WASHU-T-88-010 C2

Copies available at a minimal cost from:

University of Washington School of Fisheries
Fisheries Research Institute
554 Fisheries Center
Attn: Marcus Duke
University of Washington
Seattle, WA 98195 (206) 543-4678

FRI-UW-8819
November 1988

PUGET SOUND DREDGE DISPOSAL ANALYSIS (PSDDA) PHASE II DISPOSAL SITE BOTTOMFISH INVESTIGATIONS

FINAL REPORT

by

Robert F. Donnelly, Bruce S. Miller, John H. Stadler,
Lori Christensen, Karen Larsen, and Paul A. Dinnel

to

WASHINGTON SEA GRANT AND U.S. ARMY CORPS OF ENGINEERS

UNIVERSITY OF WASHINGTON
SCHOOL OF FISHERIES
FISHERIES RESEARCH INSTITUTE

FRI-UW-8819
November 1988

FISHERIES RESEARCH INSTITUTE
School of Fisheries
University of Washington
Seattle, WA 98195

PUGET SOUND DREDGE DISPOSAL ANALYSIS (PSDDA) PHASE II DISPOSAL SITE BOTTOMFISH INVESTIGATIONS

FINAL REPORT

by

Robert F. Donnelly, Bruce S. Miller, John H. Stadler,
Lori Christensen, Karen Larsen, and Paul A. Dinnel

to

WASHINGTON SEA GRANT AND U.S. ARMY CORPS OF ENGINEERS

Approved

Submitted 12-9-88 ______ R. C. Fron. ______
Director

ABSTRACT

Demersal fish populations were sampled on a quarterly basis in and around proposed dredge disposal sites as part of the Puget Sound Dredge Disposal Analysis (PSDDA) study. The study was conducted at two non-dispersive locations (Nisqually Reach and Bellingham Bay) and four dispersive locations (two in the Strait of Juan de Fuca, one in Rosario Strait, and one in the southern Strait of Georgia). Sampling was conducted at depths ranging from 15 to 140 m using a 7.6-m otter trawl.

Two Zones of Siting Feasibility (ZSFs) were located in Nisqually Reach, one near Ketron Island and the other near Devils Head. Twenty-seven species of fish were collected from Ketron Island, and 35 species were collected from Devils Head. Abundance, biomass, species richness and species diversity were usually higher within Ketron Island than the adjacent stations, with English sole and slender sole usually predominating in the catches. Large English sole were generally found deeper than small individuals. Species diversity and species richness were usually higher in Devils Head than adjacent stations, with abundance and biomass higher than or intermediate to the adjacent stations. Predominant species included English sole and blackbelly eelpout.

Two ZSFs were located in Bellingham Bay (north and south). The ZSFs were generally similar from season to season in abundance, species diversity and species richness; however, biomass was usually higher in the north ZSF than the south ZSF. A total of 43 and 32 species of fish were collected in the north and south ZSF, respectively. The shallowest depths adjacent to the ZSF usually had the lowest values in the ecological measures. Flathead sole, butter sole, starry flounder, English sole and longfin smelt predominated in the catches from the Bellingham Bay study area. Gravid flathead sole females in the north ZSF during Winter suggested spawning activity. Butter sole appeared to undergo offshore migrations during Autumn and Winter. Highest concentrations of starry flounder and English sole occurred during Winter. High abundance of longfin smelt juveniles and adults indicated that Bellingham Bay is used as both a nursery ground and forage area for this species.

Catches of bottomfishes in the dispersive sites and adjacent areas were generally low. Only young walleye pollock were found in substantial abundance, and then only in the Strait of Juan de Fuca during Autumn.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

Figure

Page

LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS.

A or (A)	adult, as in adult fish, generally defined as a fish over a certain size and varying by species
AEN	angioepithelial nodules
CPUE	catch-per-unit-effort, in this report defined as the catch of fish per trawl haul.
DSWG	Disposal Site Work Group
EP	epidermal papillomas
H'	species diversity
J or (J)	juvenile, as in juvenile fish, generally defined as a fish over a certain size and varying by species
m	meter
mm	millimeter
NODC	National Ocean Data Center
PCB	polychlorinated biphenyls
PSDDA	Puget Sound Dredge Disposal Analysis
TL	total length, length of a fish from the tip of the snout to the tip of the caudal fin (tail).
ZSF	Zone of Siting Feasibility
$>$	greater than
$<$	less than
$\geq$	equal to or greater than
$\leq$	equal to or less than

ACKNOWLEDGMENTS

This work was supported by the Washington Sea Grant Program in cooperation with the Seattle District, U.S. Army Corps of Engineers. We appreciate the valuable assistance of Louis Echols and Alan Kreckel, Washington Sea Grant Program; Frank Urabeck, David Kendall and Steve Martin of the U.S. Army Corps of Engineers; and members of the PSDDA Disposal Site Work Group. All trawl work was conducted on board the R/V *Kittiwake*, skippered by Charles Eaton. Abby Simpson, Maxine Davis, Marcus Duke and Roy Nakatani provided assistance with report preparation and editing.

INTRODUCTION

Several communities bordering Puget Sound are home to industrial and recreational facilities that require access to nearshore and estuarine waters. These facilities (both existing and planned) are usually in areas that are periodically dredged to maintain water depth for vessel use. The Puget Sound Dredge Disposal Analysis (PSDDA) study was undertaken to develop a management plan for the unconfined open-water disposal of dredged material. The responsibility for technical studies which identify and evaluate appropriate locations for public multiple use disposal sites has been assigned to the Disposal Site Work Group (DSWG). This group is composed of representatives from the U.S. Army Corps of Engineers, Environmental Protection Agency, Washington Department of Natural Resources, Washington Department of Ecology and other agencies and organizations responsible for or interested in dredged materials in Puget Sound. Final site selection was partially based on evaluation of the biological resources found at each of the proposed sites. This report gives the results of the trawl studies conducted to assess the bottomfish resources at, and adjacent to, dispersive and nondispersive Zones of Siting Feasibility (ZSF). A series of trawl surveys was conducted during 1987 in and around these ZSFs.

Fish are generally more mobile than benthic invertebrates and are presumably better able to escape the most direct effects of dumping (e.g., being buried). However, dredge disposal may also be detrimental to fishes in other indirect ways because species may utilize an area for feeding, spawning or as a nursery.

Since many bottomfish species feed on benthic invertebrates (Luntz and Kendall 1982), the value of an area as a bottomfish feeding habitat can be determined by examining the benthos. A change in the structure of the benthic community could have adverse effects on bottomfish populations. Numerous studies have documented changes in the benthic and bottomfish communities. Work in Upper Chesapeake Bay and in Long Island Sound has demonstrated that recovery of the benthic community may be complete 18 months after dumping of dredge materials has ceased (Chesapeake Biological Laboratory 1970; Schubel et al. 1979). Hughes et al. (1978) found that dumping dredged material in Elliott Bay, Puget Sound, had no lasting effects on the benthic community at the disposal site. A similar study has shown reductions in species diversity, density and biomass at disposal sites in Long Island Sound (Serafy et al. 1977). At a disposal site in Oregon off the mouth of the Columbia River, the benthic community was more diverse, but with lower biomass while the demersal fish species diversity, species richness and catch-per-unit-effort (CPUE) declined. Factors such as depth and material type have been suggested to influence the rate at which benthic communities recover (Grassle 1977; Schubel et al. 1979; Desbruyeres et al. 1980).

Huet (1965) suggested that changes in sediment composition may interfere with fish reproduction. Disposal of dredged material may also decrease the available shelter and result in increased inter- and intra-specific competition (Elner and Hamet 1984).

Fish health may be adversely affected by dumping contaminated materials. Fin erosion disease and liver disease in flatfish have been associated with the presence of PCBs and chlorinated hydrocarbons in the sediments (Sherwood 1976, 1978; Pierce et al. 1977; Cross 1982; Rosenthal et al. 1984). Increases in suspended sediments due to dumping have also been shown to affect fish. Johnson and Wildish (1981) demonstrated that herring will avoid dredge spoils. Suspended sediments may also clog the gills of fish causing asphyxiation (Sherk et al. 1974).

In order to minimize the impact of dredge disposal upon the bottomfish community, it is important to know which fish species are present and in what numbers. Furthermore, we must understand the temporal and spatial patterns of use by these fish species and the motivations for their presence in the area.

The purpose of this study was to assess the bottomfish community at both non-dispersive and dispersive ZSFs. A non-dispersive site is defined as one where the peak one percent current speed does not exceed 25 cm/sec; therefore, the material, which may contain low levels of contaminants, will stay on the site. These ZSFs were assessed in terms of species diversity, species richness, abundance, biomass, patterns of utilization and the state of flatfish health. The dispersive ZSFs were located in areas where the average current is greater than 25 cm/sec. Only clean materials will be dumped at these sites, which would then be dispersed by the strong tidal currents. The dispersive sites were only sampled twice (Spring and Fall) and at a limited number of stations since most of the disposal material would spread over a large area, presumably having little impact on bottom-dwelling fish. For most of the dispersive sites, the forecasted potential annual volume of dredged material that could be dumped is relatively low, which should also minimize physical impacts. The data contained in this report are intended to aid the PSDDA agencies in the final site selection process and in developing site management plans such that any potential adverse impacts on the bottomfish community will be minimized.

The following report is divided into two sections. The first section includes the Nisqually area and Bellingham Bay, both designated to be the locations of non-dispersive ZSFs. The second section is comprised of the dispersive ZSFs, which include: Point Roberts in the Strait of Georgia, Rosario Strait, and two ZSFs in the Strait of Juan de Fuca—one near Port Townsend, the other near Port Angeles.

NONDISPERSIVE SITES

MATERIALS AND METHODS

Description of the Study Areas

Nisqually Area.

The Nisqually study area is within Nisqually Reach, located at the southern end of Puget Sound between Tacoma and Olympia (Figure 1). The study was carried out in two separate parts of the area, one to the east, the other to the west. The eastern study area (Ketron Island Site), which contained ZSF2, was located between Anderson and Ketron islands and the mainland to the southeast (Figure 2). The bathymetry is typical of Puget Sound with steep side slopes and deep gently sloping flat bottom. The flat bottom ranged from 110 m to 140 m in depth and was composed of sandy mud. The western study area (Devils Head site), which contained ZSF3, was located between Anderson Island, Devils Head and the mainland to the southwest. While the bathymetry is similar to that of the eastern site, the western site was relatively shallow, with a depth of only 60 m. The Nisqually River and its associated delta are a major source of freshwater that lies between the two study sites on the south.

Bellingham Bay.

Bellingham Bay is located southeast of the southern end of the Strait of Georgia between Lummi Island and the adjacent mainland to the east (Figure 3). The Nooksak River flows into the north end, providing a large source of freshwater. The study was confined mostly to the deep portions of Bellingham Bay. The bottom is fairly flat, generally between 25 m and 30 m deep, and muddy. The side slopes, although not extensive, are steep and typical of the bathymetry in Puget Sound.

Sampling Design

The sampling design was stratified by depth and season. Results of other studies in Puget Sound (Lauth et al. 1988, Donnelly et al. 1984a, b; Wingert and Miller 1979) indicated that depth and season are important when stratifying substrate to obtain meaningful data on the fish community.

Nisqually Area.

The Ketron Island site was divided into six depths (20 m, 40 m, 60 m, 80 m, 110 m, and ZSF2), while the Devils Head site was divided into four (20 m, 40 m, 60 m and ZSF3) (Figure 2) . Samples were collected quarterly during 1987, with all depths generally being sampled twice except the ZSFs, which were sampled six times per season (Table 1). ZSF2 was located at a depth between 120 m to 140 m while ZSF3 was located at a depth between 45 m to 55 m.

Bellingham Bay

Four strata (15-20 m, >20 m, north ZSF and south ZSF) were sampled quarterly in Bellingham Bay (Figure 3). The ZSFs were located at a depth of approximately 30 m. The number of samples varied between strata and seasons and is listed in Table 2.

Description of the Sampling Gear

A 7.6-m otter trawl (Figure 4) was used to capture bottomfish. The otter trawl was a semi-balloon design with bridle, otter doors and net (Mearns and Allen 1978). The bridle was 22.7-m long and made of 1.5-cm braided nylon. The otter doors were 51 cm by 80 cm and weighed 23 kg. The body of the net was made of 3.5-cm stretch mesh covered with 2.5-cm stretch mesh to prevent chafing. The otter trawl was deployed from the 16-m research vessel *Kittiwake*. The effective fishing width of the net was 3.5 m (Donnelly et al. unpublished data). Each sample CPUE was collected by towing the otter trawl for a distance of 370 m at a target ground speed of 4.6 km per hour.

Sample Preservation

All fish collected in the field were placed in plastic bags, put on ice and later transferred to a freezer for storage. Each bag was labeled inside and outside to ensure proper identification.

Sample Processing

Fish samples were removed from the freezer and allowed to thaw. Fish were separated by species, and all flatfish, gadids (Pacific cod, Pacific tomcod, Pacific hake, and walleye pollock), surf perch (pile perch, shiner perch and striped seaperch) and ratfish were further separated by life history stage (i.e., juvenile or adult). Flatfish and gadid species juveniles were defined as being less than or equal to 120 mm in total length (TL). Surf perch were considered juveniles if they were less than or equal to 100 mm TL. The tips of ratfish tails were often missing; therefore, a length from snout to the end of the second dorsal fin, as well as total length (when possible), was recorded. Juvenile ratfish were defined as less than or equal to 150 mm to the end of the second dorsal fin. Length of each fish, total number and weight for each species and each life history stage were recorded. When a large number of individuals per species and/or life history stage were present in a sample, a subsample of at least 30 randomly selected individuals was measured and weighed, and the remainder was counted and weighed.

Female English sole were examined in the field for sexual maturity to determine if the areas were used as a spawning grounds. Sexual maturity was determined by the presence of ripe and running eggs. Gross (macroscopic) examination for fin erosion, skin tumors, liver tumors, and blood worms (*Philometra* sp.) was conducted on all flatfish species caught.

Fin erosion typically affects the anal and dorsal fins and varies in severity from minor defects to extensive destruction of the fins. The less severe cases exhibit partial loss, fusion, or destruction of the fin rays, typically accompanied by hemorrhages and granulation tissue on the surface of the fin. Along the free edge of the diseased fin there is usually a line of hyperpigmentation. In the most severe cases, parts of the fins exhibit complete loss of fin rays, and the remaining tissue becomes greatly scarred, retracted, flaccid and deformed (Wellings et al. 1976).

Skin tumors are known for several species of flatfish (Southern California Coastal Water Resources Project (SCCWRP) 1973) and the tumors are found as two main types: angioepithelial nodules (AEN) and epidermal papillomas (EP) (Angell et al. 1975; McArn et al. 1968; Miller and Wellings 1971). Field and laboratory experiments have shown the tumor types to be different stages of the same disease (McArn et al. 1968). AEN tumors may be located anywhere on the external surface of the fish and are 1 mm to 5 mm in diameter, hemispherical, pink to red, smooth surfaced, and sessile lesions (Miller et al. 1977); they are typically found on small (usually juvenile) flatfish. EP tumors were circular, 5 mm to 50 mm in diameter, brown to black, and with the outer surfaces cauliflower-like in appearance.

A random subsample (about 20%) of all adult flatfish livers was examined macroscopically for liver tumors and other obvious abnormalities. Liver tumors have been observed in several species of flatfish (Malins et al. 1982; Landolt et al. 1984). The liver, which is involved in a wide variety of physiological activities, has been shown in fishes to be sensitive to the effects of contaminants (Sinnhuber et al. 1977).

All flatfishes were examined in the laboratory for bloodworm (*Philometra* sp.), which is known to infect marine flatfish. The bloodworms are clearly visible and are typically located in the subcutaneous areas near or at the base of the fins. Bloodworms can be large, up to 100 mm in length by 2 mm in diameter, and are colored bright red (Amish 1976). The external appearance of the parasite in the fish resembles a dull red blister, usually less than 10 mm long.

Data Analyses

All the data were collected and recorded on forms following the National Ocean Data Center (NODC) format. Analyses were done graphically, with a hand calculator, and by computer program (Microsoft Excel).

Abundance and Biomass.

Abundance and biomass CPUE values were computed for each stratum and season for all species combined. Total and average abundance and biomass values for each stratum and each fish species were tabulated by season.

Species Diversity

The species diversity index (H') combines the number of fish species and their relative abundances. This index can be useful when comparing different habitats (Pielou 1975). Species diversity was calculated for each strata, season, and gear type. The formula used for species diversity was

$$H' = \sum_{i=1}^{n} p_i \ln p_i,$$

where p_i was the proportion of the community that belonged to the i^{th} species and n was the number of species.

Species Richness

Species richness, defined as the total number of species caught, was calculated for each stratum. Pielou (1975) discussed the use of community indices and considered species richness a useful tool in ecological studies of aquatic communities.

Species Composition

Dominant species caught at each depth (or stratum) and season were tabulated by relative abundance (Kenkel and Orloci 1986).

Length-Frequency

Length-frequency histograms were constructed for the most abundant exploited species found in the ZSFs using all fish captured. No attempt was made to standardize the histograms based on the number of trawls in each stratum. The results were displayed graphically in three forms:

(1) all seasons and depths (strata) combined,
(2) by season and depth (stratum), and
(3) by sex and life history stage where possible (i.e., large enough sample size to result in a meaningful graph).

Estimation of age at size and/or reproductive age at size was extracted from the literature as follows: English sole (Holland 1954; Angell 1972), Pacific hake (Pedersen 1985), Dover sole (Hagerman 1952).

Species Clusters

A numerical classification (or cluster analysis) technique was used to identify species assemblages. Advantages of the technique include:

(1) objective criteria that can be applied to a large data set to arrive at a summary,
(2) analysis that is based upon quantitative catch data, and
(3) results that can be evaluated at different levels of statistical similarities.

Data preparation involved creating a data matrix composed of catch data (numbers or weight) for a set of species among a set of strata within each season. The data were transformed ($\log_{10}$ (observation +1)) to reduce and normalize the variability. After transformation, resemblance measures were computed between species, which resulted in a matrix of resemblance values. A hierarchical clustering technique was used (Boesch 1977; Clifford and Stephenson 1975) to combine stepwise species based upon similarities (or dissimilarities) of their attributes. The dissimilarities were computed using the Bray-Curtis distance measure (Beals 1984; Bray and Curtis 1957).

A dissimilarity index of 0.75 was used as a cut-off for establishing dominant species groups.

Station Clusters

Cluster analysis was used to identify clusters of stations for two purposes: (1) to identify of a possible reference (control) site or sites that may be used in future monitoring after dredge disposal begins; and (2) to verify the basis for the selection of strata. The technique was the same as that used for species clustering. Details on the technique are given earlier, substituting site for species.

RESULTS

Nisqually Area

Fifty-one species of fish were caught at the Ketron Island site while 44 species were found at the Devils Head site during the course of this study (Table 3). Table 3 lists both common and scientific names for the fishes caught, but for the sake of easier reading, only common names of species will be used in this report.

Abundance and Biomass

Ketron Island Site. Abundance CPUE ranged from 12 to 775 fish and biomass CPUE ranged from 7 kg to 61 kg. In general, abundance and biomass CPUE values showed similar fluctuations throughout the study period (Figure 5). ZSF2 had the highest abundance values during Spring and Summer and the highest biomass values during Spring and Autumn. During Winter the 40 m depth dominated the abundance while the 60 m depth dominated the biomass. Abundance and biomass CPUE values for all species, depths and seasons are listed in the Data Appendix .

Devils Head Site. Abundance CPUE ranged from 31 to 516 fish and biomass CPUE ranged from 3 kg to 23 kg. Abundance and biomass CPUE value fluctuations were dissimilar from season to season (Figure 6). The 40 m depth consistently had the highest abundance; however, only during Winter and Autumn did biomass dominate. ZSF3 had the highest biomass values during Spring and Summer. Abundance and biomass CPUE values for all species, depths and seasons are listed in the Data Appendix.

Species Diversity

Ketron Island Site. Species diversity (H') varied by season and depth (Figure 7). Values at all depths fluctuated little between seasons except for 40 m, which was low during Winter, then higher in Spring, and relatively unchanged thereafter. ZSF2 had the highest H' value of all depths during Winter, the lowest value in Spring and intermediate values in other seasons.

Devils Head Site. Species diversity varied little by depth and season with the highest and lowest values occurring at 20 m during Summer and Autumn, respectively (Figure 8).

Species Richness

Ketron Island Site. Species richness varied by season and depth (Figure 9). Generally, the 20- and 110-m depths had the lowest values in each season except during Autumn, when the 20-, 40-, 60- and 110-m depths had similar values and were all low. ZSF2 had intermediate to high values throughout the year.

Devils Head Site. Species richness showed similar patterns for each season except for Summer, when the 20-m depth value increased (Figure 10). In general, the 20-m depth was the lowest except Summer, while ZSF3 values were the highest for all seasons.

Species Composition and Relative Abundance

Ketron Island Site. Species composition and relative abundance varied among depths and among seasons within a depth. Table 4 lists the relative abundance (as a percent of the total) of each species by depth and season.

20-m depth. Twenty-two species of fish were caught during the course of the study. Three species (English sole, rock sole and speckled sanddab) occurred during each sample period. Buffalo sculpins and roughback sculpins were present during three of the sampling periods. While these five species were present most often, in terms of relative abundance the predominant species varied among the seasons and was not necessarily one of these five. Tubesnouts and walleye pollock juveniles accounted for over 80% of the total catch during Summer while shiner perch juveniles predominated in Autumn. Ratfish and rock sole were most abundant during Winter and Spring.

40-m depth. A total of 28 species was caught at this depth. Three species (English sole, rock sole and roughback sculpin) were found throughout the year, while four species (quillback rockfish, shiner perch, speckled sanddab and sturgeon poacher) were found during three of the four seasons. Generally, rock sole and roughback sculpins predominated in the catch, followed by English sole.

60-m depth. Sampling at the 60 m depth resulted in the capture of 24 species. Of these 24 species, 3 (English sole, quillback rockfish and rock sole) were present throughout the sampling period. Four species (Pacific tomcod, ratfish, roughback sculpin and shiner perch) were present during three seasons. The single most abundant species throughout the year was English sole, followed by Pacific tomcod and ratfish in the Winter, and rock sole in Summer.

