Feeding Ecology and Niche Separation of Juvenile Northern Rock Sole and Yellowfin Sole in the Eastern Bering Sea

Christina M. Jump, Janet T. Duffy-Anderson, Kathryn L. Mier and Daniel W. Cooper

Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115, USA

INTRODUCTION

Juvenile northern rock sole (NRS; *Lepidopsetta polyxystra*) and juvenile yellowfin sole (YFS; *Limanda aspera*) are two common, commercially important flatfishes that occur over the Bering Sea shelf. NRS and YFS spatially co-occur in shallow, near-shore waters in autumn, potentially making them competitors for seasonally diminishing resources. In this study, we are comparing the feeding ecology of these ecologically similar species. We are also examining patterns of geographic distribution as well as the effects of size/age on foraging habits.

METHODS

- Juvenile NRS and YFS were collected in September 2008 and 2010 in the EBS (Fig.1) using a modified plumb-staff 3-m beam trawl. Fish were dissected in the lab and diets contents were examined.
- Diet composition (sympatric, allopatric) was evaluated using a 2-way cluster analysis, a Multi-Response Permutation Procedure (MRPP) and a Mantel test.
- Regional variations in diet composition were evaluated using a 2-way cluster analysis and MRPP.
- Diet taxonomic composition of NRS age-0 (SL<40 mm), NRS age-1 (SL>40 mm and <70 mm), YFS age-1 (SL<50 mm) and YFS age-1+ (SL>50 mm) by length and age were graphically examined and will be investigated further in subsequent analyses.

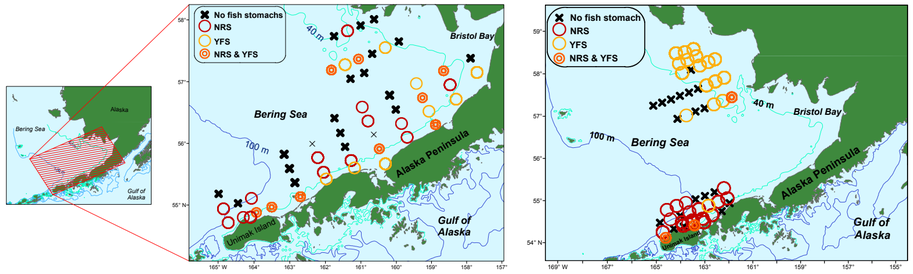

Figure 1. In 2008 (a), a total of 290 stomachs were examined from 32 locations; 173 northern rock sole (15-106 mm SL) and 117 yellowfin sole (31-91 mm SL). At 9 of the locations northern rock sole and yellowfin sole were collected together (sympatric, orange) and at the remaining 23 locations NRS (red) or YFS (yellow) were collected alone (allopatric).

In 2010 (b), a total of 534 stomachs were examined from 39 locations; 308 northern rock sole (20-114 mm SL) and 230 yellowfin sole (14-78 mm SL). During 2010 age-0 northern rock sole and age-1 yellowfin sole were only collected together at 3 locations.

RESULTS Geographic

2008

Percent Frequency of Occurrence		
Prey Category	**NRS**	**YFS**
Amphipods	5.2	7.7
Annelids	**27.2**	**25.6**
Bivalves	2.9	6.8
Copepods, <2mm prosome length	1.2	7.7
Crabs	1.2	0.9
Cumaceans	10.4	**28.2**
Gammarid amphipod	**43.9**	**53.0**
Harpacticoids	17.3	6.0
Isopods	1.7	5.1
Miscellaneous	14.5	**60.7**
Mysids	9.8	4.3
Pteropods	**27.2**	4.3
Shrimps	1.2	5.1
Empty	1.7	7.7

