APPENDIX C

APEX: 95163 C

Appendix C-1

APEX: 96163C

DIET OVERLAP OF FORAGE FISH SPECIES

Molly V. Sturdevant

National Marine Fisheries Service
Alaska Fisheries Science Center
Auke Bay Laboratory
11305 Glacier Highway
Juneau, Alaska 99801-8626

ABSTRACT

The food habits of forage fish collected by trawl in Prince William Sound for the Alaska Predator Ecosystem Study (APEX) were examined. The diet study is one of several components of APEX, which is examining trophic interactions of seabirds injured by the Exxon Valdez Oil Spill, (e.g., black-legged kittiwakes and pigeon gillemots), and their forage species. Forage fish diet samples were analyzed from the southern, central and northern regions of PWS from summer, 1995 (n = 80) and fall, 1994 (n = 90). Diets were described for multiple age-classes (as suggested by mean preserved fork lengths (FL)) of herring and pollock and for juvenile sandlance, capelin and eulachon.. Diet composition as percent biomass of pooled prey categories and diet overlap as Percent Similarity Index (PSI) calculated from biomass of prey taxa are presented in these preliminary results.

Most dietary biomass was contributed by few prey categories and differences were observed between seasons, species, age-classes, and areas. In summer, small calanoids were consumed by all except large pollock, forming 29-70% of young-of-the-year (YOY) species and 43% of older herring prey biomass. Hyperiid amphipods comprised 21-23% of YOY prey biomass, while teleosts and barnacle larvae were unique (20% biomass) in YOY pollock and sandlance, respectively. Large calanoids comprised approximately 45% of prey biomass of both older herring and older pollock, while euphausiids (24%) and chaetognaths (20%) were unique in older pollock diets. In the fall, euphausiids were consumed by all species, forming 30-81% of prey biomass. In contrast to summer diets, hyperiids and small calanoids contributed little to YOY fish diets; however, small calanoids remained in older herring diets (33-50% biomass). In southern PWS, YOY pollock diets differed by including 49% biomass from large calanoids and larvaceans combined. Most capelin and eulachon stomachs were empty.

Diet overlap ranged from approximately 32% to 59% PSI between YOY species pairs and for combinations involving herring in both spring and fall. Overlap was highest between pollock and herring collected in the same locations in northern PWS in the fall, and lowest for combinations involving older pollock in summer.

These results suggest that, although the prey resources responsible for the considerable dietary overlap observed change seasonally, competition for food could occur between several species and age classes of forage fish throughout the summer and fall.

Appendix C-2
INTRODUCTION

This report, Diet Overlap of Forage Fish Species, focuses on the trophic interactions of forage fish in Prince William Sound (PWS). The study is one component of the Alaska Predator Ecosystem Experiment (APEX), a multi-disciplinary, a multi-year study designed to examine the PWS food web and its effects on species injured by the *Exxon Valdez* Oil Spill (EVOS).

Investigations of the feeding ecology, distribution, abundance and availability of forage fish consumed by apex predators, the piscivorous marine birds and mammals of the sound, began with an FY94 pilot study, "Forage Fish Influence on Recovery of Injured Species." It was initiated because efforts to restore species injured by the EVOS oil spill, particularly harbor seals, pigeon guillemots, marbled murrelets, and black-legged kittiwakes, have been hampered by a lack of information about the biology and population dynamics of their prey resources, forage fish. Forage fish may include pelagic schooling species in the offshore region of PWS as well as demersal nearshore species. Potential prey in offshore assemblages include Pacific herring (*Clupea harengus pallasi*), Pacific sandlance (*Ammodytes hexapterus*), capelin (*Mallotus villosus*), northern smoothtongue (*Leuroglossus schmidti*), eulachon (*Thaleichthys pacificus*), walleye pollock (*Theragra chalcogramma*), Pacific cod (*Gadus macrocephalus*), tomcod (*Microgadus proximus*) and juvenile salmon (*Oncorhynchus* spp.); potential prey in nearshore assemblages may include these and other species, such as Pacific snake pricklebacks (*Lumpenus sagitta*) and daubed shanny (*L. maculatus*).

The high sea bird mortalities associated with EVOS occurred during a period of decline in several sea bird populations (Piatt and Anderson, 1996). While the environmental conditions which contributed to these declines have not been explained, damage assessment studies since the spill have associated continuing sea bird declines with the availability of forage fish prey. Reproductive failures were documented among black-legged kittiwakes from oiled areas (Irons, 1996) and may be associated with food conditions. Greater declines of pigeon guillemots in oiled areas compared to non-oiled areas were associated with reduced deliveries of sandlance, a high energy prey, to their chicks (Oakley and Kuletz, 1996).

At the same time as the health of marine birds and mammals declined in PWS in the last few decades, unexplained, long-term shifts in the relative population abundances of prominent forage species, such as herring, pollock and sandlance, have occurred (Anderson et al., 1994). Enhancement facilities have simultaneously increased production of juvenile salmonids released into the sound. Factors controlling growth and survival of forage fish are not well understood. However, population changes could be reflected in trophic interactions if food availability limits the carrying capacity of PWS. Efforts to understand the ecosystem and estimate the carrying capacity of PWS are restricted by our limited knowledge about forage fish abundance and distribution, planktonic prey production and how prey resources are partitioned (Cooney 1993). Partitioning of prey resources reflects the degree of habitat and diet overlap between species, yet the food habits for many forage fish have not been completely described. This information is needed to characterize trophic niches, determine niche overlap and assess the potential for resource competition between species. Information on the trophic dynamics and environmental variables which determine the nutritional quality and relative availability of forage fish to apex predators is also sparse. The relative availability of high quality forage fish prey can influence the population dynamics of marine bird and mammals. Understanding the trophic interactions between forage fish species may help to explain variability in the food habits and reproductive biology of injured marine birds dependent on them.

"Diet Overlap of Forage Species" was conducted under the general APEX hypothesis that "planktivory is the factor determining abundance of the preferred forage species of seabirds."

Further hypotheses state that the diets of different forage fish species will be different. Evidence supporting the alternative hypothesis, that forage fish diets are similar, suggests that food competition is possible. This hypothesis is being tested by examining the food habits, diet overlap and prey selection of forage fish. Preliminary information about trophic interactions among forage species was reported in "Forage Fish Influence on Recovery of Injured Species: Forage Fish Diet Overlap" (SEA 94163C; Willette et. al, 1995). Analyses are not complete, but substantial diet overlap among forage species pairs was demonstrated for the late summer season. Juvenile herring-pollock and juvenile pink-chum salmon pairs both had relatively high diet overlap, but partitioned available prey resources; small copepods were the principal prey of juvenile herring and pollock, while fish larvae were the principal prey for juvenile salmon.

Collections of a particularly important forage species, sandlance, have been limited in PWS. Although analyses of PWS forage fish diets are not complete, some findings suggest that sandlance trophic interactions could impact several species. Larval sandlance and herring in Port Moller, Alaska shared a diet of various copepod life history stages (McGurk and Warburton, 1992). Willette et al (unpub. data) found that sandlance and pink salmon fry collected together in spring also shared a diet consisting primarily of small copepods, similar to independent observations on these species in other areas (e.g., Craig 1987; Sturdevant et al. 1996). In one net haul, sandlance stomachs contained approximately 10 times the biomass of the pteropod, Limacina helicina, and four times the biomass of small copepods as pink salmon in spring. Trophic interactions between sandlance and other forage species may occur over broad spatial and temporal scales, and this study reports on further investigations.

METHODS

Sample Collection

Samples were collected for "Diet Overlap of Forage Fish Species" during November, 1994 (Forage Fish Cruise 94-02), in July-August, 1995 (APEX Cruise 95-01) and October, 1995 (APEX Cruise 95-02) in conjunction with Project 95163A (Tables 1-3).

Forage fish catch was sorted, identified and enumerated, and size distribution data was obtained on board the vessels. Where possible, at least 10 randomly selected specimens per species/age class combination were designated for stomach analysis from each location sampled. Whole fish were fixed in 10% saltwater-buffered formalin. The abdomens of fish larger than 100 mm forklength (FL) were slit to allow formalin to penetrate the body cavity and fix stomach contents. Since specimens were required for several APEX project components, if hauls did not contain enough specimens of key species, stomach samples were later removed in the laboratory from fish frozen whole for other project needs.

Prey resource samples (two replicates) were collected whenever diet samples were successfully collected, except in the fall of 1994. If samples were limited to frozen fish for other needs, no plankton was collected. Zooplankton samples were collected with a ring-net (0.5 m diameter) towed vertically from the depth where fish were sampled to the surface. In summer, 1995, zooplankton were collected with a net having 303-micron mesh to standardize methods to those used by SEA in 1994. At the beginning of the cruise, samples were collected at three locations using nets having three different mesh sizes to compare prey resources sampled for the purpose of selecting the mesh most appropriate for representing prey used by the fish. In fall, 1995 zooplankton were collected with a net having 243-micron mesh to collect smaller organisms believed to be more representative of the diet. Replicate samples were preserved in 10% buffered formaldehyde solution in individual 500 ml sample bottles. In addition, macroinvertebrates collected in the 0.5 mm mesh cod end of the midwater trawl were preserved for Project 95163A;

this data is available to compare to prey resources utilized by the fish.

Laboratory Methods

Forage fish stomach samples and prey samples were analyzed at the NMFS Auke Bay Laboratory. Laboratory protocols were consistent with 1994 methods for SEA Project 94163C (Forage Fish Diet Overlap).

Fish Samples

Samples were fixed in 10% buffered formaldehyde for a minimum of six weeks to allow shrinkage to stabilize. They were then transferred to 50% isopropanol for preservation. for a minimum of 10 days before analysis. Ten specimens per species/age class were randomly selected for processing from each haul. Whole fish were blotted dry, weighed to the nearest 0.01 g and measured (standard fork length, FL) to the nearest 0.5 mm. Fish stomachs, including the region from the pharynx immediately behind the gills to the pylorus, were excised from the body cavity. The foregut was blotted dry and weighed full to an accuracy of 1.0 mg, the contents were removed, and the empty stomach blotted and weighed again. Total stomach contents wet weight was estimated by subtraction. Stomach fullness and prey digestion were visually assessed and semiquantitative index values recorded. Relative fullness was recorded as: 1=empty, 2= trace, 3=25%, 4=50%, 5=75%, 6=100% full, and 7=distended. The fullness code provides an index of the amount of food consumed relative to the fish's stomach size. The state of digestion was recorded as: 0=fresh, 1=partially digested, 2=mostly digested, 3=stomach empty. These codes provide indications of how recently the fish ate as well as general prey condition, which reflects the level of identification possible.

Prey items in the gut were completely teased apart, identified to the lowest possible taxonomic level and enumerated. Standard subsampling techniques were employed when stomachs were so large and/or full that counting every prey item was not practical. The protocol for subsampling stomach contents was developed during 1994 sample processing and is patterned after general methods (Kask and Sibert 1976). Prey identification efforts were concentrated on identifying copepods to examine prey selection by species, sex and life history stage and within large and small copepod size groups. Where possible, partially digested large copepods which could not be completely identified were distinguished as pristane-manufacturing species (*Neocalanus* spp., *Calanus* spp.) or non-pristane-manufacturing species (e.g.., *Metridia* spp., *Epilabidocera longipedata*). After samples have been processed, gut contents were saved in a labeled vial in 50% isopropanol.

Prey Resources

The composition of available prey resources will be estimated from laboratory analyses of ring net samples. A Hensen-stempel pipette and Folsom plankton splitter will be used to collect at least two random subsamples (1, 5, or 10 ml capacity) from each sample bottle after appropriate dilution. Samples will be diluted to achieve a minimum total count of 500 animals or 200 of the dominant taxon. Zooplankton and epibenthic invertebrates will be identified to the lowest practical taxon and enumerated in each subsample. Total biomass in each taxonomic group will be estimated by the product of average body blotted-dry weight and abundance. Literature values for average blotted-dry wet weight of each species or developmental stage will be used when available. When literature values are not available, mean blotted-dry wet weight will be determined by weighing a sample (ns 50) of intact specimens. The composition of available prey will be described by pooling the data from epibenthic and zooplankton samples standardized to a 1 m2 surface area.

Statistical Methods

Mean preserved fork lengths (FL) for each group of fish used in diet studies were calculated to distinguish between age/size groups. Larger herring and pollock referred to as "older" were not aged. Stomach fullness index was summarized as less than a trace contents, 25-50% full and more than 75% full. The cumulative percent number of fish in a group having each level of fullness was computed. Total stomach contents weight as a percentage of fish body weight was also computed.

For this preliminary report, overall food habits were summarized by pooling specific prey taxa identified into broad prey categories presented as percent total biomass (Figures 5 and 6). Analysis of the complete food habits data set will include prey comparisons based on prey numbers and frequency of occurrence in addition to prey biomass. The Percent Similarity Index (PSI) was used as a measure of diet overlap (Wieser, 1960; Boesch, 1977; Krebs 1989). The PSI is computed by summing the minimum percentage of all prey taxa shared between two species of forage fish :

$$PSI\ jk = \min(p\ ij,\ p\ ik),$$

where p is the percentage of a given prey taxon in the pooled group of fish species j and k.

The PSI is a simple and conservative estimator of diet overlap, yet is based on the finest resolution identifications available. In addition to PSI as a measure of diet overlap, analyses in final reports will include other overlap measures (Krebs 1989), Principal Components and other multivariate analyses (Johnson and Wichern 1988; Digby and Kempton 1987), and prey selection indices which compare the numbers of taxa consumed by fish to the numbers available in plankton (Ivlev 1961; Krebs 1989; Manly 1986).

