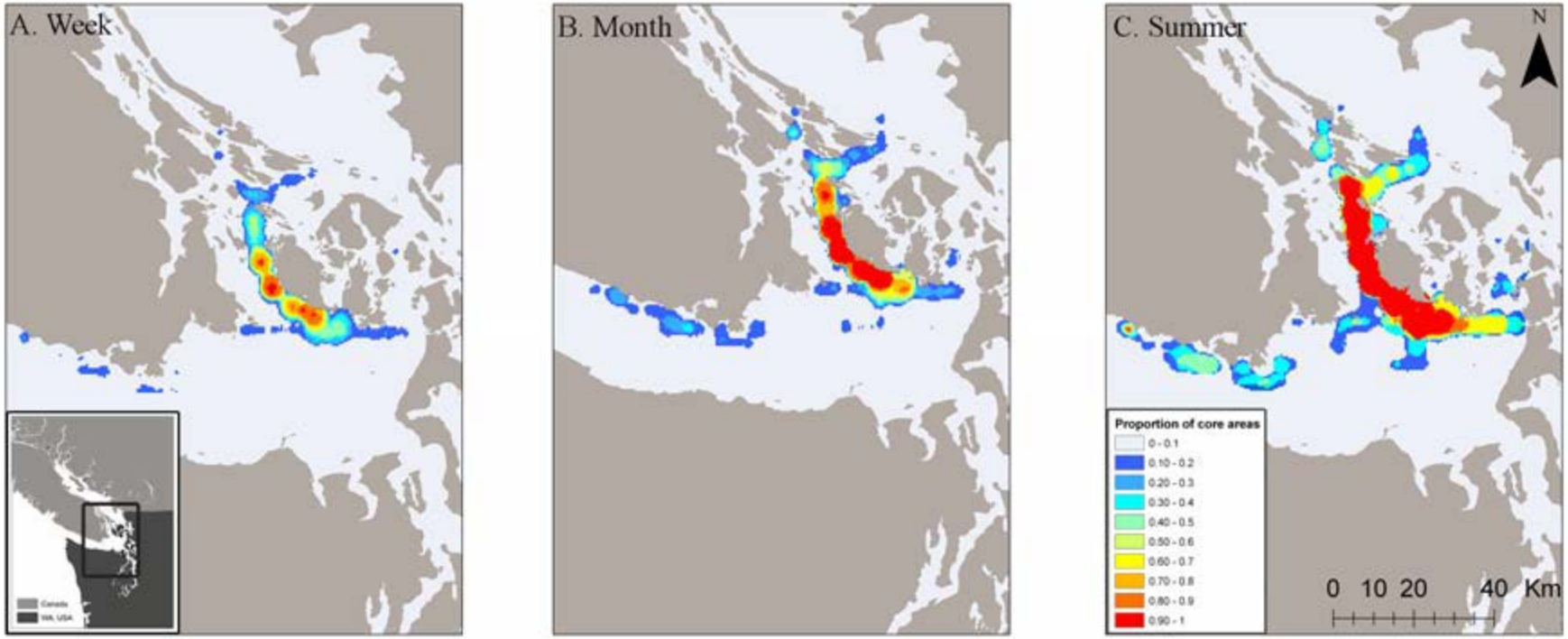
Killer Whale - Diet

- May – Sept. diet dominated by large Chinook (Hanson et al. 2010, Ford and Ellis 2006)

Killer Whale - Distribution



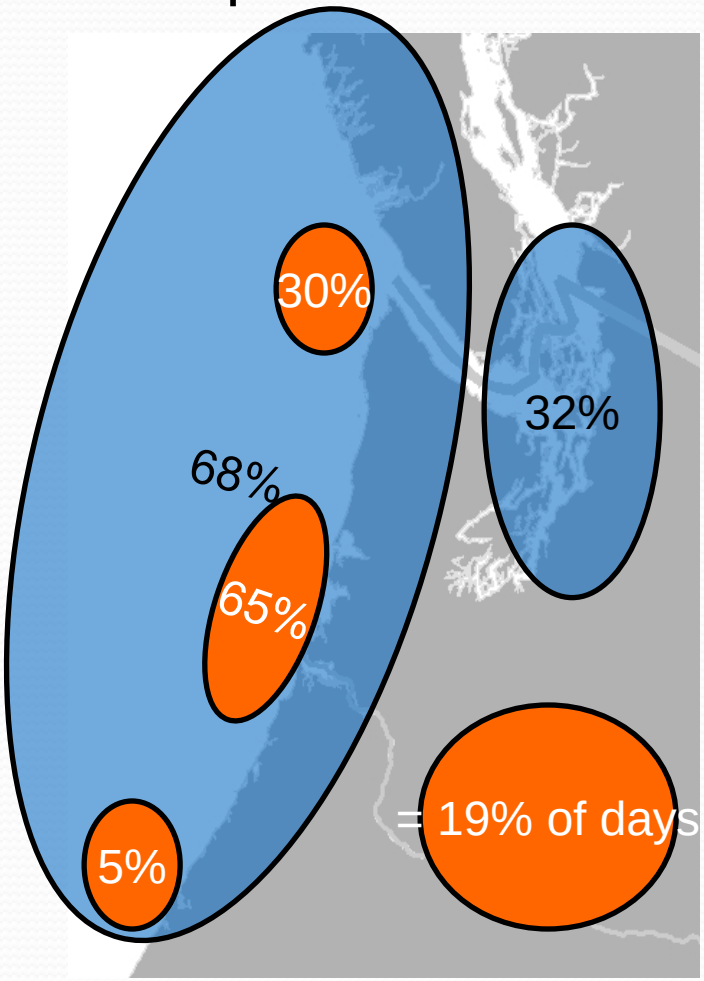
Hanson et al. 2010. Species and stock identification of prey consumed by endangered southern resident killer whales in their summer range. Endang Species Res 11: 69–82



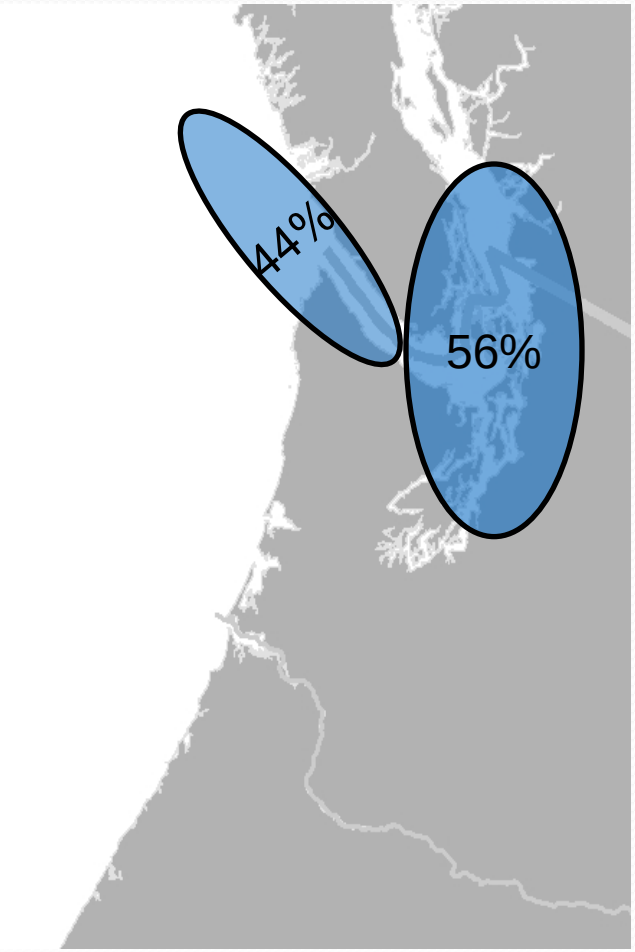
From masters thesis. Published data = Hauser et al. 2007. Summer distribution patterns of southern resident killer whales *Orcinus orca*: core areas and spatial segregation of social groups. Marine Ecology Progress Series 351:301-310.