80-m depth. Thirty species were captured throughout the year at this depth. Five of the 30 species (English sole, quillback rockfish, Pacific tomcod, ratfish and slender sole) were present in all seasons, while 6 species (blacktip poacher, butter sole, plainfin midshipman, rock sole, roughback sculpin and shiner perch) occurred during three of the four seasons. Predominant species varied from season to season. Generally, English sole was a major contributor, with Pacific tomcod, rock sole and ratfish occurring in high relative abundance during Winter, Spring and Summer, respectively.

110-m depth. Sixteen species were collected at the 110-m depth during the study. English sole, quillback rockfish, ratfish and slender sole were present in the catches throughout the sampling period. Two other species, brown rockfish and Pacific tomcod, were present during three sampling periods. English sole had the highest relative abundance for all seasons except Winter, when ratfish were prevalent. Slender sole were also in relatively high abundance, second only to English sole and ratfish throughout the year.

ZSF2. Twenty-seven species were captured in ZSF2 during the study. Almost one-half of the species occurred during either three or four of the seasons. Pacific hake was found during all seasons except Winter, while blacktip poacher, brown rockfish, Dover sole, English sole, longnose skate, Pacific tomcod, plainfin midshipman, quillback rockfish, ratfish, rex sole and slender sole were found throughout the year. English sole and slender sole were the predominant species, together accounting for 35 to 80 percent of the relative abundance during each season.

Devils Head Site. Species composition and relative abundance varied among depths, and among seasons within a depth. Table 5 lists the relative abundance (as a percent of the total) of each species by depth and season.

20-m depth. Twenty-four species of fish were caught during the course of the study. Four species (English sole, rock sole, roughback sculpin and shiner perch) occurred during each season. Snake prickleback were present during three of the sampling periods. The predominate species in terms of relative abundances changed from season to season. Rock sole, roughback sculpin and speckled sanddab predominated during Winter; English sole, rock sole and speckled sanddab were predominant in Spring; and speckled sanddab increased and snake prickleback decreased in Summer. Seventy-five percent of the catch was represented by rock sole and shiner perch during Autumn.

40-m depth. A total of 25 species was caught at this depth. Seven species (English sole, rock sole, roughback sculpin, sand sole, shiner perch, slender sole and slim sculpin) were found throughout the year, while three species (blackbelly eelpout, Pacific tomcod and sturgeon poacher) were found during three of the four seasons. English sole were the predominant species, except for Summer when Pacific tomcod accounted for over 55 percent of the fish caught, followed by English sole at approximately 20 percent.

60-m depth. Sampling at 60 m resulted in the capture of 28 species. Six of these 28 species (blackbelly eelpout, English sole, Pacific tomcod, plainfin midshipman, shiner perch and slender sole) were present throughout the study. Four species (blacktip poacher, ratfish, roughback sculpin and spiny dogfish) were present during three seasons. Species dominance varied from season to season with blackbelly eelpout and shiner perch the most abundant during Winter and Pacific tomcod in the Summer. English sole accounted for approximately 50% of the abundance during Spring and Autumn.

ZSF3. Thirty-five species were captured in ZSF3 during the study. Over one-half of the species occurred during either three or four of the sampling periods. Blackbelly eelpout, blacktip poacher, English sole, longnose skate, Pacific herring, Pacific tomcod, plainfin midshipman, ratfish, rex sole, rock sole, roughback sculpin, shiner perch and slender sole were all found throughout the year. Six other species (flathead sole, Pacific hake, sand sole, snake prickleback, speckled sanddab and spiny dogfish) were captured during three seasons. The predominant species varied from season to season with blackbelly eelpout, Pacific tomcod and shiner perch constituting the bulk of the relative abundance during Winter. In contrast, blackbelly eelpout and English sole predominated during Spring, and with the addition of Pacific tomcod, also predominated the rest of the year.

Abundance and Length Frequency Analysis of English Sole.

Ketron Island Site. English sole were found at each depth during each season (Figure 11). The abundance of English sole varied by season and depth. The highest catches for each season occurred at ZSF2, except during Winter when the largest catch was at 60 m. The 20-m depth consistently had the lowest abundance of English sole.

Length-frequency plots of English sole indicated the presence of at least seven year-classes within the study area (Figure 12). Length-frequency plots were made for only those depths that showed high abundance or had some other attribute such as a concentration of juveniles. Female English sole size distributions indicated they were on average larger than male English sole. No ripe females were found during this study.

In general, the largest English sole were found at the greatest depth (Figure 12). Small, apparently young-of-the-year English sole were found almost exclusively at the 20-m depth . The largest females and males occurred in ZSF2, where the females were on average larger than the males. The length-frequency histogram of the 110-m depth stratum was composed almost entirely of females. At 60 m, males were present but smaller than the females.

Devils Head Site. The abundance of English sole varied by depth and season (Figure 13). In general, the highest abundances were found at 40 m; the exception was Summer, when few English sole were captured at any depth. The greatest number of English sole was located at 40 m during Winter, while the lowest number was found at 20 m in Autumn. The abundance of English sole in ZSF3 was generally intermediate in value except during Autumn, when the ZSF3 abundance was second only to the 40-m depth during the same month.

The length-frequency plots of English sole at the 40-m depth indicated the presence of only one or two year-classes (Figure 14) consisting of fairly small fish. The

60-m depth and ZSF3 contained older fish in which the females were larger than the males.

Species Clusters

Ketron Island Site. The results of the species cluster analysis for each season are shown in Table 6. There were three main groups during each season and the composition of the groups changed from season to season. Adult English sole generally clustered with species associated with depths >50 m (e.g., slender sole and ratfish). The number of subgroups ranged from zero to 5. The composition of the subgroups changed from season to season.

Devils Head site. The number of major groupings varied for each season (Table 7). The number of subgroups ranged from 2 to 4. Species composition for each group or subgroup varied from season to season. The species that were associated with English sole adults varied for each season; however, English sole were generally affiliated with species found to occur at depths of 40 m or more.

Station Clusters

Ketron Island Site. Segregation of the stations appeared to be related to depth (Figure 15). The 20-m and 40-m depths usually clustered together. The 110-m depth always associated with ZSF2 stations and the ZSF2 stations fell within the same group three of the four seasons. The 60-m depth appeared to be intermediate between the deep and shallow stations, sometimes grouping with either the 40-m or 80-m depths.

Devils Head Site. Results of the cluster analysis are summarized in Figure 16. The stations generally clustered by depth, with the 20-m and 40-m depths segregating as either a distinct group or as separate stations. Most ZSF3 stations and the 60-m depth were closely related throughout the year. The ZSF3 stations showed separate groupings, depending on the time of the year. ZSF3 stations 1 and 2 formed a subgroup during three of the four seasons, while the other ZSF3 station associations were more diverse.

Flatfish Health

Ketron Island Site. Dover sole, English sole, flathead sole, rex sole and rock sole all showed indications of blood worm infestations (Table 8). The incidence of *Philometra* sp. varied among species, seasons and depths, but did not show a discernible pattern. One liver tumor was found by gross examination in a rex sole during Spring in ZSF2. There was zero incidence of fin erosion and skin tumors.

Devils Head Site. Blood worm infestation was found in English sole, rex sole, rock sole and sand sole (Table 9). The incidence of *Philometra* sp. varied among species, seasons and depths, and did not show a discernible pattern. Two skin tumors were noted on English sole at 40 m during Spring. There was zero incidence of fin erosion and liver tumors.

Bellingham Bay

Fifty-six species of fish were caught during the course of this study. Table 10 lists both common and scientific names of the fishes; for ease of reading, only common names of species are used in the rest of this report.

Abundance and Biomass

Abundance from a single sample ranged from 16 to 1592 for Autumn and Summer, respectively, while average biomass from a single sample ranged from <1 kg to 66 kg for Autumn and Winter, respectively. Average abundance and biomass CPUE values varied considerably and showed few similarities during the study period (Figure 17). Generally, 15- to 20-m depth had the lowest abundance and biomass values. The north ZSF dominated the biomass values while the south ZSF and >20-m depths showed similar values throughout the year. The north ZSF had the largest abundance values during Winter and Autumn, the south ZSF and >20-m depths were highest in Spring, and >20-m depths were slightly higher than the north ZSF during Summer.

Abundance and biomass CPUE values for all species, strata and seasons are listed in the Data Appendix.

Species Diversity

Species diversity varied by season and stratum (Figure 18). In general, Spring, Summer and Autumn species diversities showed similar patterns by depth or season. The lowest species diversity value occurred during Summer at the south ZSF and the highest during Autumn at 15- to 20-m depths. Summer values were low except for 15- to 20-m depths. The species diversities at the ZSFs were generally intermediate in value.

Species Richness

Species richness varied by depth and season (Figure 19). In general, 15- to 20-m depths showed the greatest variation, while the south ZSF showed almost no variation. Depths greater than 20 m had the highest values for all seasons except Summer, when the north ZSF was slightly higher. With the exception of Summer, the two ZSFs were intermediate in value throughout the year.

Species Composition and Relative Abundance

Species composition and relative abundance varied between strata, and between seasons within a stratum. Table 11 lists the relative abundance (as a percent of the total) of each species by stratum and season.

15- to 20-m depth. Thirty-four species were captured throughout the year at this depth. Pacific tomcod, shiner perch and staghorn sculpin were present in all seasons, while six species (butter sole, rock sole, sand sole, snake prickleback, speckled sanddab and starry flounder) occurred during three of the four seasons. Predominant species varied from season to season. Pacific tomcod were in high relative abundance throughout the year; other species that predominated included shiner perch (Winter), butter sole and English sole (Spring), longfin smelt (Summer) and Pacific herring and shiner perch (Autumn).

>20-m depths. Forty-six species were collected in >20-m depths during the study. Sixteen species (blackbelly eelpout, butter sole, daubed shanny, English sole, flathead sole, longfin smelt, Pacific herring, Pacific tomcod, plainfin midshipman, sand sole, shiner perch, snake prickleback, spiny dogfish, spinyhead sculpin, staghorn sculpin and starry flounder) were present in the catches throughout the study. Four other species (rex sole, shortfin eelpout, slim sculpin and sturgeon poacher) were present during three seasons. Longfin smelt, blackbelly eelpout, and shiner perch predominated in the catches, with longfin smelt showing the highest relative abundance for the entire year.

North ZSF. Forty-three species were captured in the north ZSF during the study. Blackbelly eelpout, butter sole, daubed shanny, English sole, flathead sole, longfin smelt, Pacific herring, Pacific tomcod, shiner perch, spiny dogfish and starry flounder were found throughout the year. Six other species (pile perch, plainfin midshipman, sand sole, shortfin eelpout, snail prickleback and staghorn sculpin) were captured during three seasons. The predominant species throughout the year was longfin smelt, with blackbelly eelpout and English sole making a substantial contribution to the catch during Spring.

South ZSF. Thirty-two species were found within this ZSF during the study. Eighteen of the species occurred during either three or four of the seasons. Nine species (blackbelly eelpout, butter sole, English sole, flathead sole, longfin smelt, Pacific herring, Pacific tomcod, slim sculpin and spinyhead sculpin) were found during each sampling period. Another nine species (daubed shanny, plainfin midshipman, sand sole, shiner perch, shortfin eelpout, snail prickleback, spiny dogfish, staghorn sculpin and starry flounder) were captured during three seasons. The predominant species throughout the year was longfin smelt. Two other species that contributed substantially were shiner perch (Winter) and blackbelly eelpout (Spring).

Abundance and Length Frequency Analysis

Butter Sole. Butter sole were present in all strata and seasons except 15- to 20-m depths during Autumn (Figure 20). The distribution varied through space and time. The largest catches of butter sole occurred both at 15- to 20-m depths and the north ZSF during Winter, as well as the south ZSF during Autumn. The lowest abundance of butter sole was found at the 15- to 20-m depth during Winter and Autumn, and the south ZSF during Spring and Summer.

Length-frequency plots of butter sole at >20-m depths and the north ZSF and the south ZSF show the presence of several size-classes within the study area (Figure 21). The size distributions of the two sexes showed that females were only slightly larger than males. The distribution of sizes among the three strata was similar. Depths >20 m showed the most pronounced modality; however, the length-frequency plots of the two ZSFs indicated the presence of minor peaks of abundance. Field sampling during the Winter indicated the presence of gravid females.

English Sole. English sole were present in all strata during all sampling periods except the Winter and Autumn samples at 15- to 20-m depths (Figure 22). Low abundances of English sole were found at all depths during Summer and Autumn. The south ZSF had the highest abundance during Spring followed by the north ZSF during Winter and Spring.

Length-frequency plots of English sole indicate the presence of several size-classes within the study area (Figure 23). Depths >20 m contained a preponderance of small fish, while the two ZSFs had an even distribution of all sizes within the ranges exhibited. Gravid females were collected throughout the study area during the Winter.

Flathead Sole. Flathead sole were found in >20-m depths and the two ZSFs during all seasons (Figure 24). Depths of 15-20 m had few or no flathead sole throughout the year. The highest abundance values of flathead sole were found at the north ZSF during Winter and Spring, and the south ZSF during Summer and Autumn. Depths >20 m had the second highest abundance during each season.

The length-frequency distributions contain many size-classes from apparent young-of-the-year to individuals exceeding 5 years of age (Figure 25). Apparent young-of-the-year were located primarily in >20-m depths and the south ZSF. In all, three strata (>20-m depths, north ZSF and south ZSF) had size distributions that showed females were larger than males. Except for the apparent young-of-the-year, the size distributions at the three strata were similar. Field observations indicated the presence of gravid females scattered throughout the study area during the Winter.

Starry Flounder. Starry flounder were generally found in lower abundance than butter sole, English sole and flathead sole (Figure 26). The distribution of starry flounder showed a pronounced seasonality with the highest abundance occurring during Winter in the two ZSFs.

Length-frequency histograms of fish from >20-m depths and the north ZSF indicated the presence of several size classes (Figure 27). The largest starry flounder found in the north ZSF were females. Although the size distribution at >20-m depth showed females to be larger than males, the difference was not as pronounced. No gravid females were located during the course of this study.

Longfin Smelt. Longfin smelt occurred in higher abundance than the above four flatfish (Figure 28). Abundances varied between strata and seasons. Longfin smelt occurred in substantial numbers at >20-m depths and the two ZSFs throughout the year, but were rarely found in 15- to 20-m depths at any time (Figure 28). The highest abundance was found at the north ZSF in Winter; during other seasons, the ZSFs had intermediate values.

Length-frequency distributions were constructed for all strata except the 15- to 20-m depths, and indicated the presence of only two strong size-classes (Figure 29). Depths >20-m depths, the north ZSF and the south ZSF all contained large individuals, while >20 depths also contained small individuals.

Species Clusters

The results of the species cluster analysis for each season are shown in Table 12. There were four or five main groups for each season and the composition of these groups changed with each season. The main groups also contained subgroups; the number of these ranged from zero to three. The composition of the subgroups, like the main groups, changed from season to season. Four species (English sole, butter sole, flathead sole and starry flounder) usually grouped together in the same or closely related groups throughout the study period.

Station Clusters

Results of the station cluster analysis are summarized in Figure 30. The most distinct location in Bellingham Bay was the 15- to 20-m depth zone, which was always separated by the greatest distance from all other stations. Those stations inside and outside of the ZSFs showed inconsistent patterns of association during the year. All stations outside of the 15- to 20-m depth aggregated as a distinct group or as separate subgroups.

Flatfish Health.

Butter sole, English sole, flathead sole, rock sole and starry flounder all showed indications of blood worm infestation (Table 13). The incidence of *Philometra* sp. varied between species, seasons and strata, and did not show a discernible pattern. Four skin tumors were noted; two on English sole caught at >20-m depths during Winter, one on an English sole at the >20-m depth during Spring, and one on a flathead sole found in the south ZSF during Summer. There was no incidence of fin erosion and liver tumors.

DISCUSSION

Nisqually Area

Ketron Island Site

Results showed that differences and similarities existed between ZSF2 and other strata within the study area. Station clustering indicated that the shallow strata were distinct from the deep strata and that the 110-m depth was most closely related to ZSF2. Abundance, biomass, species richness and species diversity were usually higher in ZSF2 than adjacent depths.

Differences in bottom topography between strata may account for some of the variability. The 20-m through 80-m depths occurred on a steep slope subjected to substantial tidal currents, whereas 110-m depth and ZSF2 are located on the relatively flat bottom. The ZSF2, and to some degree the 110-m depths, were considered depositional, while the side slope was not (David Kendall, US Army COE, personal communication). Physical differences such as these may influence the structure of a fish community (Becker 1984; SCCWRP 1973).

Temporal differences also occurred in measures of the fish community. The peaks in abundance and biomass that occurred during Spring and Autumn were apparently due to high concentrations of English sole. Species richness and species diversity at ZSF2 were highest during Autumn and Winter, respectively. Species richness and species diversity were generally low at the 20-m and 110-m depths throughout the year, while the 40-m through 80-m depths usually had intermediate values. Results of other studies contradict those of the present one. Lauth et al. (1988), Donnelly et al. (1984a, b), Moulton et al. (1974), and Miller et al. (1976) found that abundance, biomass, species diversity, and species richness were generally greatest at 40 to 50 m depths. The present study was limited to a single year of sampling; therefore, the trends in seasonal variability discussed above may not hold true from year to year.

Devils Head Site

Results indicated that differences and similarities existed between ZSF3 and other depths within the study area. Species richness and species diversity were most often higher at ZSF3 than adjacent depths; however, abundance and biomass values fluctuated considerably within the ZSF, but were either high or intermediate compared to shallower depths. Previous studies in Puget Sound generally support these findings. Lauth et al. (1988), Donnelly et al. (1984a, b, 1986) and Moulton et al. (1974), found abundance, biomass, species diversity and species richness were usually greatest at depths of 40 to 50 m, similar to those found in ZSF3. These results suggest that ZSF3 is relatively rich in fish resources compared to the adjacent area.

Cluster analysis of the sampling stations showed that the 60-m depth and ZSF3 were most closely related while the 20-m and 40-m depths segregated from the deeper strata. Differences in bottom topography between strata may account for some of the variability. The 20-m and 40-m depths occurred on a side slope, whereas ZSF3 and the 60-m depth occurred on the relatively flat bottom. ZSF3, and to some degree the 60-m depth, were considered depositional, while the side slope was not (David Kendall, US Army COE, personal communication). Physical differences such as these may influence the structure of a fish community (Becker 1984; SCCWRP 1973).

Temporal differences also occurred in measures of the fish community. The peaks in abundance and biomass that occurred during the year were due in large measure to high concentrations of English sole; however, other species such as Pacific tomcod, rock sole and shiner perch showed occasional peaks in abundance. Species richness at ZSF3 was high throughout the year, while species diversity was high during

Winter and Spring. Species richness was generally low at 20 m throughout the year while species diversity fluctuated from low to high. Results of other studies (Lauth, et al. 1988; Donnelly et al. 1984a, b; Moulton et al. 1974; Miller et al. 1976) show similar species richness patterns, but do not show the same species diversity patterns. The present study was limited to a single year of sampling; therefore, the trends in seasonal variability discussed above may not hold true from year to year.

ZSF Focus

Most species were caught in low numbers and occurred sporadically. English sole and slender sole usually predominated at ZSF2 and 110 m, and were usually associated with each other in the cluster analysis. The predominant species and relative abundances were similar for ZSF2 and 110 m; however, a greater number of species were caught at ZSF2. The shallower depths displayed the greatest variability of species composition and relative abundance for all seasons.

ZSF3 contained more species than adjacent depths. Predominant species included English sole and blackbelly eelpout, and to some degree Pacific tomcod and shiner perch. The predominant species and relative abundances were similar for ZSF3 and the 60-m depth.

More samples were taken within the ZSFs than at other depths and may explain why the ZSFs generally had the highest species richness. However, the differences in sample size do not explain the differences in abundance. Therefore, the ZSFs appeared to be richer in biological resources than the adjacent depth strata.

Exploited Fish in the ZSFs. English sole seemed to undergo migrations between shallow and deep strata in the eastern area but not in the western area. Generally, younger fish were found in the shallow strata, while older fish were found at greater depths. This suggests that English sole move into deeper water as they age, which agrees with the findings of Ketchen (1956) and English (1976). Further, Ketchen

(1956) found a pronounced shift of abundance into shallow water during Spring; however, this same phenomenon was not detected in the study areas. Since English sole are known to undergo migrations between different areas (Ketchen 1950), the decline in abundance at all strata during Summer may indicate migration out of the area. In Puget Sound, English sole spawn from January through April (Smith 1936); therefore, the low abundance in Winter and the lack of ripe females suggests that the ZSFs were not being used as a spawning areas. However, individuals larger than 300 mm (males) and 280 mm (females) may represent fish older than 7 years of age (Holland, 1954; Angell, 1972). Cluster analysis found that English sole were usually caught with slender sole and ratfish at ZSF2 (>110 m deep). All three species are usually found as adults at depths of 40 m or more in other parts of Puget Sound (Lauth et al. 1988; Donnelly et al. 1984a, b).

The depth of ZSF3 is generally shallow ($\leq$60 m) and the species associated with English sole were those species usually found at similar depths in other parts of Puget Sound (Donnelly et al. 1984a, b). English sole predominate in the commercial catches in the whole area (Pattie 1986). While English sole may be exploited, it is important to bear in mind that they also play a vital role in the overall ecology of the marine community.

Bellingham Bay

Results indicated that differences and similarities existed between the strata within the study area. Cluster analysis showed that the 15- to 20-m depth was distinct, while the stations that made up the other strata were generally diffuse and did not cluster based on stratum boundaries. Abundance, species richness and species diversity results indicated that the north ZSF, the south ZSF and >20-m depths were more often similar than dissimilar; however, biomass results showed that the south ZSF and >20-m depths were similar while the north ZSF always had higher values. The shallowest depths, 15-20 m, generally had the lowest values in the ecological measures. The similarities in the ecological measures of the two ZSFs and other stations at depths >20 m may be due to the fact that these strata were at similar depths (all within 5 m of each other). Most of Bellingham Bay that was included in the study area was approximately 30 m in depth. Previous studies in Puget Sound have generally shown that similar fish assemblages occur at similar depths within geographically limited areas (Lauth et al. 1988, Donnelly et al. 1984a, b, 1986; Wingert and Miller 1979; Moulton et al. 1974).

