Calculating an index of predation to improve the stock assessment for Walleye Pollock (*Gadus chalcogrammus*) in the Gulf of Alaska

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Introduction

- Predation plays an important role in shaping the population dynamics of Walleye Pollock. Additionally, the intensity of predation may vary in time and space due to shifts in the distributions and abundances of both Walleye Pollock and their major predators.
- Currently, Walleye Pollock mortality due to predation is not accounted for in the Gulf of Alaska stock assessment. Instead, estimates of natural mortality are held constant through time and space.
- There has been increased interest in modifying estimates of natural mortality to account for variation in the consumption of Walleye Pollock as a way of improving future projections of biomass and yield.

Overarching Research Objectives:

1) calculate an index of predation that measures the relative intensity of pollock consumption by four major groundfish predators throughout the Gulf of Alaska
2) quantify spatial and temporal variation in the predation index as a function of environmental and demographic factors

As a first step toward meeting our research objectives, we have explored the effects of environmental and demographic variables on the probability of occurrence and relative abundances of Walleye Pollock, Pacific Halibut, Arrowtooth Flounder, and Pacific Cod.

Methods

- Fishery-independent data were collected by the Alaska Fisheries Science Center (AFSC). Bottom trawl surveys were conducted throughout the Gulf of Alaska (GOA) triennially between 1990 and 1999 and biennially from 2001 to 2015. Date, location (latitude and longitude), depth (m), bottom temperature (°C), and species-specific catch (kg/ha) were recorded.

Fig. 2

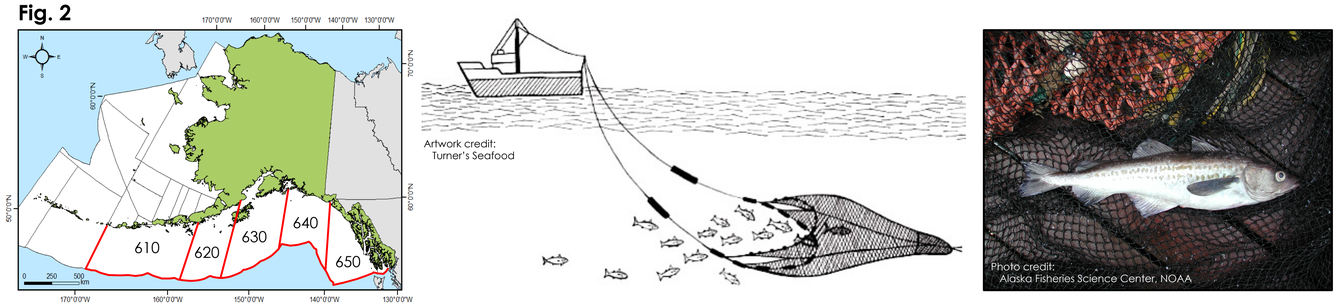


Figure 2 Map of the National Marine Fisheries Service management areas sampled (left), illustration of bottom trawl gear used to collect fishes and invertebrates throughout the Gulf of Alaska (center), and image of a Walleye Pollock caught by the Alaska Fisheries Science Center (right).

- Generalized additive models (R Studio, v3) were used to separately assess the probability of occurrence and relative abundances (i.e., log-transformed BPUE) of Walleye Pollock, Pacific Halibut, Arrowtooth Flounder, and Pacific Cod as a function of year, location, and environmental (i.e., depth, and temperature) and demographic (i.e., BPUE of each species) variables.
- The amount of smoothing for non-parametric terms was selected via generalized cross-validation. Non-significant terms (a = 0.05) were sequentially excluded from full models. Final models were identified as those with the lowest Akaike Information Criterion (AIC) value. If model-specific AIC values were similar (i.e., difference < 4), the more parsimonious model was selected.

Results

A total of 8,121 unique trawl tows were used to analyze the probability of occurrence and relative abundances of Walleye Pollock, Pacific Halibut, Arrowtooth Flounder, and Pacific Cod.

Walleye Pollock

- The greatest pollock biomass (1.4 ± 0.14) was in 1990. The lowest biomass records were in 2001 (0.2 ± 0.13) and 2007 (0.2 ± 0.09).
- Peak probability of occurrence and relative abundance of Walleye Pollock was between depths of 150 and 375 m.
- The probability of catching pollock decreased with increasing bottom temperature.
- Probability of occurrence and relative abundance of pollock decreased with increasing Pacific Halibut biomass, but increased with increasing Pacific Cod biomass.
- Though pollock were less likely to be caught when biomass of Arrowtooth Flounder was at its greatest, there was a positive relationship at low to medium Arrowtooth Flounder biomasses.

