Using Cooperative Acoustic Surveys to Manage Small-Scale Fisheries:

Relationships between Distribution of Steller Sea Lions, Diet Composition, Prey Biomass Distribution and Oceanographic Properties

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Introduction

The goal of our project is to investigate whether cooperative biomass surveys are an effective way to manage fisheries at local scales important to predators such as Steller sea lions. Our long-term vision is that one or more commercial fishing vessels conducts hydro-acoustic surveys in specific areas of Steller sea lion critical habitat prior to commercial fishing beginning in these areas. Biomass estimates from these surveys would then be used to set a quota for the area surveyed that does not jeopardize the foraging success of Steller sea lions in the area. To design an effective cooperative survey, we need to know whether the data collected by commercial vessels is of sufficiently high quality and resolution, and sufficiently low variability to assess biomass at local scales.

We also need to know where the fishery would be expected to operate and where Steller sea lions prey upon pollock. To address these information needs, we conducted winter acoustic surveys of pollock covering the same area in the central Aleutians from a NOAA research vessel and a commercial vessel equipped with a scientific quality ES60 echosounder. To assess the relative importance of haul-outs near pollock spawning areas and near fished areas, we collected data on sea lion distribution and diet. Here we present a preliminary analysis of the distribution of sea lions and the prey composition of their diet; and how both relate to pollock biomass distribution.

Pollock Acoustic Surveys

- Two surveys of pollock were conducted
- 16-29 February, 2008 on the NOAA Vessel *Oscar Dyson* (Fig. 1a)
  - Acoustic data were collected with a calibrated Simrad ER60 quantitative echosounding system comprised of five split-beam transducers (18, 38, 70, 120, and 200 kHz).
  - Species and size-composition of acoustic sign were verified with midwater and bottom trawls
- 22-28 March, 2008 on the Fishing Vessel *Muir Milach* (Fig. 1b)
  - Acoustic data were collected with calibrated Simrad ES60 echosounders with 38kHz split beam transducers
  - Verification tows were conducted with pelagic pollock trawls fitted with 3/8-inch knotless liners
- The distribution (Fig. 1), total pollock biomass and size of pollock were similar during the two cruises, with the exception of a few large aggregations of pollock near Atka Island during the March *Muir Milach* survey
- The reproductive state of pollock changed from mostly pre-spawning to developing in February to pre-spawning and spawning in March

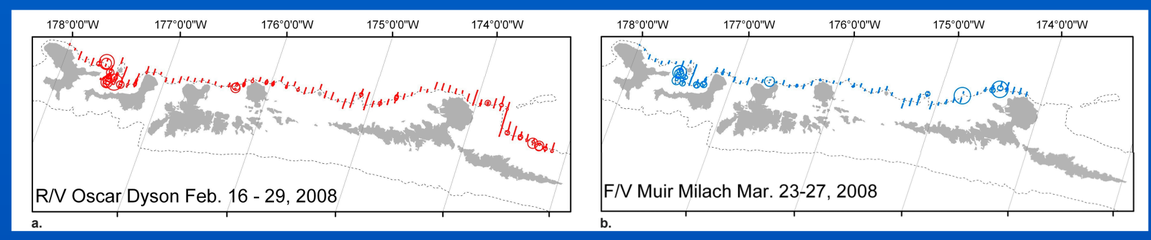


Figure 1. Distribution of adult pollock (circle diameter is proportional to acoustically-determined biomass) during a) *Oscar Dyson* survey, 16-29 February 2008, and b) *Muir Milach* survey, 23-27 March 2008.

Steller Sea Lion Aerial Survey

- Surveyed all 59 haul-out sites from Seguam Island through the Delarof Islands on 24-25 March 2008 using NOAA AOC Twin Otter aircraft.
- Sea lions counted off photographs taken vertically with Canon EOS-1DS Mark II digital camera (50 mm lens) mounted in the belly using forward image motion compensation. Animals assigned to one of 4 age-sex classes: juveniles (both sexes), sub-adult males, adult female, and adult males.
- Total count = 3,236 sea lions. More than 150 were counted at: Agligadak (in Seguam Pass), Atka-North Cape, Kasatochi, Adak-Lake Point, Kagalaska, and Kanaga-Ship Rock.
- 90% of sea lions were adult females or juveniles (Fig. 2)
- Only 2 sites (Adak-Head Rock and Atka-Cape Korovin; Fig. 2) had a significant number of sub-adult and adult males

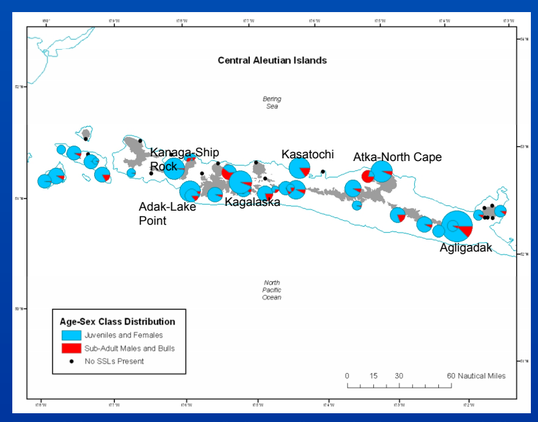


Figure 2. Age-sex structure of Steller sea lions at haul-outs surveyed. Size of circle is proportional to the number of animals counted.