Temporal differences also occurred in measures of the fish community. The peaks in abundance and biomass that occurred during the year were due in large measure to relatively high concentrations of longfin smelt; however, other species such as blackbelly eelpout, English sole, Pacific tomcod and shiner perch showed occasional peaks in abundance. Species richness showed irregular changes, while fluctuations in species diversities were similar from season to season. Results of other studies (Palmisano 1984; Weber 1975) generally agreed with the findings of the present study except for the species composition found by Palmisano (1984) and the predominant species found by Weber (1975). The differences may be due to different sampling designs and locations of sample stations. Most of the two previous studies' work was concentrated in the inner part of the bay near the city of Bellingham and Post Point. The present study was spread over a larger area, and most sampling was done away from the shoreline. Bellingham Bay is biologically rich and has numerous species of fish, many of which appear to use Bellingham Bay as both a spawning and a nursery area. The large, relatively shallow area appears to be very productive and would seem to be a good location for demersal fish. The overwhelming impression is one of similarity at all locations sampled that were below 20 m in depth.

ZSF Focus

The two ZSFs were similar to each other and to depths >20 m in all ecological measures except biomass. At similar depths, there appeared to be little difference in any of the sites sampled during this study. Temporally, abundance and biomass were generally lowest during the Spring, while species diversity was lowest during Summer. The predominant species and relative abundances were also similar for the three depth strata.

Exploited Fish in the ZSFs. Butter sole appeared to undergo migrations within the study area. Abundances at the two ZSFs and at >20-m depths were highest during Autumn and Winter, while abundances in the 15- to 20-m depths decreased during Autumn and Winter and increased during Spring and Summer. This suggests that butter sole in Bellingham Bay move offshore during Autumn and Winter, possibly for spawning purposes. Butter sole in Bellingham Bay are known to move from shallow water during Summer into deep water, to spawn from February through late April (Hart 1973; Levings 1968; Manzer 1949). Field observations were in agreement with the literature since gravid female butter sole were found during the Winter sampling period.

Relatively high concentrations of English sole were found in the north ZSF and >20-m depths during Winter and the north ZSF during Spring. Abundance levels at other times of the year were relatively low, suggesting little or no migration within the study area. English sole are known to undergo migrations between different areas (Ketchen 1950); the decline in abundance at all strata during Summer and Autumn may indicate migration out of the area. In Puget Sound, English sole spawn from January through April (Smith 1936); therefore, the high abundance in Winter and the presence of gravid females found during field sampling suggest that the ZSFs and >20-m depths may be used as spawning areas.

Flathead sole were found in the greatest abundance during Spring through Autumn in >20-m depths and the two ZSFs. The individuals captured at these depths included small apparently young-of-the-year mixed in with the larger adults. Miller (1969) indicated that flathead sole spawn from March to late April in some parts of Puget Sound. There was a single, relatively large peak of abundance of flathead sole in the north ZSF during Winter, at the same time gravid females were found. These results suggested a concentration of individuals for spawning; however, the number of individuals involved was not large (approximately 30) and, therefore, additional observations would be needed to confirm the suggestion of spawning. In addition, the shifts in abundance from area to area within Bellingham Bay were small and not suggestive of migratory behavior.

Relatively high concentrations of starry flounder were found in both ZSFs during Winter. Abundance levels at other times of the year were low, suggesting little or no migration within the study area, but possibly migration into and out of the area. These results are counter to the findings of Manzer (1952) where most starry flounder hardly migrated at all. Starry flounder are known to spawn in shallow water in Puget Sound during the Winter months (Smith 1936). The relatively large concentration of starry flounder during the Winter may suggest a spawning aggregation, since captured individuals contained eggs that were nearly ripe. Speculations on the movement and spawning aggregation, based on a small sample size, would need to be confirmed with additional sampling.

Longfin smelt was the predominant species in terms of abundance in Bellingham Bay. High numbers occurred in >20-m depth and the two ZSFs during most seasons. Longfin smelt in Puget Sound are known to be anadromous and are thought to spawn and die at the end of two years (Hart 1973). Length-frequency histograms of the sampled individuals support the hypothesis of only two year-classes. The occurrence of juveniles and adults together, and in high numbers, suggests the bay is being used as a nursery area for the young and a forage area for adults. Longfin smelt appear to prefer the deeper portions of Bellingham Bay, since few were captured at depths of 15-20 m.

Butter sole, English sole, flathead sole and starry flounder are caught by commercial and sport fisheries in Bellingham Bay and other locations in Puget Sound. Cluster analysis showed that these four species usually clustered in the same or closely related species groups. Longfin smelt are captured by a fishery in the Nooksak River. Starry flounder predominate in the catches of flatfish in Bellingham Bay (Pattie 1986). The order of importance, based on catches, of the other flatfish is English sole, butter sole and flathead sole. It is important to bear in mind that, while all five species may be exploited, they also play a vital role in the overall ecology of the marine community.

Other species such as larger skates, ratfish and other flatfish also exploited in Bellingham Bay are taken as incidental catch. Ratfish have been actively fished in the past but only occasionally, and then for their oil content, which is used for specific lubricant applications.

Flatfish Health

The flatfish throughout the Nisqually study area, especially English sole and rock sole, were heavily infested with blood worms. The infestation rate of the two species is known to increase from north to south in Puget Sound (Amish 1976). Thus, most of the commercially captured English sole in southern Puget Sound are processed for animal food. Flatfish appeared to be in good health in Bellingham Bay based upon macroscopic examination for bloodworms, fin erosion, skin tumors and liver tumors.

CONCLUSIONS

Nisqually Area

Ketron Island Site

On the basis of the findings of this study, the 110-m depth should be used as a reference location for the ZSF2 site in future monitoring studies. The 110-m depth was the most similar to ZSF2 based on species composition, cluster analysis and depth. Other measures were not as similar as one would like; however, given the alternatives, the 110-m depth is the best choice.

Devils Head Site

The ZSF3 site ecological measures had similarities to both the 40 m and 60-m depths. On the basis of depth, dissimilarity measure and species composition, the 60-m depth is closest to ZSF3. Similarities between the ZSF3 site and either depth (40 m and 60 m) depended on the specific season. Both 40-m and 60-m depths should be considered as reference stations in any future monitoring at the ZSF3 site.

Bellingham Bay

In Bellingham Bay, the ecological measures were similar for >20-m depths and both ZSFs. Therefore, the >20-m depth could be used as a reference location for either ZSF. In fact, either ZSF could be used as a reference for the other. Results suggested that most of the study area at 20 m and deeper was similar.

Gear Efficiency

Gear efficiency of the otter trawl was not assumed to be 100% and it is unknown how the catches compare with actual abundance. Tagging studies have shown that indices based on trawl captures per unit area swept are generally low by a factor of two or more (Loesch et al. 1976; Kjelson and Johnson 1978). Mesh size may select for fish that cannot slip through the net. Towing speed can affect the mouth opening of the net (R.F. Donnelly, unpublished data) and also affect the catch by selecting for fishes that swim slower than the trawl velocity. Furthermore, some fishes may avoid the trawl by their behavior (e.g., burying), other species are pelagic (e.g., salmon) and are generally not caught in bottom trawls.

DISPERSIVE SITES

MATERIALS AND METHODS

Sampling Design

The sampling was conducted twice, once during Spring (April) and again during Autumn (October). The specific location of the sampling stations was determined by the location of the ZSF and tidal currents (unless otherwise noted). Figure 1 shows the location of all the stations sampled for dispersive ZSFs.

Point Roberts

Sampling stations in the Point Roberts area included four stations within the ZSF (stations 1, 2, 3 and 5), one station to the southeast (station 7) and four on a transect line to the northeast (stations 8-11, Figure 31). Selection of stations 8-11 was based on depth. Each station was sampled once during each collection period. Station depths ranged from 20 m to >200 m, with the ZSF and station 7 occurring at the greatest depths.

Rosario Strait

Otter trawl samples were originally planned at six locations (stations); however, initial sampling showed the bottom to be rocky and too rough for trawls. Therefore, a rock dredge was employed and the number of stations was increased to 11 with one sample taken at each station (Figure 32).

Port Townsend

Six stations were sampled, once each, in the Port Townsend area. Four stations were inside the ZSF and two outside, one to the northeast and one to the southeast (Figure 33). The stations outside of the ZSF were at locations where drifting dredged materials placed in the ZSF would be expected because of the dominant tidal currents (Ebbesmeyer, personal communication). Station depths ranged from 70 m to 150 m.

Port Angeles

Six stations were sampled, once each, in the Port Angeles area. Four stations were inside the ZSF and two outside to the east (Figure 34). The two stations to the east of the ZSF were selected for the same reason as those outside the ZSF at Port Townsend. Station depths ranged from 110 m to 135 m.

Description of the Sampling Gear

Otter Trawl. A 7.6-m otter trawl (Figure 4) was used to capture bottomfish in all areas except Rosario Strait. The specifics of the net were covered under Description of the Sampling gear, page 5.

Rock Dredge. A rock dredge was used to sample Rosario Strait because of the presence of rock and other obstacles on the bottom. The rock dredge consisted of a steel frame that measured 86-cm wide by 38-cm high surrounding the mouth opening (Figure 35) and bag portion. The bag or net of the rock dredge was made of chain and chain link lined on the inside with the cod end from a 3-m beam trawl (5-mm mesh). The rock dredge was towed approximately 245 m at a ground speed of less than 1.8 km/hr. The catches from the rock dredge were considered an alternative to otter trawl catches since rock dredge sampling efficiency is unknown.

Sample Preservation and Sample Processing

The details of both sample preservation and sample processing are given earlier under Non-dispersive Sites.

Data Analysis

All the data were collected and recorded on forms following the National Ocean Data Center (NODC) format. Analysis consisted of tabulating the catches by area and station.

RESULTS

Point Roberts

Thirty-six species of fish were captured during the two sampling periods (Table 14). Thirty-two were found in the Spring and 22 in the Autumn. The deep stations, those in the ZSF and adjacent to it, had low numbers of species and few individuals. Five species and 10 individuals were captured in the ZSF during Spring; in contrast, sampling resulted in 11 species and 35 individuals in the Autumn. The two shallowest stations (10 and 11) had the largest number of fish during Spring, and station 10 contained the largest abundance in the Autumn. Pacific tomcod and snake prickleback predominated in the catches at the shallow stations in the Spring; and Pacific tomcod and flathead sole predominated in the shallow stations during Autumn.

Rosario Strait

Few species or individuals were captured at any of the Rosario Strait sampling stations (Table 15). One large catch of ringtail snailfish (66) was collected at station 1 with a beam trawl just prior to the destruction of the net (see Dinnel et al. 1988 for a description of the beam trawl). All other samples from the rock dredge contained very few fish.

Port Townsend

Twenty-seven species were found in the Port Townsend area (Table 16). Eight species and a total of 12 specimens were captured during Spring, and 23 species and 382 individuals were caught during Autumn. The number of species and abundance of each increased in the ZSF and adjacent stations from Spring to Autumn. Walleye pollock predominated in the catches during Autumn. In contrast, only one walleye pollock was captured in the Spring at station 6. The catches from stations within the ZSF were comparable to those from outside the ZSF.

Port Angeles

A total of 21 species were caught; some overlap occurred between the two sampling periods, with 12 species being caught each time (Table 17). Nine of the 12 species were unique to each season. Forty individuals were caught in the Spring and 991 fish were captured during Autumn. Subadult walleye pollock predominated in the catches during Autumn (936 were caught). Walleye pollock were caught in substantial numbers at all stations except station 6. Few species or individuals were found within the ZSF during either season except for walleye pollock during Autumn, when the majority were found in the ZSF.

DISCUSSION

As a result of annual spawning aggregations or migratory routes used by bottomfishes, the abundance of any one species may change significantly during the course of the year (e.g., for example, Pacific cod (Karp 1982) and English sole (Day 1976)). Since the investigation of the bottomfish community at the dispersive sites was limited to only two sampling periods, it is possible that important annual trends in the species present and species abundances may have been missed.

Commercial trawlers fish for bottomfishes in the vicinity of several of the dispersive sites. These trawlers use nets designed to target species or sizes of individuals while the research otter trawl is designed to capture a wider range of organisms. These differences between the gear used for commercial and research purposes precludes the direct comparison of their catches.

Point Roberts

Almost 1.8 million kilograms of bottomfish were commercially trawled from the Strait of Georgia during 1984; the bulk of these catches contained Pacific cod, spiny dogfish and English sole (Pattie 1986). Pacific cod and English sole were both caught during this study, but only the latter species was caught in any appreciable numbers, and they were caught at shallow stations outside the ZSF. The bulk of the catch consisted of species with little direct commercial value. Predominant among these were Pacific tomcod, which may serve as forage for exploited fishes. However, since the catches of these fish were limited to stations located outside the ZSFs, Pacific tomcod may not be impacted by dredge disposal activities.

Rosario Strait

A small beam trawl, used for the collection of demersal invertebrates, was first used to sample Rosario Strait. The result was a demolished net that captured 66 ringtail snailfish and a cod end full of rocks. The decision was made to use a rock dredge better suited to a rocky substrate. The catches from the rock dredge were small and contained few species of commercial interest. The comparison of catches by rock dredge and by research otter trawl is unknown; however, it was presumed that the rock dredge is a much less efficient sampler of fish.

Port Townsend and Port Angeles

The Port Townsend and Port Angeles areas are both fished extensively by a sport fishery. There is a small commercial trawl fishery in the Strait of Juan de Fuca that targets Pacific cod and also catches some English sole and rockfish incidentally. Several species of interest to sport and commercial fisheries were captured during this study (e.g., English sole, Dover sole, quillback rockfish, walleye pollock). All of the exploited species, except walleye pollock, were in low abundance. Walleye pollock subadults were encountered in substantial numbers during the Autumn sampling period, but in Spring they were represented by a single individual. These results are interesting since young walleye pollock were captured during the Spring by surface trawl in the Strait of Georgia (Hart 1967). The presence of walleye pollock in substantial numbers during Autumn in the Strait of Juan de Fuca might imply migration from one area to the other during the Summer.

CONCLUSIONS

On the basis of this study, the proposed ZSFs at Point Roberts and in Rosario Strait were not found to contain any fish resources that would be significantly impacted by the disposal of clean dredge materials. The two ZSFs in the Strait of Juan de Fuca, however, contained substantial numbers of subadult walleye pollock during the Autumn sampling period. Dredged materials that are anticipated to be disposed of in the Strait of Juan de Fuca ZSFs would be rapidly dispersed by the tidal currents (Coomes et al., 1987) and should not have much physical impact on bottomfish.

These conclusions are based on only two seasons of sampling with small research trawls and important species or aggregations of fish could have been missed. The authors recommend additional sampling at the other seasons of the year and with other types of gear. Commercial style otter trawl, underwater camera and possibly trammel net would be better suited to the current-swept, hard bottom conditions that were encountered.

LITERATURE CITED

Amish, R. 1976. Infestations of some Puget Sound demersal fishes by blood worm, *Philometra americana.* M. S. Thesis, Univ. Washington, Seattle. 41 pp.

Angell, C. H. 1972. The epizootiology of a skin tumor of a Central Puget Sound population of English sole (*Parophrys vetulus*, Girard) with a special reference to its early life history. M. S. Thesis, Univ. Washington, D. F. 1977. Seattle. 100 pp.

Angell, C. L., B. S. Miller and S. R. Wellings. 1975. Epizootiology of tumors in a population of juvenile English sole (*Parophrys vetulus*) from Puget Sound, Washington. J. Fish. Res. Board. Canada 32:1723-1732.

Beals, E. W. 1984. Bray-Curtis ordination: an effective strategy for analysis of multivariate ecological data. In: Advances in ecological research (A. Macfadyen and E. D. Ford, eds.). Vol. 14, pp. 1-55.

Becker, D. S. 1984. Resource partitioning by small-mouthed pleuronectids in Puget Sound, Washington. Ph.D. Dissertation, Univ. Washington, Seattle. 139 pp.

Boesch, D. F. 1977. An application of numerical classification in ecological investigations of water pollution. Va. Inst. Mar. Sci., Spec. Sci. Rep. 77, 114 pp. (Avail. U.S. Dept. Commer., Natl. Tech. Inf. Serv., Springfield, VA, as EPA-600/3-77-033.)

Bray, J. R. and J. T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecol. Monogr. 27:325-349.

Chesapeake Biological Laboratory. 1970. Gross physical and biological effects of overboard spoil disposal in upper Chesapeake Bay. Nat. Res. Inst. Spec. Rep. 3, Univ. Maryland, Solomons. 66 pp.

Clifford, H. T. and W. Stephenson. 1975. An introduction to numerical classification. Academic Press, Inc., New York, 229 pp.

Cross, J. N. 1982. Trends in fin erosion among fishes on the Palos Verdes shelf. In: Biennial report, 1981-1982 (W. Bascom, ed.). South. Calif. Coast. Water Res. Proj. pp.99-110.

Day, D. 1976. Homing behavior and population stratification in central Puget Sound English sole (*Parophrys vetulus*). J. Fish. Res. Board Can. 33:278-282.

Desbruyeres, D., J.Y. Bervas, and A. Khripovnoff. 1980. Un cas de colonization rapide d'un sediment profond. Ocoenol. Acta 3:285-291.

Dinnel, P.A., D.A. Armstrong, R.R. Lauth and K. Larsen. 1988. Puget Sound dredge disposal analysis (PSDDA) disposal site investigations; Phase II trawl studies in north and south Puget Sound. Invertebrate Resource Assessments. Final Report to Washington Sea Grant at U.S. Army COE. FRI-UW-8818, 92 pp.

Donnelly, R. F., B. S. Miller, R. R. Lauth, and S. C. Clarke. 1986. Demersal fish studies. Part II In: Puget Sound dredge disposal analysis (PSDDA) disposal site investigations: Phase 1 trawl studies in Saratoga Passage, Port Gardner, Elliott Bay and Commencement Bay, Washington. Final report to Washington Sea Grant in cooperation with Seattle District, U. S. Army Corps of Engineers, Seattle Washington. FRI-UW-8615. 201 pp.

Donnelly, R. F., B. S. Miller, R.R. Lauth, and J. Shriner. 1984a. Fish ecology. Vol. VI, Section 7 in: Renton sewage treatment plant project: Seahurst baseline study (Q. J. Stober and K. K. Chew, eds.). Final report by University of Washington , Fish, Res. Institute to METRO. FRI-UW-8413. 276 pp.

Donnelly, R. , B. Miller and R. Lauth. 1984b. Fish ecology. Section 6 in: Renton sewage treatment plant project: Duwamish Head (Q. J. Stober and K. K. Chew eds.). Final report by Univ. of Washington, Fish. Res. Institute to METRO. FRI-UW-8417. 370 pp.

Elner, R. W. and S. L. Hamet. 1984. The effects of ocean dumping of dredge spoils onto juvenile lobster habitat: A field evaluation. Can. Tech. Rep. Fish. Aquat. Sci. No. 1247. 15 pp.

English, T. S. 1976. Trawling observations in Port Gardner, Washington, 1973, 1974 and 1975. Section VI in: Ecological baseline and monitoring study for Port Gardner and adjacent waters. A summary report for the years 1972 through 1975. State of Washington, Dept of Ecology, Olympia, Wa. DOE 76-20.

Grassle, J. F. 1977. Slow recolonization of deep-sea sediment. Nature, London. 265:618-619.

Hagerman, F. B. 1952. The biology of the Dover sole, *Microstomus pacificus* (Lockington). Calif. Dept Fish and Game, Bureau Mar. Fish., Fish Bull, No. 85. 48 pp.

Hart, J. L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Can. Bull. 180. Info. Canada, Ottawa K1A OS9, 740 pp.

Holland, G. A. 1954. A preliminary study of the populations of English sole (*Parophrys vetulus*, Girard) in Carr Inlet and other localities in Puget Sound. MS Thesis. Univ. Washington, Seattle. 139 pp.

Hughes, J. R., W. E. Ames, and G. F. Slusser. 1978. Aquatic disposal field investigations, Duwamish waterway disposal site, Puget Sound, Washington; Appendix A: Effects of dredged material disposal on demersal fish and shellfish on Elliott Bay, Seattle , Washington. Army Eng. Waterways Exper. Station, Vicksburg, MS, Tech. Rept. D-77-24, 105 pp.

Huet, M. 1965. Water quality criteria for fish life. Pages 160-167 in C. Tarzwell, ed. Biological problems in water pollution. U. S. Public Health Serv. Publ. 999-WP-25.

Johnson, D. W. and D. J. Wildish. 1981. Avoidance of dredge spoil by herring (*Clupea harengus harengus*). Bull. Environmental Contamination and Toxicology 26(3):307-314.

Karp, W.A. 1982. Biology and management of Pacific cod (*Gadus macrocephalus* Tilesius) in Port Townsend, Washington. Ph.D. dissertation, Univ. Washington, Seattle. Wa. 119 pp.

Kenkel, N. C. and L. Orloci. 1986. Applying metric and nonmetric multidimensional scaling to ecological studies: some new results. Ecology 67(4):919-928.

Ketchen, K. S. 1950. The migration of lemon soles in northern Hecate Strait. Fish. Res. Board Can. Pac. Progr. Rep. 85: 75-79.

Ketchen, K. S. 1956. Factors influencing the survival of the lemon sole (*Parophrys vetulus*) in Hecate Strait, British Columbia. J. Fish. Res. Bd. Canada 13(5): 513-558.

Kjelson, M. A. and G. N. Johnson. 1978. Catch efficiencies of a 6.1-meter otter trawl for estuarine fish populations. Trans. Am .Fish. Soc. 107(2):246-254.

Landolt, M. L., D. B. Powell and R. M. Kocan. 1984. Fish health. Vol. VII, Sec. 8 In: Renton sewage treatment plant project: Seahurst baseline study (Q. J. Stober and K. K. Chew, eds.). Final report by University of Washington, Fish. Res. Institute to METRO. FRI-UW-8413. 276 pp.