RESULTS

This preliminary report summarizes the food habits, prey biomass and diet overlap of forage fish species in several size classes from three areas of PWS in summer, 1995 and fall, 1994 (Figure 1; Tables 1 and 2). Preliminary results are based on prey biomass from all stomach samples available from fall, 1994 collections (n = 90) and a subset of stomach samples from approximately 300 fish collected for diet analyses in summer, 1995 (n = 80). Since the analysis was conducted, approximately 100 additional fish and half of the 70 zooplankton prey resource samples collected in summer, 1995 have been processed. None of the approximately 230 diet samples or 14 zooplankton samples collected in fall, 1995 have been analyzed (Table 3). No zooplankton data or prey selection information from any season is included. Stomach analysis of the remainder of priority samples from 1994 (Willette et al 1995) and 1995 (this report) is expected to be complete by summer, 1996.

Figure 1 shows the sample locations in southern, central and northern regions of PWS from which priority diet samples were analyzed. A complete list of species, samples, locations and other pertinent collection data is given in Tables 1-3 (see also Haldorson et al 1996). Priority samples analyzed from summer, 1995, included YOY pollock (56 mm FL) and adult, post-spawning male capelin (135 mm FL) from the central area and sandlance (90 mm FL), juvenile pollock (181 mm FL), and two age groups of herring (YOY at 76 mm FL and older juveniles at 143 mm FL) from the northern area of PWS. None of the fish analyzed from summer, 1995, sample collections were from southern PWS. The locations represented by the summer diet samples (8 hauls at 8 sites) include Port Fidalgo and Bligh Island in the northern region and Seal, Eleanor, northeast Knight and northwest Montague Islands in the central region. Samples were collected at various depths and times of day and none of the data presented comes from fish species collected in the same hauls (Table 1).

Samples analyzed from fall, 1994 included adult herring (215 mm FL) from the southwest area, two size classes of herring (YOY at 94 mm FL and older juveniles at 170 mm FL) and YOY pollock (105 mm FL) from the northern region, and YOY pollock (111 mm FL) and juvenile eulachon (84 mm FL) from the central region of PWS. None of the fish analyzed from fall, 1994, were from central PWS. The locations represented by the fall diet samples (7 hauls at 5 sites) include Port Gravina and Galena Bay in the northern region and Needles and Icy Bay in the southern region of PWS. Approximately half of the diet samples from trawl hauls in the fall were made in the day, half at night (Table 2). Most of the YOY herring and pollock analyzed from the fall were collected in the same hauls.

Fish used for diet studies were larger in the fall than in the summer. Mean preserved fork lengths (FL) of each species and size group are shown in Figure 2 along with sample sizes analyzed from each area. I assume from their discreet FL's that there were at least three age classes of herring and two of pollock. Comparisons between areas, seasons and size/age groups of fish will be more complete when all samples are analyzed.

Preliminary data suggests differences in the total amount of food consumed by forage fish in the two seasons and possibly between areas and size/age groups. Stomach fullness index and percent body weight for each species and size/age group of forage fish are shown in Figures 3 and 4, respectively. All herring size groups tended to have fuller stomachs in the summer than in the fall (Figure 3) and contents were a higher percentage of body weight (Figure 4). Age-0 herring also tended to have fuller stomachs (mean = 100% full) than older juvenile herring (mean = 50% full) in summer (Figures 3 and 4). Stomachs of all herring age/size groups in the fall, particularly the oldest, contained only trace contents. For pollock, in the summer, stomachs of both 0-age pllock from the central region and older pollock from the northern region were 50% full on average. In the fall, stomachs of 0-age pollock from the northern area were less full (mean = 25%) than those from the southern area (mean = 100% full). Less data is available for the other species represented. Sandlance from the single haul in the northern region in summer averaged 50% full. Adult male capelin from the central region in summer and juvenile eulachon from the northern region in the fall had virtually empty stomachs.

The prey taxa consumed by forage fish species in fall, 1994 and summer, 1995 are shown in Tables 4 and 5, respectively. The species, life history stages and sizes of prey taxa consumed were pooled into 15 taxonomic categories (Figures 5 and 6, pie diagrams. Analyses have not been conducted at the detailed levels of specific taxa and life history stages. Among the prominent categories, the identifiable hyperiid amphipods were primarily juvenile *Parathemisto* spp., euphausiids were primarily juvenile *Thyssanoessa* spp., and gastropods were mainly *Limacina helicina* and, occasionally, pteropods and juvenile snails. Large calanoids, however, were commonly a mixture of several species, including *Calanus pacificus* and *C. marshallae*, Metridia *okhotensis* and *M. pacifica*, *Epilabidocera longipedata* and *Euchaeta elongata*; *Neocalanus* spp. were not common at these times of year. Small calanoids were primarily *Pseudocalanus* and *Acartia* spp. Infrequently-occurring prey taxa, such as harpacticoid copepods, were included the "other" category for this report, but may be prominent dietary components in some forage species in other seasons.

Summer Food Habits

The food habits of all species and size classes of forage fish analyzed to date from summer, 1995 collections are depicted in Figure 5 as percent biomass by prey category. Pie diagrams are arranged to facilitate comparisons between multiple species in young-of-the-year or older size groups or single species in multiple size groups. Small calanoid copepods and hyperiid amphipods dominated the diets of YOY species in the northern and central areas of the sound in summer. Small calanoid copepods formed approximately 29% of prey biomass in YOY pollock, 46% in sandlance and 68% in herring. Hyperiid amphipods formed slightly more than 20% of each diet. Several other categories were present, notably about 20% fish larvae in the YOY pollock from the central area and 20% barnacle larvae in the sandlance collected nearshore by beach seine. Large calanoids were minor components of YOY fish diets.

Two size classes of herring were examined from the northern area of the sound in summer. A large percentage of the dietary biomass for both the YOY and older size class of herring was small calanoids (68% and 46%, respectively). Two size classes of pollock were examined from different areas of the sound in summer, a YOY group from the central area and older fish (181 mm FL) from the northern area. Data is not yet available for diet comparisons between age classes of pollock collected from the same area. Pollock of different sizes had only small percentages of prey biomass in common. The older pollock appeared to switch from small calanoids consumed by younger fish to larger, similar prey, with diets of approximately 45% large calanoids. While YOY pollock consumed small fish larvae (20%), older fish consumed consumed equal proportions of large calanoids (45%) and chaetognaths (16%).

The diet overlap in summer (Figure 6) is presented as a half matrix of PSI values (y-axis) for all possible paired comparisons, with each cell representing a species or size class combination. The right axis lists species representing each row and the x-axis lists the paired group. Combinations involving YOY herring in summer are all in the back row, but cells represented by other species combinations are scattered on the grid. The highest diet overlap values in summer involved combinations with YOY herring : YOY herring with YOY pollock, YOY herring with YOY sandlance, and YOY herring with older herring all had PSI values greater than 50%. Diet overlap for YOY pollock was generally lower, ranging from 22-38%, except for the 53% overlap with YOY herring. Sandlance diet overlapped most with other YOY fish, older herring diet overlapped by close to 50% with both YOY herring and with older pollock, and older pollock diet overlap was greatest, 46%, in combination with older herring.

Fall Food Habits

The food habits of all species and size classes of forage fish analyzed from fall, 1994 collections are depicted in Figure 7. In contrast to summer, euphausiids were the most common prey in fall diets of YOY fish. Euphausiids formed approximately 30% of prey biomass in YOY pollock from the south, 56% in YOY herring from the northern area, and 81% in YOY pollock from the northern area. Only small proportions of the prey categories common in the summer diets, hyperiids and small calanoids, were present in YOY fish in the fall. As in summer, YOYpollock from different areas in the fall consumed different prey, with the exception of euphausiids; large calanoids (19% biomass) and larvaceans (30% biomass) were consumed by pollock only in the southern area.

The three size classes of herring analyzed from fall collections all consumed substantial proportions of euphausiids, 33-57% of the dietary biomass. Small calanoids comprised 33-50% of the older herring's prey biomass in both the northern and southern areas, but were not prominent in diet of YOY herring from the northern sound (8% biomass). The thousands of minute invertebrate eggs in northern YOY herring diets (11% biomass) were probably calanoid eggs consumed during filter-feeding (see Batty et al 1986).

The diet overlap of forage fish in the fall is again presented as a half matrix of PSI values for all possible paired comparisons (Figure 8). The greatest diet overlap in fall again involved herring combinations: YOY herring and YOY pollock from the northern area, most of which were caught in the same 2 hauls, had 59% PSI. Diet overlap for other herring-pollock combinations was usually lower, approximately 35%. The herring size class combinations had overlap values of between 34 % and 52%, and was considerable even when the fish were collected in different areas of the sound. Young-of-the-year pollock from different areas of the sound, north and south, had only 32% overlap.

DISCUSSION

Seasonal, ontogenetic, spatial or temporal partitioning of prey resources may occur among forage fish species inhabiting the same area. A species preferred foraging habitat may change with changing hydrographic conditions and will reflect foraging behaviors that could also change ontogenetically. Species caught in the same area also may have foraged in different levels of the water column. This spatial segregation will be reflected by low dietary overlap. Niche overlap between age-1 herring and capelin, for example, was highest in the spring when both species foraged in the water column; after the water column stratified, herring switched to a surface foraging mode in response to a newly available prey assemblage (Coyle and Paul 1992). Niche overlap between the two species then decreased as capelin continued to feed in the water column. Such trophic shifts also suggest that species which are not competitors during one season or life history stage may become competitors at another time.

Species sharing the same habitat may also partition resources on a temporaral basis, for example by having different diurnal feeding rhythms. For example, juvenile herring are sometimes observed schooling in shallow water at the head of bays (personal observation, APEX 1995). In these conditions, juvenile herring may compete with sandlance or demersal nearshore species for epibenthic or brackish water prey, or perhaps partition resources by feeding at different tidal stages when the suite of available prey changes. Conversely, herring located in pelagic waters offshore may compete with juvenile pollock for planktonic copepod prey.

Sandlance is an important forage species with the potential for food competition with several other species because of its diel behavioral pattern. Pacific sandlance perform a daily migration between feeding grounds, schooling sites and benthic refuge areas in soft substrates, primarily feeding during daylight (Hobson 1986). This transient behavior and the sandlance's attraction to light (Hobson 1986) suggests that sandlance could feed from both epibenthic and pelagic production systems, intermixing with both schooling and demersal fish species at various times during a 24-hour cycle. Calanoid copepods are commonly reported as the majority of prey weight found in the stomachs of several species of sandlance (e.g., Meyer et al 1979; Craig 1987; Field 1988). Meyer et al. observed that American sand lance (*A. americanus*) feed in schools between midwater and the surface, not on the bottom. Pacific sandlance (*A. hexapterus*), however, consumed a variety of prey taxa, with epibenthic taxa more common in diets during fall and winter (Field 1988). Similarly, epibenthic harpacticoid copepods are commonly observed along with other prey in the stomach contents of sandlance in PWS (Sturdevant, unpub. data; Willette et al. 1995). Diet overlap based on numbers of epibenthic prey is likely to be high between sandlance, tomcod (*Microgadus proximus*) and juvenile salmon (*O. gorbuscha* and *O. keta*), the forage species whose stomach contents commonly contained high numbers, but usually low biomass, of these small epibenthic prey (Sturdevant, unpub. data; Sturdevant et al. 1996; Willette 1996).

Information on seasonal changes in diet overlap and food competition among forage species is limited. Craig (1987) observed seasonal changes in the principal dietary components (% biomass) of YOY sandlance on the north Aleutian shelf. Copepods predominated in summer (90%), euphausiids predominated in winter (100%), and a mixture of the two taxa predominated in spring (26% copepods and 40% euphausiids). Although seasonal data were not available for the herring from his study, their diets overlapped with sandlance in summer; the predominant prey of both large (28.2 cm) and small (91 mm) herring in summer were copepods, crustacean larvae, and chaetognaths. Hobson (1986), Field (1988) and McGurk and Warburton (1992) also noted the co-occurrence and similarity in diets of Pacific herring and sandlance during several life stages.

These observations are similar to our preliminary data from APEX collections in the summer of 1995. We found high diet overlap between sandlance and two size classes of herring, largely based on small copepods (Figures 5 and 6). Likewise, we observed high biomass proportions of euphausiids in the diets of both herring and pollock in November (Figure 7), when sandlance were not caught. Euphausiids predominated in sandlance winter diet on the Aleutian shelf (Craig 1987). The best available seasonal data from PWS studies will be provided by our 1994 Forage Fish diet data set (Willette et al 1995). The report (in progress) will cover seasonal diet overlap of forage species from April -September. We do not yet have data to determine if these species diets overlap with sandlance in winter, when food resources are probably at their annual minimum; we have unanalyzed diet samples from the SEA cruise conducted in March, 1996, however.

Although "copepods" are commonly reported in fish diets, specific identifications of the prey are not always made and can be important. *Epilabidocera longipedata,* a surface swarming copepod species (Johnson, 1934), and *Metridia ohkotensis* and *M. pacifica*, diel vertical migrators (Hattori 1989) were consumed by herring and other forage species (Willette et al, unpub. data). The presence of these very different prey organisms in the same spring diets indicates that trophic interactions could occur at several depths in the water column or that oceanographic processes play a large role in determining which prey are available and whether partitioning occurs. The results from analysis of seasonal diet data may also depend on detailed species identifications.

While the APEX project focused on the summer nesting period of marine birds, a complete understanding of the influence of their forage species trophic niche must take into account the fish's entire life history and environment. Ideally, trophic studies should examine seasonal relationships over a broad area, include as many stages of the life history as possible, investigate diel feeding rhythms and behavior, and assess the dynamics of prey resources. These factors may contribute to an explanation of how co-occurring species partition resources and each sustain healthy populations. Competition among species can be inferred from an observed shift in resource use, such as absence from preferred habitat or failure to use a preferred a prey resource (Sogard 1994); the shift is then reflected in some measure of health, such as poor condition or small size. Ultimately, survival may be affected and populations reduced. While a complete investigation of all of these factors is outside the scope of the APEX forage fish diet study, some aspects can be addressed in the 1996 field study.

