Essential Fish Habitat project status report

Reporting date: 10/22/12

Project number: 6

Title: Northern Bering Sea habitat suitability for benthic-feeding flatfishes

PIs: Yeung, Cynthia, Yang, Mei-Sun.

Funding year: 2010

Funding amount: $96,300

Status: ☐ Complete ☐ Incomplete, on schedule ☒ Incomplete, behind schedule

Planned completion date if incomplete:

All laboratory analyses completed. Data analysis in progress. Manuscript preparation to be completed by Feb 2013.

Reporting: Have the project results been reported? If yes, state where the results were reported and attach an electronic copy of the report.

No.

Results: What is the most important result of the study?

Twelve stations were sampled along a north–south (60-63°N) oriented transect in the northern Bering Sea (NBS) (Figure 1). The stations were a subset of the NBS extension of the 2010 RACE bottom-trawl survey. Benthivorous flatfish encountered in the NBS were mostly Alaska plaice, northern rock sole, and yellowfin sole - subarctic species abundant in the eastern Bering Sea (EBS), and whose distributions may shift northward with ocean warming. Smaller arctic species - Bering flounder (*Hippoglossoides robustus*), a congener of flathead sole, and Sakhalin sole (*Limanda sakhalinensis*) - were also present. Stomachs and tissue from the five flatfish were sampled out of trawl survey catches at the twelve stations for comparative diet studies (Table 1).

At each station, three benthic grab samples were collected: one for sediment biogeochemistry (grainsize, total phosphorus (TP), total organic carbon (TOC), total nitrogen (TN), chlorophyll-a, carbon-nitrogen (CN) stable isotopes) and infauna prey tissue (CN stable isotopes); two replicates for infauna community characterization. Dominant epifauna prey groups caught in the trawl: small specimens of clams, echinoderms, holothurians, amphipods, fish, shrimp, polychaetes and crabs, were also collected for isotopes analysis. Benthic invertebrate prey groups catchable by trawl are likely to differ from those catchable by grab. Thus, analyses on prey groups from both sets of gear will

offer a complementary view of the benthic macroinvertebrate community and food availability. A high-definition videocamera sled was deployed to drift over the bottom to visualize the habitat.

Replicate infauna samples at a station were taken <0.6 km apart. The average distance of separation between replicates was 150 m. Replicates showed high similarity in infauna assemblage on that spatial scale, suggesting that a single sample may suffice in characterizing infauna assemblage on the NBS shelf.

The sediment was predominantly a mix of sand (58-93%) and mud (where sand is defined as particles 0.0625-2 mm dia., mud <0.0625 mm dia., and gravel >2 mm dia.). No gravel was present in any sediment sample in this study. The finest sediments were near St. Lawrence Island. Habitat types are either sandy (<20% mud, or ≥80% sand) or muddy sand (20%≤mud≤ 50%), generally similar to the EBS middle shelf (Figure 2).

There was high diversity and density in the NBS infauna, also comparable to the EBS middle shelf (Figure 2). Infauna biomass increased northwards (≥62°N). Overall, 175 infauna taxa were identified from 24 NBS infauna samples over an area of ~17x10^{3} km^{2}: 77 polychaetes, 18 bivalves, 19 gastropods, 37 amphipods, 7 cumaceans. This is about half the number of taxa (380) collected from 68 EBS infauna samples in 2006 and 2009 south of 58°N, over an area of ~75x10^{3} km^{2}: 165 polychaetes, 48 bivalves, 24 gastropods, 50 amphipods, 11 cumaceans.

Polychaetes, amphipods, and bivalves were the three main infauna groups in the NBS, as in the EBS. However, there were marked differences between NBS and EBS infauna assemblages. Amphipod diversity and density were high in the NBS compared to the EBS. Echinoderms (particularly ophiurids) and gastropods, which were sporadically highly abundant in the EBS, were of relatively low importance among infauna groups in the NBS. Rather, the mollusk Aplacophora emerged as an infauna group of secondary importance in the NBS.

Polychaetes dominated the infauna biomass at the three southernmost stations in the NBS, but the infauna assemblage transitioned to mainly bivalve-dominant northwards (≥62°N) (Figure 3). Many uncommon polychaete species were encountered, some new to science. At two stations, amphipods were the most dominant group in the infauna by biomass. In terms of percentage biomass composition of the dominant infauna groups, the polychaete-dominant southern NBS was similar to the nearshore end of the EBS middle shelf, whereas the northern NBS resembled the EBS inner shelf. However, overall polychaete biomass in the NBS was high, similar to the EBS middle shelf (Figure 4).