Lauth, R.R., R.F. Donnelly, J.H. Stadler B.S. Miller and S.C. Clarke. 1988. Demersal fish studies. In: Dinnel, P.A., D.A. Armstrong, B.S. Miller and R.F. Donnelly. U.S Navy Homeport Disposal Site Investigations in Port Gardner, Washington. Final Report for Wash. Sea Grant, U.S. Army COE and U.S. Navy. Univ. of Washington, Fish. Res. Inst. FRI-UW-8803. In preparation.

Levings, C.D. 1986. Fertilized eggs of the butter sole, *Isopsetta isolepis*, in Skidegate Inlet, British Columbia. J. Fish. Res. Bd. Canada 25(8): 1743-1744.

Loesch, H., J. Bishop, A. Crowe, R. Kuckyr and P. Wagner. 1976. Technique for estimating trawl efficiency in catching brown shrimp (*Penaeus aztecus*), Atlantic croaker (*Micropogon undulatus*) and Spot (*Leiostomus xanthurus*). Gulf Res. Rep. 5(2):29-33.

Luntz, J. D. and D. R. Kendall. 1982. Benthic resources assessment technique, a method for quantifying the effects of benthic community changes on fish resources. p. 1021-1027 in: Conference Proceedings, Oceans 82.

Malins, D. C., B. B. McCain, D. W. Brown, A. K. Sparks, H. O. Hodgins and S. L. Chan. 1982. Chemical contaminates and abnormalities in fish and invertebrates from Puget Sound. NOAA Tech. Memo. OMPA-19, 168 pp.

Manzer, J.I. 1949. The availability, exploitation, abundance and movement of the butter sole (*Isopsetta isolepis* Lockington) in Skidegate Inlet, Queen Charlotte Islands, during 1946. M.A. Thesis. Dep.Zool.Univ. British Columbia.

Manzer, J.I. 1952. Notes on dispersion and growth of some British Columbia bottom fishes. J. Fish. Res. Board Can. 8(5):374-377.

McArn, G. E., R. G. Chuinard, B. S. Miller, R. E. Brooks and S. R. Wellings. 1968. Pathology of skin tumors found on English sole and starry flounder of Puget Sound, Washington. J. Nat. Cancer Inst. 41:229-242.

Mearns, A. J. and M. J. Allen. 1978. Use of small otter trawls in coastal biological surveys. Contribution No. 66, South. Calif. Water. Res. Project. EPA-600/3-78-083.

Miller, B.S. 1969. Life history observations on normal and tumor bearing flathead sole in East Sound, Orcas Island (Washington). Ph.D. Thesis. Univ. Wash. 131 pp.

Miller, B. S., B. B. McCain, R. C. Wingert, S. F. Borton and K. V. Pierce. 1976. Ecological and disease studies of demersal fishes near METRO operated sewage treatment plants on Puget Sound and the Duwamish River. Puget Sound Interim Studies Rep., Univ of Wash. Coll. of Fish. FRI-UW-7608, 135 pp.

Miller, B. S., B. B. McCain, R. C. Wingert, S. F. Borton, K. V. Pierce and D. T. Griggs. 1977. Ecological and disease studies of demersal fishes in Puget Sound near METRO-operated sewage treatment plants and in the Duwamish River. Puget Sound Interim Studies Rep., Univ of Wash. Coll. of Fish. FRI-UW-7721, 164 pp.

Miller, B. S. and S. R. Wellings. 1971. Epizootiology of tumors on flathead sole (*Hippoglossoides elassodon*) in East Sound, Orcas Island, Washington. Trans. Am. Fish. Soc. 100:247-266.

Moulton, L. L., B. S. Miller, and R. I. Matsuda. 1974. Ecological survey of demersal fishes at Metro's West Point and Alki Point outfalls, January through December, 1973. Washington Sea Grant, Univ. Wash., Seattle. WSG-TA 74-11, 39 pp.

Palmisano, J.F. 1984. Application for variance from secondary treatment requirements. Final Report, Submitted to the U.S. Environmental Protection Agency. CH2M Hill.

Pattie, B. 1986. The 1984 Washington trawl landings by Pacific Marine Fisheries Commission and state bottomfish statistical areas. Wash. Dept. Fish. Prog. Rept. No. 246: 50 pp.

Pedersen, M. 1985. Puget Sound Pacific whiting, *Merluccius productus*, resource and industry: an overview. Mar. Fish. Rev. 47(2): 35-38.

Pielou, E. C. 1975. Ecological diversity. Wiley Interscience Pub., New York, 165 pp.

Pierce, K. V., B. McCain and M. J. Sherwood. 1977. Histology of liver tissue from Dover sole. In: Coastal Water Research Project, annual report for the year ended 30 June 1977. South. Calif. Coast. Water Res. Proj. pp 207-212.

Rosenthal, K. D., D. A. Brown, J. N. Cross, E. M. Perkins and R. W. Gossett. 1984. Histological condition of fish livers. In: Biennial report, 1983- 1984 (W. Bascom, ed.). South. Calif. Coast. Water Res. Proj. pp. 229-246.

Schubel, J. R., W. M. Wise and J. Schoof. 1979. Questions about dredging and dredged material disposal in Long Island Sound. State Univ. of New York at Stony Brook, Mar. Sci. Res. Center, Spec. Rep. 28, ref. 79-11. 136 pp

Serafy, D. K., D. J. Hartzband and M. Bowen. 1977. Aquatic disposal field investigations, Eatons Neck disposal site, Long Island Sound; Appendix C: predisposal baseline conditions of benthic assemblages. Army Eng. Water. Exper. Stn. Vicksburg, MS, Tech. Rep. D-77-6, 238. pp.

Sherk, J. A., J. M. O'Conner and D. A. Neumann. 1974. Effects of suspended and deposited sediments on estuarine organisms. Phase II: Final Report. No. 74-20. Univ. Maryland, Nat. Resource Inst., Prince Fredrick. 259 pp.

Sherwood, M. 1976. Fin erosion disease induced in the laboratory. In: Annual report for the year ended 30 June 1976. South. Calif. Coast. Water Res. Proj. pp. 149-154.

Sherwood M. J. 1978. The fin erosion syndrome. In: Annual report for the year 1978 (W. Bascom, ed.). South. Calif. Coast. Water Res. Proj. pp. 203-222.

Sinnhuber, R. O., J. D. Hendricks, J. H. Wales and G. B. Putnam. 1977. Neoplasms in rainbow trout, a sensitive animal model for environmental carcinogenesis. Ann. New York Acad. Sci. 298:389-408.

Smith, R. T. 1936. Report on the Puget Sound otter trawl investigations. Wash. Dep. Fish. Biol. Rep. 36B:1-61.

Southern California Coastal Water Research Project (SCCWRP). 1973. Coastal fish populations. In: The ecology of the Southern California Bight: implications for water quality management. 505 pp.

Weber, H.H. 1975. The Bellingham Bay estuary: a natural history study. U.S. Fish and Wildlife Service.

Wellings, S. R., C. E. Alpers, B. B. McCain and B. S. Miller. 1976. Fin erosion disease of starry flounder (*Platichthys stellatus*) and English sole (*Parophrys vetulus*) in the estuary of the Duwamish River,Seattle,Washington. J. Fish. Res. Board Canada 33:2577-2586.

Wingert, R. C. and B. S. Miller. 1979. Distributional analysis of nearshore and demersal fish species groups and nearshore fish habitat associations in Puget Sound. Final report to Washington State Dept. of Ecology. FRI-UW-7901. 110 pp.

TABLES AND FIGURES

Table 1. Sampling schedule for the Nisqually area.

Season	Depth	# of Trawls	Depth	# of Trawls
	Ketron Island		Devils Head	
Winter	20 m	1	20 m	1
	40 m	1	40 m	1
	60 m	1	60 m	2
	80 m	2	ZSF3	6
	110 m	1		
	ZSF2	6		
Spring	20 m	2	20 m	2
	40 m	2	40 m	2
	60 m	2	60 m	2
	80 m	3	ZSF3	6
	110 m	2		
	ZSF2	6		
Summer	20 m	2	20 m	2
	40 m	2	40 m	2
	60 m	2	60 m	2
	80 m	2	ZSF3	6
	110 m	2		
	ZSF2	6		
Autumn	20 m	2	20 m	2
	40 m	2	40 m	2
	60 m	2	60 m	2
	80 m	2	ZSF3	6
	110 m	2		
	ZSF2	6		

Table 2. Sampling schedule for Bellingham Bay.

Season	Depth	Number of Trawls
Winter	15-20 m	2
	> 20 m	8
	North ZSF	2
	South ZSF	3
Spring	15-20 m	4
	> 20 m	9
	North ZSF	2
	South ZSF	3
Summer	15-20 m	2
	> 20 m	8
	Norht ZSF	4
	South ZSF	3
Autumn	15-20 m	2
	> 20 m	9
	North ZSF	4
	South ZSF	3

Table 3. Species list for the Nisqually area, Ketron Island and Devils Head. A = adult, J = juvenile

Ketron Island

Common name	Scientific name
arrowtooth flounder	*Atheresthes stomias*
bay pipefish	*Syngnathus griseolineatus*
blackbelly eelpout	*Lycodopsis pacifica*
blacktip poacher	*Xeneretmus latifrons*
brown rockfish	*Sebastes auriculatus*
buffalo sculpin	*Enophrys bison*
butter sole (A)	*Isopsetta isolepis*
C-O sole (A and J)	*Pleuronichthys coenosus*
Dover sole (A and J)	*Microstomus pacificus*
English sole (A and J)	*Parophrys vetulus*
flathead sole (A)	*Hippoglossoides elassodon*
great sculpin	*Myoxocephalus polyacanthocephalus*
greenstripe rockfish	*Sebastes elongatus*
longfin smelt (J)	*Spirinchus thaleichthys*
longnose skate	*Raja rhina*
marbled snailfish	*Liparis dennyi*
northern ronquil	*Ronquilus jordani*
northern spearnose poacher	*Agonopsis emmelane*
Pacific cod	*Gadus macrocephalus*
Pacific hake (A and J)	*Merluccius productus*
Pacific herring	*Clupea harengus*
Pacific sanddab (A and J)	*Citharichthys sordidus*
Pacific tomcod (A and J)	*Microgadus proximus*
pile perch (A and J)	*Rhacochilus vacca*
plainfin midshipman	*Porichthys notatus*
pygmy poacher	*Odontopyxis trispinosa*
quillback rockfish	*Sebastes maliger*
ratfish (A and J)	*Hydrolagus colliei*
red brotula	*brosmophycis marginata*
rex sole (A and J)	*Glyptocephalus zachirus*
rock sole (A and J)	*Lepidopsetta bilineata*
roughback sculpin	*Chitonotus pugetensis*
sailfin sculpin	*Nautichthys oculofasciatus*
sand sole (A and J)	*Psettichthys melanostictus*
shiner perch (A and J)	*Cymatogaster aggregata*
shortspine thornyhead	*Sebastolobus alascanus*
showy snailfish	*Liparis pulchellus*
slender sole (A and J)	*Lyopsetta exilis*
slim sculpin	*Radulinus asprellus*
snailfish unidentified	*Liparsis spp.*
snake prickleback	*Lumpenus sagitta*
soft sculpin	*Gilbertidia sigalutes*
speckled sanddab (A and J)	*Citharichthys stigmaeus*

Table 3. Continued.

Ketron Island

Common name	Scientific name
spiny dogfish	*Squalus acathias*
staghorn sculpin	*Leptocottus armatus*
starry flounder (A)	*Platichthys stellatus*
striped seaperch	*Embiotoca lateralis*
sturgeon poacher	*Agonus acipenserinus*
tubesnout	*Aulorhynchus flavidus*
walleye polloack (A and J)	*Theragra chalcogramma*
whitespotted greenling	*Hexagramos stelleri*
TOTAL 51 SPECIES	

Table 3. Continued.

Devils Head

Common name	Scientific name
arrowtooth flounder	*Atherestes stomias*
big skate	*Raja binoculata*
blackbelly eelpout	*Lycodes pacifica*
blacktip poacher	*Xeneretmus latifrons*
brown rockfish	*Sebastes auriculatus*
buffalo sculpin	*Enophrys bison*
butter sole - ad	*Iopsetta isolepis*
C-O sole	*Pleuronichthys coenosus*
copper rockfish	*Sebastes caurinus*
daubed shanny	*Lumpenus maculatus*
Dover sole (A and J)	*Microstomus pacificus*
English sole (A and J)	*Parophrys vetulus*
flathead sole (A and J)	*Hippoglossoides elassodon*
great sculpin	*Myoxocephalus polyacanthocephalus*
hybrid sole	*Inopsetta ischyra*
longnose skate	*Raja rhina*
longspine combfish	*Zaniolepis latipinnis*
Pacific cod	*Gadus macrocephalus*
Pacific hake (A and J)	*Merluccius productus*
Pacific herring	*Clupea harengus*
Pacific sanddab (A and J)	*Citharichthys sordidus*
Pacific tomcod (A and J)	*Microgadus proximus*
pile perch (A)	*Rhacochilus vacca*
plainfin midshipman	*Porichthys notatus*
quillback rockfish	*Sebastes maliger*
ratfish (A)	*Hydrolagus colliei*
rex sole (A and J)	*Glyptocephalus zachirus*
rock sole (A and J)	*Lepidopsetta bilineata*
roughback sculpin	*Chitonotus pugetensis*
sand sole (A and J)	*Psettichthys melanostictus*
shiner perch (A and J)	*Cymatogaster aggregata*
showy snailfish	*Liparis pulchellus*
slender sole (A and J)	*Lyopsetta exilis*
slim sculpin	*Radulinus asprellus*

Table 3. Continued

Devils Head

Common name	Scientific name
snailfish unidentified	*Liparis sp.*
snake prickleback	*Lumpenus sagitta*
speckled sanddab (A and J)	*Citharichthys stigmaeus*
spiny dogfish	*Squalus acanthias*
staghorn sculpin	*Leptocottus armatus*
starry flounder (A)	*Platichthys stellatus*
sturgeon poacher	*Agonus acipenserinus*
tubesnout	*Aulorhynchus flavidus*
walleye pollock (A and J)	*Theragra chalcogramma*
whitespotted greenling	*Hexagrammos stelleri*
TOTAL 44 SPECIES	

Table 4. Ketron Island relative species composition (%) by season and depth.

	20 m			
SPECIES	W	Sp	Su	Au
bay pipefish				7.05
big skate				
buffalo sculpin	8.33	4.44		0.64
C-O sole (A)	2.78			
Dover sole (J)		2.22		
English sole (A)		4.44	2.82	
English sole (J)	2.78			7.69
great sculpin				0.64
longnose skate	2.78			
Pacific sanddab (J)				7.69
pile perch (A)				0.64
plainfin midshipman			2.82	
ratfish (A)	16.67	26.67		
rock sole (A)	44.44	24.44	9.86	12.82
rock sole (J)		2.22		8.33
roughback sculpin	11.11	8.89		3.21
sand sole (A)				0.64
shiner perch (J)				38.46
speckled sanddab (A)			1.41	0.64
speckled sanddab (J)	8.33	26.67		5.13
striped perch				0.64
sturgeon poacher			1.41	
tubesnout			30.99	5.77
walleye pollock (J)			50.70	
whitespotted greenling	2.78			
Total	100.00	100.00	100.00	100.00

Figure 4. Continued.

SPECIES	40 m W	Sp	Su	A
blacktip poacher				0.79
brown rockfish			12.86	4.37
buffalo sculpin	0.65	1.42		
C-O sole (A)	0.65	2.13		
C-O sole (J)	0.13			
Dover sole (A)			4.29	
Dover sole (J)			1.43	
English sole (A)	3.35	16.31	17.14	1.59
English sole (J)	0.13	0.71		0.40
great sculpin	1.81	1.42		
longfin smelt (J)	0.26			
Northern ronquil		0.71	1.43	
northern spearnose poacher	0.13		1.43	
Pacific sanddab (A)	0.13			0.40
Pacific tomcod (A)	0.90		2.86	2.38
Pacific tomcod (J)	0.52			2.78
pile perch (A)	1.29			1.19
quillback rockfish		2.13	5.71	0.79
ratfish (A)	0.52	5.67		
rock sole (A)	63.87	34.04	14.29	47.22
rock sole (J)	6.19	0.71		
roughback sculpin	12.00	19.15	31.43	19.05
sailfin sculpin	0.13	0.71	1.43	
shiner perch (A)	0.52		1.43	6.35
shiner perch (J)	0.65			3.57
slender sole (A)	0.13		2.86	
slim sculpin		1.42		
snake prickleback	0.13	2.13		
speckled sanddab (A)	1.29			2.38
speckled sanddab (J)	0.65	9.93		3.97
staghorn sculpin	1.94			1.98
striped seaperch	0.65			0.79
sturgeon poacher	1.03	0.71	1.43	
walleye pollock (J)	0.13			
whitespotted greenling	0.26	0.71		
TOTAL	100.00	100.00	100.00	100.00

Table 4. Continued.

SPECIES	60 m W	Sp	Su	A
arrowtooth flounder	2.56			
blacktip poacher		0.75		1.05
brown rockfish			1.75	
C-O sole (A)	5.56	1.50		
Dover sole (A)			1.75	
Dover sole (J)		0.75		
English sole (A)	28.21	56.39	43.86	14.21
English sole (J)				0.53
great sculpin		0.75		
greenstripe rockfish	0.43	0.75		
Pacific tomcod (A)	16.24		1.75	26.32
Pacific tomcod (J)				35.26
pile perch (A)		1.50		
pile perch (J)		0.75		
plainfin midshipman	0.85			
pygmy poacher				0.53
quillback rockfish	8.55	2.26	17.54	3.16
ratfish (A)	23.50	6.02	7.02	
rock sole (A)	0.85	12.78	5.26	8.95
rock sole (J)	0.43			
roughback sculpin	3.42	6.02		0.53
shiner perch (A)	6.41	0.75		0.53
shiner perch (J)				2.11
slender sole (A)	1.71	4.51	17.54	1.05
slender sole (J)		0.75		
slim sculpin			1.75	
speckled sanddab (J)		0.75		
spiny dogfish			1.75	1.05
staghorn sculpin				0.53
sturgeon poacher		2.26		
walleye pollock (A)	1.28			2.11
walleye pollock (J)				2.11
TOTAL	100.00	99.25	100.00	100.00

Table 4. Continued.

	80 m			
SPECIES	W	Sp	Su	A
arrowtooth flounder	1.52			
blacktip poacher	8.33		5.80	0.95
brown rockfish		0.90		
butter sole (A)	6.06		1.45	1.43
C-O sole (A)				0.24
English sole (A)	16.67	57.66	42.03	17.82
English sole (J)				0.24
greenstripe rockfish				0.24
longnose skate				0.48
Pacific hake (A)				0.48
Pacific herring	0.76			0.24
Pacific sanddab (A)	0.76			
Pacific tomcod (A)	38.64	0.90	2.90	33.73
Pacific tomcod (J)	0.76			27.32
pile perch (A)				0.24
plainfin midshipman	3.79	0.90		4.75
pygmy poacher	0.76			
quillback rockfish	3.79	3.60	11.59	2.61
ratfish (A)	4.55	6.31	20.29	1.43
rex sole (A)			4.35	
rock sole (A)	1.51	21.62		0.71
roughback sculpin	2.27	0.90		0.48
sand sole (J)	0.76			
shiner perch (A)	1.52	2.70		1.90
showy snailfish				0.48
slender sole (A)	5.30	2.70	10.14	2.61
slender sole (J)		0.90		
slim sculpin	1.52			
snailfish unidentified			1.45	
speckled sanddab (J)		0.90		
spiny dogfish				0.95
staghorn sculpin				0.48
walleye pollock (A)	0.76			
walleye pollock (J)				0.24
TOTAL	100.03	100.00	100.00	100.00

Table 4. Continued.

	110m			
SPECIES	W	Sp	Su	A
blacktip poacher				1.10
brown rockfish		1.96	4.00	2.20
Dover sole (A)	19.23			
Dover sole (J)		1.96		
English sole (A)	19.23	56.86	46.67	45.05
longnose skate			1.33	
Pacific hake (A)		1.96		1.10
Pacific herring				
Pacific tomcod (A)	3.85	9.80		12.09
Pacific tomcod (J)				1.10
pile perch (J)		1.96		
plainfin midshipman				2.20
quillback rockfish	3.85	7.84	1.33	2.20
ratfish (A)	23.08	1.96	25.33	9.89
ratfish (J)				1.10
rex sole (A)	11.54			1.10
slender sole (A)	19.23	15.69	18.67	19.78
snailfish unidentified				1.10
spiny dogfish			2.67	
TOTAL	100.00	100.00	100.00	100.00

Table 4. Continued.

	ZSF2			
SPECIES	W	Sp	Su	A
blackbelly eelpout				0.59
blacktip poacher	1.90	0.13	0.53	0.07
brown rockfish	2.38	1.02	0.27	0.15
Dover sole (A)	11.90		1.87	1.18
Dover sole (J)		1.14		
English sole (A)	16.67	58.96	52.68	46.73
English sole (J)				0.07
flathead sole (A)	7.62			0.15
longnose skate	3.33	0.25	0.53	0.22
longfin smelt				0.15
marbled snailfish				0.15
northern ronquil				0.07
Pacific cod				0.07
Pacific hake (A)		5.34	0.53	1.98
Pacific hake (J)			0.27	
Pacific tomcod (A)	3.33	1.27	1.07	19.69
Pacific tomcod (J)			0.27	0.07
plainfin midshipman	9.00	1.91	0.27	6.25
quillback rockfish	5.24	2.80	2.94	1.32
ratfish (A)	10.00	2.03	7.22	3.38
ratfish (J)	0.48	0.13		
red brotula	0.48			
rex sole (A)	6.67	1.65	4.01	0.37
rex sole (J)	0.48	0.76		
rock sole (A)				0.15
rockfish unidentified				0.22
shortspine thornyhead				0.07
slender sole (A)	20.48	22.36	24.87	16.53
slender sole (J)				0.07
snailfish unidentified		0.13	0.80	
soft sculpin			0.27	
speckled sanddab (A)				0.15
spiny dogfish				0.15
walleye pollock (A)		0.13	1.60	
TOTAL	99.96	100.00	100.01	100.00

Table 5. Devils Head relative species composition (%) by season and depth.

