**STUDY TITLE:** Analysis of Benthic Communities on Weathervane Scallop Beds in Shelikof Strait

**REPORT TITLE:** Technical Summary

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**BACKGROUND:**
Weathervane scallops have been fished commercially in Alaska since 1967. One area containing prominent commercial weathervane scallop beds is Shelikof Strait, which consistently provides some of the highest levels of scallop harvest in the state. Large numbers of scallops are extracted annually from beds found between Cape Douglas and Hallo Bay, with dredging also extending into Cook Inlet. All vessels catching and processing scallops off Alaska are required to carry onboard observers, with the exception of those fishing in the Cook Inlet registration area. Data available from these observers date back to 1996, and contain daily information on the complete dredge haul composition, including scallops, benthic invertebrates (e.g., sea stars, anemones, brittle stars, crabs, and octopus), and fishes (e.g., skates, groundfish, and flatfishes). These observations provide a rich database on the biogeography and biodiversity of benthic communities on the continental shelf off Alaska, and contribute towards advancing our knowledge of essential fish habitat (EFH). An EFH definition is required for weathervane scallops by the U.S. Sustainable Fisheries Act, but remains poorly defined. Through quantitative analyses of these benthic communities, we can investigate detailed information on the habitat characteristics and community composition found on scallop beds.

**OBJECTIVES:**
1) Quantify community composition on weathervane scallop beds in Shelikof Strait, reflective of species interactions (e.g., predation, competition) and relationships to environmental factors (e.g., depth, substrate type, currents, temperature).
2) Quantify interannual changes in species composition over the past 17 years (1996–2012) that may be related to climate forcing (e.g., temperature variability) and anthropogenic effects (e.g., dredge and trawl fishing intensity).

**DESCRIPTION:**

Using onboard observer data collected from the commercial weathervane scallop fishery during 1996–2012, we analyzed differences in benthic community composition with multivariate statistical methods. Data were converted to catch per unit effort (CPUE) to adjust for differences in dredge width and tow duration. The study area within Shelikof Strait consisted of seven scallop beds that have been delineated by the Alaska Department of Fish and Game based on historic fishing effort. Data consisted of biomass recordings of fish and invertebrate taxa, ranging from taxonomic classifications of family to phylum. Analyses were conducted in the software PRIMER, and consisted of methods such as non-metric multidimensional scaling (NMDS) to visualize biological differences in two dimensions, analysis of similarity (ANOSIM) to test for the significance of group differences, and similarity percentages analyses to identify which taxa contributed the most to differences between beds and across years. Using a Bio-Environmental analysis, we compared patterns in the biological dataset to anthropogenic and environmental variables, including commercial trawling effort, commercial dredging effort, depth, bottom water temperature, sediment type, and freshwater discharge as a proxy for surface currents. Surficial sediment data, however, were scarce in Shelikof Strait and were only available for one bed.

**STUDY RESULTS:**

Significant spatial differences were observed across weathervane scallop beds in Shelikof Strait throughout the sampling period. Beds were distinguished from one another based on variability in CPUE among taxa rather than major differences in presence or absence of taxa. We observed large differences in haul composition between bed KSH 1, the northwestern most bed in Shelikof Strait, and bed KSH 6, located in southeast Shelikof Strait. The dissimilarity between the two beds was characterized by higher CPUEs of most taxa on KSH 6, including brachiopods, rock crabs, polychaetes, sea squirts, basket stars and sponges, among others. Dredging effort was the only variable significantly correlated with biological differences. Dredging effort was nominally higher in KSH 1, which is the largest and most heavily fished bed. From 1996–2012, the average proportion of bed KSH 1 dredged was 0.275, compared to 0.16 in KSH 6.

Temporal analyses in Shelikof Strait were only conducted on bed KSH 1, because it was the only bed consistently fished throughout our sampling period. Changes in haul composition over time were apparent on KSH 1, and we observed a trajectory throughout the sampling period on the NMDS ordination. A split between 1996–1999 and the remaining sampling years (2000–2012) was observed and deemed significant through a cluster analysis. Temporal differences were significant even when the years 1996–1999 were excluded from the dataset. Changes in community composition occurred sequentially across years, but differences were more apparent from 1996–2012 than 2000–2012. Dredging effort was significantly, although weakly, correlated with temporal changes on bed KSH 1. A comparison of the early (1996–1999) and late years (2010–2012) indicated a higher prevalence in 2010–2012 of tritons, bristle worms, skates, and whelks, among other taxa. Bivalves, gastropods, barnacles, and leeches, among others, were more prevalent in the early years.

**SIGNIFICANT CONCLUSIONS:**

Across weathervane scallop beds in Shelikof Strait, significant differences in benthic community composition were observed between individual beds, as well as over a 17-year period. In this district, dredging effort was significantly correlated with both spatial and temporal changes,

indicating sensitivity to human disturbance by benthic communities, including commercially important species. This was portrayed mainly by decreased CPUE of taxa on the bed most heavily dredged by the commercial scallop fishery. Splits from 1996–1999 may be due to changes in observer haul composition sampling over time, behavioral changes in fishing associated with the formation of a fishery cooperative in 2000, or other environmental or anthropologic variables not included in this study, including a regime shift in the late 1990's. Nevertheless, these changes are real and reflect the ability of these benthic communities to change over a relatively short time period (17 years), despite the fact that many of these taxa, including weathervane scallops, anemones, and sea pens, are long-lived.

This project was part of a larger study examining spatiotemporal changes in benthic communities associated with weathervane scallops across the Gulf of Alaska, southeastern Bering Sea, and Aleutian Islands. Significant spatiotemporal differences were observed in other beds and regions. On a larger scale, sediment and depth were major drivers of spatial differences in community composition, while dredging effort was most correlated with temporal changes. Through collaborations with state and federal agencies, this project has synthesized information from multiple sources to provide baseline data for the benefit of environmental and resource management. We identified associations between scallops and other species, habitat characteristics that drive differences in community composition, and areas where benthic species have been impacted by scallop dredging. These dredged areas may be less resilient in the face of increased disturbance due to oil and gas extraction in this region. Continued monitoring of weathervane scallop beds will provide additional insight, over a longer time period, on the stability and resilience of this ecosystem.

**STUDY PRODUCT(S):**

Glass, J. R. 2014. Spatiotemporal variation of benthic communities on weathervane scallop (*Patinopecten caurinus*) beds with socioeconomic considerations of the commercial fishery off the coast of Alaska. Master's thesis. University of Alaska Fairbanks.

Glass, J. R. and G. H. Kruse. 2014. Spatiotemporal variation of benthic communities associated with weathervane scallop (*Patinopecten caurinus*) beds off Alaska. Marine Ecological Progress Series, in preparation.