Summary: SR whale distribution by season

April - June



July - Sept



Harbor Seal

Harbor Seal Population Trends

- In general, Oregon and Washington coastal and inland stocks reached carrying capacity and have apparently been stable since the late 1980s to mid-1990s
- BC harbor seals are thought to be near carrying capacity
- No recent abundance or distribution surveys in Oregon and Washington

Jeffries et al. 2003. Journal of Wildlife Management 67:208-219
Brown et al. 2005. Marine Mammal Science 21 (4): 657-670
DFO. 2010. Population Assessment Pacific Harbour Seal (*Phoca vitulina richardsi*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/011
Caretta et al. 2011. U.S. Pacific marine mammal stock assessments. ACIFIC 2011NOAA-TM-NMFS-SWFSC-488

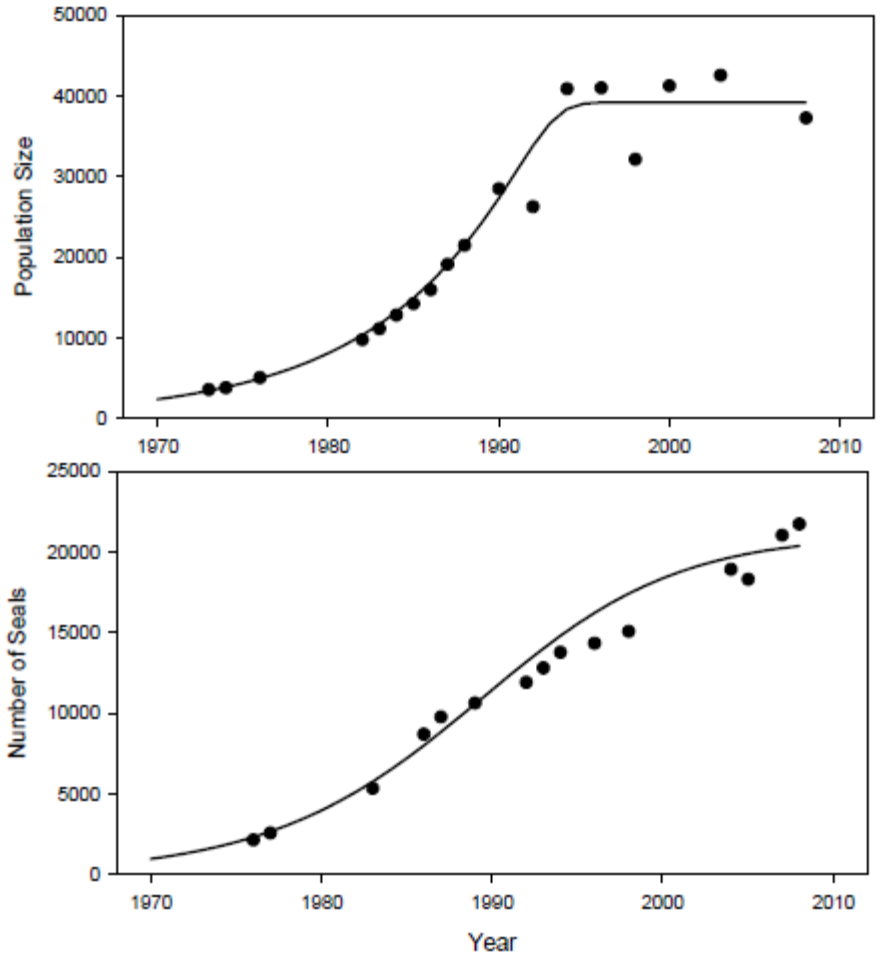


Figure 1. *Recent trends in harbour seal abundance in the Strait of Georgia (top panel) and in Index Areas outside the Strait of Georgia (bottom panel). The Index Areas are widely distributed throughout B.C. and include the lower Skeena River, most of the Queen Charlotte Islands, Queen Charlotte Strait and Broughton Archipelago, and the west coast of Vancouver Island. The trend lines represent generalized logistic curves fitted using maximum likelihood methods.*

DFO. 2010. Population Assessment Pacific Harbour Seal (*Phoca vitulina richardsi*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/011