	20 m			
SPECIES	W	Sp	Su	A
blackbelly eelpout			3.33	
blacktip poacher			1.67	
buffalo sculpin		2.27	1.67	
C-O sole (A)	2.94			
daubed shanny			1.67	
English sole (A)	8.82	31.82	26.67	0.74
English sole (J)		2.27		0.74
great sculpin		2.27		
longnose skate		2.27		
northern ronquil		2.27		
Pacific sanddab (A)				5.93
Pacific tomcod (J)			6.67	
pile perch (A)				7.41
plainfin midshipman			3.33	1.48
rock sole (A)	26.47	25.00	11.67	12.59
rock sole (J)	8.82			5.19
roughback sculpin	23.53	2.27	10.00	2.96
sand sole (A)				1.48
sand sole (J)	8.82			
shiner perch (A)		2.27	3.33	59.26
shiner perch (J)	2.94	2.27		
showy snailfish				0.74
snake prickleback		2.27	15.00	1.48
speckled sanddab (A)	14.71	22.73		
staghorn sculpin	2.94			
sturgeon poacher			1.67	
tubesnout			11.67	
whitespotted greenling			1.67	
TOTAL	100.00	100.00	100.00	100.00

Table 5. Continued.

SPECIES	40 m			
	W	Sp	Su	A
arrowtooth flounder				0.77
blackbelly eelpout	2.20		9.32	0.48
C-O sole (A)		0.27		
daubed shanny		0.81	0.32	
English sole (A)	12.98	36.17	22.83	80.83
English sole (J)	42.46	29.28		0.10
great sculpin		0.13		
hybrid sole		0.13		
longnose skate	0.11			0.10
longspine combfish			0.32	0.19
Pacific sanddab (A)				1.45
Pacific sanddab (J)				2.03
Pacific tomcod (A)	6.38		19.29	0.97
Pacific tomcod (J)	0.99		36.98	0.39
pile perch (A)	0.44			
plainfin midshipman	0.33	0.27		
rock sole (A)	3.30	5.80	3.22	0.87
rock sole (J)	0.44			
roughback sculpin	2.97	2.83	1.61	4.26
sand sole (A)	3.52	2.70	0.96	0.29
sand sole (J)	2.97			
shiner perch (A)	0.66	3.51	2.89	0.39
shiner perch (J)	0.22			3.39
slender sole (A)		0.13	1.61	0.48
slender sole (J)	0.22		0.32	
slim sculpin	0.11	0.13	0.32	0.10
snake prickleback	0.22	14.17		
speckled sanddab (A)	8.03	3.37		
speckled sanddab (J)	4.40			
spiny dogfish				0.19
staghorn sculpin	6.82			2.61
starry flounder (A)	0.11			
sturgeon poacher	0.11	0.27		0.10
TOTAL	100.00	100.00	100.00	100.00

Table 5. Continued.

	60 m			
SPECIES	W	Sp	Su	A
arrowtooth flounder				0.25
blackbelly eelpout	11.67	18.91	37.35	4.30
blacktip poacher	2.42	1.09		1.01
copper rockfish	0.22			
English sole (A)	11.67	49.09	20.88	50.89
flathead sole (A)	4.41			
flathead sole (J)	0.22			
longnose skate	0.22			
northern spearnose poacher	0.00			
Pacific hake (A)	0.22			
Pacific hake (J)			0.40	
Pacific herring			1.20	
Pacific sanddab (A)				0.25
Pacific tomcod (A)	10.35	5.82	8.03	8.86
Pacific tomcod (J)	0.22		23.29	6.33
pile perch (A)	0.22			0.25
plainfin midshipman	0.88	3.27	0.80	0.76
quillback rockfish			0.40	0.25
ratfish (A)	3.74		5.62	2.78
rex sole (A)	0.22			
rock sole (A)	0.22			0.25
roughback sculpin	0.44	11.27		2.03
shiner perch (A)	41.85	1.45	0.80	9.37
shiner perch (J)	3.08			5.06
slender sole (A)	7.05	4.73	0.40	5.06
slender sole (J)		2.91		
snailfish unidentified			0.40	
snake prickleback	0.22			
speckled sanddab (A)		0.36		
spiny dogfish	0.44		0.40	1.27
staghorn sculpin		0.73		
sturgeon poacher		0.36		
walleye pollock (A)				1.01
TOTAL	100.00	100.00	100.00	100.00

Table 5. Continued.

SPECIES	ZSF3 W	Sp	Su	A
arrowtooth flounder		0.10		0.10
big skate		0.10		
blackbelly eelpout	44.71	30.75	28.97	19.70
blacktip poacher	2.45	0.77	1.71	0.24
brown rockfish		0.19		
butter sole (A)	0.06			
C-O sole (A)				0.05
daubed shanny			0.18	
Dover sole (A)	0.06			0.05
English sole (A)	9.58	48.16	23.83	32.19
English sole (J)				0.15
flathead sole (A)	0.35	0.10	0.18	
longnose skate	0.58	0.10	0.45	0.15
Pacific cod				0.05
Pacific hake (A)	0.23	0.29		1.32
Pacific herring	0.70	0.19	0.54	1.03
Pacific sanddab (A)				0.05
Pacific tomcod (A)	13.44	0.48	9.57	3.38
Pacific tomcod (J)	0.18		12.64	22.59
pile perch (A)	0.18			0.05
plainfin midshipman	1.69	2.32	0.90	1.62
quillback rockfish	0.23		0.09	
ratfish (A)	1.11	0.77	2.08	0.24
rex sole (A)	0.06	0.29	0.45	0.49
rex sole (J)			0.27	
rock sole (A)	0.12	1.74	0.54	0.34
roughback sculpin	1.52	6.19	2.62	2.11
sand sole (A)		0.10	0.54	0.05
shiner perch (A)	12.74	0.58	0.27	4.16
shiner perch (J)	1.29			0.39
showy snailfish				0.05
slender sole (A)	6.20	3.87	10.83	2.99
slender sole (J)	0.47	1.74	2.26	0.05
snailfish unidentified			0.09	
snake prickleback	0.06	0.97		0.05
speckled sanddab (A)	0.06	0.19		0.05
spiny dogfish	1.23		0.81	1.13
staghorn sculpin			0.09	0.39
sturgeon poacher			0.09	
walleye pollock (A)	0.41			2.74
walleye pollock (J)				2.06
TOTAL	99.71	100.00	100.00	100.00

Table 6. Ketron Island species clusters based on Bray-Curtis distance measures by season.

Winter

GROUP	SUBGROUP	SPECIES
I	a	Walleye pollock (J) Longfin smelt (J) Great sculpin Staghorn sculpin Pile perch (A) Speckled sanddab (A) Sturgeon poacher Pacific tomcod (J) Shiner perch (J) Striped perch Greenstriped rockfish Walleye pollock (A) Rock sole (J) Red brotula Rex sole (J) Sand sole (J) Flathead sole (A) Ratfish (J)
I	a	Buffalo sculpin Speckled sanddab (J) English sole (J) Whitespotted greenling C-O sole (A) Rock sole (A) Roughback sculpin Shiner perch (A)
II		Blacktip poacher Brown rockfish Longnose skate Plainfin midshipman
III	a	Dover sole (A) Rex sole (A) Quillback rockfish Slender sole (A)
III	b	English sole (A) Ratfish (A) Pacific tomcod (A)

Table 6. Continued.

Spring

GROUP	SUBGROUP	SPECIES
I	a	English sole (J) Northern ronquil Sailfin sculpin Slim sculpin Whitespotted greenling Snake prickleback Buffalo sculpin Rock sole (J) C-O sole (A) Great sculpin Sturgeon poacher Rock sole (A) Roughback sculpin Speckled sanddab (A)
I	b	Blacktip poacher Greenstriped rockfish Pile perch (A) Pile perch (J) Slender sole (J) Longnose skate Shiner perch (A)
I	c	Ratfish (J) Snailfish spp Walleye pollock (A) Rex sole (J)
II	a	Brown rockfish Dover sole (A) Pacific hake (A) Rex sole (A) Plainfin midshipman
II	b	Pacific tomcod (A)
III	a	English sole (A) Slender sole (A)
III	b	Quillback rockfish Ratfish (A)

Table 6. Continued.

Summer

GROUP	SUBGROUP	SPECIES
I	a	Butter sole Blacktip poacher Longnose skate Slim sculpin Spiny dogfish
I	b	Dover sole (J) Northern ronquil Northern spearnose poacher Sailfin sculpin Shiner perch (A) Roughback sculpin Pacific tomcod (J) Plainfin midshipman Speckled sanddab (A) Tubesnout Walleye pollock (J) Rock sole (A) Sturgeon poacher
I	c	Brown rockfish Dover sole (A)
I	d	Pacific hake (A) Pacific hake (J) Soft sculpin Pacific tomcod (A)
I	e	Snailfish spp Walleye pollock (A)
II	a	English sole (A) Slender sole (A)
II	b	Quillback rockfish Ratfish (A) Rex sole (A)

Table 6. Continued.

Autumn

GROUP	SUBGROUP	SPECIES
I	a	Bay pipefish Buffalo sculpin Great sculpin Sand sole (A) Pacific sanddab (J) Rock sole (J) Tubesnout Butter sole C-O sole (A) Greenstripe rockfish Showy snailfish Marbled snailfish Pacific cod Pacific sanddab (A) Pygmy poacher Walleye pollock (A) Walleye pollock (J) Ratfish (J) Snailfish spp Rockfish spp Shortspine thornyhead Slender sole (J) Dover sole (A) Flathead sole (A) Longfin smelt Northern ronquil Blackbelly eelpout Longnose skate
I	b	Rex sole (A) Spiny dogfish
I	c	English sole (J) Roughback sculpin Shiner perch (J) Shiner perch (A) Staghorn sculpin Pile perch (A) Striped perch (A) Soft sculpin Speckled sanddab (A) Rock sole (A)
II	a	Blacktip poacher Pacific tomcod (J)
II	b	Brown rockfish

Table 6. Continued.

Autumn

GROUP	SUBGROUP	SPECIES
III	a	English sole (A) Pacific tomcod (A) Slender sole (A) Quillback rockfish
III	b	Pacific hake (A) Plainfin midshipman Ratfish (A)

Table 7. Devils Head species clusters based on Bray -Curtis distance measures by season.

Winter

GROUP	SUBGROUP	SPECIES
I	a	Butter sole (A) Dover sole (A) Quillback rockfish
I	b	C-O sole (A) Rock sole (J) Sand sole (J) staghorn sculpin English sole (J) Sand sole (A) Speckled sanddab (J) Starry flounder (A) Sturgeon poacher Speckled sanddab (A)
I	c	Copper rockfish Flathead sole (J) Rex sole (A) Pacific tomcod (J) Rock sole (A)
I	d	Blackbelly eelpout Flathead sole (A) Snake prickleback Slender sole (J) Slim sculpin
II	a	Blacktip poacher Spiny dogfish Slender sole (A) Pacific herring Longnose skate Plainfin midshipman
II	b	Ratfish (A)
II	c	Pacific hake (A) Walleye pollock (A) Pile perch (A)
III	a	English sole (A) Pacific tomcod (A) Shiner perch (A)
III	b	Roughback sculpin Shiner perch (J)

Table 7. Continued.

Spring

GROUP	SUBGROUP	SPECIES
I	a	Arrowtooth flounder Big skate Brown rockfish Pacific hake (A) Flathead sole (A) Pacific herring (A) Rex sole (J)
I	b	Buffalo sculpin Northern ronquil Longnose skate English sole (J) Great sculpin C-O sole (A) Hybrid sole Slim sculpin Daubed shanny Sand sole (A) Pacific tomcod (A) Staghorn sculpin Sturgeon poacher
II	a	Blackbelly eelpout Slender sole (J) Blacktip poacher Ratfish (A) English sole (A) Roughback sculpin Plainfin midshipman Slender sole (A)
II	b	Rock sole (A) Snake prickleback Shiner perch (A) Speckled sanddab (A)

Table 7. Continued.

Summer

GROUP	SUBGROUP	SPECIES
I	a	Buffalo sculpin Whitespotted greenling Snake prickleback Tubesnout Sturgeon poacher
I	b	Flathead sole (A) Staghorn sculpin Snailfish spp Longspine combfish Slim sculpin Sand sole (A)
I	c	Longnose skate Rex sole (A) Rex sole (J)
II	a	Pacific hake (J) Quillback rockfish Pacific herring (A)
II	b	Ratfish (A)
II	c	Plainfin midshipman Spiny dogfish
III	a	Blackbelly eelpout English sole (A) Pacific tomcod (J) Pacific tomcod (A) Slender sole (A)
III	b	Roughback sculpin
IV	a	Blacktip poacher Slender sole (J) Daubed shanny
IV	b	Rock sole (A)
IV	c	Shiner perch (A)

Table 7. Continued.

Autumn

GROUP	SUBGROUP	SPECIES
I	a	Arrowtooth flounder Pacific sanddab (A) Rock sole (A) English sole (J)
I	b	Staghorn sculpin
I	c	Blacktip poacher Rex sole (A) Longnose skate
II	a	C-O sole (A) Showy snailfish Snake prickleback Dover sole (A) Longspine combfish Slim sculpin Sturgeon poacher Pacific sanddab (J) Pacific herring (A) Slender sole (J) Quillback rockfish Rock sole (J) Pacific cod Speckled sanddab (A)
II	b	Pile perch (A)
III	a	Blackbelly eelpout Pacific tomcod (A) Pacific tomcod (J) Spiny dogfish
III	b	Ratfish (A) Walleye Pollock (A) Walleye pollock (J)
IV	a	English sole (A)
IV	b	Plainfin midshipman Roughback sculpin Slender sole (A)
IV	c	Pacific hake (A) Shiner perch (A) Shiner perch (J)
IV	d	Sand sole (A)

Table 8. Incidence of blood worm (Philometra) infestation, Ketron Island.

Species	Winter	Spring	Summer	Autumn
		20 m		
English sole	100 (1)	0 (1)	50 (2)	0 (2)
Rock sole	0 (0)	0 (11)	57 (7)	13 (23)
		40 m		
English sole	56 (27)	72 (43)	100 (12)	100 (5)
Rock sole	46 (543)	32 (19)	59 (7)	100 (119)
		60 m		
English sole	89 (66)	79 (75)	100 (24)	39 (28)
Rock sole	0 (0)	94 (17)	0 (0)	0 (0)
		80 m		
English sole	78 (9)	100 (30)	100 (29)	88 (49)
		110 m		
Dover sole	20 (5)	0 (0)	0 (0)	0 (0)
English sole	100 (5)	79 (29)	100 (35)	61 (41)
Rex sole	100 (3)	0 (0)	0 (0)	0 (0)
		ZSF 2		
Dover sole	8 (25)	11 (9)	0 (0)	0 (0)
English sole	94 (32)	100 (468)	86 (197)	34 (635)
Flathead sole	6 (16)	0 (0)	0 (0)	0 (0)
Rex sole	20 (15)	5 (19)	38 (13)	0 (0)

Table 9. Incidence of blood worm (Philometra) infestation, Devils Head

Species	Winter	Spring	Summer	Autumn
		20 m		
English sole	100 (3)	87 (15)	100 (17)	50 (2)
Rock sole	0 (0)	64 (11)	100 (7)	0 (0)
		40 m		
English sole	5 (504)	4 (225)	99 (71)	11 (835)
Rock sole	38 (34)	100 (18)	20)10)	0 (0)
Sand sole	7 (59)	0 (0)	0 (0)	0 (0)
		60 m		
English sole	91 (53)	94 (132)	100 (52)	0 (0)
		ZSF 3		
English sole	85 (164)	99 (509)	100 (264)	28 (647)
Rex sole	100 (1)	0 (0)	0 (0)	0 (0)
Rock sole	100 (2)	0 (0)	0 (0)	0 (0)
Slender sole	0 (0)	0 (0)	0 (0)	16 (62)

Table 10. Species list for Bellingham Bay. A = adult, J = juvenile

Common name	Scientific name
American shad	*Alosa aspidissima*
bay pipefish	*Sygnathus griseolineatus*
big skate	*Raja binoculata*
blackbelly eelpout	*Lycodopsis pacificua*
blacktip poacher	*Xeneretmus latifrons*
bluebarred prickleback	*Plectobranchus evides*
buffalo sculpin	*Enophrys bison*
butter sole (A and J)	*Isopsetta isolepis*
chinook salmon	*Oncorhyncus tshawytscha*
copper rockfish	*Sebastes caurinus*
daubed shanny	*Lumpenus maculatus*
Dover sole (A and J)	*Microstomus pacificus*
English sole (A and J)	*Parophrys vetulus*
flathead sole (A and J)	*Hippoglossoides elassodon*
gray starsnout poacher	*Asterotheca alascana*
great sculpin	*Myoxocephalus polyacanthocephalus*
longfin smelt (A and J)	*Spirinchus thaleichthys*
greenling unidentified	*Hexagrammos sp.*
grunt sculpin	*Rhamphocottus richardsoni*
longnose skate	*Raja rhina*
marbled snailfish	*Liparis dennyi*
northern anchovy	*Engraulis mordax*
northern sculpin	*Icelinus borealis*
Pacific hake (J)	*Merluccius productus*
Pacific herring (A and J)	*Clupea harengus*
Pacific sandfish	*Trichodon trichodon*
Pacific sandlance	*Ammodytes hexapterus*
Pacific tomcod (A and J)	*Microgadus proximus*
padded sculpin	*Artedius fenestralis*
pile perch	*Rhacichilus vacca*
plainfin midshipman	*Porichthys notatus*
quillback rockfish	*Sebastes maliger*
ratfish	*Hydrolagus colliei*
Rex sole (A and J)	*Glyptocephalus zachirus*
rock sole (A and J)	*Lepidopsetta bilineata*
roughback sculpin	*Chitonotus pugetensis*
sablefish	*Anoplopoma fimbria*
saddleback gunnel	*Pholis ornata*
sand sole (A and J)	*Psettichthys melanostictus*
shiner perch (A and J)	*Cymatogaster aggregata*
shortfin eelpout	*Lycodes brevipes*
showy snailfish	*Liparis pulchellus*
slender sole (A and J)	*Lyopsetta exilis*

Table 10. Continued.

Common name	Scientific name
slim sculpin	*Radulinus asprellus*
snake prickleback	*Lumpenus saggita*
speckled sanddab (A and J)	*Citharichtys stigmaeus*
spiny dogfish	*Squalus acanthias*
spinyhead sculpin	*Dasycottus setiger*
staghorn sculpin	*Leptocottus armatus*
starry flounder	*Platichthys stellatus*
stickleback	*Gasterosteus aculeatus*
sturgeon poacher	*Agonus acipenserinus*
tubesnout	*Aulorhynchus flavidus*
walleye pollock (A and J)	*Theragra chalcogramma*
whitebait smelt	*Allosmerus elongatus*
whitespotted greenling	*Hexagrammos stelleri*

TOTAL 56 SPECIES

Table 11. Bellingham Bay relative species composition % by season and depth.

	15-20 m			
Species	W	Sp	Su	A
big skate	0.31			
blackbelly eelpout			0.98	
buffalo sculpin			0.20	
butter sole (A)	1.54	12.81	4.51	
butter sole (J)		5.72	0.98	
daubed shanny		0.82		
English sole (A)		10.35	2.94	
English sole (J)		6.81		
flathead sole (A)	0.62	1.09		
gray starsnout poacher	0.31			
great sculpin				3.23
grunt sculpin				3.23
longfin smelt (A)		0.82		
longfin smelt (J)		3.81	41.96	
marbled snailfish	0.31			
Pacific hake (J)	0.92			
Pacific herring			0.20	12.90
Pacific tomcod (A)	7.38	22.34	14.51	
Pacific tomcod (J)	18.15	11.99	10.39	25.81
padded sculpin				3.23
plainfin midshipman		0.82		
rock sole (A)		1.09	0.98	6.45
rock sole (J)		1.36	0.39	
roughback sculpin			0.39	
sand sole (A)	1.54	3.00	0.20	
shiner perch (A)		0.54	1.76	
shiner perch (J)	65.85	0.82		19.35
shortfin eelpout			0.20	
slender sole (J)	0.31			
snake prickleback		12.53	13.14	3.23
speckled sanddab (A)			1.57	6.45
speckled sanddab (J)		0.27		3.23
spiny dogfish	0.92		0.78	
spinyhead sculpin	0.31	0.27		
staghorn sculpin	0.92	1.09	0.20	3.23
starry flounder (A)	0.62	0.82		3.23
sturgeon poacher		0.27	0.78	
tubenose poacher			1.76	3.23
walleye pollock (A)	0.31			
whitebait smelt		0.54		
whitespotted greenling			1.18	3.23
TOTAL	100.31	100.00	100.00	100.00

Table 11. Continued.

SPECIES	W	Sp	Su	A
		> 20 m		
bay pipefish		0.03		0.02
blackbelly eelpout	0.53	11.59	14.98	1.11
blacktip poacher			0.01	
butter sole (A)	3.00	1.22	0.61	2.72
butter sole (J)	1.40	0.54	0.02	0.02
chinook salmon				0.02
daubed shanny	0.14	0.68	0.51	0.13
Dover sole (A)			0.04	0.02
Dover sole (J)		0.03		
English sole (A)	4.36	2.98	0.51	1.32
English sole (J)	4.36	0.20		0.33
flathead sole (A)	0.83	3.38	1.29	1.69
flathead sole (J)	0.73	1.16	0.22	1.09
gray starsnout poacher	0.02	0.03		
great sculpin				0.09
greenling unidentified				0.02
longfin smelt (A)	1.90	6.88	4.17	33.53
longfin smelt (J)	41.70	53.18	70.44	33.78
longnose skate		0.06	0.04	
marbled snailfish	0.02			
northern anchovy	0.05	0.06		
northern sculpin	0.05			
Pacific hake (J)	0.05	0.03		
Pacific herring (A)	1.99	1.11	0.19	0.76
Pacific herring (J)				2.54
Pacific sandfish			0.02	
Pacific sandlance	0.02			
Pacific tomcod (A)	4.91	5.57	0.88	1.18
Pacific tomcod (J)	8.39	0.82	0.47	3.79
pile perch	0.14			0.02
plainfin midshipman	0.62	0.06	0.05	0.29
rex sole (A)		0.03	0.02	
rex sole (J)	0.05	0.28		
rock sole (A)	0.05			0.13
roughback sculpin			0.07	
sablefish		0.06		0.02
saddleback gunnel	0.02			0.02
sand sole (A)	0.23	0.14	0.04	0.18
sand sole (J)	0.05	0.03		
shiner perch (A)	1.12	0.20	0.04	4.04
shiner perch (J)	19.56	0.26		7.40

Table 11. Continued.