During the nearshore work scheduled for the 1996 APEX field season, it is likely that a number of additional nearshore benthic and demersal forage species exhibiting substantial diet overlap with sandlance will be collected. Information from APEX and SEA studies of oceanographic processes and fish dynamics will be important for understanding the food observations. Seasonal and tidal oceanographic processes that affect zooplankton and epibenthic prey abundance and distribution could impact trophic interactions (Field 1988; Hobson 1986). Our observation that both same-age classes (fall) and different age classes (summer) of pollock from different areas of PWS had different diets, for example, suggests that the spatial availability of prey in geographic areas may be one factor affecting the amount of diet overlap observed. A number of behaviors could also influence the degree of overlap in diets. Seasonal and/or diel differences in both horizontal and vertical distribution of the fish (and prey) are likely to affect both observations of fullness and prey selection (see Haldorson 1995; Haldorson et al 1996). The prey available may also affect the relative fullness of stomachs, if different size prey are available in different areas. Simultaneous collections of prey samples will be important to determine whether fish are selecting prey from the resources available where they are caught. Furthermore, because mouth gape increases with fish growth, seasonal differences in prey selection from taxa present year round, such as euphausiids, may be a reflection of both fish distribution and their ability to select larger prey specimens. Other aspects of particular species' biology are also important, such as the habit of capelin to stop feeding during the spawning period, which had likely taken place shortly before our summer sampling period.

Systematic collection of diet samples over the diel period will enable us to determine if the preliminary observations of seasonal differences in stomach fullness and the empty stomachs of juvenile eulachon (this report) can actually be attributed to differences in the time of day fish were collected. In addition, the degree of dietary overlap observed among co-occurring species may be explained by other trophic interactions, such as shifts in habitat use like those documented for juvenile cod avoiding predation (sensu Gotceitas et al 1995). A clearer understanding of diel feeding behavior and activity patterns of sandlance and other forage species will be important to explain the simlilarities and differences observed.

SUMMARY AND CONCLUSIONS

Summer diets are of forage fish were primarily small calanoids and hyperiids in the YOY groups, both small and large calanoids in older herring, and large calanoids, euphausiids and chaetognaths in older pollock. No data is shown for capelin because most of them had empty stomachs. Fall diets of all species and age groups included large proportions of euphausiid biomass. Only the older herring consumed substantial proportions of small calanoids, and YOY pollock diets differed between areas of the sound. Eulachon had empty stomachs in the fall. High diet overlap was observed in summer between YOY fish, between herring size classes, and between different species of older fish, the herring and pollock. Similarly, diet overlap in the fall was greatest between YOY herring and YOY pollock and between different size classes of herring.

Preliminary conclusions from this analysis of summer and fall forage fish diets are: 1) that diet overlap is substantial across summer and fall; 2) that the diet composition of forage fish species changes seasonally; and 3) this high diet overlap suggests that competion for food could occur between multiple species and size classes of forage fish and could particularly affect herring condition. While some preliminary information about trophic interactions among forage species has been gained from APEX and its predecessor, efforts in future years will include directed sampling to better address competition. The 1996 forage fish diet component of APEX is designed to examine prey composition and selection, interspecific diet overlap, diel feeding periodicity and potential food competition among forage fish species in PWS. Information obtained from this study will contribute further to an understanding of the mechanisms affecting population and trophic dynamics of forage fish and their availability to apex predators.

ACKNOWLEDGEMENTS

This work would not have been possible without the cooperation of many individuals. I appreciate the assistance of other APEX investigators, particularly Dr. Lewis Haldorson and Ms. Jennifer Boldt, in collecting the fish samples used in this diet study. Thanks are also due to Rosemary Bailey, Shannon Keegan, Mary Auburn and Lee Hulbert for their extensive hours of microscopic analysis.

LITERATURE CITED

Anderson, P. J., S. A. Payne, and B. A. Johnson. 1994. Multi-species dynamics and changes in community structure in Pavlof Bay, Alaska, 1972-1992. Unpub. manus., National Marine Fisheries Service, Kodiak, Alaska. 26 pp.

Batty, R. S., J. H. S. Blaxter, and D. A. Libby. 1986. Herring (*Clupea harengus*) filter feeding in the dark. Mar. Biol. 91(3):371-375.

Boesch, D. F. 1977. Application of numerical classification in ecological investigations of water pollution. Special Scientific Rep. No. 77, Virginia Institute of Marine Science, EPA-600/3-77-033. 114 pp.

Cooney, R. T. 1993. A theoretical evaluation of the carrying capacity of Prince William Sound, Alaska for juvenile Pacific salmon. Fish. Res. 18:1-17.

Coyle, K. O. and A. J. Paul. 1992. Interannual differences in prey taken by capelin, herring, and red salmon relative to zooplankton abundance during the spring bloom in a southeast Alaskan embayment. Fish. Oceanogr. 1(4):294-305.

Craig, P. 1987. Forage fishes in the shallow waters of the North Aleutian Shelf. Pp. 49-54 in: Proceedings of the Conference on Forage Fishes of the Southeastern Bering Sea. Anchorage, Alaska, November 4-5, 1986. 116 pp. MMS Rep. 87-0017.

Digby, P. G. N. And R. A. Kempton. 1987. Multivariate Analysis of Ecological Communities. Chapman and Hall, London.

Dwyer, D. A., K. M. Bailey, and P. A. Livingston. 1987. Feeding habits and daily ration of walleye pollock (*Theragra chalcogramma*) in the eastern Bering Sea, with special reference to cannibalism. Can. J Fish. Aquat. Sci. 44: 1972-1984.

Field, L. J. 1988. Pacific sand lance, *Ammodytes hexapterus*, with notes on related *Ammodytes* species. p. 15-33 In: N. J. Wilimovsky, L. S. Incze and S. J. Westrheim, (eds.) Species Synopses: Life Histories of Selected Fish and Shellfish of the Northeast Pacific and Bering Sea. Washington Sea Grant Program and Fisheries Research Institute, Univ. Washington, Seattle.

Gotceitas, V., S. Fraser and J. A. Brown. 1995. Habitat use by juvenile Atlantic cod (*Gadus morhua*) in the presence of an actively foraging and non-foraging predator. Mar. Biol. 123:421-430.

Grover, J. J. 1991. Trophic relationship of age-0 and age-1 walleye pollock, *Theragra chalcogramma*, from the Gulf of Alaska in 1987. Fish Bull., U. S. 88:463-470.

Haldorson, L. 1995. Fish net sampling. p. 55-83 In: Forage Fish Study in Prince William Sound, Alaska. *Exxon Valdez* Oil Spill Restoration Project 94163A Annual Report, University of Alaska Fairbanks, September, 1995. 208 p.

Haldorson, L. J., T. C. Shirley and K. C. Coyle. 1996. Biomass and distribution of forage species in Prince William Sound.

Hatch, S. A., G. V. Byrd, D. B. Irons, and G. L. Hunt. 1993. Status and ecology of kittiwakes in the North Pacific Ocean. Pages 140-153 In: K. Vermeer, K. T. Briggs, K. H. Morgan and D. Siegel-Causey, eds. The status, ecology, and conservation of marine birds of the North Pacific. Can. Wildl. Serv. Spec. Publ., Ottawa, Canada.

Hattori, H. 1989. Bimodal vertical distribution and diel migration of the copepods *Metridia pacifica, M. okhotensis* and *Pleuromamma scutullata* in the western North Pacific Ocean. Mar. Biol. 103:39-50.

Hobson, E. S. 1986. Predation on the Pacific sand lance *Ammodytes hexapterus* (Pisces: Ammodytidae), during the transition between day and night in southeastern Alaska. Copeia 1:223-226.

Irons, D. B. 1996. Size and productivity of black-lgged kittiwake colonies in Prince William Sound, Alaska before and after the *Exxon Valdez* oil spill. In: S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright (eds.), *Exxon Valdez* Oil Spill Symposium Proceedings. American Fisheries Society Symposium Number 18. American Fisheries Society, Bethesda, Maryland.

Ivlev, V. S. 1961. Experimental Ecology of the Feeding of Fishes. Yale University Press, New Haven, CT.

Johnson, M. W. 1934. The developmental stages of the copepod *Epilabidocera amphitrites* (= *E. longipedata*) McMurrich. Biol. Bull. 67(3):466-483.

Johnson, R. A. And D. W. Wichern. 1988. Applied Multivariate Statistical Analysis. Prentice-

Hall, New Jersey.
Kask, B. And J. Sibert. 1976. A laboratory method for the analyses of fish stomach contents. Pp. 77-79 In: C. A. Simenstad and S. J. Lipovsky, eds. Fish Food Habits Studies. Proceedings of the 1st Pacific Northwest Technical workshop. Astoria, Oregon, October 13-15, 1976. Wash. Sea Grant pub. 193 pp.
Krebs, C. J. 1989. Ecological Methodology. Harper and Row, New York.
Ludwig, J. A. And J. F. Reynolds. 1988. Statistical Ecology: a primer on methods and computing. John Wiley and Sons, Inc., New York.
Manly, B. F. J. 1986. Multivariate statistical methods: a primer. Chapman and Hall, London and New York.
McGurk, M. D. and Warburton. 1992. Fisheries Oceanography of the Southeast Bering Sea: Relationships of growth, dispersion and mortality of sand lance larvae to environmental conditions in the Port Moller Estuary. OCS Study MMS 92-0019, U. S. Dept. Interior.
Meyer, T. L., R. A. Cooper and R. W. Langton. 1979. Relative abundance, behavior, and food habits of the American sand lance, *Ammodytes americanus*, from the Gulf of Maine. Fish. Bull. 77(1):243-253.
Oakley, K. L. and K. J. and Kuletz. 1996. Population, reproduction and foraging of pigeon guillemots at Naked Island, Alaska, before and after the *Exxon Valdez* oil spill. In: S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright (eds.), *Exxon Valdez* Oil Spill Symposium Proceedings. American Fisheries Society Symposium Number 18. American Fisheries Society, Bethesda, Maryland.
Piatt, J. F. and P. Anderson. 1996. Response of common murres to the *Exxon Valdez* oil spill and long-term changes in the Gulf of Alaska marine ecosystem. In: S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright (eds.), *Exxon Valdez* Oil Spill Symposium Proceedings. American Fisheries Society Symposium Number 18. American Fisheries Society, Bethesda, Maryland.
Sogard, S. M. 1994. Use of suboptimal foraging habitats by fishes: consequences to growth and survival. p. 103-132 In: D. J. Stouder, K. L. Fresh, and R. J. Feller (eds.). Theory and application in fish feeding ecology. University of South Carolina Press, Columbia, South Carolina. 390 p.
Sturdevant, M. V., A. C. Wertheimer, and J. L. Lum. 1996. Diets of juvenile pink and chum salmon in oiled and non-oiled nearshore habitats in Prince William Sound, 1989 and 1990. In: S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright (eds.). Exxon Valdez Oil Spill Symposium Proceedings. American Fisheries Society Symposium Number 18. American Fisheries Society, Bethesda, Maryland.
Wieser, W. 1960. Benthic studies in Buzzards Bay: II. The meiofauna. Limnol. Oceanog. 5(2):121-137.
Willette, T. M. 1996. Impacts of the *Exxon Valdez* Oil Spill on the migration, growth, and survival of juvenile pink salmon in Prince William Sound. In: Rice, S. D., R. B. Spies, D. A. Wolfe, and B. A. Wright (eds.). *Exxon Valdez* Oil Spill Symposium Proceedings. American Fisheries Society Symposium Number 18. American Fisheries Society, Bethesda, Maryland.
Willette, T. M., M. V. Sturdevant, S. Jewitt and E. Debevec. 1995. Forage fish influence on recovery of injured species: forage fish diet overlap. *Exxon Valdez* Oil Spill Restoration Project 94163 Annual Report, Alaska Dept. Fish Game. 105 p.

Table 1. Forage fish diet samples collected during the summer, 1995, cruise APEX 95-01 (July 20-August 12, 1995) aboard the F/V Caravelle. Priority samples were processed and data are summarized for this report. Priority: Y = yes, N = no; Area: C = Central, NE = Northeast, SW = Southwest; Gear: T = midwater trawl, M = methot trawl, B= beach seine, D = dipnet, R = pair trawl.