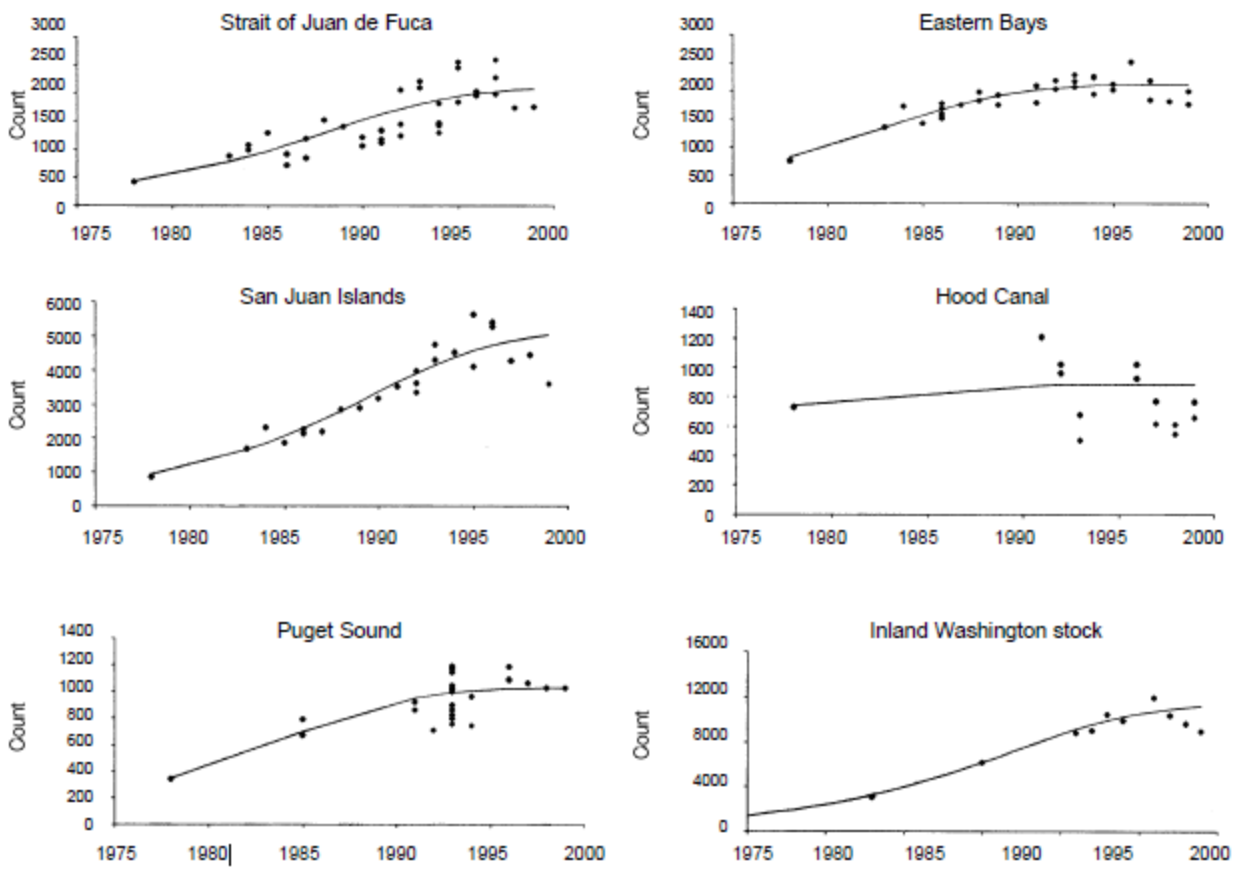


Fig. 4. Generalized logistic growth curves of harbor seals in the Washington, USA, inland stock for Strait of Juan de Fuca, Eastern Bays, San Juan Islands, Hood Canal, and Puget Sound regions and their sums.

Jeffries et al. 2003. Journal of Wildlife Management 67:208-219

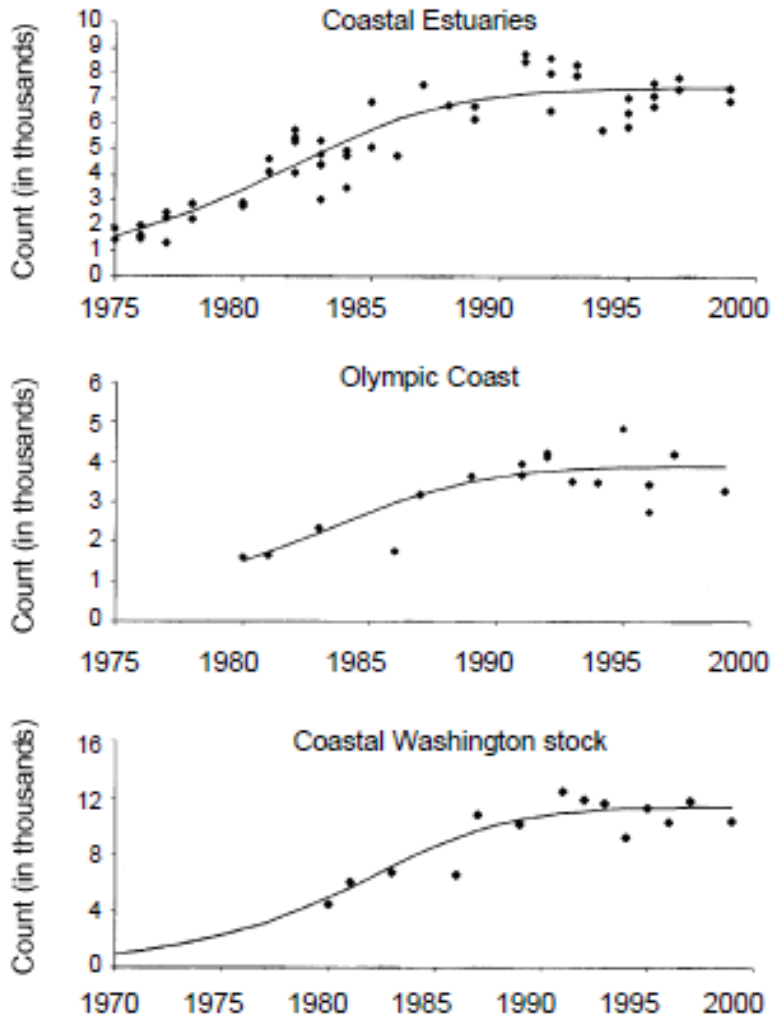


Fig. 3. Generalized logistic growth curves of harbor seals in Washington, USA, portion of the coastal stock for coastal estuaries and outer Olympic Peninsula coast regions and their sum.