	> 20 m (continued)			
SPECIES	W	Sp	Su	A
shortfin eelpout		2.84	2.22	0.18
showy snailfish				
slender sole (A)		0.03		
slender sole (J)	0.02	0.06		
slim sculpin	0.05		0.10	0.04
snake prickleback	0.07	5.43	2.09	0.65
speckled sanddab (A)				0.04
speckled sanddab (J)		0.03		0.02
spiny dogfish	0.09	0.37	0.22	0.13
spinyhead sculpin	0.23	0.11	0.10	0.20
staghorn sculpin	1.65	0.03	0.02	0.45
starry flounder (A)	1.08	0.45	0.33	1.61
stickleback			0.30	
sturgeon poacher	0.11	0.06		0.02
tubenose poacher	0.07			0.04
walleye pollock (A)	0.11			0.04
walleye pollock (J)	0.02			0.27
whitebait smelt				
whitespotted greenling	0.23			
TOTAL	100.00	100.00	100.00	100.00

Table 11. Continued.

	North ZSF			
SPECIES	W	Sp	Su	A
American anchovy			0.03	
bay anchovy				0.03
big skate	0.03			
blackbelly eelpout	0.51	12.37	6.92	2.32
blacktip poacher			0.03	
bluebarred prickleback			0.13	
butter sole (A)	3.05	2.04	0.42	1.99
butter sole (J)	1.31	0.77	0.16	
copper rockfish			0.13	
daubed shanny	0.05	0.26	0.76	0.03
Dover sole (A)			0.03	
Dover sole (J)			0.03	
English sole (A)	1.90	11.86	1.07	1.11
English sole (J)	1.68	0.38		0.10
flathead sole (A)	1.23	4.08	0.78	1.60
flathead sole (J)	0.48	1.28		0.03
gray starsnout poacher	0.03			
longfin smelt (A)	3.29	8.93	7.71	64.67
longfin smelt (J)	58.05	28.06	71.83	
longnose skate			0.03	
marbled snailfish			0.03	
northern anchovy	0.03	0.26		
Pacific herring (A)	1.71	1.40	0.26	3.33
Pacific herring (J)				1.37
Pacific sandfish			0.05	
Pacific sandlance	0.03			
Pacific tomcod (A)	6.34	16.71	2.82	5.12
Pacific tomcod (J)	7.57	1.66	0.57	3.16
padded sculpin				0.03
pile perch	0.05	0.26		0.95
plainfin midshipman	0.05	0.13		0.03
Quillback rockfish			0.24	
rex sole (A)		0.13		
rock sole (A)	0.03			
sablefish		0.26		
saddleback gunnel			0.03	
sand sole (A)	0.11		0.05	0.07
sand sole (J)	0.03			
shiner perch (A)	0.32	0.38	0.03	4.96
shiner perch (J)	8.37	0.13	0.03	6.59
shortfin eelpout		0.77	0.34	0.20
showy snailfish			0.31	0.07
snake prickleback		6.89	4.13	0.10
speckled sanddab				0.03
spiny dogfish	0.08	0.89	0.08	0.59

Table 11. Continued.

SPECIES	North ZSF (continued) W	Sp	Su	A
spinyhead sculpin	0.05		0.03	
staghorn sculpin	1.50		0.03	0.10
starry flounder	1.42	0.13	0.94	1.21
stickleback				0.03
sturgeon poacher	0.05			
tubenose poacher	0.05			
walleye pollock (A)	0.21			0.03
walleye pollock (J)	0.05			0.16
TOTAL	99.65	100.00	100.00	100.00

Table 11. Continued.

	South ZSF			
SPECIES	W	Sp	Su	W
blackbelly eelpout	0.15	11.24	7.89	1.65
butter sole (A)	1.90	0.19	0.14	4.22
butter sole (J)	1.07			
daubed shanny	0.10	0.78	1.30	
Dover sole		0.13	0.05	
English sole (A)	5.75	0.58	0.09	0.74
English sole (J)	4.88			
flathead sole (A)	0.78	2.01	2.37	2.17
flathead sole (J)	0.15	0.65	0.05	1.43
longfin smelt (A)	2.00	7.73	12.81	72.28
longfin smelt (J)	35.01	59.00	67.24	6.96
longnose skate			0.05	
northern sculpin	0.20			
Pacific hake (J)	0.05			
Pacific herring	2.24	1.43	0.23	0.11
Pacific sandfish			0.05	
Pacific sandlance				
Pacific tomcod (A)	4.68	3.12	2.37	0.34
Pacific tomcod (J)	18.82	0.32	0.37	1.14
pile perch		0.06		
plainfin midshipman	0.24	0.19		0.17
rex sole (J)	0.05	0.39		
rock sole (A)		0.06		0.11
saddleback gunnel	0.05			
sand sole (A)	0.10	0.13		0.17
shiner perch (A)	0.63	0.06		3.59
shiner perch (J)	17.31	0.19		2.51
shortfin eelpout		2.14	0.70	0.06
slender sole (A)		1.04	0.05	
slender sole (J)		0.26		
slim sculpin	0.05	0.58	0.56	0.17
snake prickleback		7.15	3.06	1.03
spiny dogfish		0.32	0.28	0.06
spinyhead sculpin	0.15	0.06	0.19	0.23
staghorn sculpin	0.83	0.06		0.29
starry flounder (A)	2.54		0.19	0.46
sturgeon poacher	0.05			
walleye pollock (A)		0.06		
whitespotted greenling	0.24			0.11
TOTAL	100.00	100.00	100.00	100.00

Table 12. Bellingham Bay species clusters based on Bray-Curtis distance by season.

Winter

GROUP	SUBGROUP	SPECIES
I	a	Whitebait smelt
		Big skate
		Gray starsnout poacher
		Pacific sanddab (A)
		Pacific sanddab (J)
		Rock sole (J)
		Rex sole (J)
		Slim sculpin
		Saddleback gunnel
		Slender sole (J)
		Marbled snailfish
		Surf smelt
		Northern sculpin
		Pacific hake (J)
I	b	Rock sole (A)
		Snake prickleback
I	c	Northern anchovy
		Walleye pollock (J)
		Pile perch (A)
		Sturgeon poacher
II		Pacific sandlance
		Walleye pollock (A)
		Sand sole (J)
		Tubenose poacher
III	a	Blackbelly eelpout
		Whitespotted greenling
		Daubed shanny
		Spiny dogfish
III	b	Plainfin midshipman
		Spinyhead sculpin
		Sand sole (A)
IV	a	Butter sole (A)
		Pacific tomcod (A)
		English sole (A)
		English sole (J)
		Shiner perch (A)
		Butter sole (J)
		Staghorn sculpin
		Flathead sole (A)
		Longfin smelt (A)
		Flathead sole (J)
		Pacific herring (A)
		Starry flounder (A)
IV	b	Longfin smelt (J)
		Pacific tomcod (J)
		Shiner perch (J)

Table 12. Continued.

Spring

GROUP	SUBGROUP	SPECIES
I	a	Whitespotted greenling
		Big skate
		Dover sole (J)
		Rex sole (A)
		Sand sole (J)
		Bay anchovy
		Northern anchovy
		Pacific hake (J)
		Longnose skate
		Rock sole (J)
		Whitebait smelt
		Speckled sanddab (J)
		Sturgeon poacher
		Dover sole (A)
		Rock sole (A)
		Slim sculpin
		Slender sole (A)
		Slender sole (J)
		Sablefish
		Spinyhead sculpin
I	b	Pile perch (A)
		Staghorn sculpin
		Walleye pollock (A)
II	a	English sole (J)
		Shiner perch (A)
		Sand sole (A)
II	b	Rex sole (J)
		Spiny dogfish
III	a	Blackbelly eelpout
		Longfin smelt (J)
		Longfin smelt (A)
		Pacific tomcod (A)
		Snake prickleback
III	b	Daubed shanny
		English sole (A)
		Pacific tomcod (J)
		Flathead sole (A)
		Flathead sole (J)
		Pacific herring (A)
		Shortfin eelpout
IV		Butter sole (A)
		Plainfin midshipman
		Butter sole (J)
		Starry flounder (A)
		Shiner perch (J)

Table 12. Continued.

Summer

GROUP	SUBGROUP	SPECIES
I	a	American shad Copper rockfish Shiner perch (A) Padded sculpin Blacktip poacher Pacific sandfish Bluebarred prickleback Dover sole (J) Marbled snailfish Saddleback gunnel Sablefish Rex sole (A) Stickleback
I	b	Dover sole (A) Longnose skate Plainfin midshipman
I	c	Butter sole (J) Staghorn sculpin
II	a	Buffalo sculpin Rock sole (J) Rock sole (A) Whitespotted greenling Sturgeon poacher Speckled sanddab (A) Tubesnout Roughback sculpin Shiner perch (A) Flathead sole (J)
II	b	Butter sole (A) Sand sole (A)
III		Blackbelly eelpout Longfin smelt (A) Longfin smelt (J)
IV	a	Daubed shanny Flathead sole (A) English sole (A) Pacific tomcod (A) Snake prickleback Pacific herring (A) Spiny dogfish
IV	b	Shortfin eelpout Starry flounder
IV	c	Pacific tomcod (J) Spinyhead sculpin Slim sculpin

Table 12. Continued.

Autumn

GROUP	SUBGROUP	SPECIES
I	a	Bay anchovy Bay pipefish Chinook salmon Dover sole (A) Saddleback gunnel Grunt sculpin Padded sculpin Whitespotted greenling Sablefish Slim sculpin Sturgeon poacher Great sculpin Speckled sanddab (J) Tubesnout Rock sole (A)
I	b	Daubed shanny Walleye pollock (J)
I	c	English sole (J) Stickleback Speckled sanddab (A) Walleye pollock (A) Pile perch (A) Showy snailfish Shortfin eelpout
II		Spiny dogfish Spinyhead sculpin
III	a	Flathead sole (J) Longfin smelt
III	b	Shiner perch (J) Staghorn sculpin
IV	a	Blackbelly eelpout Pacific tomcod (A) Flathead sole (A) Butter sole (A) Shiner perch (A) English sole (A) Pacific tomcod (J)
IV	b	Pacific herring (A) Starry flounder Pacific herring (J)
IV	c	Plainfin midshipman Snake prickleback
V		Longfin smelt (A) Sand sole (A)

Table 13. Incidence of blood worm (Philometra) infestation, Bellingham Bay

Species	Winter	Spring	Summer	Autumn
		15-20 m		
Rock sole	0 (1)	11 (9)	0 (7)	0 (0)
Starry flounder	0 (3)	0 (3)	0 (0)	0 (0)
		> 20 m		
Butter sole	0.5 (233)	0 (65)	0 (52)	0 (0)
English sole	0.2 (500)	0 (106)	0 (42)	0 (82)
Flathead sole	1 (72)	0(184)	0 (118)	3(78)
Rock sole	0 (2)	0(0)	0 (0)	0 (0)
Starry flounder	4 (73)	0(16)	0 (27)	1(88)
		North ZSF		
English sole	0 (134)	0(96)	0 (41)	0 (37)
Flathead sole	0 (64)	0(42)	0 (30)	0 (50)
Rock sole	0 (1)	0(0)	0 (0)	0 (0)
Starry flounder	9 (53)	0(1)	0 (36)	0 (37)
		South ZSF		
English sole	3(98)	0(5)	0 (2)	0 (13)
Flathead Sole	0 (1)	0 (17)	0 (31)	0 (63)
Rock Sole	0 (0)	0 (1)	0 (0)	0 (2)
Starry Flounder	0 (8)	0 (0)	0 (4)	0 (8)

Table 14. Strait of Georgia (Point Roberts) trawl caught fish by species and station

Species	Sta1	Sta2	Sta3	Sta5	Sta7	Sta8	Sta9	Sta 10	Sta 11
April									
Pacific tomcod								24	292
snake prickleback								1	41
Pacific herring									21
English sole		1		1				2	19
sturgeon poacher								6	12
flathead sole								5	11
butter sole								1	5
rex sole								2	5
blackbelly eelpout						1		3	4
daubed shanny									2
Pacific sanddab								2	2
staghorn sculpin									2
gray starsnout poacher						1	4	1	1
longfin smelt									1
plainfin midshipman								13	1
shiner perch									1
speckled sanddab									1
California headlight fish						1			
Dover sole					1		2	3	
eulachon			1	3	2				
marbled snailfish					1				
Pacific cod						1			
Pacific sand lance				1					
ratfish	1	1			3				
sablefish							1	1	
shortfin eelpout								1	
showy snailfish					1		1	1	
slender sole								1	

Table 14. Continued

Species	Sta 1	Sta 2	Sta 3	Sta 5	Sta 7	Sta 8	Sta 9	Sta 10	Sta 11
spinyhead sculpin								1	
starry skate					1				
walleye pollack				1					
wattled eelpout							1	1	
Total fish caught	1	2	1	6	10	5	9	68	421
October									
daubed shanny			1						
Dover sole	1		1				3		
English sole	3		3	2	2	2	19	3	1
flathead sole							5	30	
gray starsnout poacher						4	1	5	
longfin smelt						3			4
marbled snailfish					7				
Pacific cod	1	1		1			1		
Pacific hake	1								
Pacific tomcod						2		47	8
plainfin midshipman							1	2	
ratfish	6	1			3		1		
rex sole								3	
shiner perch								10	10
showy snailfish							1		
spiny dogfish								11	
spotted snailfish				1	2				
staghorn sculpin							1		
starry skate			1						
UID larvae		1							
walleye pollack	8	3				2	1	28	
Total	20	6	6	3	13	13	34	139	23

Table 15. Rosario Strait rock dredge caught fish by species and station.

Species	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6	Sta 7	Sta 8	Sta 9	Sta 10	Sta 11
April											
Dover sole, A								1			
marbled snailfish	1				1		1				
northern sculpin	1					1			1		1
ratfish, A	1	1									
ringtail snailfish	66										
slipskin snailfish		2	1								
smooth alligatorfish			1								
Total	70	3	2	0	1	1	1	1	1	0	1
October											
Pacific sandlance	12										
Total	12	0	0	0	0	0	0	0	0	0	0

Table 16. Port Townsend area trawl caught fish by species and station.

Species	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6
April						
English sole		1	1			
gray starsnout poacher				1		
northern ronquil						2
northern sculpin				1		
Pacific cod			1			
quillback rockfish					1	
ratfish	2			1		
walleye pollack						1
Total	2	1	2	3	1	3
October						
arrowtooth flounder	2		1		2	
blacktip poacher		1				3
daubed shanny	1		1			
Dover sole	3		1			
English sole	1	1	8		2	2
flathead sole			1			
Pacific cod						1
Pacific sandlance			2		1	
Pacific tomcod			3			
ratfish	2	1		1		5
red Irish lord						1
rex sole	2					
rock sole				2		1
rockfish unidentified	1	1				
ronquil unidentified				6		2
sanddab unidentified			1		1	
sculpin unidentified		2	2	26		15
slim sculpin				3	1	
snailfish unidentified	8	26	1	5	1	
snake prickleback	5		1		2	
tadpole sculpin	2		1			
thornback sculpin				6		6
walleye pollack	8	26	60	47	12	52
Total	35	58	83	96	22	88

Table 17. Port Angeles area trawl caught fish by species and station.

Species	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6
April						
California headlight fish				1		
Dover sole - adult		1	2	1	1	
Dover sole - juvenile				4		
eulachon	3	1		1		2
gray starsnout poacher	1	1			1	1
northern sculpin	1					
Pacific cod			1			
ratfish - adult	2		2	2	4	1
rex sole - adult				1		
rex sole - juvenile				1		
slipskin snailfish			1			1
starry skate		1		1		1
tadpole sculpin		1				
UID larvae		1				
Total	7	6	6	9	6	6
October						
arrowtooth flounder			2			
blacktip poacher					2	
daubed shanny			2			1
Dover sole			2			1
ratfish	1				4	2
rex sole			1		1	2
roughback sculpin	1				11	
snailfish UID		2	3		3	6
snake prickleback		3				
soft sculpin		4	2		1	
walleye pollock	216	339	316		59	6
Total	218	348	326	NA	81	18

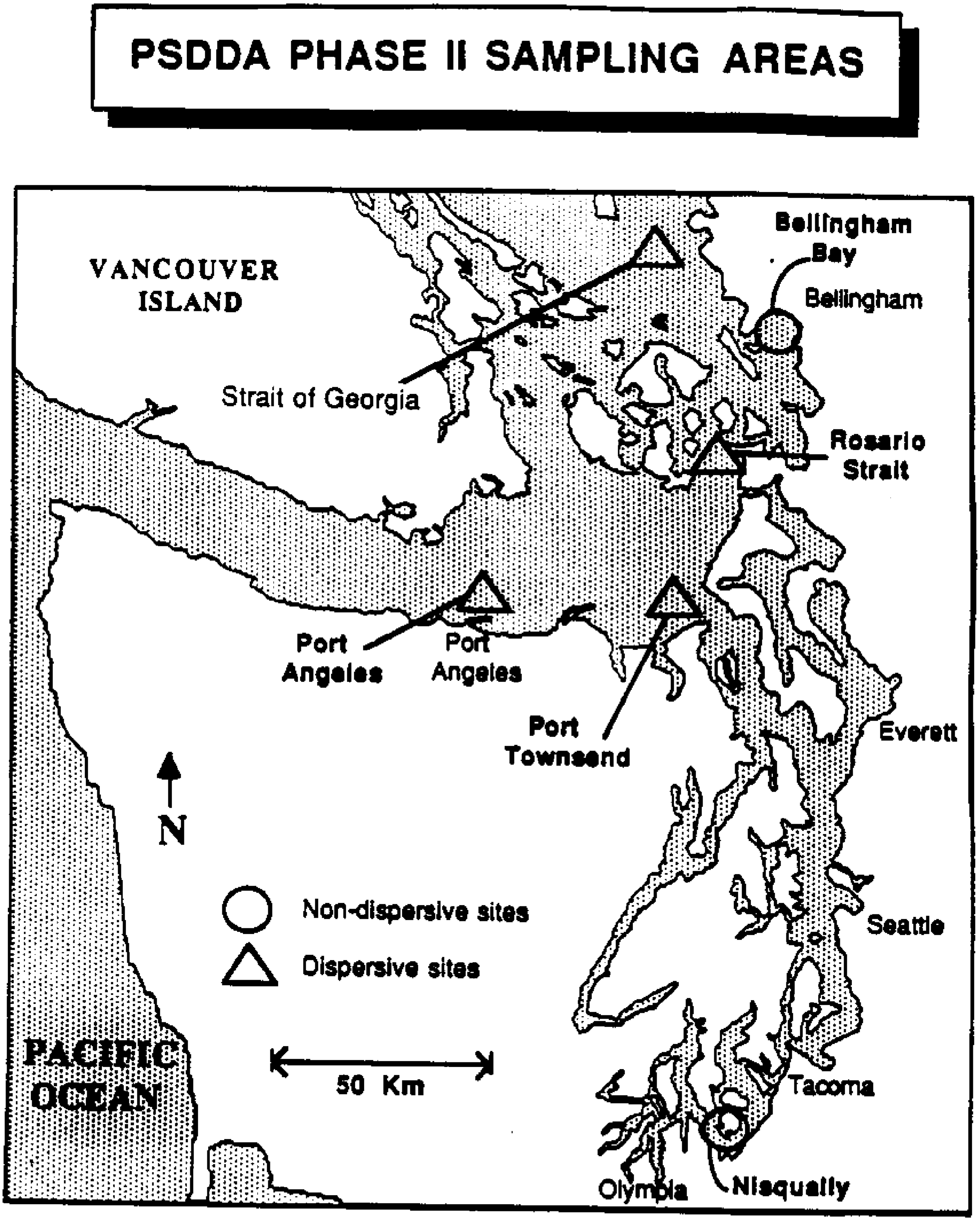

Figure 1. Map of Puget Sound showing the PSDDA II sampling locations.