The stomachs of a maximum of 17 specimens per flatfish species were sampled at each of 12 stations on the NBS transect to analyze flatfish diets. Two additional trawl stations, EE01 and DD18, were sampled. They were neighbors to planned station DD01 and were sampled to compensate for the lack of yellowfin sole samples at DD01 (Figure 1). Yellowfin sole had the most empty stomachs collected – 21 of 176 (12%), while other species had no more than 3% of all the stomachs collected being empty (Table 1).

Table 1. Number of (F)ull and (E)mpty stomachs collected by species at each station in 2010 (AKP = Alaska plaice; BRF = Bering flounder; NRS = Northern rock sole; SKS = Sakhalin sole; YFS = Yellowfin sole).

	AKP		BRF		NRS		SKS		YFS	
	F	E	F	E	F	E	F	E	F	E
Station										
AA01	14	0	4	0	15	0	4	0	14	1
BB01	16	0	15	0	10	0	14	0	13	1
CC01	14	0	4	0	14	0	0	0	12	0
DD01	15	0	4	0	4	0	2	0	0	0
DD18	0	0	16	1	0	0	5	0	0	0
EE01	0	0	14	1	0	0	14	0	15	0
S01	15	0	0	0	14	1	0	0	12	4
T01	13	2	0	0	13	0	0	0	12	3
U01	14	0	0	0	13	0	0	0	10	5
V01	6	0	0	0	15	1	0	0	12	1
W01	14	0	0	0	14	1	0	0	13	2
X01	15	1	0	0	14	0	0	0	16	0
Y01	15	0	9	0	12	0	0	0	14	3
ZZ01	14	1	8	0	11	0	4	0	12	1
Total	165	4	74	2	149	3	43	0	155	21

160 unique prey taxa, including unknown or unclassified groups, were identified overall in the stomachs: 55 polychaetes, 10 bivalves, 7 gastropods, 25 amphipods, 10 echinoderms, 17 decapods. The major prey groups for each flatfish species (mean percentage weight over all specimens) are shown in Figure 5. Alaska plaice and northern rock sole consumed primarily polychaetes, and secondarily amphipods; the reverse is true for yellowfin sole. Bivalves were only consumed in relatively small proportions. For the small-sized Bering flounder and Sakhalin sole, amphipods were the most important prey, and bivalves were not consumed at all. Considering the dominance of bivalves north of 62°N, prey availability may be a factor in the northward extension of flatfish distribution. Comparisons of the prey fields and flatfish diets between the northern and eastern Bering Sea will reveal important knowledge on habitat and prey characteristics and how flatfish populations adapt over their range of distribution. Multivariate analyses are in progress to describe and compare benthic habitat characteristics and correlate flatfish distributions to habitat types. Stable isotope analysis of flatfish and prey tissues is also being investigated to help identify trophic relationships and link flatfish directly to their feeding habitats.

Figure 1. Sampling stations of the NBS benthic habitats study (+). Video footage of the bottom was taken at all the planned stations except BB01 and CC01 because of equipment malfunction. Trawl catches were sampled at additional stations DD18 and EE01 flatfish stomachs and tissue (●).