Species	No.	Priority	Area	Location	Station	Haul	Gear	Date	Time	Notes	Plankton#	Depth (m)
Prowfish	1	N	C	NE Montague	1	2	T	07/21/95	16:40:00	-0-	NONE	60
Pink Salmon	27	N	C	NE Montague	1	2	T	07/21/95	16:40:00	-0-	NONE	60
Sculpin	1	N	C	NW Montague	3	1	T	07/22/95	12:23:00	-0-	003P/004P	60
Prowfish	1	N	C	NW Montague	3	1	T	07/22/95	12:23:00	-0-	003P/004P	60
Pink Salmon	1	N	C	NW Montague	3	1	T	07/22/95	12:23:00	-0-	003P/004P	60
Pollock	12	N	C	NW Montague	3	1	T	07/22/95	12:23:00	-0-	003P/004P	60
Pollock	3	N	C	Manning Rocks	4	1	T	07/22/95	-0-	FROZEN	-0-	-0-
Pollock	31	N	C	NW Seal Island	5	2	T	07/22/95	-0-	FROZEN	-0-	-0-
Pollock	3	N	C	East of NE Knight Island	6	2	T	07/23/95	-0-	FROZEN	-0-	-0-
Pink Salmon	1	N	C	SW of Naked Island	11	1	T	07/24/9	10:15:00	-0-	009P/010P	8

Chum Salmon	1	N	C	SW of Naked Island	11	1	T	07/24/95	10:15:00	-0-	009P/010P	8
P. Sandfish	1	N	C	SW of Naked Island	11	1	T	07/24/95	10:15:00	-0-	009P/010P	8
Sculpin	1	N	C	SW of Naked Island	11	1	T	07/24/95	10:15:00	-0-	009P/010P	8
Sandlance	1	N	C	SW of Naked Island	11	2	T	07/24/95	10:53:00	-0-	009P/010P	15
Prowfish	1	N	C	SW of Naked Island	11	2	T	07/24/95	10:53:00	-0-	009P/010P	15
Prowfish	1	N	C	SW tip of Naked Island	11	3	M	07/24/95	11:44:00	-0-	009P/010P	1
Pollock	12	N	C	E. Liljegren Pass	19	1	T	07/25/95	15:37:00	-0-	NONE	50
Prowfish	1	N	C	N. of Montague Pt.	53	1	T	08/01/95	09:17:00	PLANKTON 20 M & 60 M	021P-024P	60
Pollock	12	N	C	N. OF Montague Pt.	53	1	T	08/01/95	0 9:17:00	1 PINK, 1 Capelin FROZEN	021P-024P	60
Pollock	15	N	C	N. of Montague	54	2	T	08/01/95	12:14:00	PLANKTON 20M & 60M	025P-028P	60
Pollock	12	Y	C	Seal Island	56	1	T	08/01/95	15:27:00	PLANKTON 20 M & 80 M	029P-032P	80
Pollock	15	N	C	Seal Island	57	2	T	08/01/95	17:30:00	PLANKTON 20 M & 80 M	033P-036P	80
Pollock	14	Y	C	N. Knight Island	58	2	T	08/02/95	9:25:00	PLANKTON 20 M & 80 M	037P-040P	80
Pollock	12	Y	C	Eleanor Island	62	2	T	08/02/95	15:16:00	PLANKTON 20 M & 60 M	041P-044P	60

Herring		N	C	Eleanor Island	63	1	B	08/02/95	-0-	*4 HERRING, 2 SL FROZEN	-0-	1
Eulachon		N	C	S. Naked Island	65	1	R	08/03/95	-0-	*2 EULACHON FROZEN	-0-	-0-
Capelin	12	N	C	S. tip Naked Island	65	1	R	08/03/95	10:45:00	-0-	NONE	-0-
Pink Salmon	12	N	C	Eleanor Passage	66	2	T	08/03/95	14:49:00	NO PLANKTON #045	046P/047P	8
Prowfish	1	N	C	Eleanor Passage	66	2	T	08/03/95	14:49:00	NO PLANKTON #045P	046P/047P	8
Pink Salmon		N	C	E. of Peak Island	67	1	T	08/03/95	-0-	*1 PINK & LARVAE FROZ EN	-0-	-0
Pollock		N	C	E. of Liljegren Passage	72	1	T	08/04/95	-0-	*1 POLLOCK, 1 COHO & LARVAE FROZEN	-0-	-0-
Pollock		N	C	E. of Liljegren Passage	73	1	T	08/04/95	-0-	*130 POLLOCK, LARVAE, SCULPINS FROZEN	-0-	-0-
Capelin		N	C	E. of Storey Island	94	1	T	08/07/95	-0-	*2 CAPELIN FROZEN	-0-	-0-
Pollock		N	C	N. Hogan Bay	108	1	T	08/08/95	-0-	*22 POLL., 6 CAPELIN, 4 HER. FROZEN	-0-	-0-
Pollock		N	C	E. Discovery Pt. (Snug)	109	1	T	0 08/09/95	-0-	*1 POLL., 1 CAPELIN, 2 LINGCOD FROZEN	-0-	-0-
Herring		N	C	SE Eleanor Island	110	1	B	08/09/95	-0-	*LARVAL HERRING, 1 LINGCOD. GREENLING FROZEN	-0-	-0-
Pollock	12	N	C	S. of Naked Island	112	1	T	08 10/95	13:13:00	PLANKTON 20 M & 80 M	063P-066P	80
Prowfish	1	N	C	S. of Naked Island	112	1	T	08 10/95	13:13:00	PLANKTON 20 M & 80 M	063P-066P	80
Pollock		N	C	E. Naked Island	113	1	T	08 10/95	-0-	*2 POLLOCK FROZEN	-0-	-0-

Capelin	12	Y	C	NW Montague Island	114	1	T	08/10/9	-0-	*16 CAPELIN FROZEN	-0-	-0-
Capelin	12	Y	C	NW Montague Island	114	7	T	08/10/95	20:38:00	*1 POLLOCK FROZEN; PLANKTON DEPTH 20 M	067P-068P	15
Pollock		N	C	NE Montague Pt.	117	1	D	08/10/95	-0-	*1 POLLOCK 1 CAPELIN, 12 STICKLEBACK FROZE	-0-	-0-
Sandlance	151	N	C	Cabin Bay	99	1	B	08/16/95	-0-	Lyndsey's group catch	-0-	-0-
Herring	12	Y	NE	S. of Bligh Island	22	2	T	07/26/95	11:07:00	-0-	015P/016P	20
Prowfish	1	N	NE	S. of Bligh Island	22	2	T	07/26/95	11:07:00	-0-	015P/016P	20
Crested Sculpin	2	N	NE	S. of Bligh Island	22	2	T	07/26/95	11:07:00	-0-	015P/016P	20
Crested Sculpin	3	N	NE	S. of Bligh Island	26	1	T	07/26/95	18:10:00	-0-	NONE	10
Prowfish	1	N	NE	S. of Graveyard, Fidalgo	26	1	T	07/26/95	18:10:00	-0-	NONE	10
Herring	14	Y	NE	S. Graveyard, Fidalgo	27	1	D	07/26/95	19:30:00	-0-	NONE	-0-
Pollock		N	NE	SE of Bligh Island	28	1	T	07/27/95	-0-	*4 pollock frozen	-0-	-0-
Pollock	6	N	NE	W of Bligh Reef	29	1	T	07/27/95	10:57:00	20 & 80 M PLANKTON	017P-020P	80
Crested Sculpin	1	N	NE	Outer Galena Bay	3	51	T	07/28/95	8:45:00	* LARVAE & CRESTED SCULPIN FROZEN	NONE	110
Pollock	12	Y	NE	E. Graveyard, Fidalgo	82	1	T	08/05/95	14:25:00	PLANK. 20M&8OM *ALSO FROZEN LARVAE	051P-054P	100
Crested Sculpin	3	N	NE	S. Bligh Island	84	1	T	08/05/95	17:29:00	105, 243, 303 micron mesh plankton hauls	055P-057P	15
Prowfish	2	N	NE	S. Bligh Island	84	1	T	08/05/95	17:29:00	105, 243, 303 micron mesh plankton hauls	055P-057P	15
Prowfish	1	N	NE	S. Bligh Island	84	1	T	08/05/95	17:29:00	105, 243, 303 micron mesh plankton hauls	055P-057P	15

Fish Larvae		N	NE	Outer Galena Bay	93	2	T	08/07/95		*LARVAL FISH FROZEN	-0-	-0-
Pollock		N	NE	Outer Galena Bay	93	3	T	08/07/95		*LARVAE, LG. POLLOCK, & EULACHON FROZEN	-0-	-0-
Herring	13	N	NE	Port Gravina	116	1	T	08/11/95	12:10:00	PLANKTON 20 M	069P-070P	30
Prowfish	1	N	NE	Port Gravina	116	1	T	08/11/95	12:10:00	PLANKTON 20 M	069P-070P	30
Sandlance	12	Y	NE	Outer Port Gravina	118	1	B	08/11/95	15:30:00	*ALSO 10 HERRING 1 STICKLEB FROZEN	-0-	-0-
Herring		N	SW	Whale Bay (Dual Hd.)	43	1	T	07/30/95	-0-	*HERRING FROZEN	-0-	-0-
Fish Larvae		N	SW	Whale Bay (Dual Hd.)	43	1	T	07/30/95	-0-	*LARVAE FROZEN	-0-	-0-
Fish Larvae		N	SW	NE Pt. Countess	47	1	T	07/30/95	-0-	*LARVAE FROZEN	-0-	-0-
Pollock		N	SW	NE Pt. Countess	50	1	T	07/31/95	-0-	*8 YOY POLLOCK FROZEN	-0-	-0-
Fish Larvae		N	SW	NE Pt. Countess	50	1	T	07/31/95	-0-	*LARVAL FISH FROZEN	-0-	-0-
Fish Larvae		N	SW	NE Pt. Countess	50	2	T	07/31/95	-0-	*LARVAL FISH FROZEN	-0-	-0-
Herring		N	SW	NE Pt. Countess	50	2	T	07/31/95	-0-	*1 HERRING FROZEN	-0-	-0-
Unid. Greenling	4	N	SW	Pt. Countess	51	1	B	07/31/95	11:30:00	*8 FROZEN POLLOCK	NONE	6
Daubed Shanny	4	N	SW	Pt. Countess	51	1	B	07/31/95	11:30:00	*8 FROZEN POLLOCK	NONE	6
Tomcod	8	N	SW	Pt. Countess	51	1	B	07/31/95	11:30:00	*8 FROZEN POLLOCK	NONE	6
Crested Gunnel	2	N	SW	Pt. Countess	51	1	B	07/31/95	11:30:00	*8 FROZEN POLLOCK	NONE	6
Kelp Greenling	5	N	SW	Pt. Countess	51	1	B	07/31/95	11:30:00	*8 FROZEN POLLOCK	NONE	6
Unidentif. Fish	3	N	SW	Pt. Countess	51	1	B	07/31/95	11:30:00	*8 FROZEN POLLOCK	NONE	6
Lingcod	2	N	SW	Pt. Countess	51	1	B	07/31/95	11:30:00	*8 FROZEN POLLOCK	NONE	6
Wh. Greenling	6	N	SW	Pt. Countess	51	1	B	07/31/95	11:30:00	*8 FROZEN POLLOCK	NONE	6

Prowfish	1	N	SW	E. Whale Bay (Dual H.)	100	2	T	08/08/95	13:20:00	* 1 HERRING FROZEN	NONE	10
Prowfish	1	N	SW	SO. OF PT.HELEN	107	2	T	08/08/95	20:16:00	PLANKTON 20 M	061P-062P	20
Herring	10	N	SW	SO. OF PT.HELEN	107	2	T	08/08/95	20:16:00	PLANKTON 20 M	061P-062P	20

Table 2. Forage fish diet samples collected by trawl (T)in Prince William Sound during the fall, 1994, cruise FOR94-02 (November 7-13, 1994) aboard the R/V Medeia. All samples have been processed and data are summarized in this report. No zooplankton was collected.

Species	No.	Area	Location	Station	Haul	Gear	Date	Time	Depth (m)
Herring	10	NE	INNER GALENA BAY	6	1	T	11/10/94	22:42:00	20
Pollock	10	NE	INNER GALENA BAY	6	1	T	11/10/94	22:42:00	20
Pollock	15	NE	MOUTH OF PORT GRAVINA	7	4	T	11/12/94	22:32:00	21
Herring	14	NE	MOUTH OF PORT GRAVINA	7	4	T	11/12/94	22:30:00	21
Eulachon	10	NE	MOUTH OF PORT GRAVINA	7	5	T	11/12/94	23:25:00	80
Herring	10	NE	MOUTH OF PORT GRAVINA	8	2	T	11/13/94	15:10:00	36
Herring	12	NE	MOUTH OF PORT GRAVINA	8	3	T	11/13/94	16:15:00	35
Herring	12	SW	NEEDLES	3	1	T	11/07/94	13:25:00	95
Pollock	12	SW	ICY BAY	5	5	T	11/08/94	15:32:00	50

Table 3. Forage fish diet samples collected during the fall, 1995, cruise APEX 95-02 (October 5-14, 1995) aboard the R/V Medeia.
No samples have been processed to date. Area: C = Central, NE = Northeast, SW = Southwest; Gear: T = midwater trawl, M = methot trawl, B= beach seine, D = dipnet, R = pair trawl.

Species	No.	Area	Location	Station	Haul	Gear	Date	Time	Notes	Plankton#	Depth (m)
Fish Larvae	0	C	APPLEGATE-KNIGHT IS.	1	1	N	10/09/95	12:20:00	LARVAE	NONE	
Fish Larvae	0	C	APPLEGATE-KNIGHT IS.	1	2	N	10/09/95	12:56:00	LARVAE	NONE	
Fish Larvae	2	C	NW OF APPLEGATE ROCKS	1	3	T	10/09/95	15:20:00	LARVAE	NONE	
Snailfish	2	C	NW OF APPLEGATE ROCKS	1	3	T	10/09/95	15:20:00	*FROZEN HERRING & POLLOCK	NONE	
Pollock	20	C	APPLEGATE ROCKS	3	1	T	10/11/95	21:00:00	*YOY POLLOCK	003P/004P;	100M
Fish Larvae	20	C	APPLEGATE ROCKS	3	2	T	10/11/95	22:00:00	* LARVAE; 1 SQUID	003P/004P;	100M
Pollock	12	C	APPLEGATE ROCKS	3	2	T	10/11/95	22:00:00	*LARGE POLLOCK	003P/004P;	100M
Pollock	12	C	SMITH ISLAND	4	3	T	10/12/95	21:50:00	*FROZEN YOY POLLOCK	005P/006P;	75M
Snailfish	1	C	SMITH ISLAND	4	3	T	10/12/95	21:50:00	SNAILFISH	005P/006P;	75M
Lanternfish	1	C	SMITH ISLAND	4	3	T	10/12/95	21:50:00	MYCTOPHID	005P/006P;	75M
Fish Larvae	0	C	SMITH ISLAND	4	3	T	10/12/95	21:50:00	LARVAE, 1 SQUID	005P/006P;	75M
Herring	22	C	EAST NAKED ISLAND (3FNZ4S)	5	1	T	10/13/95	11:30:00	YOY HERRING	007P/008P;	80M
Pollock	21	NE	GALENA BAY (OUTER, SOUTH)	6	1	T	10/13/95	21:42:00	YOY POLLOCK	009P/010P;	50M
Prowfish	1	NE	GALENA BAY (OUTER SOUTH)	6	1	T	10/13/95	21:42:00	1 SQUID ALSO	009P/010P;	50M
Herring	21	NE	GALENA BAY (OUTER SOUTH)	6	1	T	10/13/95	21:42:00	YOY HERRING	009P/010P;	80M
Pollock	21	NE	LANDLOCKED BAY-FIDALGO;15M	7	1	T	10/14/95	21:58:00	-0-	011P/012P;	25M
Prowfish	1	NE	LANDLOCKED BAY-FIDALGO; 15M	7	1	T	10/14/95	21:58:00	PROWFISH	011P/012P;	25M
Herring	21	NE	LANDLOCKED BAY-FIDALGO; 15M	7	1	T	10/14/95	21:58:00	HERRING	011P/012P;	25M
Pollock	21	NE	LANDLOCKED BAY-FIDALGO; 60M	7	2	T	10/14/95	23:20:00	* FROZEN SMELT &. POLLOCK	013P/014P;	100M
Fish Larvae	11	NE	GOOSE IS.-GRAVINA	8	1	N	10/15/95	10:42:00	LARVAE	013P/014P;	100M
Pollock	15	SW	WHALE BAY	2	1	T	10/10/95	19:40:00	YOY POLLOCK	001P/002P;	75M
Pollock	13	SW	WHALE BAY	2	1	T	10/10/95	19:40:00	* FROZEN HERRING & LARVAE	001P/002P;	75M
Snailfish	1	SW	WHALE BAY	2	1	T	10/10/95	19:40:00	SNAILFISH	001P/002P;	75M

Table 4. Prey species observed in stomachs of forage fish by area and size/age group in Prince William Sound in fall, 1994. Category refers to taxonomic grouping for prey species. LARGE = large calanoid copepods, SMALL = small calanoid copepods (see text).