Jeffries et al. 2003. Journal of Wildlife Management 67:208-219

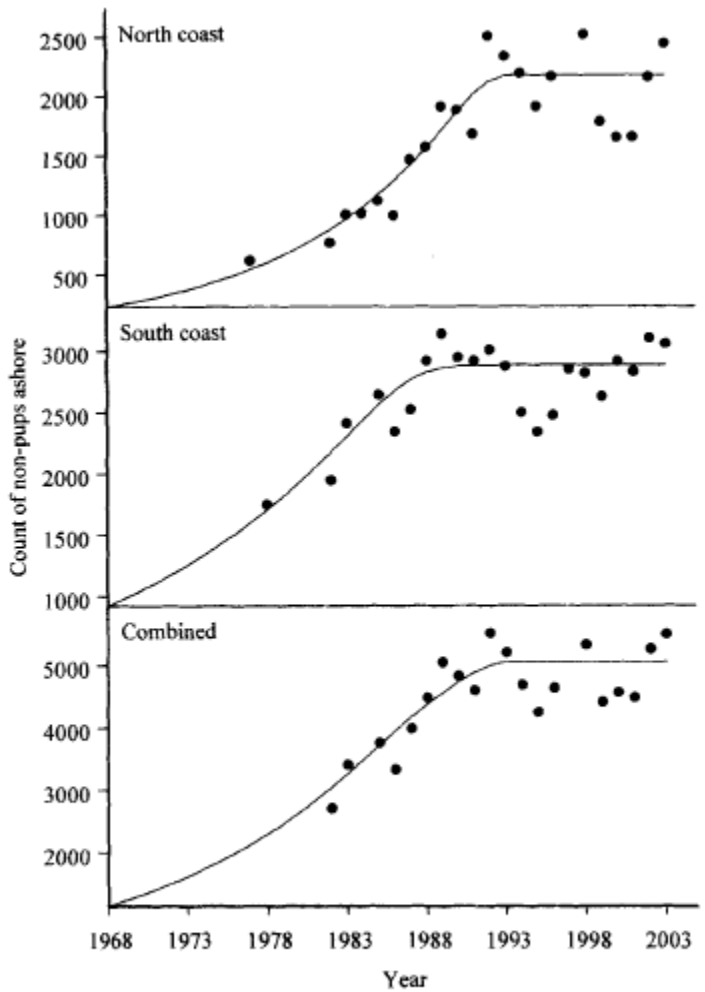
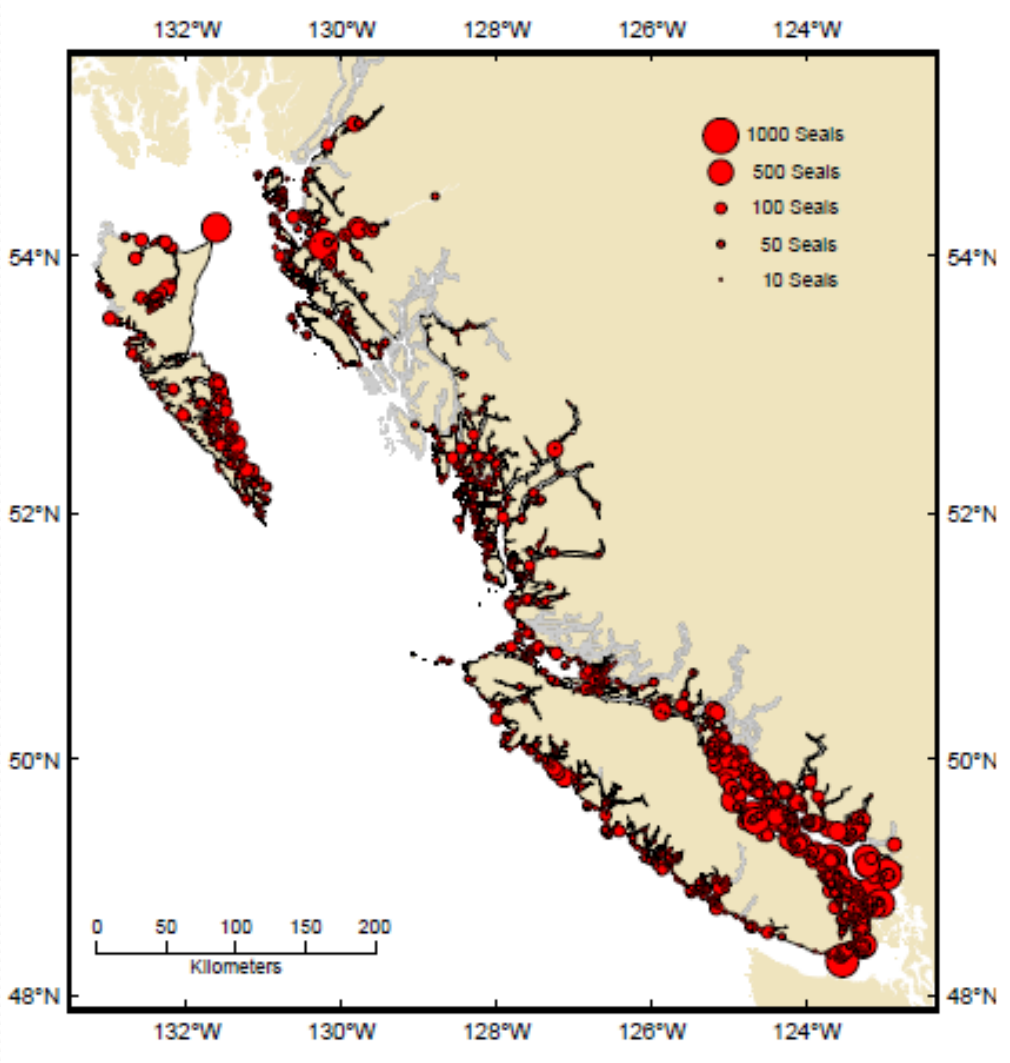


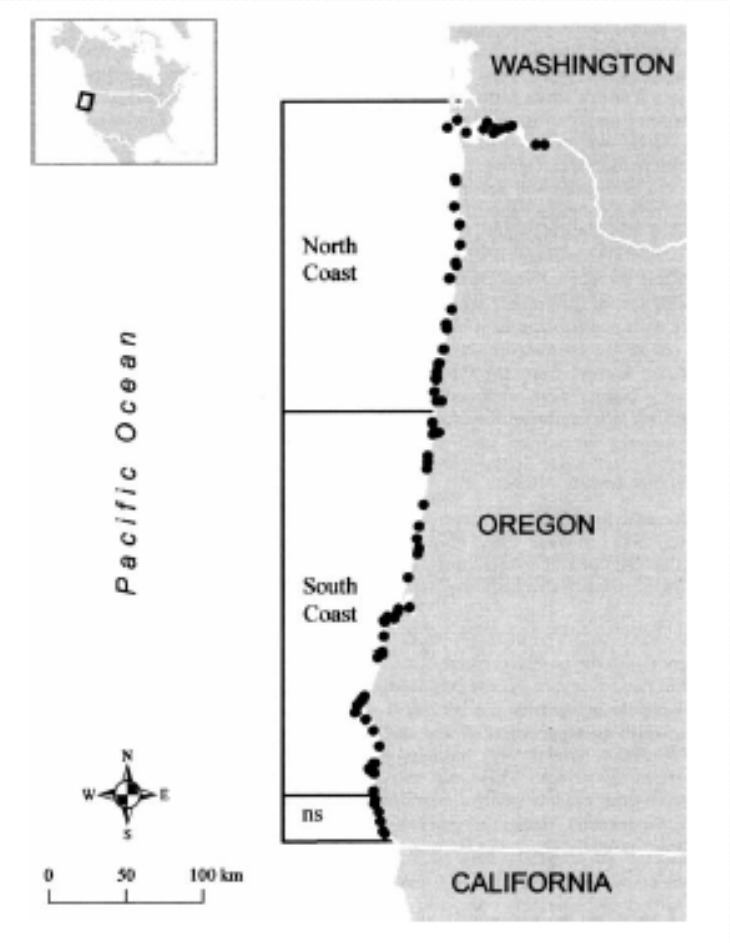
Figure 2. Average (circles) and predicted (line) counts of non-pup harbor seals ashore for two survey regions in Oregon. The combined total represents the sum of the regional averages and predicted values.

Brown et al. 2005. Marine Mammal Science 21 (4): 657-670

Harbor Seal Spatial Overlap

- Considerable spatial overlap with SRKW year-round


132°W
130°W
128°W
126°W
124°W
54°N
52°N
50°N
48°N
1000 Seals
500 Seals
100 Seals
50 Seals
10 Seals
0
50
100
150
200
Kilometers