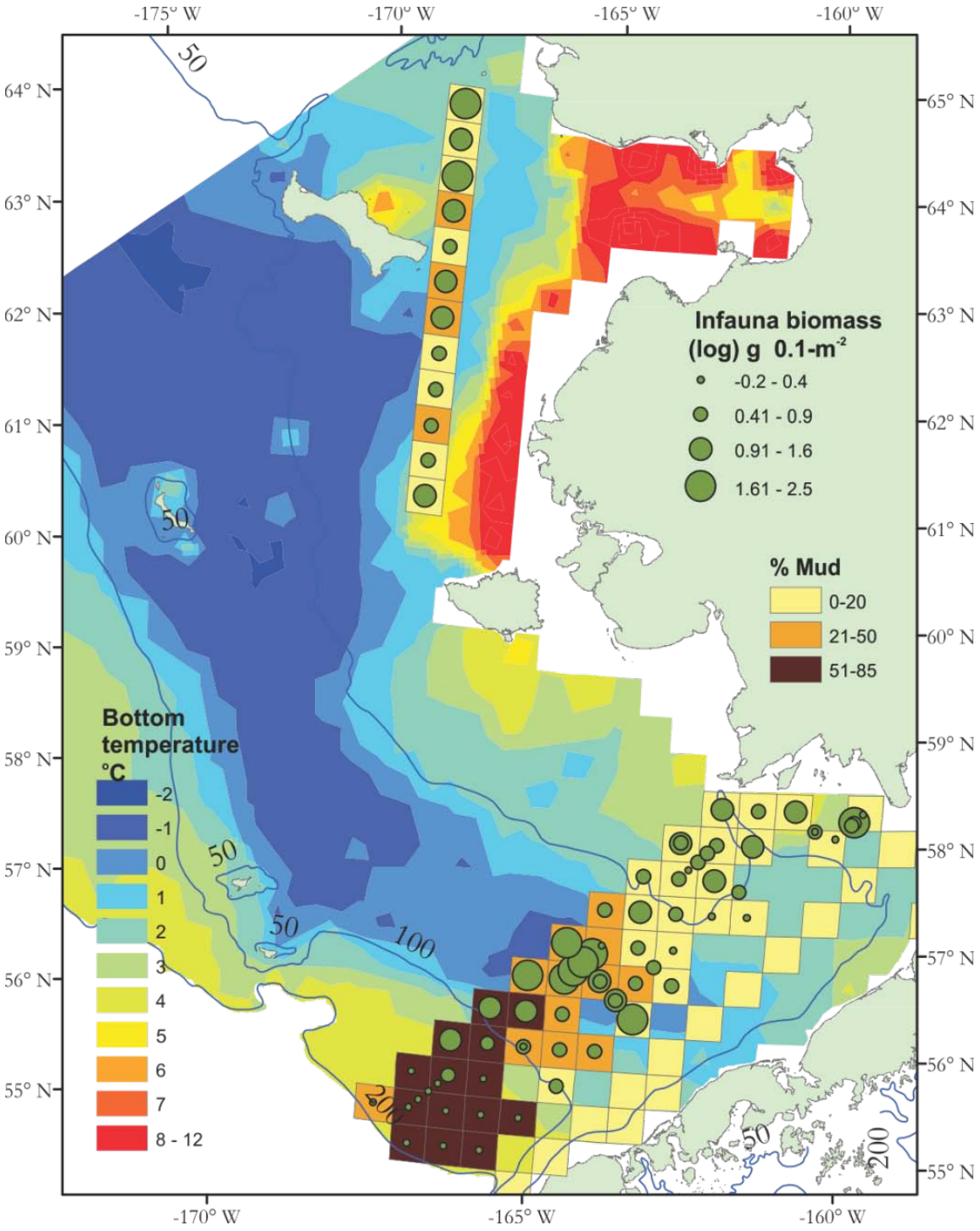

Figure 2. Infauna biomass and sediment type in the northern and eastern Bering Sea, superimposed upon 2010 Bering Sea bottom temperature.