Category	Prey Taxon	Prey Code
Northeast Region		
Herring, 0-age		
BIVALVE	Bivalve, larvae	BVL
EUPHAUSIID	Euphausiid calyptopis	EU3
EUPHAUSIID	Euphausiid furcilia	EU4
EUPHAUSIID	Euphausiid, general unknown	EUP
EUPHAUSIID	Euphausiid, Thysannoessa sp., adult	TH
GAMMARID	Amphipod, Gammarid, unknown, small	GA1
GASTROPOD	Gastropod, Pteropod, Limacina helicina J	LMJ
GASTROPOD	Gastropoda, general juvenile (SNAIL)	GST
HARPACTICO	Harpacticoid, Zaus copepodite	HZC
HYPERIID	Amphipod, Hyperiid, unknown juvenile	HYP
INVERTEGG	Unknown invertebrate egg, large (>0.2mm)	EGL
INVERTEGG	Unknown invertebrate egg, small (<0.2mm)	EGG
LARGE	Calanoid, Epilabidocera longipedata, AM	EPM
LARGE	Calanoid, general large (>2.5 mm)	CAL
LARGE	Calanoid, large, Neocalanus/Calanus	CLN
LARGE	Calanoid, Metridia pacifica, AF	MPF
LARGE	Calanoid, Metridia pacifica, AM	MPM
LARVACEA	Larvacea, Oikopleura dioica	OKI
NOTHING	Unidentified item	UNI
OTHER	Chaetognath, species unknown	CHT
OTHER	Isopod, general	ISP
OTHER	Malacostraca, eyes only	MAE
POLYCHAETE	Polychaeta, general, juvenile	PLL

POLYCHAETE	Polychaeta, Pectinariidae	PEC
SMALL	Calanoid, Acartia clausi adult	ACA
SMALL	Calanoid, Centropages abdominalis, AM	CAM
SMALL	Calanoid, general small (<2.5 mm)	CAS
SMALL	Calanoid, Pseudocalanus AF	PSF
SMALL	Calanoid, Pseudocalanus AM	PSM
SMALL	Calanoid, Pseudocalanus copepodids I-IV	PCP
SMALL	Calanoid, Pseudocalanus sp., general	PSA

Northeast Region

Herring, 1-age

BIVALVE	Bivalve, larvae	BVL
EUPHAUSIID	Euphausiid calyptopis	EU3
EUPHAUSIID	Euphausiid furcilia	EU4
EUPHAUSIID	Euphausiid, general unknown	EUP
GASTROPOD	Gastropod, Pteropod, Limacina helicina J	LMJ
HYPERIID	Amphipod, Hyperiid, unknown juvenile	HYP
INVERTEGG	Unknown egg mass	UEM
INVERTEGG	Unknown invertebrate egg, small (<0.2mm)	EGG
LARGE	Calanoid, general large (>2.5 mm)	CAL
LARVACEA	Larvacea, Oikopleura dioica	OKI
OTHER	Chaetognath, Sagitta	SGE
OTHER	Copepod, Caligidae, parasitic copepod	PCO
OTHER	Nematode	NEM
SMALL	Calanoid, Acartia clausi adult	ACA
SMALL	Calanoid, Centropages abdominalis, AF	CAF
SMALL	Calanoid, Centropages abdominalis, AM	CAM
SMALL	Calanoid, general small (<2.5 mm)	CAS
SMALL	Calanoid, Lucicutia flavicornis	LUC

SMALL	Calanoid, Pseudocalanus AF	PSF
SMALL	Calanoid, Pseudocalanus AM	PSM
SMALL	Calanoid, Pseudocalanus copepodids I-IV	PCP
SMALL	Calanoid, Pseudocalanus sp., general	PSA
SMALL	Cyclopoid, Oithona similis AF	OSF
SMALL	Cyclopoid, Oithona similis, general	OS

Northeast Region

Pollock, 0-age

EUPHAUSIID	Euphausiid calyptopis	EU3
EUPHAUSIID	Euphausiid furcilia	EU4
EUPHAUSIID	Euphausiid, general unknown	EUP
EUPHAUSIID	Euphausiid, T. raschii females	TRF
EUPHAUSIID	Euphausiid, Thysannoessa sp., adult	TH
GAMMARID	Amphipod, Gammarid, unknown, medium	GA2
GASTROPOD	Gastropoda, Pteropod, unidentified	PTP
HYPERIID	Amphipod, Hyperiid, P. libellula 2-6.9mm	PL2
HYPERIID	Amphipod, Hyperiid, unknown juvenile	HYP
LARGE	Calanoid, general large (>2.5 mm)	CAL
LARGE	Calanoid, large, Neocalanus/Calanus	CLN
LARGE	Calanoid, Metridia pacifica, AF	MPF
LARGE	Calanoid, Metridia pacifica, AM	MPM
LARVACEA	Larvacea, Oikopleura dioica	OKI
NOTHING	Unidentified item	UNI
OTHER	Chaetognath, species unknown	CHT
POLYCHAETE	Polychaeta, general, juvenile	PLL
SMALL	Calanoid, general small (<2.5 mm)	CAS
SMALL	Calanoid, Pseudocalanus AM	PSM
SMALL	Calanoid, Pseudocalanus sp., general	PSA

ZOEAE	Decapod zoea, general unknown group	DZG
EUPHAUSIID	Euphausiid, general unknown	EUP
OTHER	Malacostraca	MAL

Southwest Region
Herring, 2-age

EUPHAUSIID	Euphausiid, general unknown	EUP
EUPHAUSIID	Euphausiid, T. raschii females	TRF
HYPERIID	Amphipod, Hyperiid, Primno macropa, <2mm	PR1
LARGE	Calanoid, Metridia pacifica, AF	MPF
LARVACEA	Larvacea, Oikopleura dioica	OKI
NOTHING	Unidentified item	UNI
OTHER	Malacostraca, eyes only	MAE
OTHER	Nematode	NEM
SMALL	Calanoid, Acartia clausi adult	ACA
SMALL	Calanoid, general small (<2.5 mm)	CAS
SMALL	Calanoid, Pseudocalanus AF	PSF
SMALL	Calanoid, Pseudocalanus AM	PSM
SMALL	Calanoid, Pseudocalanus sp., general	PSA

Southwest Region
Pollock 0-age

EUPHAUSIID	Euphausiid, general unknown	EUP
EUPHAUSIID	Euphausiid, T. raschii females	TRF
EUPHAUSIID	Euphausiid, T. raschii males	TRM
EUPHAUSIID	Euphausiid, Thysannoessa sp., adult	TH
GAMMARID	Amphipod, Gammarid, unknown, medium	GA2

GASTROPOD	Gastropod, Pteropod, Limacina helicina J	LMJ
GASTROPOD	Gastropoda, Pteropod, unidentified	PTP
HYPERIID	Amphipod, Hyperiid, Hyperia sp.	HP
HYPERIID	Amphipod, Hyperiid, P. macropa, 2-6.9mm	PR2
HYPERIID	Amphipod, Hyperiid, unknown juvenile	HYP
HYPERIID	Amphipod, Hyperiid/Parath. pacifica gen.	PP
HYPERIID	Amphipod, P. pacifica juvenile, 2-6.9mm	PA2
HYPERIID	Amphipod, P. pacifica juvenile, <2mm	PA1
INVERTEGG	Unknown invertebrate egg, small (<0.2mm)	EGG
LARGE	Calanoid, Calanus marshallae AF	CMF
LARGE	Calanoid, Calanus pacificus AM	CPM
LARGE	Calanoid, Calanus/Neocalanus copepodids	CPD
LARGE	Calanoid, Euchaeta elongata ad. male	ECM
LARGE	Calanoid, Euchaeta elongata, AF	ECF
LARGE	Calanoid, general large (>2.5 mm)	CAL
LARGE	Calanoid, large, Neocalanus/Calanus	CLN
LARGE	Calanoid, Metridia pacifica, AF	MPF
LARVACEA	Larvacea, Oikopleura dioica	OKI
OTHER	Chaetognath, Sagitta	SGE
OTHER	Nematode	NEM
POLYCHAETE	Polychaeta, general, juvenile	PLL
SMALL	Calanoid, Acartia longiremis AF	ALF
SMALL	Calanoid, Acartia longiremus adult	AL
SMALL	Calanoid, general small (<2.5 mm)	CAS
SMALL	Calanoid, Pseudocalanus AF	PSF
SMALL	Calanoid, Pseudocalanus AM	PSM
SMALL	Calanoid, Pseudocalanus copepodids I-IV	PCP
SMALL	Calanoid, Pseudocalanus sp., general	PSA
SMALL	Cyclopoid, Oithona similis AF	OSF
ZOEAE	Decapod zoea, Shrimp, Crangonidae	DZC

Table 5. Preliminary list of prey species observed in stomachs of forage fish by area and size group in Prince William Sound in summer, 1995. See Figure 2 for mean lengths of fish size groups. Category refers to taxonomic grouping for prey species. LARGE = large calanoid copepods, SMALL = small calanoid copepods (see text).

Area	Species	Size Group	Prey Category	Prey Taxon	Prey Code
Central Region					
	Pollock, 0-age				
C	Pollock	0	BARNACLE	Barnacle, nauplius	BMP
C	Pollock	0	BIVALVE	Bivalve, larvae	BVL
C	Pollock	0	CLADOCERA	Cladocera, General	CLA
C	Pollock	0	CLADOCERA	Cladoceran, Evadne sp.	EVD
C	Pollock	0	CLADOCERA	Cladoceran, Podon sp.	PON
C	Pollock	0	EUPHAUSIID	Euphausiid furcilia	EU4
C	Pollock	0	EUPHAUSIID	Euphausiid, general unknown	EUP
C	Pollock	0	EUPHAUSIID	Euphausiid, Thysannoessa sp., adult	TH
C	Pollock	0	FISH	Fish larvae, general	FSL
C	Pollock	0	GAMMARID	Amphipod, Gammarid, unknown, small	GA1
C	Pollock	0	GASTROPOD	Gastropod, Pteropod, Limacina helicina J	LMJ
C	Pollock	0	HYPERIID	Amphipod, Hyperiid, Parathem. sp.2-6.9mm	PS2
C	Pollock	0	HYPERIID	Amphipod, Hyperiid, Parathemisto sp.<2mm	PS1
C	Pollock	0	HYPERIID	Amphipod, Hyperiid, unknown juvenile	HYP
C	Pollock	0	INVERTEGG	Unknown invertebrate egg, small (<0.2mm)	EGG
C	Pollock	0	LARGE	Calanoid, general large (>2.5 mm)	CAL
C	Pollock	0	LARGE	Calanoid, large, Neocalanus/Calanus	CLN
C	Pollock	0	LARGE	Calanoid, Metridia pacifica, AF	MPF
C	Pollock	0	LARGE	Calanoid, Metridia sp., General	MG
C	Pollock	0	LARGE	Calanoid, Metridia sp., general male	MGM
C	Pollock	0	LARVACEA	Larvacea, Oikopleura sp.	OKP
C	Pollock	0	OTHER	Chaetognath, species unknown	CHT
C	Pollock	0	OTHER	Malacostraca, eyes only	MAE
C	Pollock	0	SMALL	Calanoid, Centropages abdominalis, adult	CA
C	Pollock	0	SMALL	Calanoid, general small (<2.5 mm)	CAS
C	Pollock	0	SMALL	Calanoid, Pseudocalanus AF	PSF
C	Pollock	0	SMALL	Calanoid, Pseudocalanus sp., general	PSA
Central Region					
	Capelin, spawned-out male				
C	Capelin	1	GASTROPOD	Gastropod, Pteropod, Limacina helicina J	LMJ

