Dietary Overlap and Competitive Interactions between Juvenile Gadids in Coastal Alaska

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INTRODUCTION

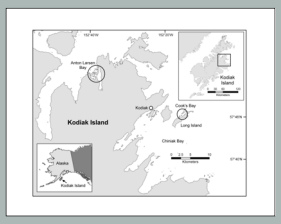
In Alaska, Pacific cod (*Gadus macrocephalus*) support a commercially valuable fishery and they consistently rank 2nd in catch and value landed in the Alaska groundfish fishery (see http://www.afsc.noaa.gov/species/Pacific_cod.php). Pacific cod spawn demersal eggs (Yamamoto 1939) and pelagic larvae are transported toward shore by currents in the upper water column (Rugen and Matarese 1988). Juvenile cod settle to the bottom and inhabit the shallow waters of coastal Alaska. Pacific cod occur sympatrically in these shallow-water coastal nursery areas with other gadids such as saffron cod, *Eleginus gracilis* and these congeners continue to use coastal nursery habitats beyond their first year of development (Laurel et al. *in review*). Biological processes including food competition, cannibalism, and prey availability may be important determinants influencing cod growth and survival in these areas. It is hypothesized that there is food competition between these congeners and that the prolonged residency of multiple age classes in the nursery areas may promote inter-cohort cannibalism. A thorough understanding of the juvenile gadid diets is needed in order to predict the impacts these processes have on their growth and survival. The overarching goal of this project is to examine the diet composition of juvenile (age 1+) Pacific and saffron cod in order to quantify the degree of dietary overlap and the extent of cannibalism on younger conspecifics.

Objectives:

- To describe the summer diets of each gadid species in the nearshore nursery areas.
- To quantify the degree of dietary overlap between the two gadids within these areas.
- To measure the extent of inter-cohort cannibalism for each species in years of varying age 0 cod densities.

STUDY AREA

The study area for this project was the coastal waters of the western Gulf of Alaska near Kodiak Island, Alaska. Field collections were made primarily in Anton Larsen Bay and Cook's Bay near Kodiak, Alaska. Previous investigations have indentified these and other nearshore bays around Kodiak as potentially important juvenile cod nursery areas.



METHODS

Field collections-

- Juvenile cod (age 1+) were collected using a combination of beach seining and angling.
- Cod were collected during the summer months (July and August) in 2007 and 2008.
- Cod were immediately frozen in the field and brought back to the lab for the stomach content analysis.

Laboratory analysis-

- In the laboratory, fish were partially thawed, weighed (0.01 g), measured (cm, total length), and dissected.
- Prey items were removed, identified to the lowest practical taxonomic category, and enumerated.

Data analysis-

- Diet composition was described by the percent frequency of occurrence (% O) and percent number (%N) for each prey category.
- Dietary overlap was examined using Morisita's index of niche overlap:

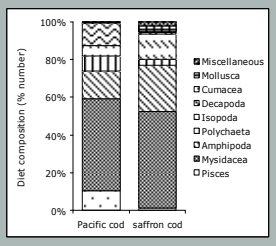
$$C = 2 \sum p_{ij} p_{ik} / \sum p_{ij} [(n_{ij}-1)/(N_j-1)] + \sum p_{ik} [(n_{ik}-1)/(N_k-1)],$$

- Inter-cohort cannibalism was quantified by measuring the extent of piscivory and type of fish prey consumed by each gadid species.

PRELIMINARY RESULTS

Diet composition

- To date, 354 juvenile cod (n = 260 saffron cod, 17.1 - 39.0 cm TL; n = 94 Pacific cod, 17.4 - 36.0 cm TL) have been collected.
- Mysids were the most common prey encountered, occurring in > 60% of the samples of each gadid in 2008.
- Gammarid amphipods, polychaetes, isopods (suborders Flabellifera and Valvifera), and decadpods (Hippolytidae shrimp) were also common prey.
- Mysids and amphipods were the most important prey (in terms of % number) for both gadids in 2008.
- Fish and decapods were important secondary prey items for Pacific cod; whereas, isopods were important for saffron cod in 2008.



Diet composition (%N) of juvenile gadids in 2008

Prey	Pacific cod	saffron cod
Pisces	27.27	22.73
Mysidacea	63.64	77.27
Amphipoda	40.91	86.36
Polychaeta	31.82	40.91
Isopoda	22.73	59.09
Decapoda	40.91	22.73
Cumacea	0.00	4.55
Mollusca	9.09	27.27
Miscellaneous	9.09	13.64

Frequency of occurrence (%FO) of major prey groups in 2008

Dietary overlap and inter-cohort cannibalism

- The gadid species consumed primarily benthic invertebrates and displayed a high degree of dietary overlap in 2008 (driven mainly by the importance of mysids and amphipods in the gadid diets).
- Morisita's index of niche overlap: C = 0.863 [Morisita's index (C) ranges from 0 (no resources in common) to 1 (complete overlap].
- The two gadid species were moderately piscivorous:
  - In 2007: Pacific cod (16%); saffron cod (3%)
  - In 2008: Pacific cod (27%); saffron cod (23%)
- Fish prey were primarily Pacific sand lance (*Ammodytes hexapterus*) and members of the Cottidae, Stichaeidae, and Hexagrammidae families. None of the fish in the guts were positively identified as smaller conspecifics.
- Piscivory was not related to Pacific cod total length (logistic regression; $p=0.559$); however, piscivory increased with increasing saffron cod length (logistic regression; $p<0.001$).

PRELIMINARY CONCLUSIONS

- The gadid species displayed a high degree of dietary overlap (driven mainly by the importance of mysids and gammarid amphipods). A high degree of dietary overlap suggests competition for food resources may occur if food supplies become limited. However, the diets of the two gadids varied noticeably outside the importance of mysids and amphipods which suggests these cod species are able to exploit different niches which may reduce competition.
- Differences in the relative importance of secondary prey items (i.e. fish and decapods- Pacific cod *versus* isopods-saffron cod) may reflect small scale differences in habitat use by the juvenile gadids within the nursery areas.
- Inter-cohort cannibalism does not appear to be a factor affecting cod survival in these areas. However, the abundance of age 0+ cod in coastal Alaska can fluctuate greatly on a yearly basis (Laurel et al. *in review*) and it is possible that cannibalism is density dependent and is an important function when densities are high.

FUTURE ANALYSES

- Additional field work is planned for 2009. This will allow researchers to collect age 1+ cod in a year when age 0 cod may be highly abundant.
- Complete stomach content analysis of 2007 and 2009 samples and investigate interannual changes in diet composition, dietary overlap, and inter-cohort cannibalism.

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Acknowledgements:

This project was supported in part from NOAA Fisheries HEPR-EFH funds. Photo credits: Ben Laurel and Brian Knoth. Eric Munk, Cliff Ryer, Lei Guo, and Paul Iseri provided assistance in the field. Tim Tripp and Jan Axel provided boat charters.

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