a

2010

Percent Frequency of Occurrence		
Prey Category	**NRS**	**YFS**
Amphipods	7.4	0.9
Annelids	**49.2**	**27.8**
Bivalves	**25.4**	7.0
Copepods, <2mm prosome length	3.3	1.3
Crabs	3.7	0.0
Cumaceans	14.4	**20.9**
Gammarid amphipod	**69.2**	**45.7**
Harpacticoids	**20.4**	5.2
Isopods	**12.7**	**53.9**
Miscellaneous	13.0	3.5
Mysids	0.7	**22.2**
Pteropods	4.3	2.6
Shrimps	0.3	10.0
Empty	6.0	16.5

b

Table 1. Integrated over the whole area, primary prey categories (FO>20%) for 2008 (a). The diets for both species were predominantly gammarid amphipods and annelid worms. The diets of NRS also included pteropods. YFS diets were more diverse and included cumaceans and miscellaneous (echinoderms, gastropods, ostracods, and invertebrate tubes). 2010 (b) the diets for both species were composed of gammarid amphipods and annelids. However, YFS diets were also dominated by isopods. YFS diets included cumaceans and mysids. The diets of NRS were more diverse and included bivalves and harpacticoids.

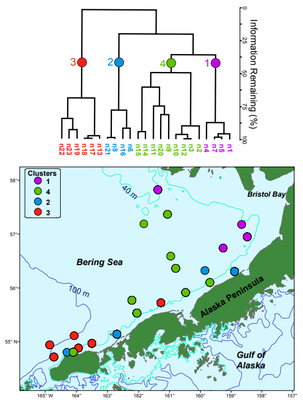

Figure 2. A 2-way cluster dendrogram of 2008 diets (NRS) by station (above) illustrated four geographic clusters (map, below). Data suggest geographic structuring of NRS diets.

Unique groups were: Unimak Island (red) amphipods, pteropods, annelids, and ostracods. **Bristol Bay** (purple) gammarid amphipods, and mysids. **Mid-shelf region** (green) annelids, gammarid amphipods, harpacticoids, ostracods, and mysids. **40 m isobath** (blue) annelids, invertebrate tubes, gammarid amphipods, harpacticoids, bivalves, cumaceans, crabs, and shrimp.

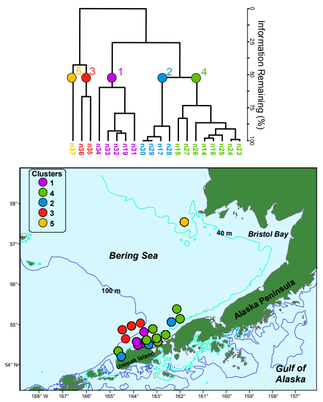

Figure 3. A 2-way cluster dendrogram of 2010 diets (NRS) by station (above) illustrated 2 cohesive clusters (map, below). The data are more spatially limited, but reflect geographic structuring as observed in 2008. In addition, we hypothesize a relationship with prevailing hydrographic conditions (Cooper et al., 2011). Quantitative relationships will be explored in future analyses.

Unique groups were: Outside an inner front (purple) gammarid amphipods and barnacles. **Inside an inner front** (green) annelids, gammarid amphipods, and harpacticoids. **The 40 m isobath** (blue) annelids, gammarid amphipods, harpacticoids, bivalves, cumaceans, barnacles, and fish.

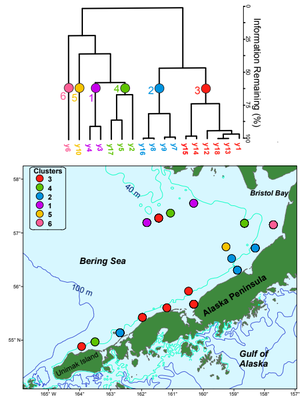

Figure 4. A 2-way cluster dendrogram of 2008 diets (YFS) by station (above) illustrated more chaining, but 2 cohesive clusters could be resolved (map, below). In general, geographic patterns were not well-defined.

Unique groups were: (Red) gammarid amphipods, annelids, cumaceans. (Blue) gammarids, annelids, cumaceans, and shrimp.