WASHINGTON
North Coast
Pacific Ocean
OREGON
South Coast
ns
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S
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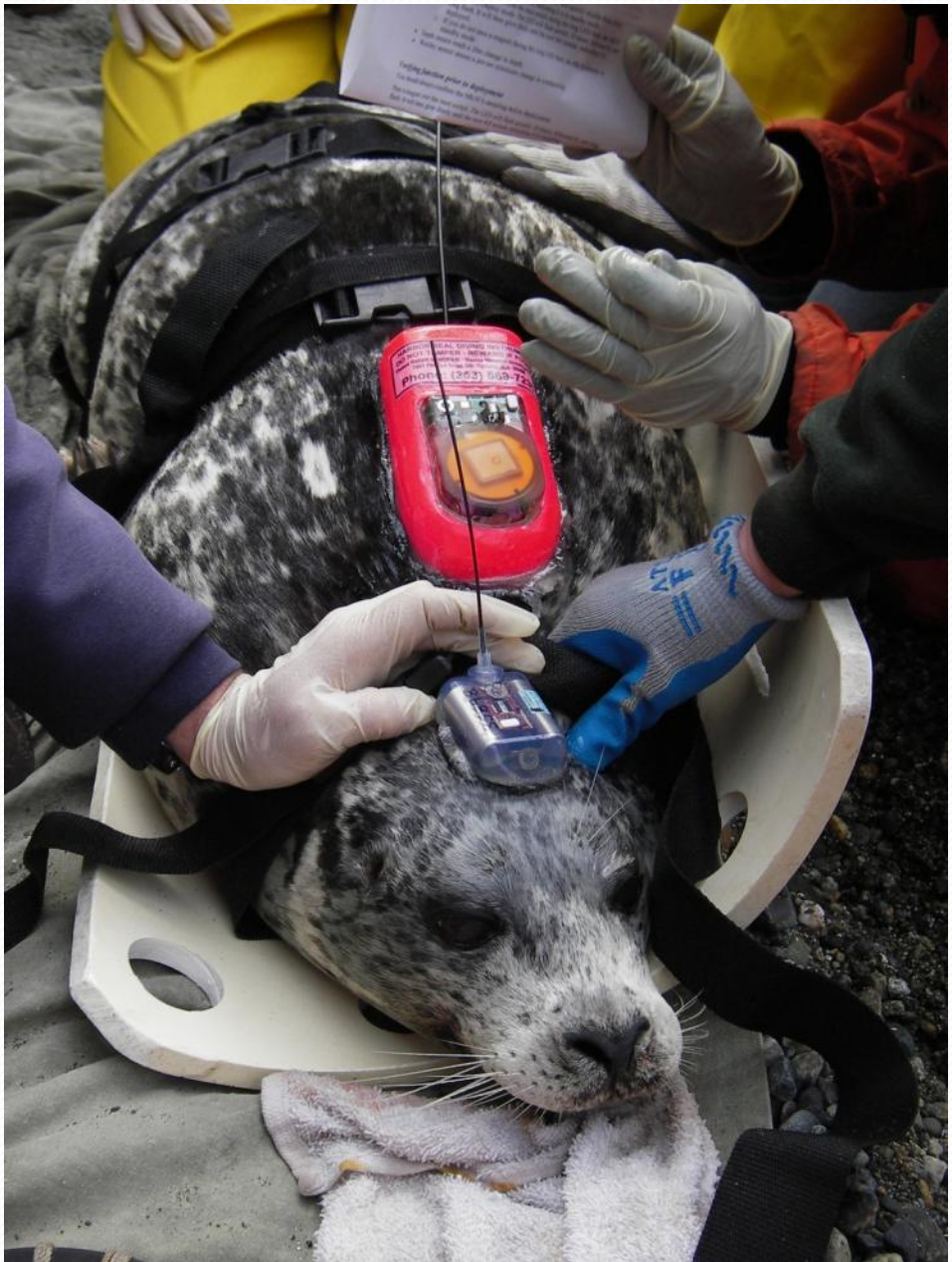
50
100 km



Harbor Seal Diet Overlap

- Strait of Georgia, Salmon = 1.3-8.6% (Olesiuk 1993)
- San Juan Archipelago, Salmon = 4.16-51.37% (FO)with nearly all of the consumption occurring in the fall (Lance et al. in press).
  - Salmon identified to species = 8.83% and, of that, adult Chinook = 0.58%.

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

California Sea Population Trends

- California sea lion population growth rate = 5.4% yr^{-1}
- Lack range-wide abundance and distribution surveys.

Caretta et al. 2011. U.S. Pacific marine mammal stock assessments. ACIFIC 2011NOAA-TM-NMFS-SWFSC-488

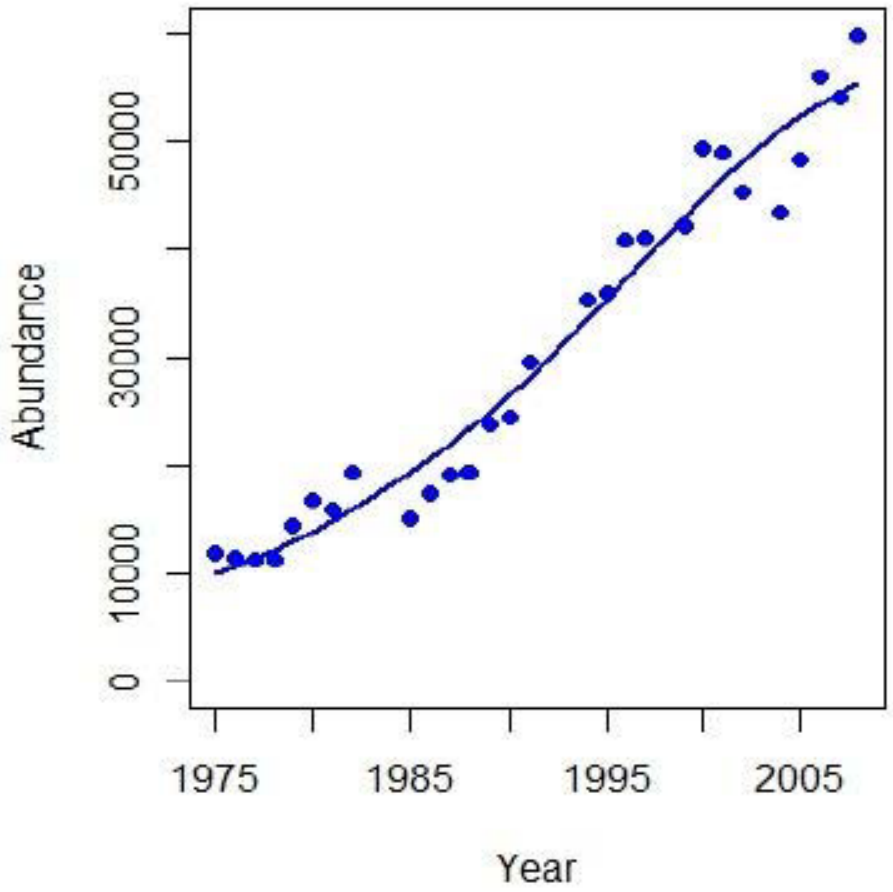
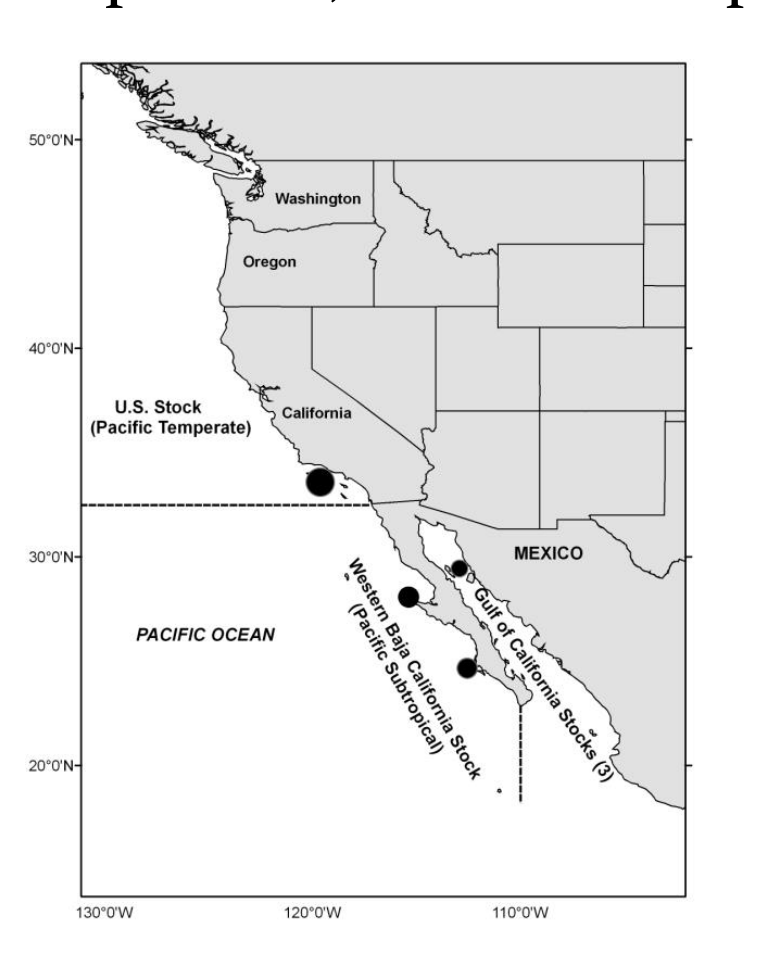