Pollock Predators

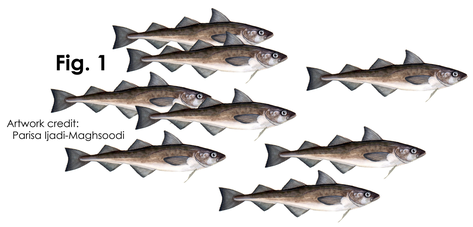
- Pacific Halibut were most commonly caught at depths < 100 m, temperatures < 8 °C, and in/near Prince William Sound.
- Arrowtooth Flounder were caught most frequently at depths > 150 m and exhibited greater abundances at temperatures ranging from 4 to 8 °C and near the continental shelf break.
- Pacific Cod were encountered more frequently as depths and temperatures decreased.

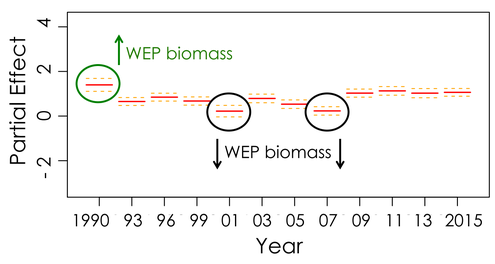
Future Directions

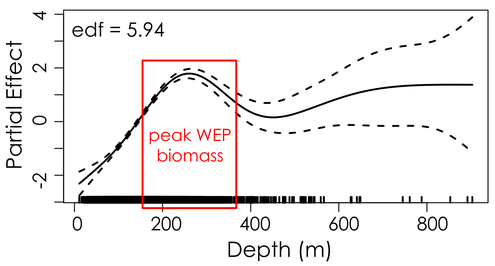
- Use diet composition, feeding rate, and length/weight data for adult Walleye Pollock, Pacific Halibut, Arrowtooth Flounder, and Pacific Cod to calculate age-specific indices of predation on Walleye Pollock.
- Quantify variation in predation indices as a function of spatial, temporal, and environmental variables.
- Develop an analytical framework for incorporating predation indices (using year-specific estimates as modifiers of natural mortality) into the Gulf of Alaska stock assessment for Walleye Pollock.

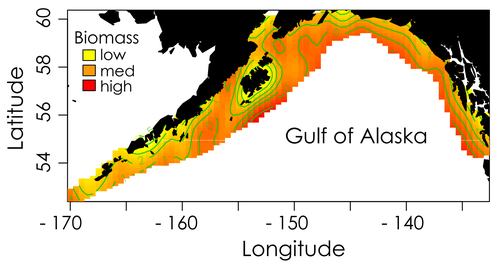
Spatiotemporal Effects on Biomass of Walleye Pollock

Fig. 1

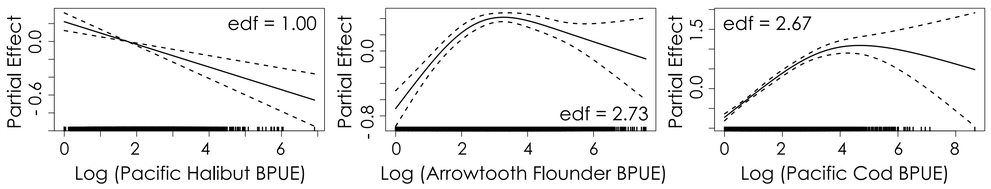


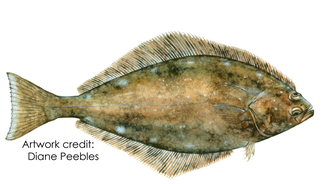


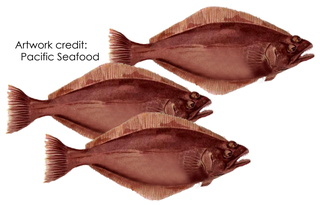




Demographic Effects on Biomass of Walleye Pollock







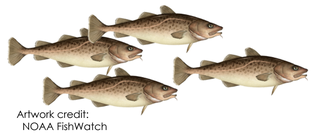


Figure 1 Partial effects of spatiotemporal and demographic variables on the relative abundance of Walleye Pollock. Solid lines represent predicted relationships (holding all other variables constant) and dashed lines denote standard errors. Equivalent degrees of freedom (edf) are listed for non-parametric (i.e., smoothed) terms.

Acknowledgments

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