Northeast Region

Herring, 0-age

NE	Herring	0	BARNACLE	Barnacle, cyprid	BMC
NE	Herring	0	BARNACLE	Barnacle, nauplius	BMP
NE	Herring	0	BIVALVE	Bivalve, larvae	BVL
NE	Herring	0	CLADOCERA	Cladocera, General	CLA
NE	Herring	0	CLADOCERA	Cladoceran, Evadne sp.	EVD
NE	Herring	0	CLADOCERA	Cladoceran, Podon sp.	PON
NE	Herring	0	DECAPOD	Decapod, megalops, Paguridae	DMP
NE	Herring	0	EUPHAUSIID	Euphausiid calyptopis	EU3
NE	Herring	0	EUPHAUSIID	Euphausiid furcilia	EU4
NE	Herring	0	FISH	Fish egg (~1.0 mm)	FSE
NE	Herring	0	GASTROPOD	Gastropod, juv. snail w/ black pigment	GSB
NE	Herring	0	GASTROPOD	Gastropod, Pteropod, Limacina helicina J	LMJ
NE	Herring	0	GASTROPOD	Gastropoda, general juvenile (SNAIL)	GST
NE	Herring	0	HARPACTICO	Harpacticoid, general copepodite	HRC
NE	Herring	0	HARPACTICO	Harpacticoid, general eggsac	HEM
NE	Herring	0	HARPACTICO	Harpacticoid, general, unknown stage	HR
NE	Herring	0	HYPERIID	Amphipod, Hyperiid, unknown juvenile	HYP
NE	Herring	0	INVERTEGG	Unknown invertebrate egg, large (>0.2mm)	EGL
NE	Herring	0	INVERTEGG	Unknown invertebrate egg, small (<0.2mm)	EGG
NE	Herring	0	LARGE	Calanoid, general large (>2.5 mm)	CAL
NE	Herring	0	OTHER	Bryozoa, cyphonautes larva	CFN
NE	Herring	0	OTHER	Malacostraca	MAL
NE	Herring	0	OTHER	Malacostraca, eyes only	MAE
NE	Herring	0	OTHER	Unknown nauplius	UNP
NE	Herring	0	SMALL	Calanoid, Acartia clausi adult	ACA
NE	Herring	0	SMALL	Calanoid, Acartia clausi copepodite	ACC
NE	Herring	0	SMALL	Calanoid, Acartia sp.	AC
NE	Herring	0	SMALL	Calanoid, Centropages abdominalis, adult	CA
NE	Herring	0	SMALL	Calanoid, Centropages abdominalis, AF	CAF
NE	Herring	0	SMALL	Calanoid, Eurytemora pacifica AF	EYF
NE	Herring	0	SMALL	Calanoid, Eurytemora pacifica, general	EYT
NE	Herring	0	SMALL	Calanoid, general nauplius	CAN
NE	Herring	0	SMALL	Calanoid, general small (<2.5 mm)	CAS
NE	Herring	0	SMALL	Calanoid, Pseudocalanus AF	PSF
NE	Herring	0	SMALL	Calanoid, Pseudocalanus copepodids I-IV	PCP
NE	Herring	0	SMALL	Calanoid, Pseudocalanus sp., general	PSA

NE	Herring	0	SMALL	Cyclopoid, Oithona similis AF	OSF
NE	Herring	0	SMALL	Cyclopoid, Oithona similis, general	OS
NE	Herring	0	ZOEAE	Decapod zoea, crab, Brachyrhyncha	DZB
NE	Herring	0	ZOEAE	Decapod zoea, general shrimp	SHR
NE	Herring	0	ZOEAE	Decapod zoea, general unknown group	DZG
NE	Herring	0	ZOEAE	Decapod zoea, Shrimp, Pandalidae	PDZ

Northeast Region

Herring, 1-age

NE	Herring	1	BARNACLE	Barnacle, cyprid	BMC
NE	Herring	1	BIVALVE	Bivalve, larvae	BVL
NE	Herring	1	CLADOCERA	Cladocera, General	CLA
NE	Herring	1	CLADOCERA	Cladoceran, Evadne sp.	EVD
NE	Herring	1	CLADOCERA	Cladoceran, Podon sp.	PON
NE	Herring	1	DECAPOD	Decapod, megalops, Lithodidae	DML
NE	Herring	1	EUPHAUSIID	Euphausiid furcilia	EU4
NE	Herring	1	EUPHAUSIID	Euphausiid, general unknown	EUP
NE	Herring	1	GASTROPOD	Gastropod, juv. snail w/ black pigment	GSB
NE	Herring	1	GASTROPOD	Gastropod, Pteropod, Limacina helicina J	LMJ
NE	Herring	1	GASTROPOD	Gastropoda, general juvenile (SNAIL)	GST
NE	Herring	1	HYPERIID	Amphipod, Hyperiid, Parathem. sp.2-6.9mm	PS2
NE	Herring	1	HYPERIID	Amphipod, Hyperiid, Parathemisto sp.<2mm	PS1
NE	Herring	1	HYPERIID	Amphipod, Hyperiid, unknown juvenile	HYP
NE	Herring	1	HYPERIID	Amphipod, P. pacifica juvenile, 2-6.9mm	PA2
NE	Herring	1	INVERTEGG	Unknown invertebrate egg, large (>0.2mm)	EGL
NE	Herring	1	INVERTEGG	Unknown invertebrate egg, small (<0.2mm)	EGG
NE	Herring	1	LARGE	Calanoid, Epilabidocera longipedata, AF	EPF
NE	Herring	1	LARGE	Calanoid, Epilabidocera longipedata, AM	EPM
NE	Herring	1	LARGE	Calanoid, Epilabidocera longipedata, gen	EPI
NE	Herring	1	LARGE	Calanoid, general large (>2.5 mm)	CAL
NE	Herring	1	LARGE	Calanoid, large, Neocalanus/Calanus	CLN
NE	Herring	1	LARVACEA	Larvacea, Oikopleura sp.	OKP
NE	Herring	1	OTHER	Malacostraca	MAL
NE	Herring	1	OTHER	Malacostraca, eyes only	MAE
NE	Herring	1	OTHER	Unknown nauplius	UNP
NE	Herring	1	POLYCHAETE	Polychaeta, general, juvenile	PLL
NE	Herring	1	SMALL	Calanoid, Acartia longiremis , General	ALG
NE	Herring	1	SMALL	Calanoid, Acartia sp.	AC
NE	Herring	1	SMALL	Calanoid, Centropages abdominalis, adult	CA
NE	Herring	1	SMALL	Calanoid, Centropages abdominalis, AF	CAF

NE	Herring	1	SMALL	Calanoid, general small (<2.5 mm)	CAS
NE	Herring	1	SMALL	Calanoid, Pseudocalanus AF	PSF
NE	Herring	1	SMALL	Calanoid, Pseudocalanus copepodids I-IV	PCP
NE	Herring	1	SMALL	Calanoid, Pseudocalanus sp., general	PSA
NE	Herring	1	SMALL	Cyclopoid, Oithona similis, general	OS
NE	Herring	1	ZOEAE	Decapod zoea, Anomuran, Lithodidae	LIZ
NE	Herring	1	ZOEAE	Decapod zoea, crab, Brachyrhyncha	DZB
NE	Herring	1	ZOEAE	Decapod zoea, general shrimp	SHR
NE	Herring	1	ZOEAE	Decapod zoea, general unknown group	DZG
NE	Herring	1	ZOEAE	Decapod zoea, Shrimp, Hippolytidae	HIE
NE	Herring	1	ZOEAE	Decapod, Brachyura general, zoeae	DGB

Northeast Region
Pollock, 2-age

NE	Pollock	2	DECAPOD	Decapod, Brachyuran megalops	DMG
NE	Pollock	2	DECAPOD	Shrimp, general unknown juv./adult	SHP
NE	Pollock	2	EUPHAUSIID	Euphausiid, general unknown	EUP
NE	Pollock	2	EUPHAUSIID	Euphausiid, T. longipes	TL
NE	Pollock	2	HYPERIID	Amphipod, Hyperiid, unknown juvenile	HYP
NE	Pollock	2	INVERTEGG	Unknown egg mass	UEM
NE	Pollock	2	LARGE	Calanoid, general large (>2.5 mm)	CAL
NE	Pollock	2	LARGE	Calanoid, large, Neocalanus/Calanus	CLN
NE	Pollock	2	LARVACEA	Larvacea, Oikopleura sp.	OKP
NE	Pollock	2	OTHER	Chaetognath, species unknown	CHT
NE	Pollock	2	OTHER	Malacostraca, eyes only	MAE
NE	Pollock	2	SMALL	Calanoid, general small (<2.5 mm)	CAS

Northeast Region
Sandlance, 0-age

NE	Sandlance	0	BARNACLE	Barnacle, cyprid	BMC
NE	Sandlance	0	BIVALVE	Bivalve, larvae	BVL
NE	Sandlance	0	CLADOCERA	Cladoceran, Evadne sp.	EVD
NE	Sandlance	0	CLADOCERA	Cladoceran, Podon sp.	PON
NE	Sandlance	0	GASTROPOD	Gastropod, Pteropod, Limacina helicina J	LMJ
NE	Sandlance	0	GASTROPOD	Gastropoda, general juvenile (SNAIL)	GST
NE	Sandlance	0	HARPACTICO	Harpacticoid, general copepodite	HRC
NE	Sandlance	0	HARPACTICO	Harpacticoid, general, unknown stage	HR

NE	Sandlance	0	HARPACTICO	Harpacticoid, Laophontidae, adult	LAO
NE	Sandlance	0	HARPACTICO	Harpacticoid, Laophontidae, copepodite	LAC
NE	Sandlance	0	HARPACTICO	Harpacticoid, Tisbe copepodite	TSC
NE	Sandlance	0	HARPACTICO	Harpacticoid, Zaus copepodite	HZC
NE	Sandlance	0	HYPERIID	Amphipod, Hyperiid, unknown juvenile	HYP
NE	Sandlance	0	INVERTEGG	Unknown invertebrate egg, small (<0.2mm)	EGG
NE	Sandlance	0	LARVACEA	Larvacea, Oikopleura sp.	OKP
NE	Sandlance	0	SMALL	Calanoid, Centropages abdominalis, adult	CA
NE	Sandlance	0	SMALL	Calanoid, general small (<2.5 mm)	CAS

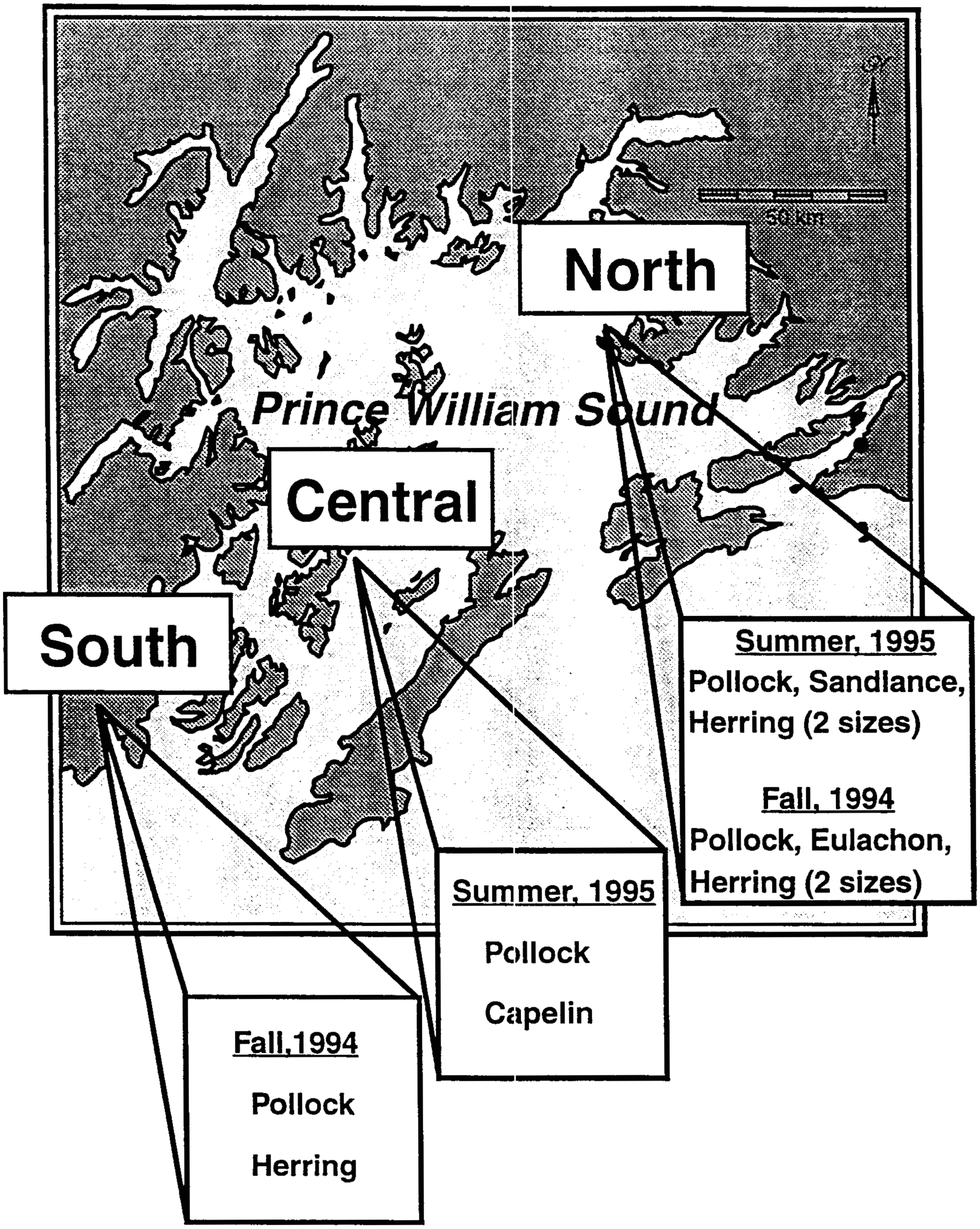

Figure 1 . Map of APEX sampling areas and species of forage fish represented in preliminary diet analyses for fall, 1994 and summer, 1995, in Prince William Sound, Alaska.