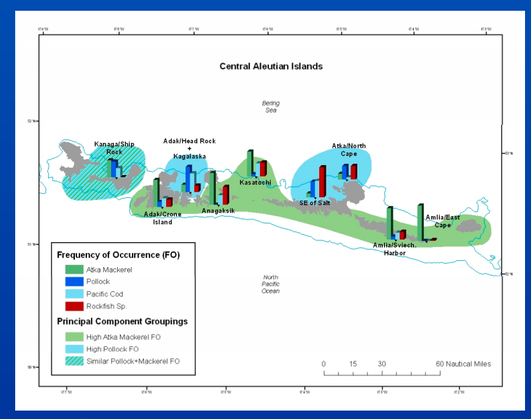


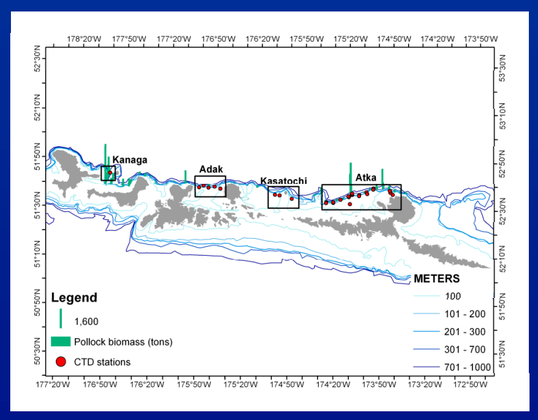
Figure 3. Frequencies of occurrence of four major prey at each site and areas that had similar diets based on principle components analysis.

Steller Sea Lion Food Habits Collections

- Collected a total of 305 scat (fecal) and spew samples at 10 sites from 2-12 April 2008
- A total of 41 different species or groups of prey were identified, with the most common being the commercially-important Atka mackerel, a rockfish species (most likely Pacific ocean perch), Pacific cod and pollock.
- Principal component analysis revealed 3 groups of sites (Fig. 3) which had similar frequencies of occurrence (FO) of the top 7 prey (>10% FO).

Physical Oceanographic Data

- Water temperature and salinity profile data were collected at selected locations with a calibrated conductivity-temperature-depth (CTD) probe during both pollock surveys. Chlorophyll-a biomass data were obtained from satellites.
- Comparison of vertical profiles of temperature and salinity and maps of chlorophyll biomass showed no consistent difference in the degree of mixing between areas of high and low pollock biomass.
- Surface temperature showed no consistent differences between areas of high and low pollock biomass. Surface temperature was high at Kanaga, one area of high pollock biomass, but not at Atka, another area of high biomass.
- Temperature and salinity at depth (defined as the maximum depth of the CTD cast, or 300 m, whichever was shallowest) were slightly higher at Atka than in areas of low pollock biomass, but not higher at Kanaga another area of high pollock biomass.
- Surface salinity (a tracer of nutrients), was consistently higher in the Kanaga and Atka areas where pollock biomass was highest. However the error bars (standard deviations) overlap between areas, so the differences are not likely to be statistically significant (Fig. 4).



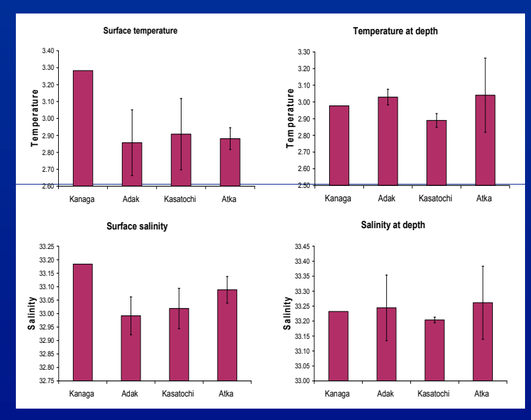


Figure 4. Mean (± stdev) temperature and salinity at the surface and at depth from CTD casts made in the four areas shown in the map at the right of the figure during the *Muir Milach* cruise.

Conclusions

Our study design and data analyses were directed by the following conceptual model: Geographic patterns in Steller sea lion haul-out and diet composition are directly related to pollock distribution/abundance; and indirectly related to water depth, water column structure, and satellite-derived chlorophyll. The diet composition of sea lions showed a response to spatial variability in pollock abundance (a functional response), however the distribution of sea lion abundance did not (a numerical response).

The distribution of sea lions may primarily reflect the distribution of Atka mackerel. Atka mackerel are dominant prey items for Steller sea lions during all seasons, whereas it appears that pollock (and Pacific cod, along with a suite of demersal species) are important prey primarily in the winter. This suggests that sea lion diets respond to small-scale, short-term distribution of prey. Seasonal diet changes reflect differences in availability due to seasonal differences in spawning and aggregating of various prey species. To assess the indirect, environmental effects on sea lions, we examined a suite of oceanographic properties that are indicators of ocean production.

None showed more than a suggestive relationship with the distribution and abundance of pollock biomass, and thus the availability of Steller sea lion prey. However, the processes underlying these oceanographic indicators, such as mixing cold, nutrient rich waters to the surface, may only be relevant during the spring and summer when light levels are sufficient for chlorophyll growth and subsequent food chain productivity to take place. If oceanographic processes are important for driving the distribution and abundance of pollock in the Aleutian Islands during winter, they were not well represented by the variables we examined and a new conceptual model needs to be developed that takes into account whatever other processes are important during this season.

The recommendations and general content presented in this poster do not necessarily represent the views or official position of the Department of Commerce, the National Oceanic and Atmospheric Administration, or the National Marine Fisheries Service.