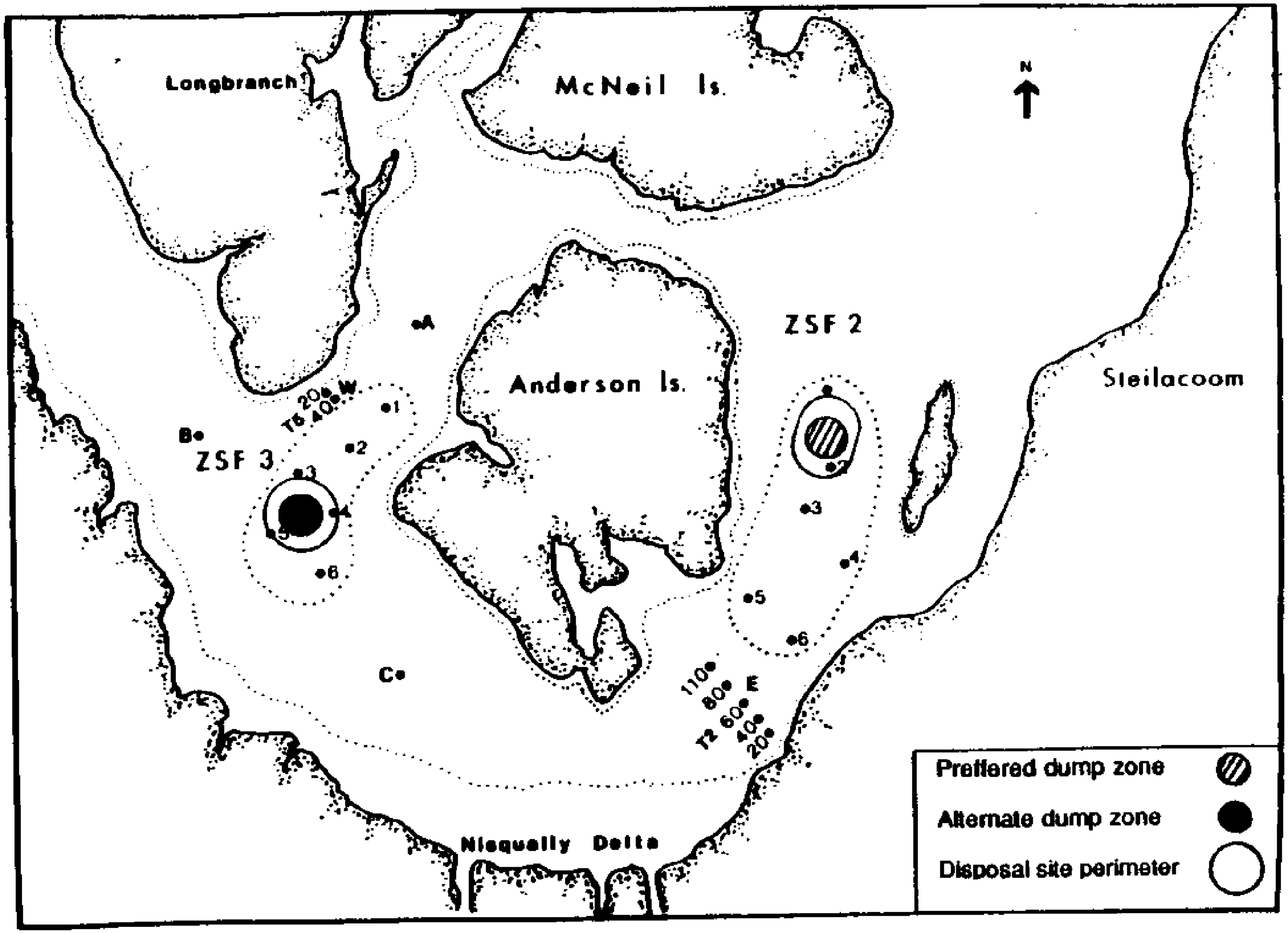

Figure 2 Map of Nisqually region showing the locations of Zones of Siting Feasibility (ZFS) 2 and 3, and the stations sampled.

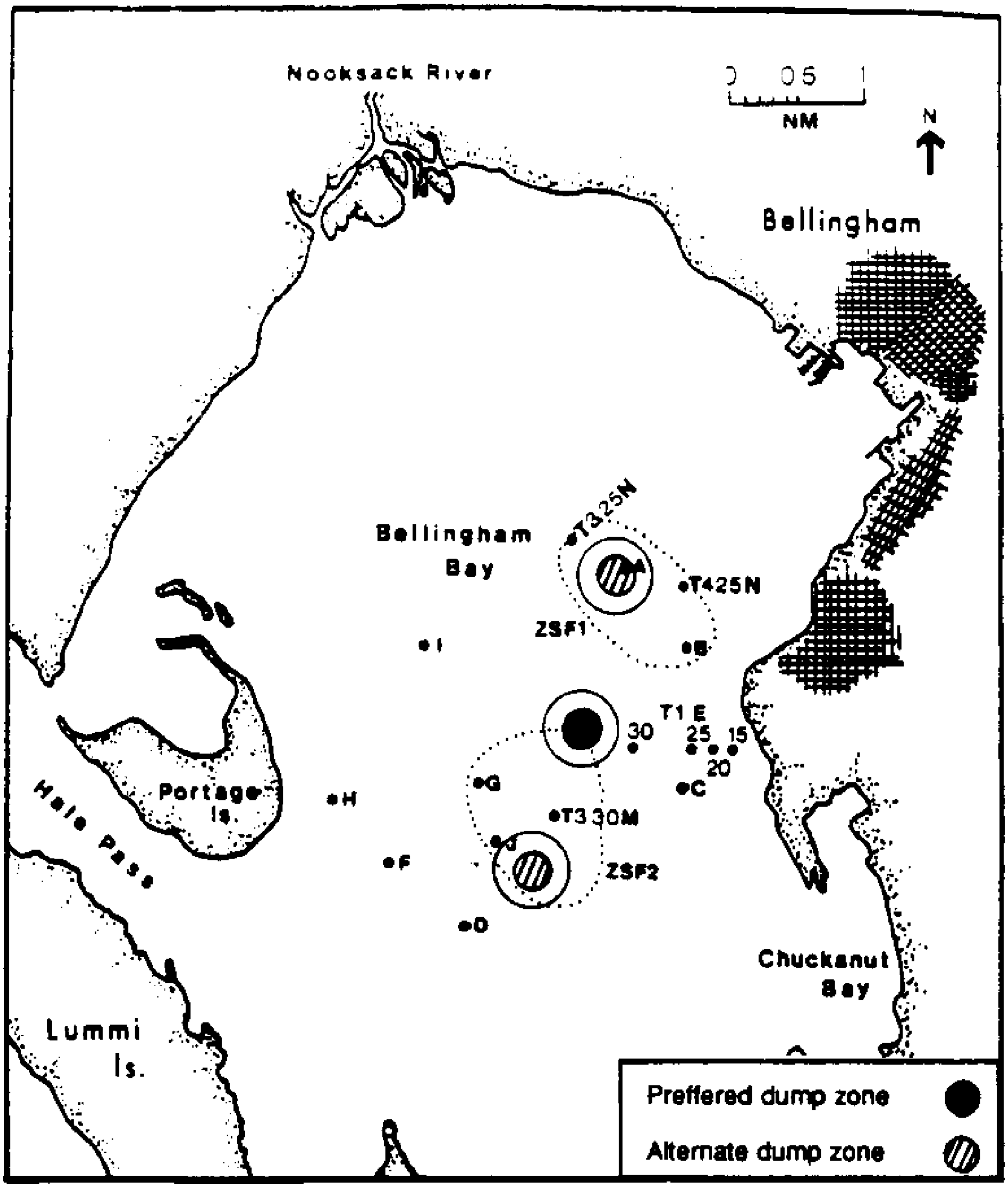

Figure 3. Map of Bellingham Bay showing the locations of the Zones of Siting Feasibility (ZSF) 1 and 2, and stations sampled.

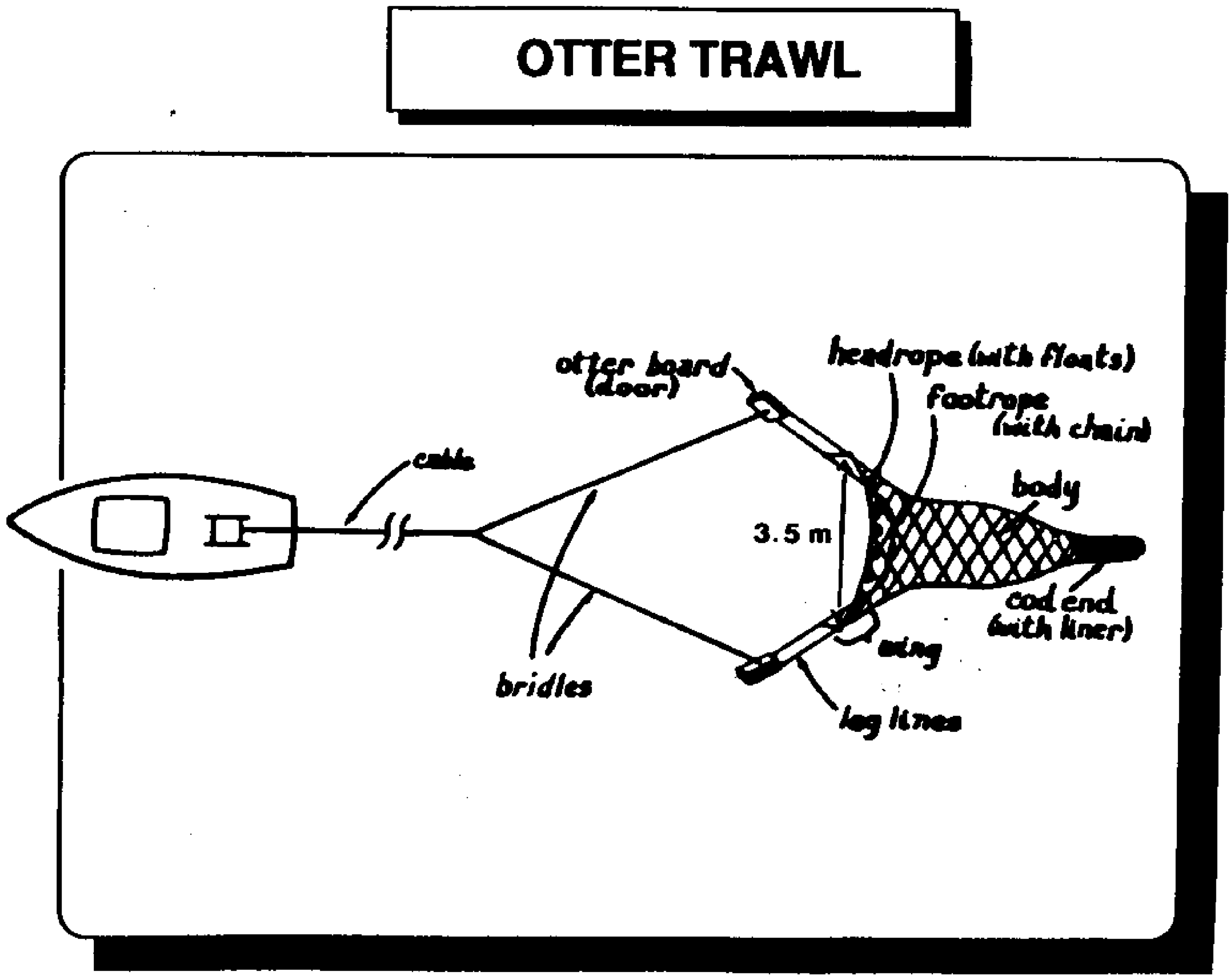

Figure 4. Diagram of the otter trawl used to capture bottomfish.

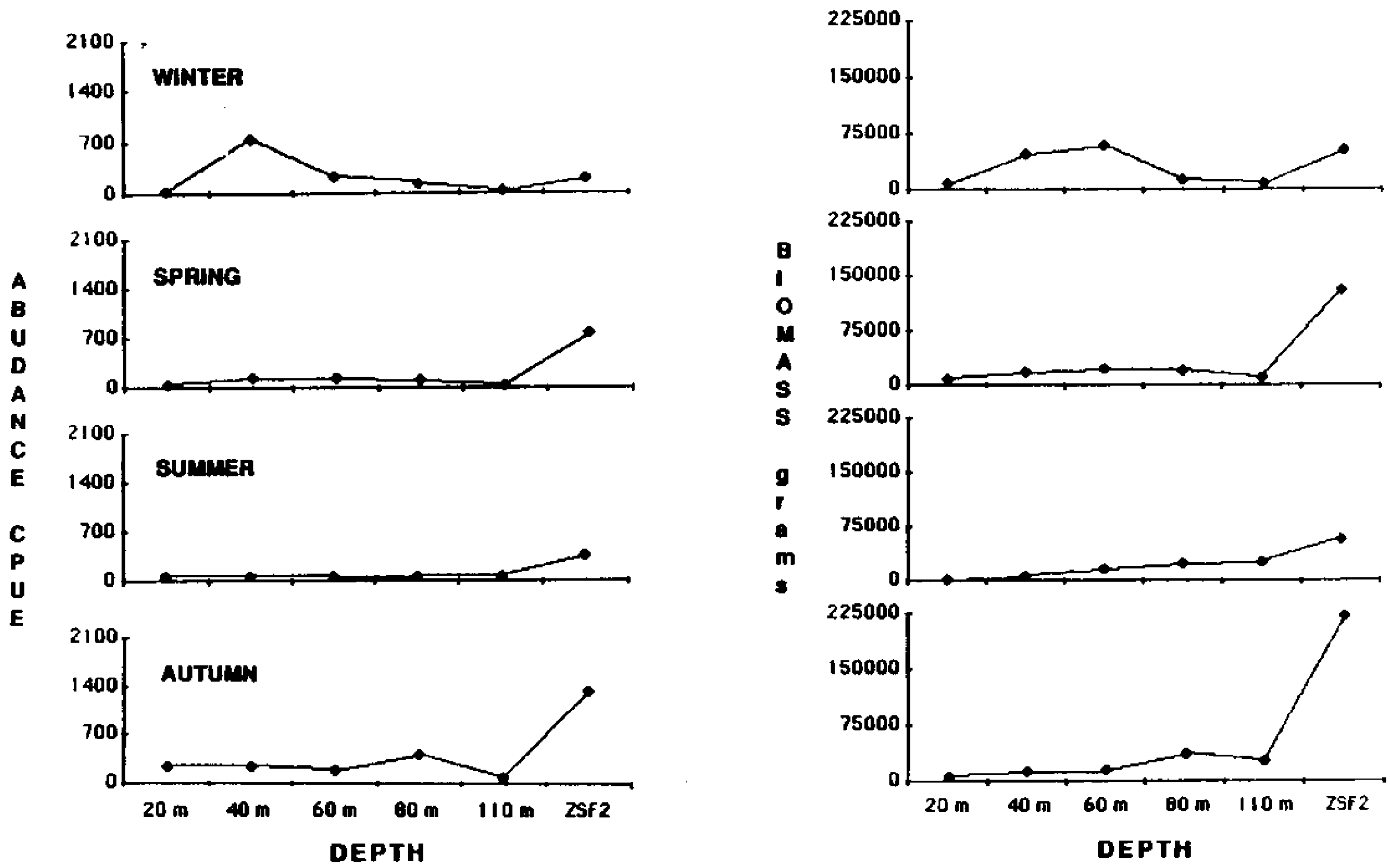

Figure 5. Ketron Island abundance and biomass by depth and season.

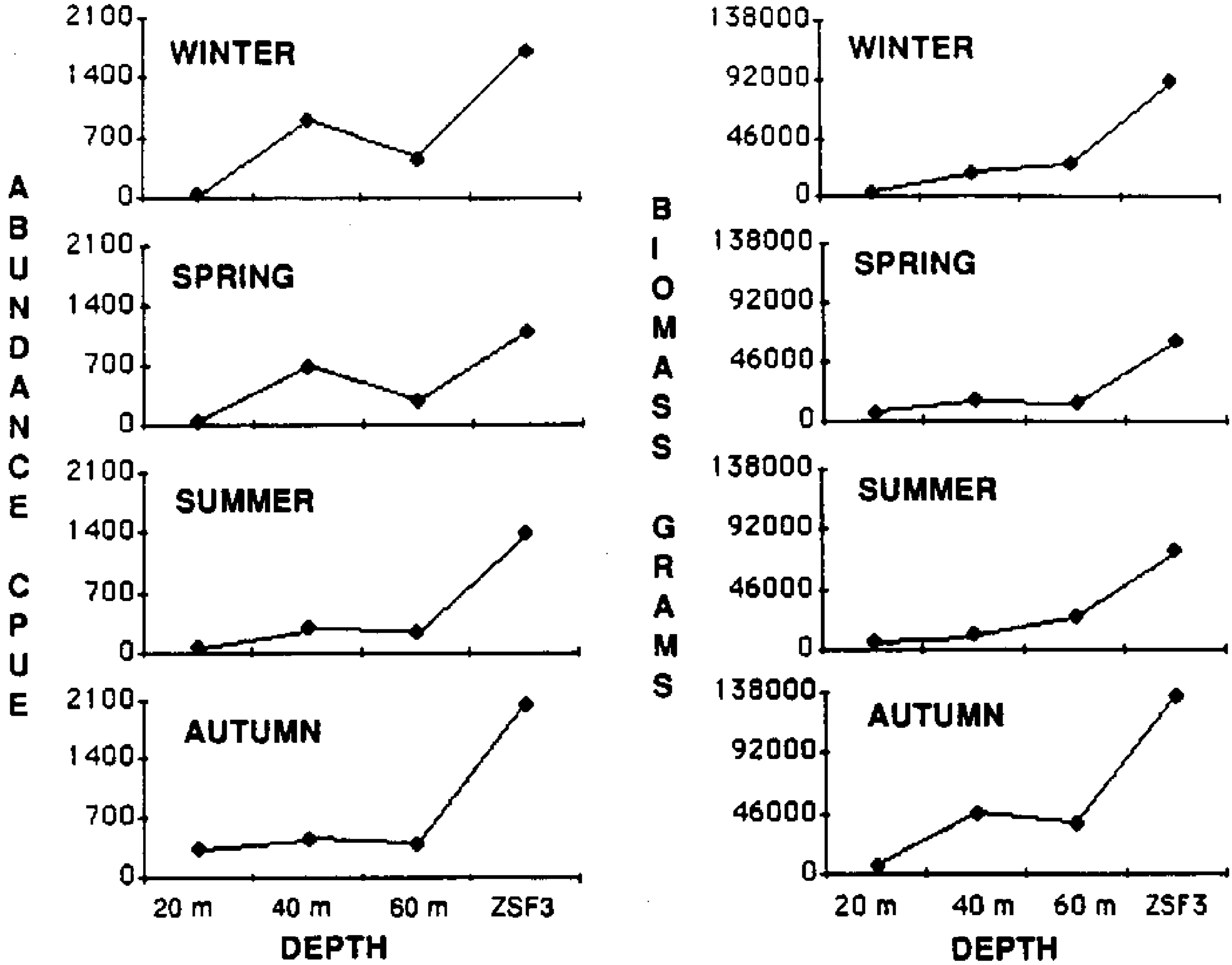

Figure 6. Devils Head abundance and biomass by depth and season.

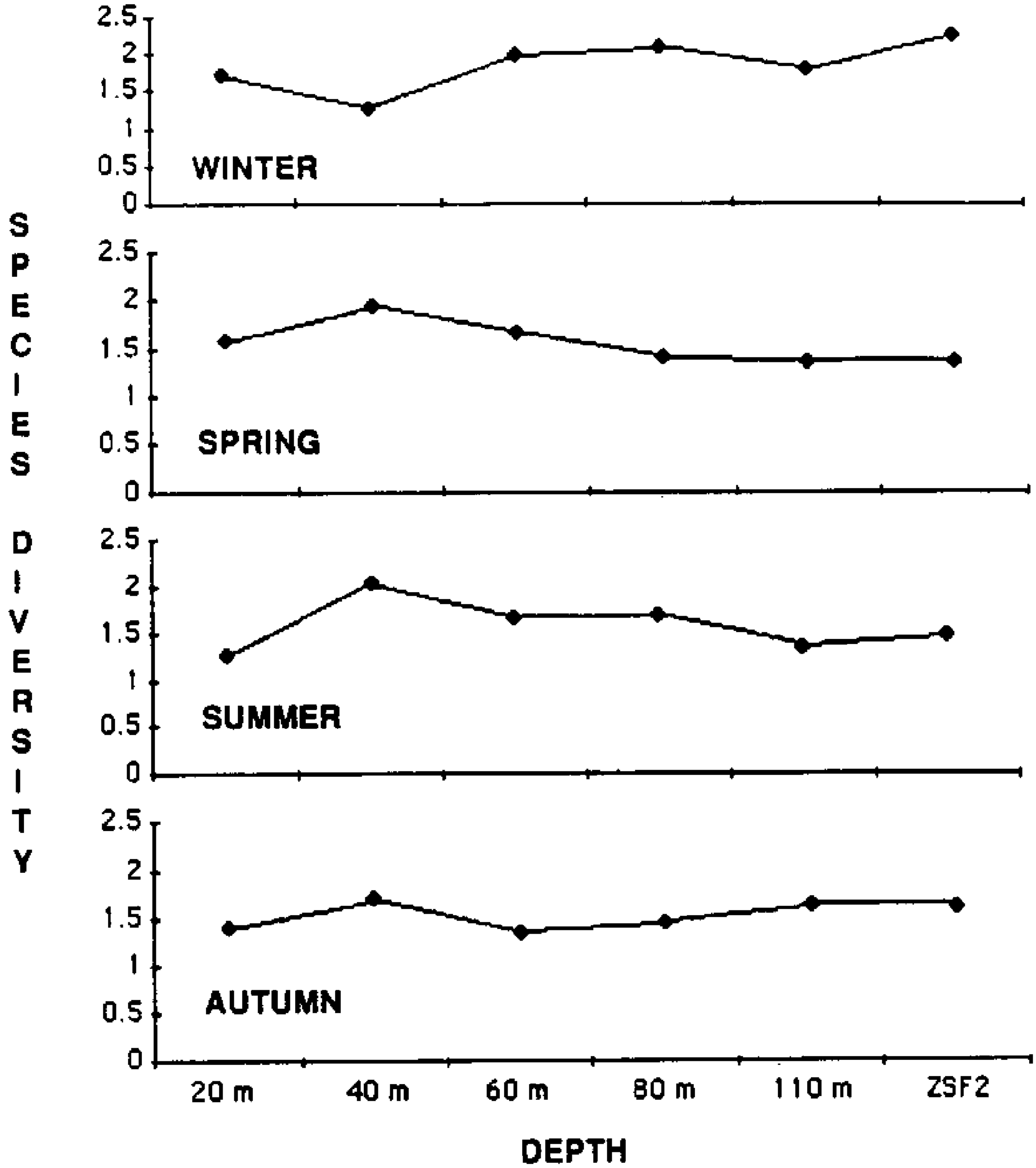

Figure 7. Ketron Island species diversity by depth and season.