Figure 3. Fit of standard logistic growth curve to California sea lion pup counts, 1975-2008 (excluding El Niño years).

Caretta et al. 2011. U.S. Pacific marine mammal stock assessments. ACIFIC 2011NOAA-TM-NMFS-SWFSC-488

California Sea Lion Spatial Overlap

- Some spatial overlap in fall, winter and spring



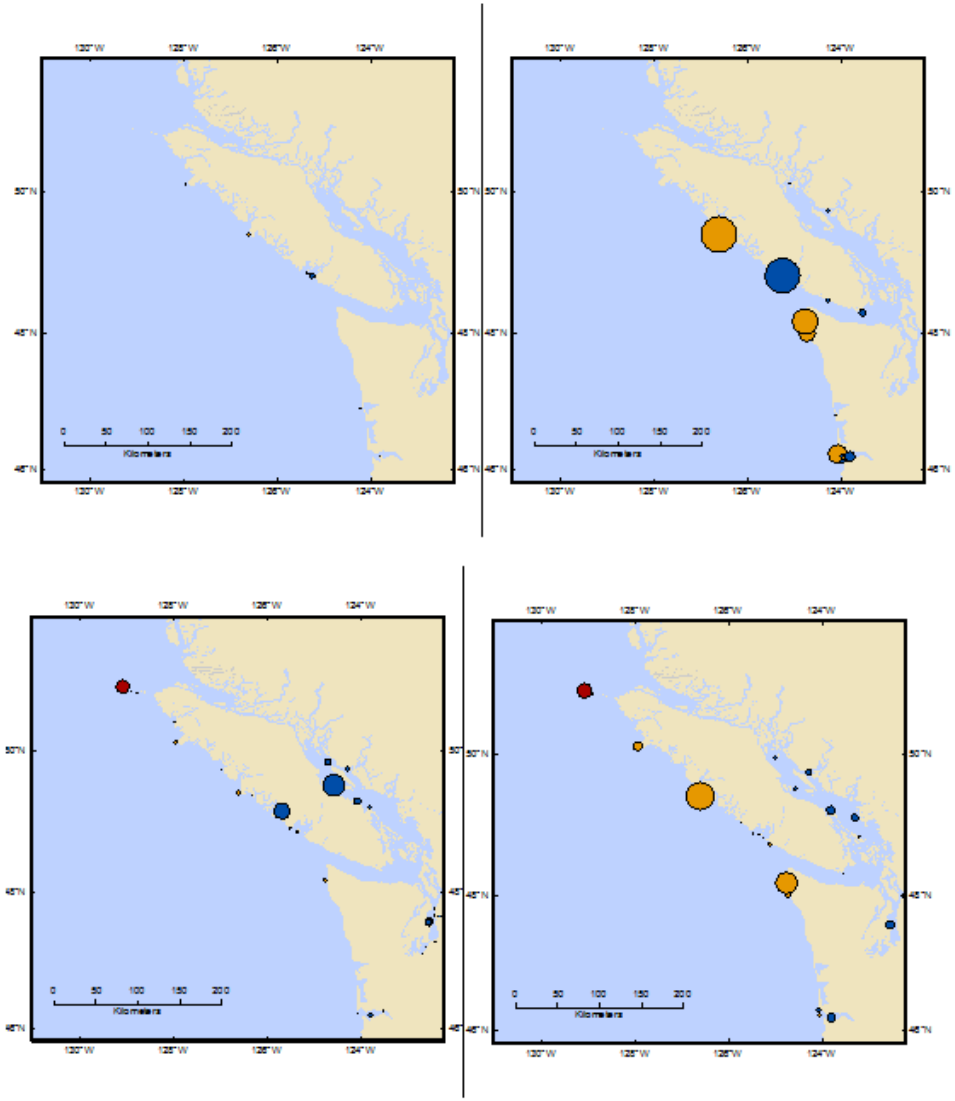


Figure 16. Maps showing seasonal changes in distribution of California sea lions counted during the summer (top left), fall (top right), winter (bottom right) and spring (bottom right) surveys. Symbol sizes are drawn proportional to the average site counts. Red symbols denote rookeries, orange symbols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

California Sea Lion Diet Overlap

- Salmon = 5-25% frequency of occurrence (note: diet dominate by whiting and pollock)
  - Shilshole Bay, WA (1987) = 25%
  - Puget Sound, WA (1988) = 21 %
  - 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

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 (Pitecher et al. 2007) and BC non-pup numbers have increased by 3.5%/year since the 1970s (National Marine Fisheries Service 2012).

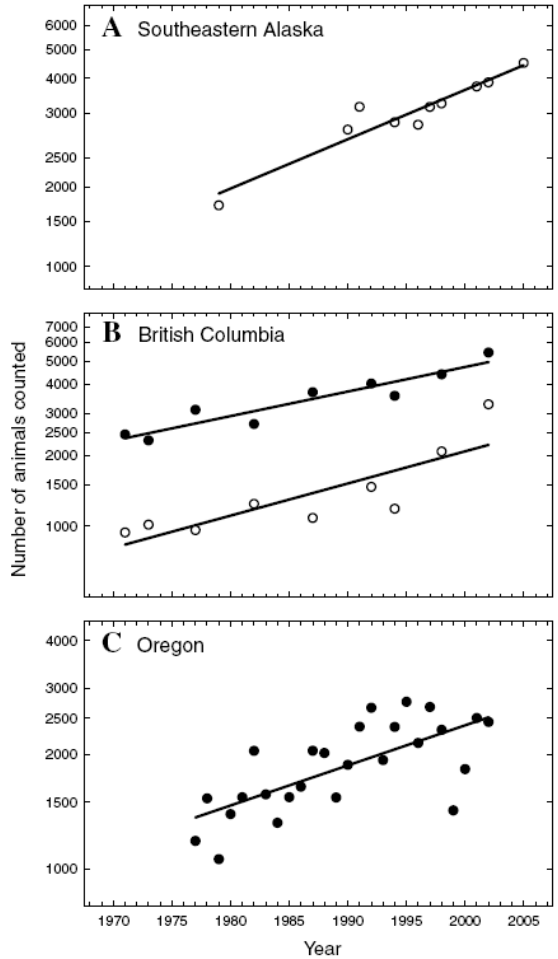


Figure 3

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%.