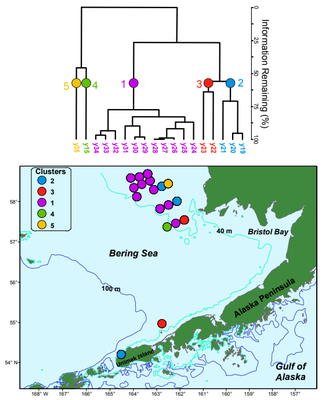

Figure 5. A 2-way cluster dendrogram of 2010 diets (YFS) by station (above). There was one major group that clustered over the inner (<40 m depth) shelf (map, below) (purple; isopods, gammarid amphipods, cumaceans, annelids, and mysids), though that grouping failed to describe all diets of YFS collected within the inner shelf. Several other smaller groups were also identified that were less well-defined. Save for the one large grouping within the inner shelf, obvious geographic patterns were few.

RESULTS Age/Size

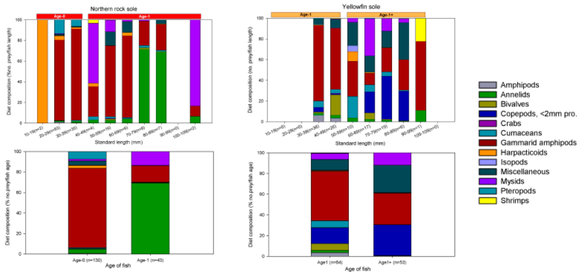

Figure 6. Taxonomic composition by standard length (top) and age (bottom) for 2008. Gammarid amphipods comprised the majority of the diet of age-0 NRS; annelids and mysids comprised the majority of the diet of age-1 NRS. Gammarid amphipods were the majority of the diet of age-1 YFS; gammarid amphipods, copepods, miscellaneous (echinoderms and gastropods), and mysids comprised the diets of age-1+YFS. Diet compositions of both species displayed ontogenetic shifts; however patterns have not been verified statistically.

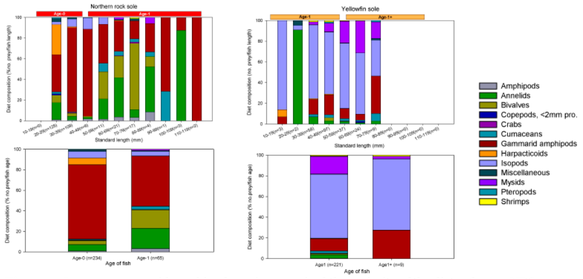

Figure 7. In 2010, gammarid amphipods again comprised the majority of the diets of age-0 NRS; bivalves, annelids, and gammarid amphipods comprised the majority of the diets age-1. Isopods were the majority of the diet of age-1 and age-1+ YFS. The diets of the age-1+ YFS also had higher proportions of gammarid amphipods and mysids. Additional work is in progress to quantify observed differences.

CONCLUSIONS

- In both years the principal prey were gammarid amphipods and annelids for NRS. In 2010 NRS diets were more diverse and included bivalves and harpacticoids.
- 2008 and 2010 diets of NRS were spatially structured.
- In both years, diets of NRS and YFS appear to be age-structured, but structuring was not related to geography in YFS.
- 2008 YFS diets were mainly gammarid amphipods and annelids; however YFS diets were diverse and included cumaceans, echinoderms, gastropods, ostrocods.
- In 2010, the primary prey for YFS were isopods and gammarid amphipods. Mysid, annelids, and cumaceans were also prevelant prey for YFS.
- 2008 diets of YFS showed no spatial structuring; however, 2010 diets indicate limited spatial structuring within the inner shelf.
- Conclusions will be investigated further with more statistical analysis on age structure and length of flatfish.
- Prey field data will also be investigated from 2008 and 2010 benthic infauna collections.

REFERENCE

Poster presentation: Northern rock sole (*Lepidopsetta polyxystra*) juvenile nursery areas in the eastern Bering Sea in relation to hydrography and thermal regimes. Daniel Cooper, Janet Duffy-Anderson, Brenda Norcross, Brenda Holladay and Phyllis Stabeno.

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.