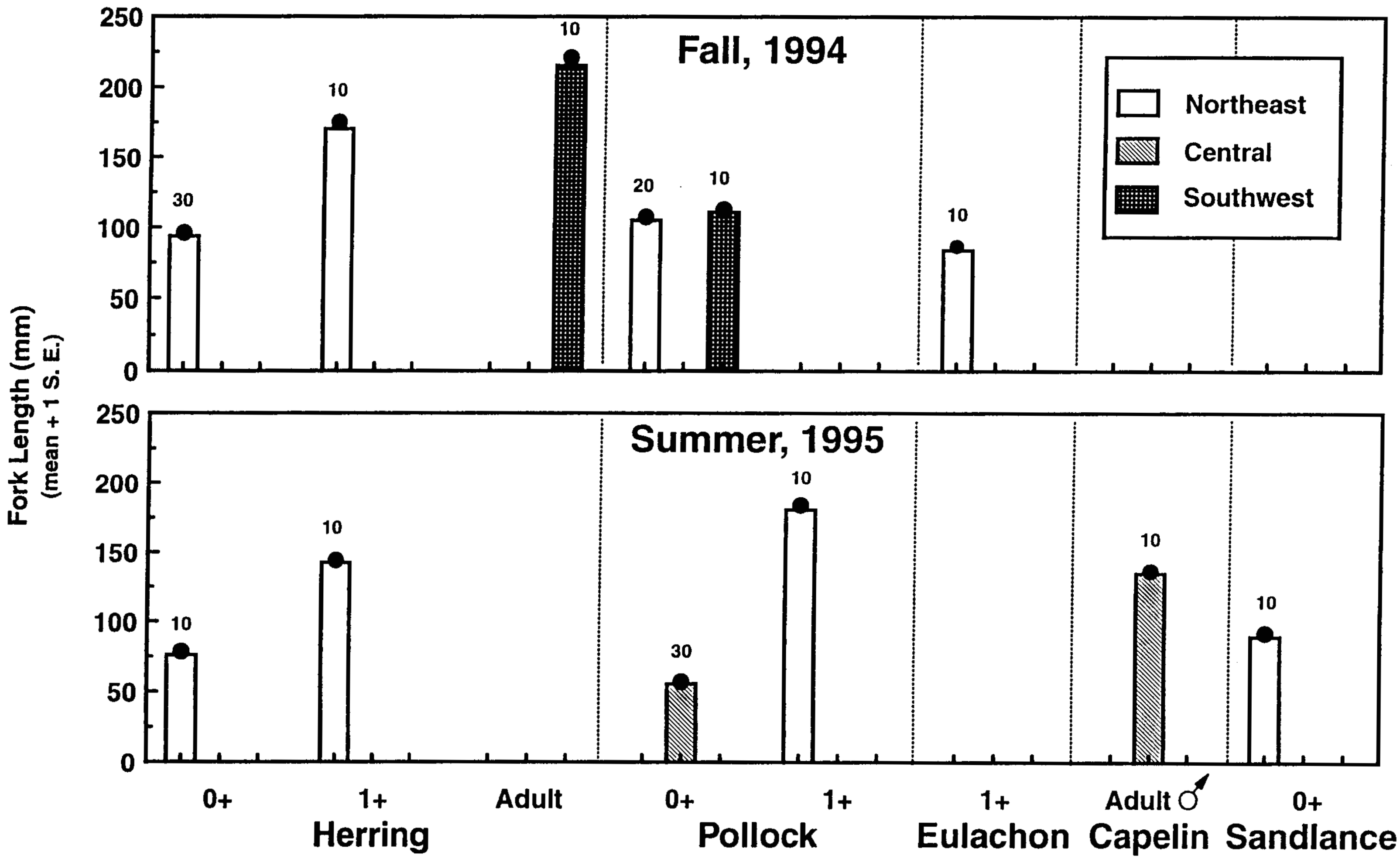

Figure 2. Size of forage fish used in APEX 95163C preliminary diet analyses, by season and area collected in Prince William Sound, fall, 1994 and summer, 1995. The number of preserved specimens analyzed is shown above each bar.

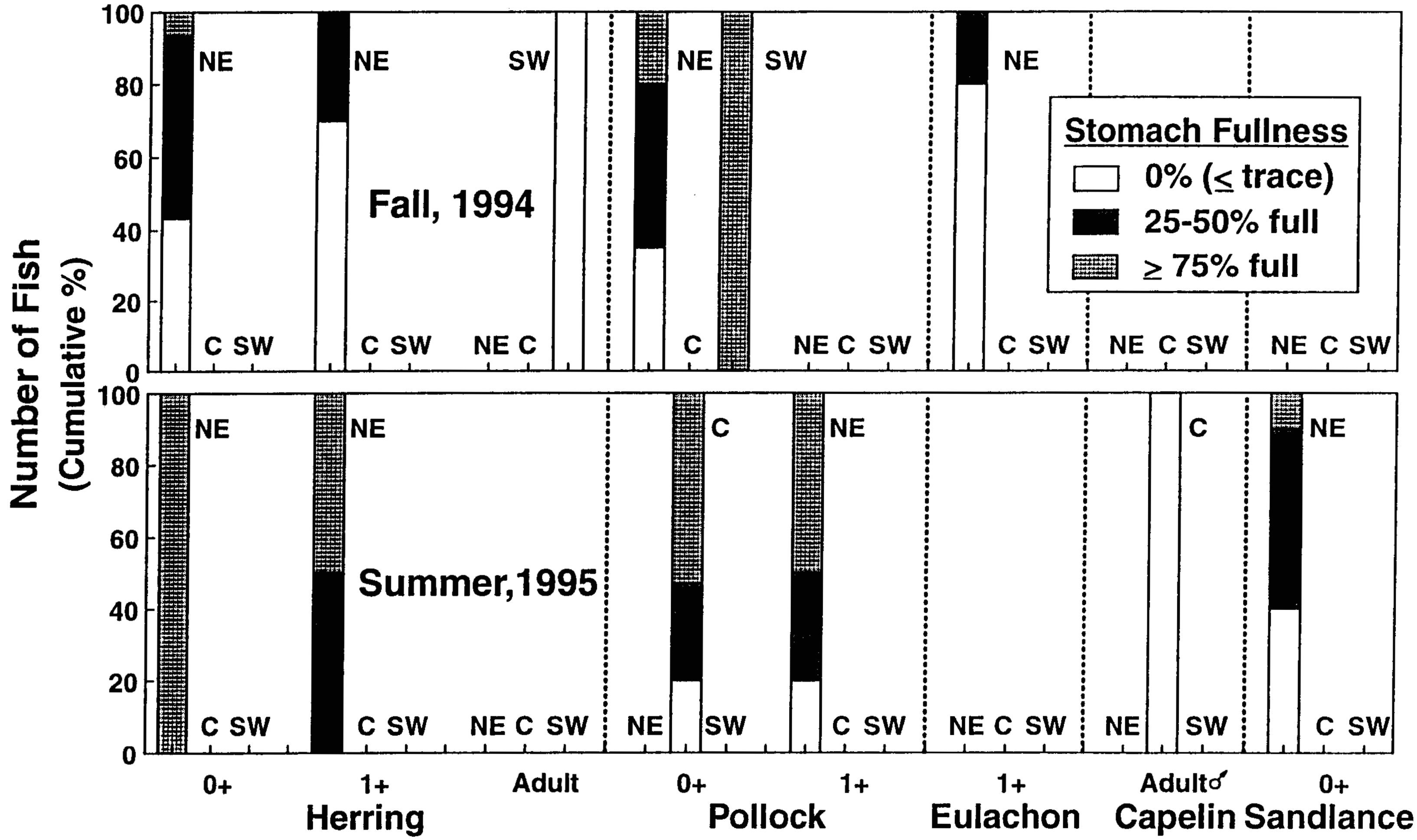

Figure 3. Percent number of forage fish with stomachs containing trace amounts of prey, 25-50% full, and greater than 75% full, from APEX preliminary diet analyses for fall, 1994 and summer, 1995.

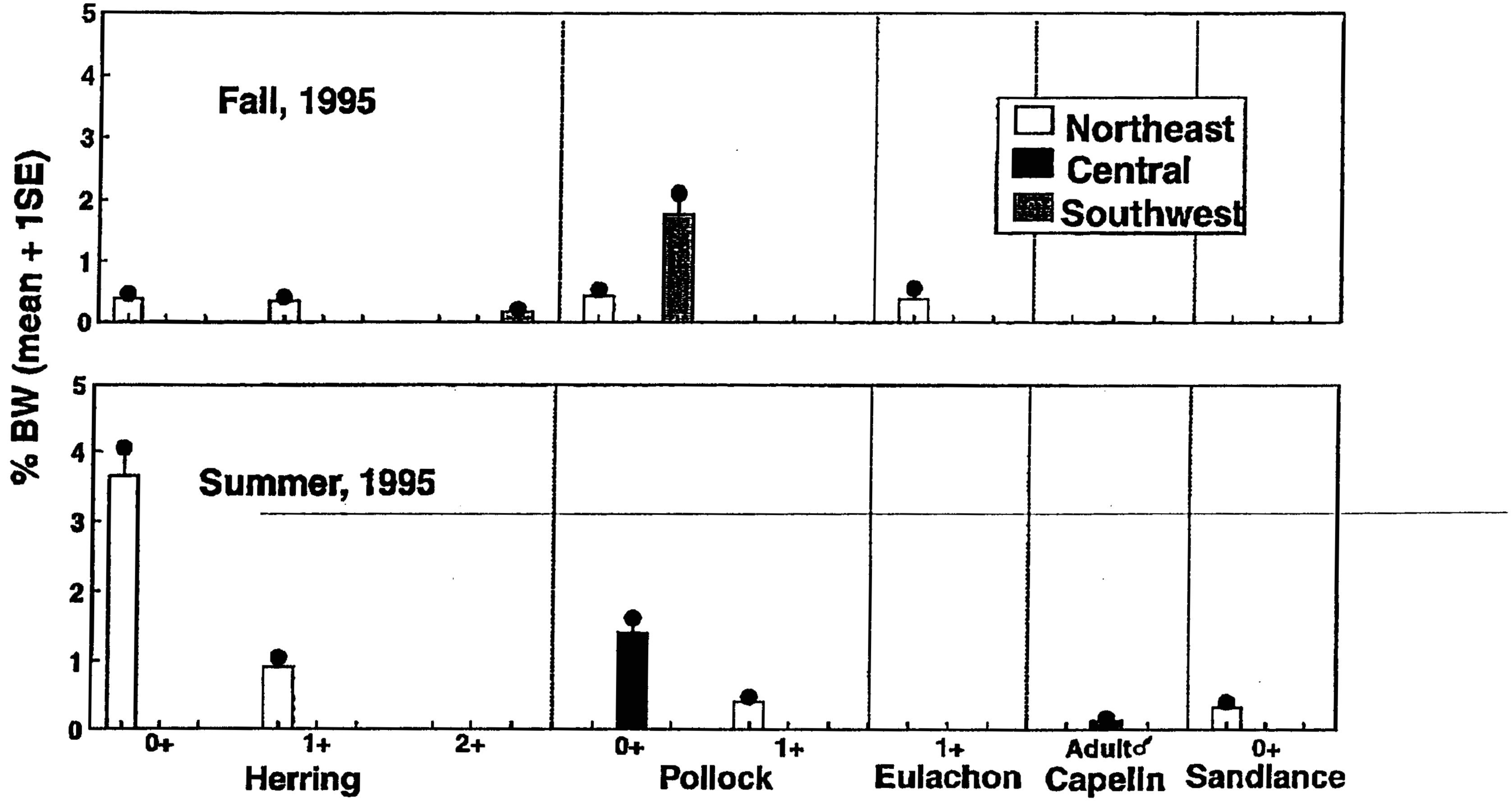

Figure 4. Stomach content as percent body weight for forage fish used in APEX preliminary diet analyses for fall, 1994 and summer, 1995.