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

Steller Sea Lion Overlap

- Little overlap in inland waters of Washington
- Considerable overlap on west coast of Vancouver Island
- All Steller rookeries are located in proximity to major Salmon runs i.e., St. George Reef, Rogue Reef, Scott Islands

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.

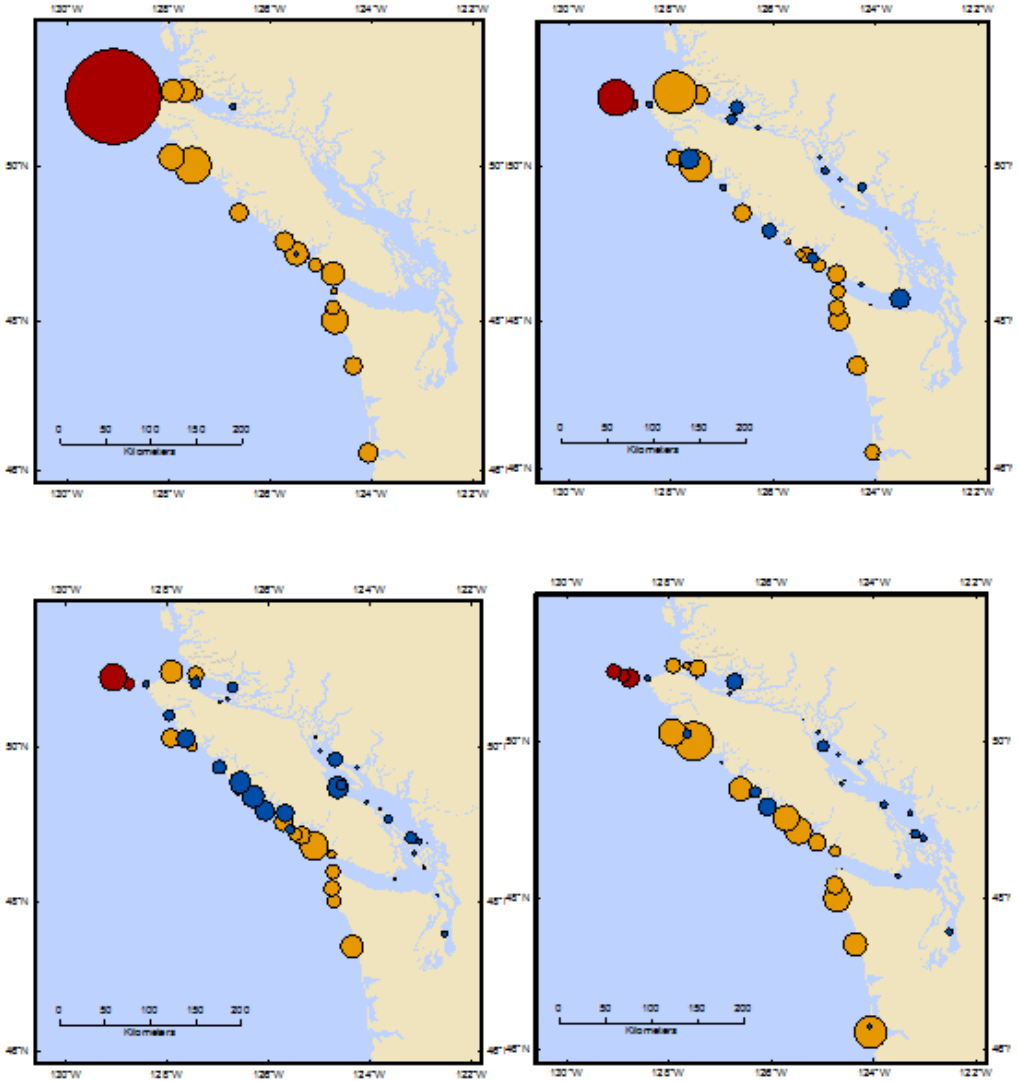


Figure 13. Maps showing seasonal changes in distribution of Steller sea lions counted during the summer (top left), fall (top right), winter (bottom right) and spring (bottom right) surveys. Symbol sizes are drawn proportional to the average site counts. Red symbols denote rookeries, orange symbols year-round 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)
- 84% of the consumption is in B.C., with 16% in Washington
- <10% of the salmon in the size class selected by SRKW
- Chinook composed about 18% of the Salmon identified genetically (% salmon in diet ranges from 7-15%)

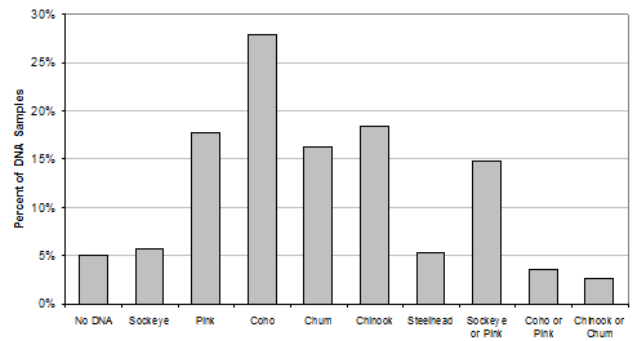


Figure 36. Species of salmon identified from DNA extracted from a subset of 320 scat samples from the study area. In some cases, multiple loci were required to positively identify species, but some loci were not as robust and more prone to "drop-outs", so there are a number of instances (3 far right bars) where the species could only be narrowed down to one of two possible species.

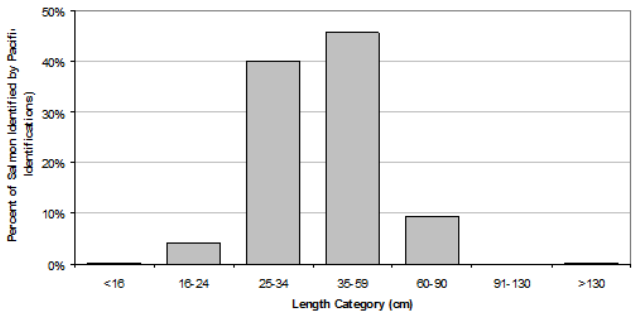


Figure 34. Size distribution of salmon that were identified by Pacific Identifications and subjectively categorized by size. In cases where the size may have fallen in either of two adjacent size categories, the item was tallied as half an occurrence in each of the potential size categories. Note that size was estimated subjectively, and the subjective estimates have not been tested or calibrated. The smallest size category (<16cm) were considered juvenile-sized salmon.