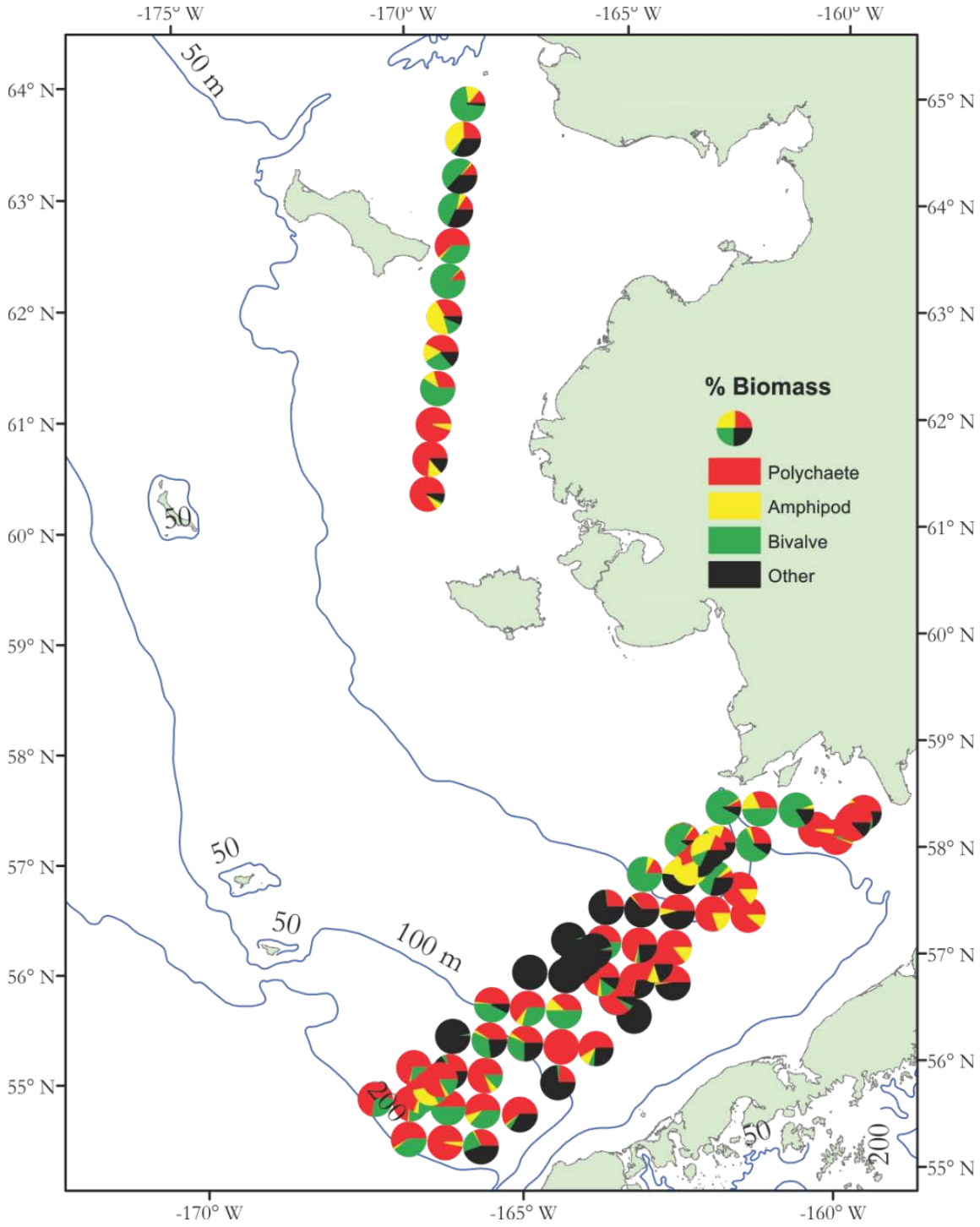

Figure 3. Percentage biomass composition of major infauna groups in the northern and eastern Bering Sea