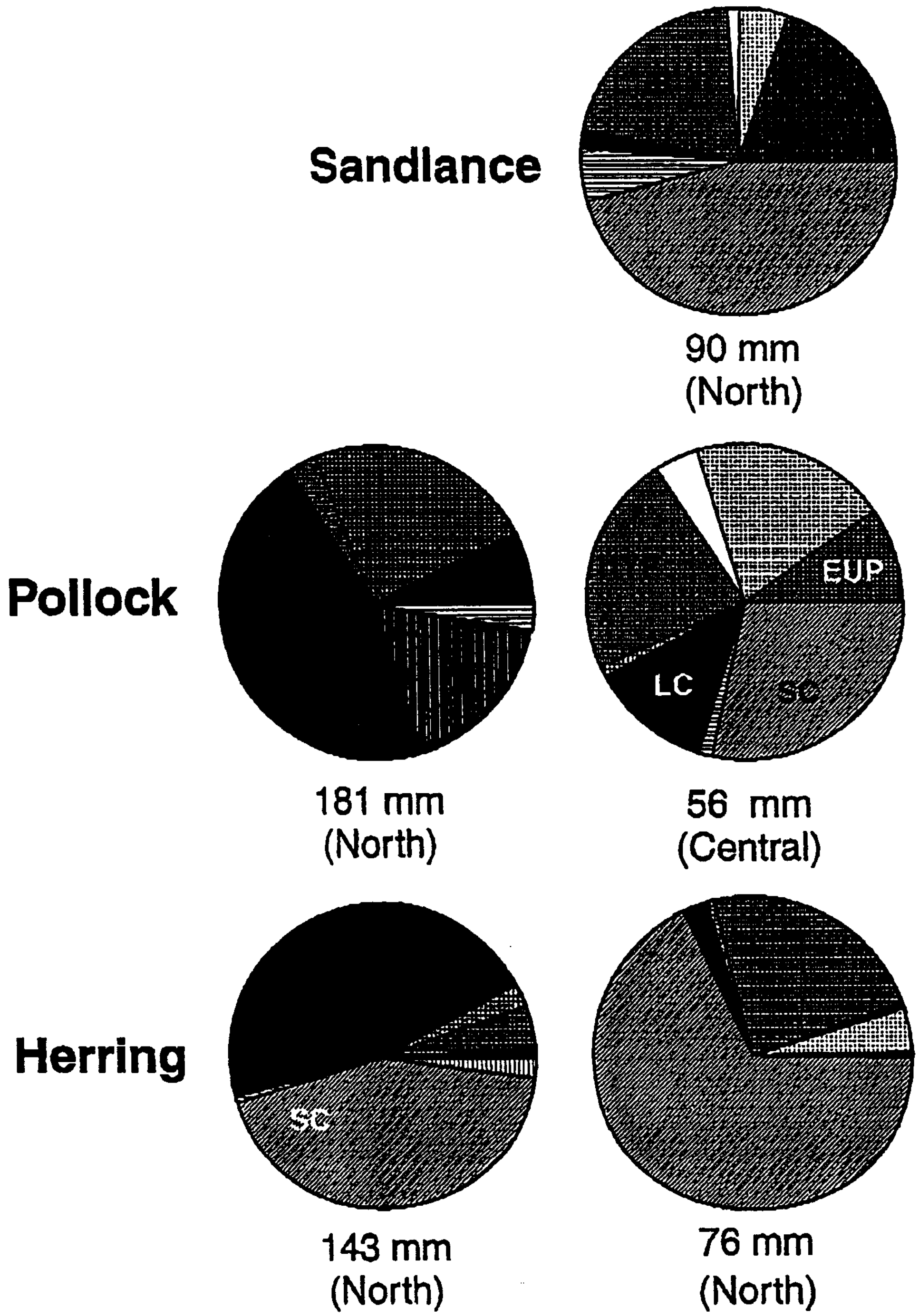

Figure 5 . Diet composition of forage fish collected in Prince William Sound in summer, 1995, as percent biomass of 15 prey categories, with mean FL and area collected. Preylegend is the same as in Figure x.

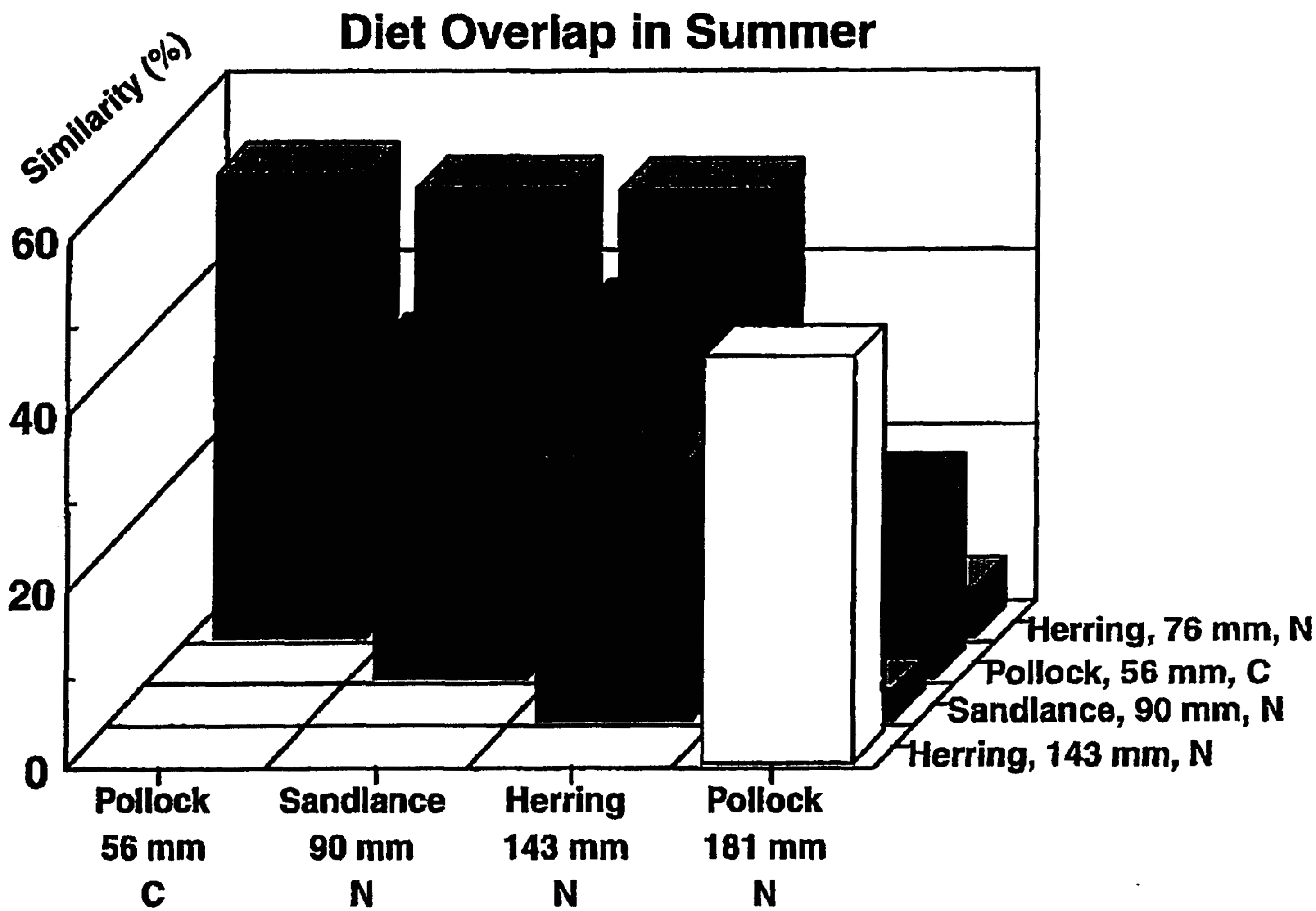

Figure 6 . Diet overlap (Percent Similarity Index) for forage fish collected in Prince William Sound in summer, 1995, with mean FL and area collected.

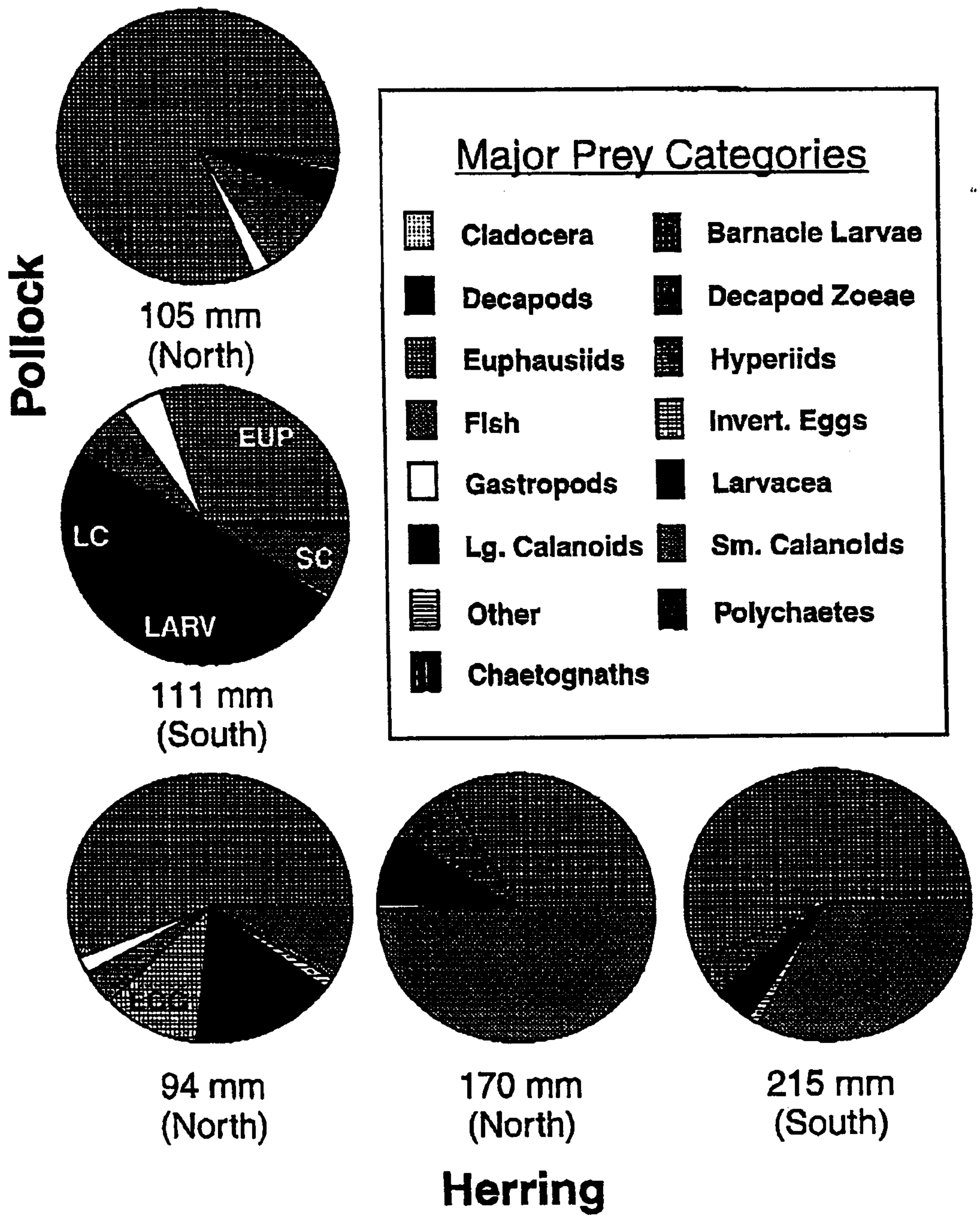

Figure 7. Diet composition of forage fish collected in Prince William Sound in fall, 1994,, as percent biomass of 15 prey categories, with mean FL and area collected. Prey category legend is the same as in Figure x.

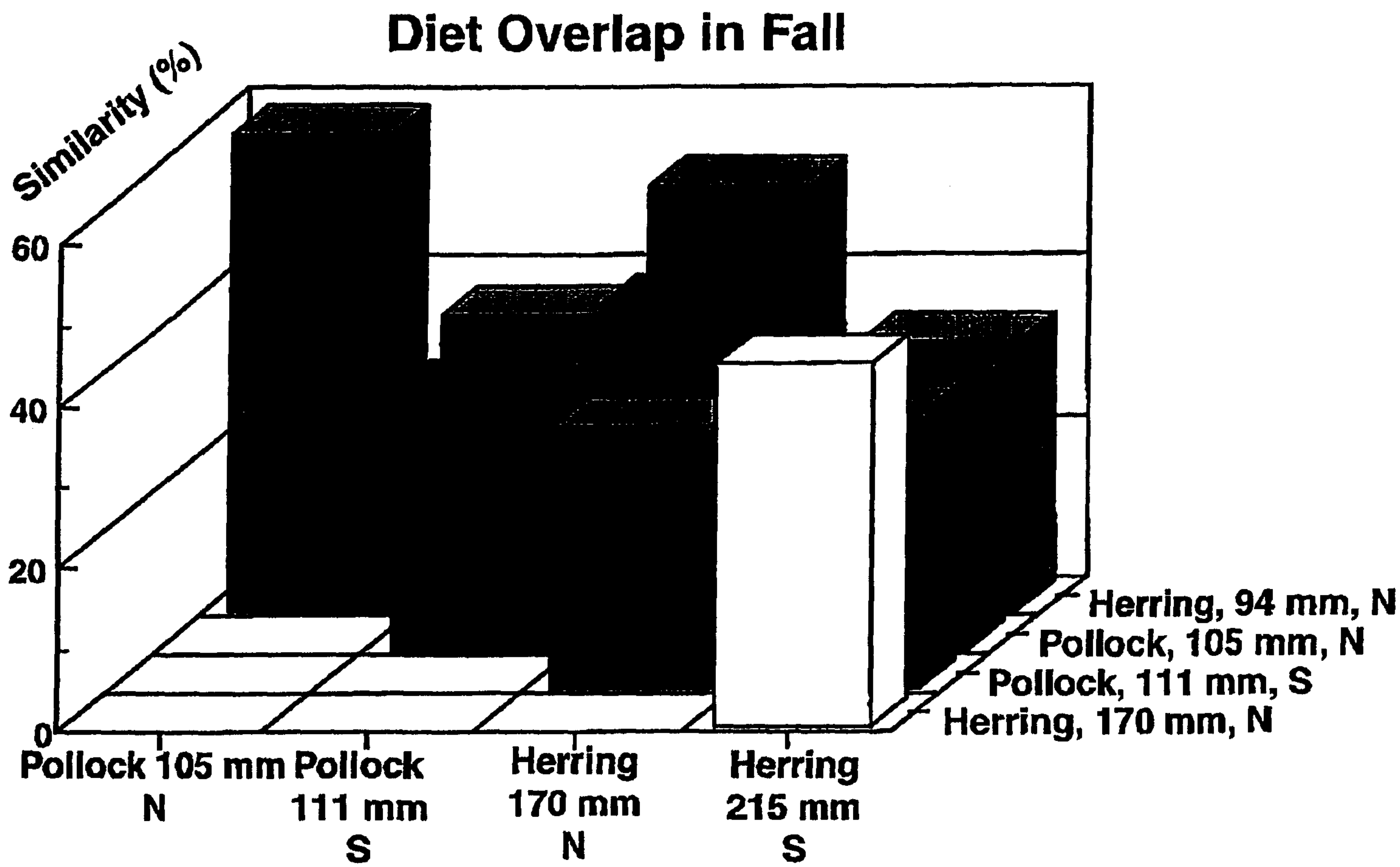

Figure 8. Diet overlap (Percent Similarity Index) for forage fish collected in Prince William Sound in fall, 1994, with mean FL and area collected.