Olesiuk et al. 2010

Summary

- It is complicated!
- But, competition for food resources with killer whales should consider:
  - Pinniped population size & trends
  - Seasonal spatial overlap
  - Foraging spatial overlap (exclude indiv. in fresh water)
  - Diet overlap (composition and size distribution)
  - Indirect effects

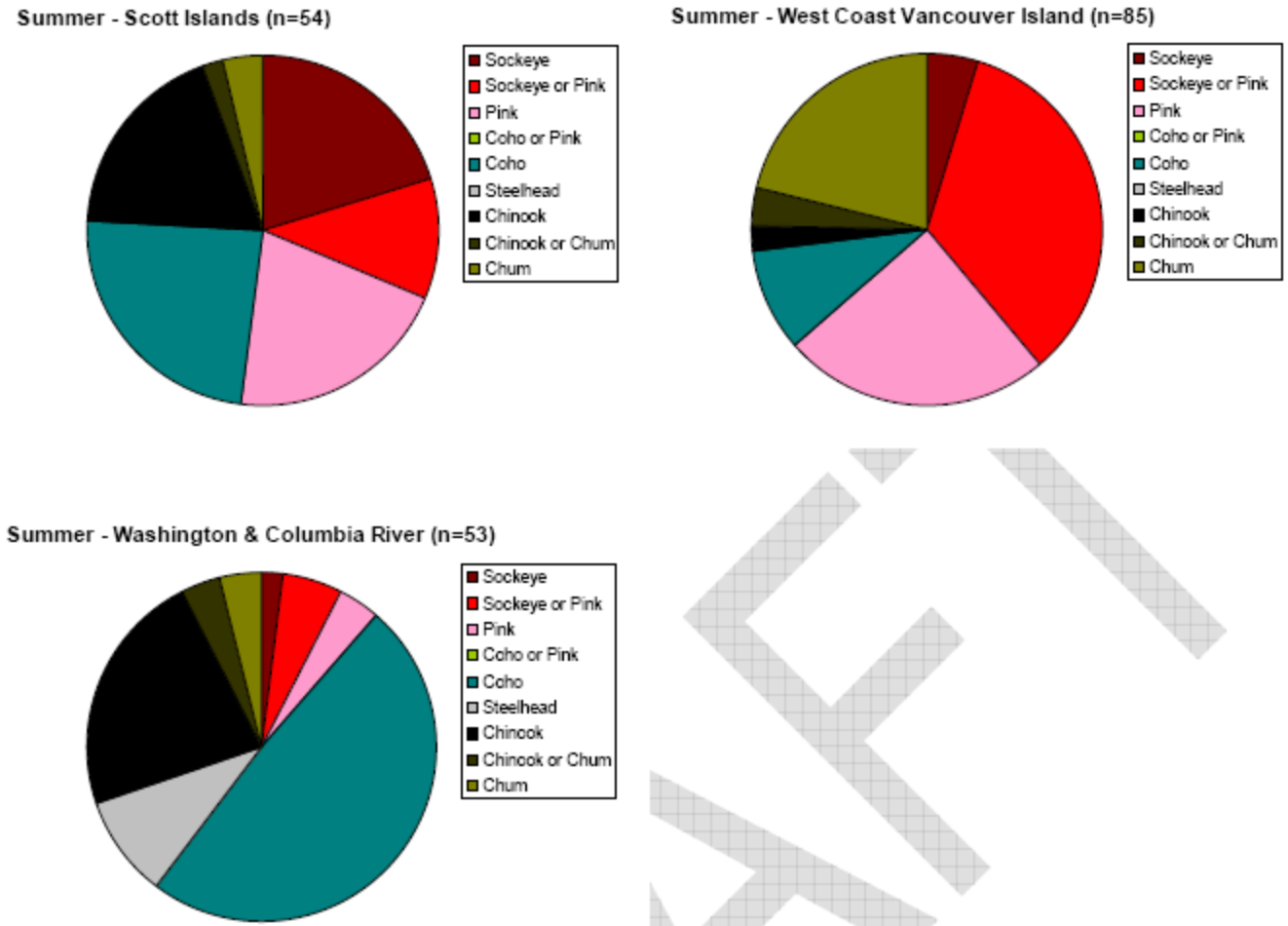


Figure 37a. Species of salmon consumed by Steller sea lions during summer at the Scott Islands (top left), northwest coast of Vancouver Island (top right), and Washington coast and Columbia River (lower left).

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.

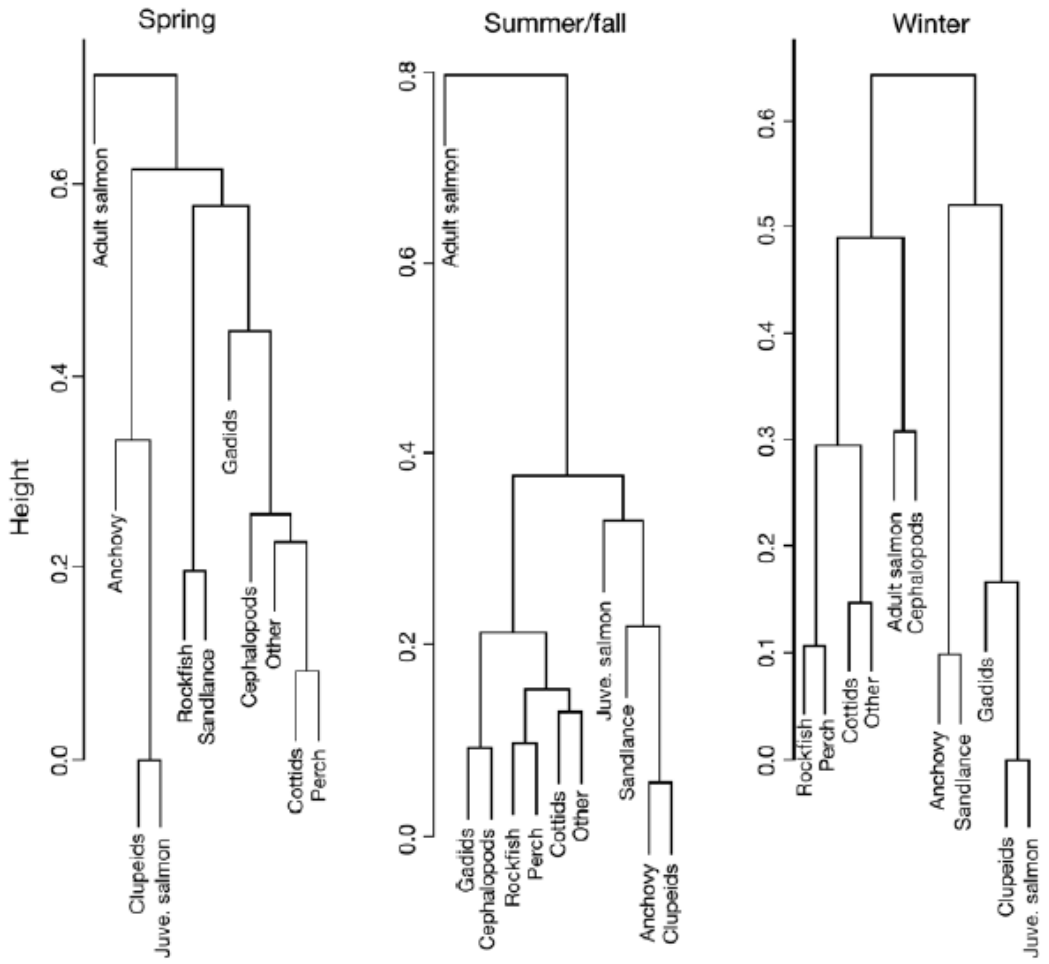


Fig. 4. Prey group associations in harbor seal scat samples illustrated in hierarchical clustering dendrograms by season. Juve. = juvenile