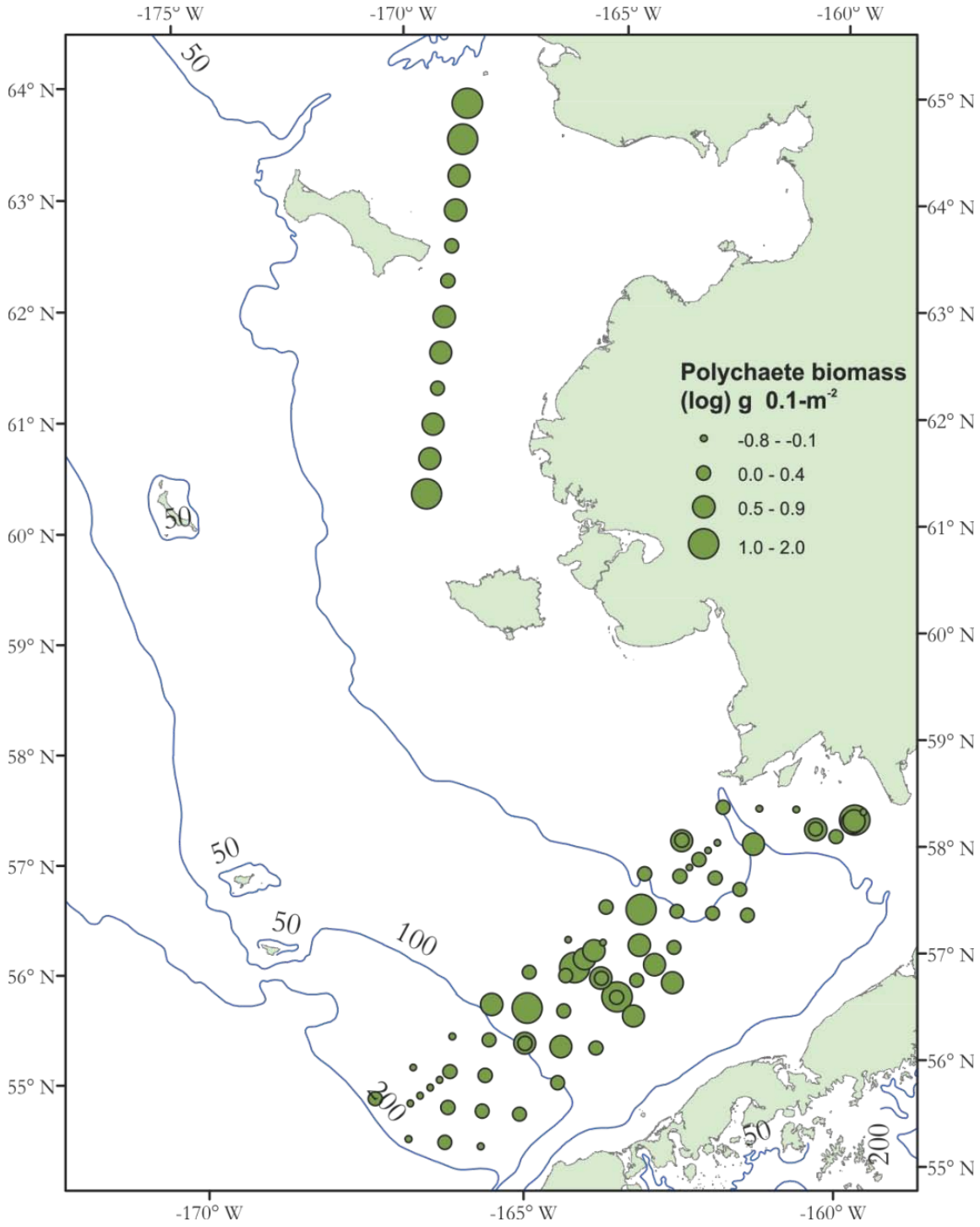

Figure 4. Polychaete biomass in the northern and eastern Bering Sea

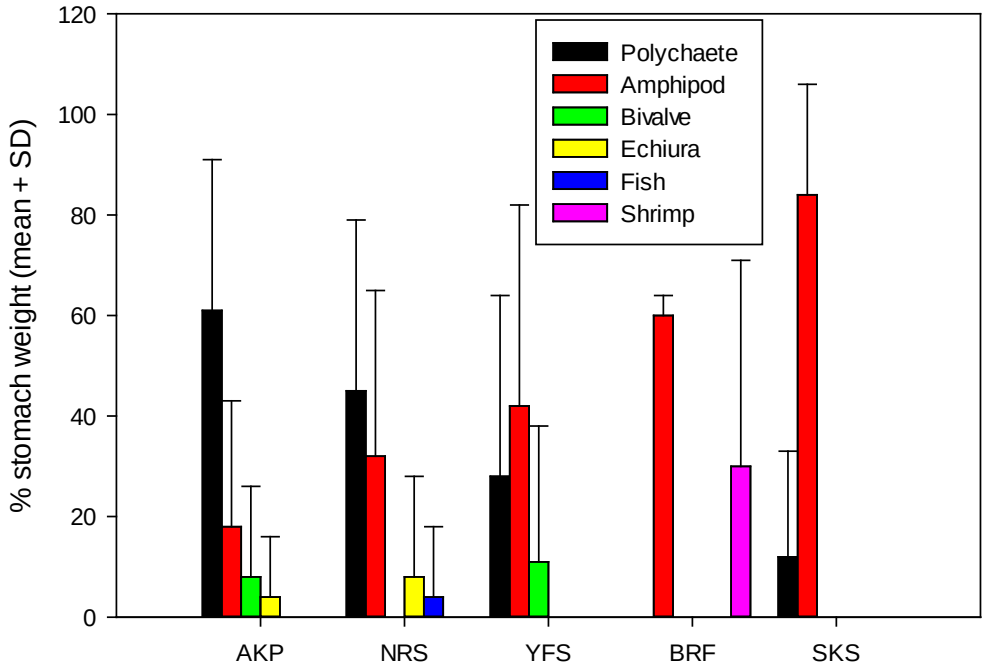

Figure 5. Major infauna prey groups of northern Bering Sea flatfish (AKP – Alaska plaice; NRS – northern rock sole; YFS – yellowfin sole; BRF – Bering flounder; SKS – Sakhalin sole)