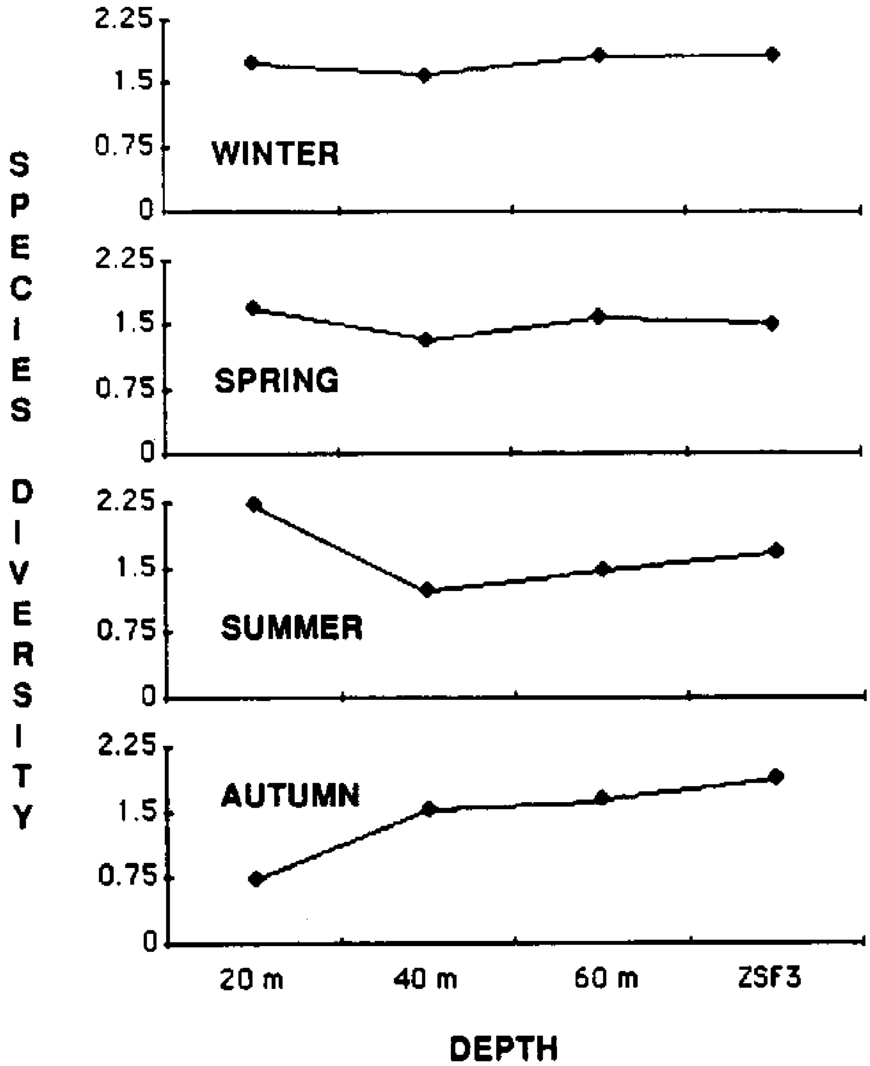

Figure 8. Devils Head species diversity by depth and season.

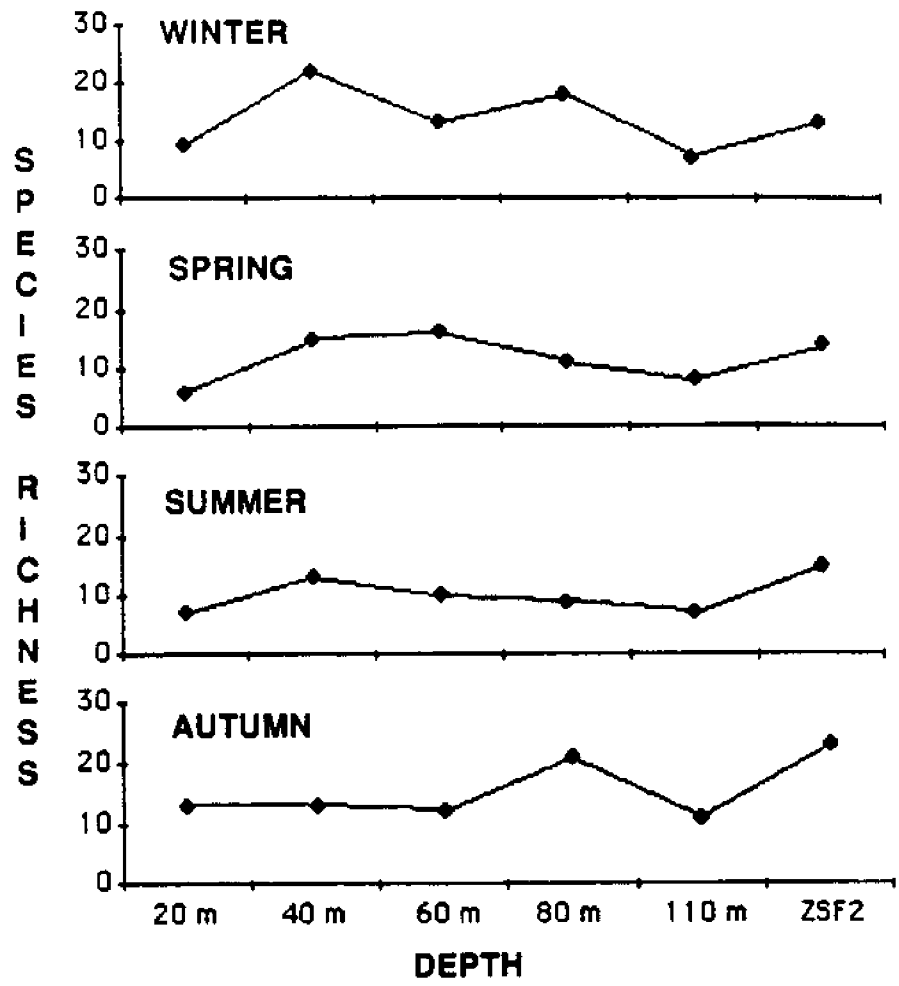

Figure 9. Ketron Island species richness by depth and season.

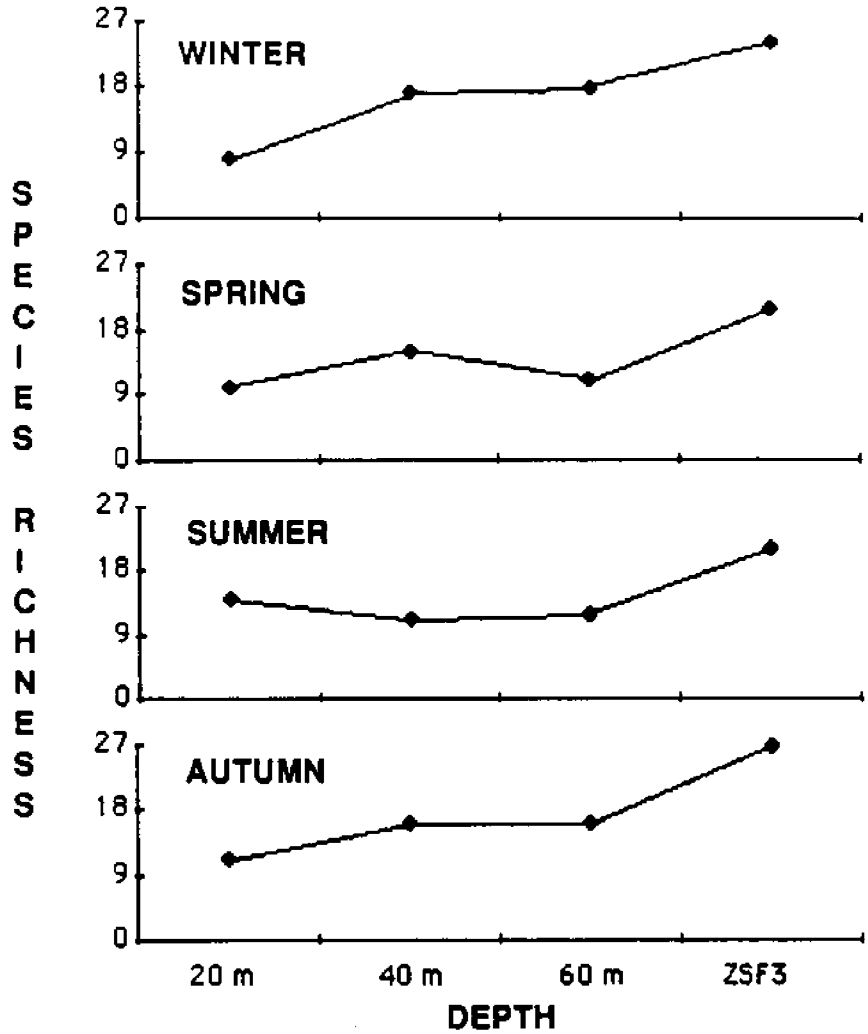

Figure 10. Devils Head species richness by depth and season.

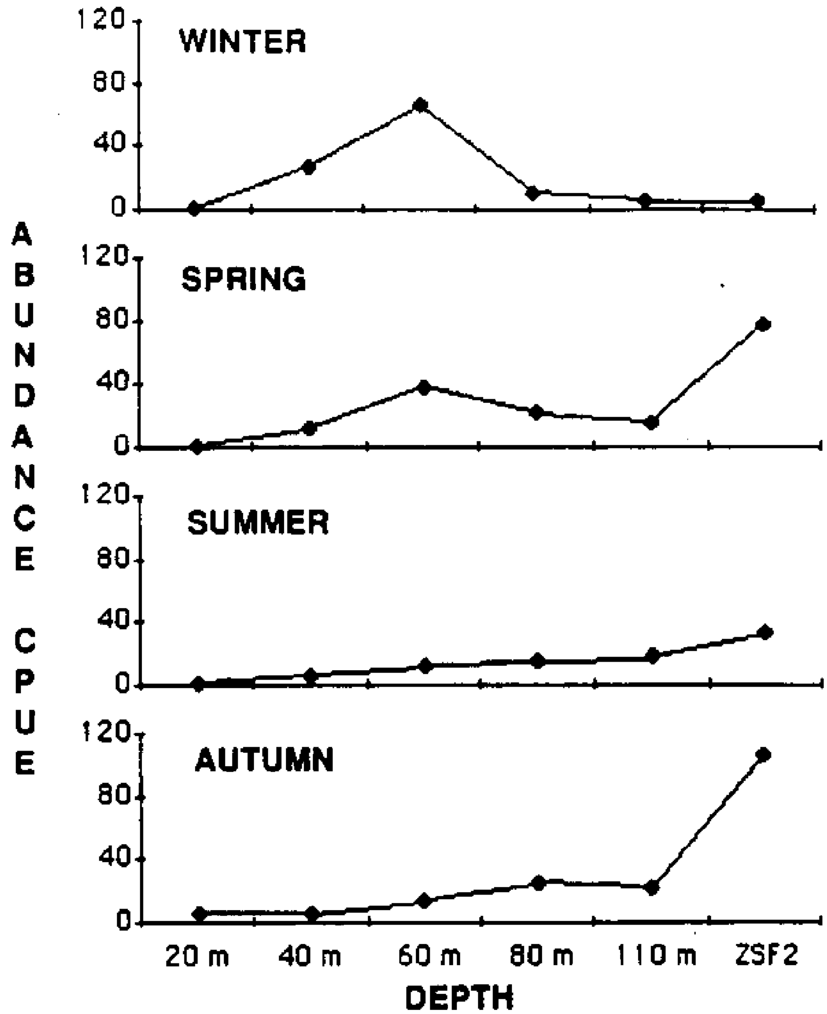

Figure 11. Ketron Island English sole abundance (CPUE) by depth and season.

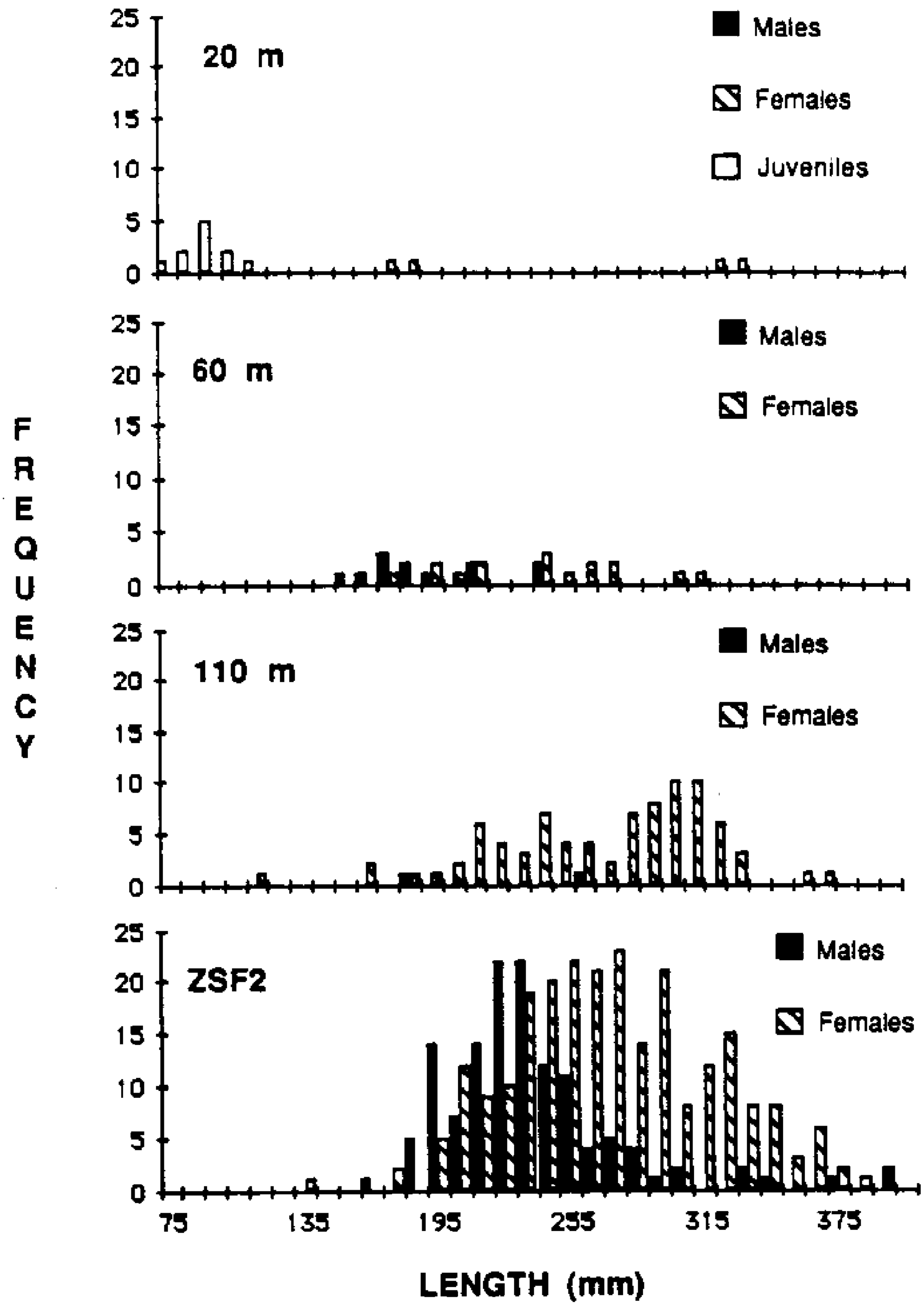

Figure 12. Ketron Island English sole length-frequencies.

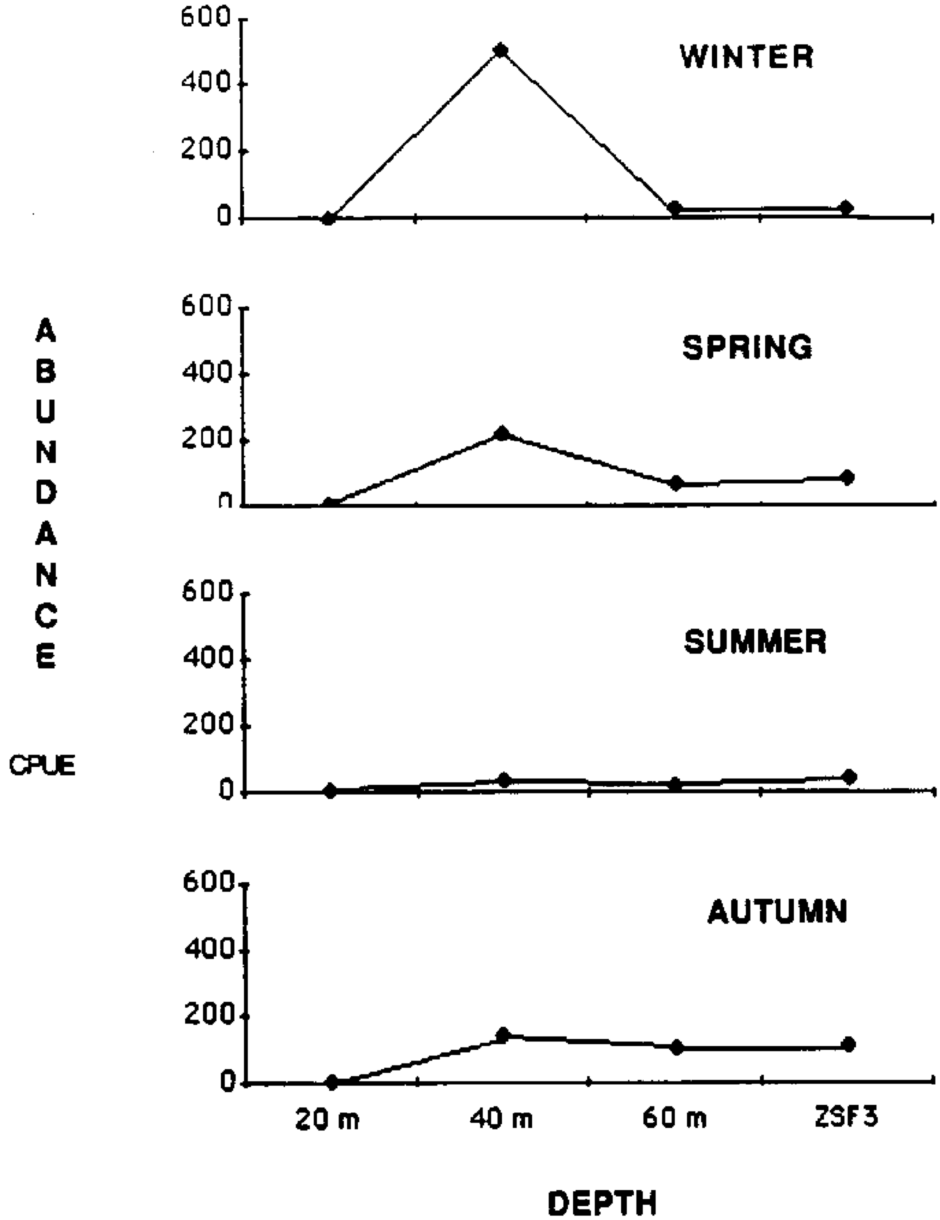

Figure 13. Devils Head English sole abundances (CPUE) by depth and season.

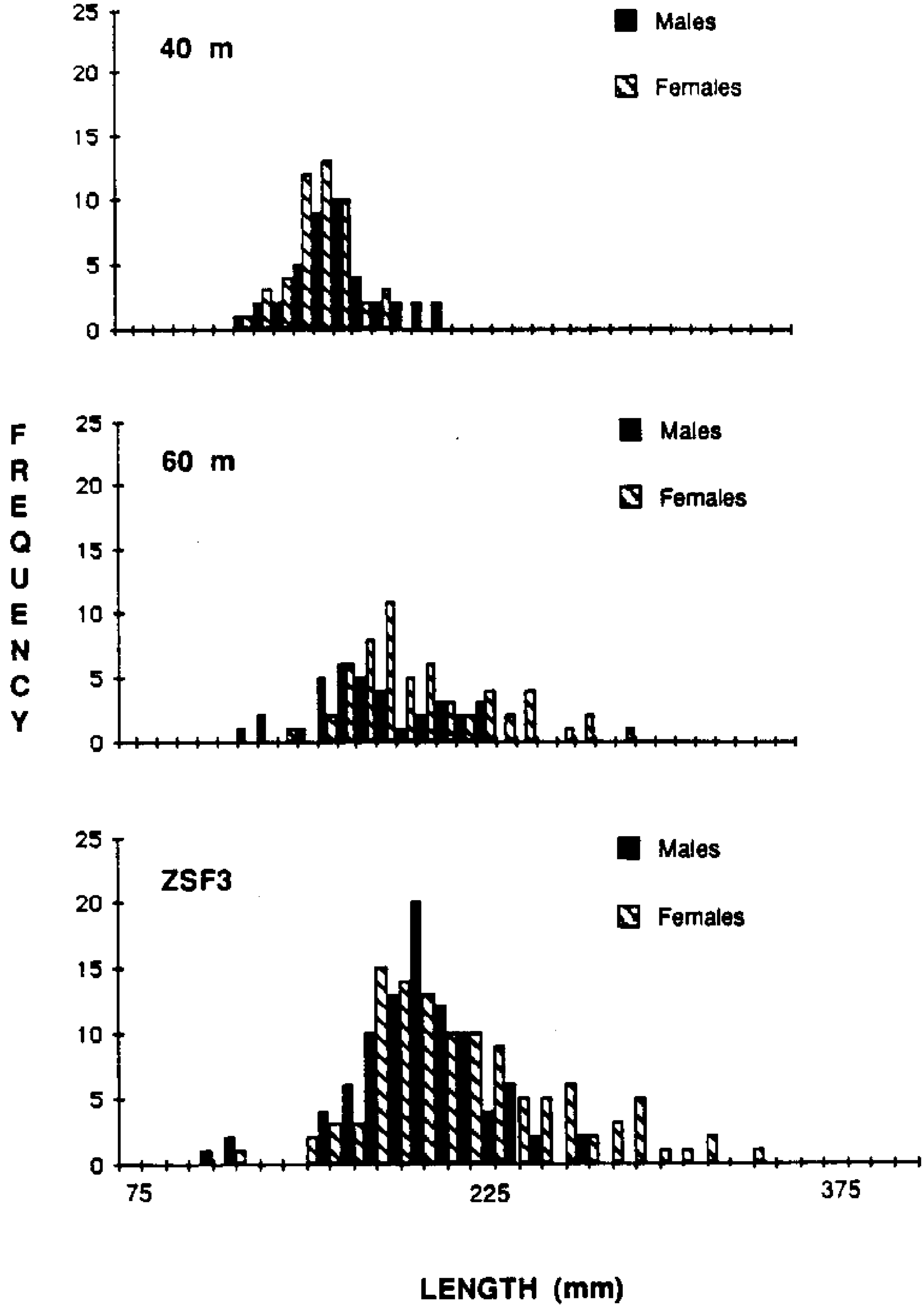

Figure 14. Devils Head English sole length-frequencies.

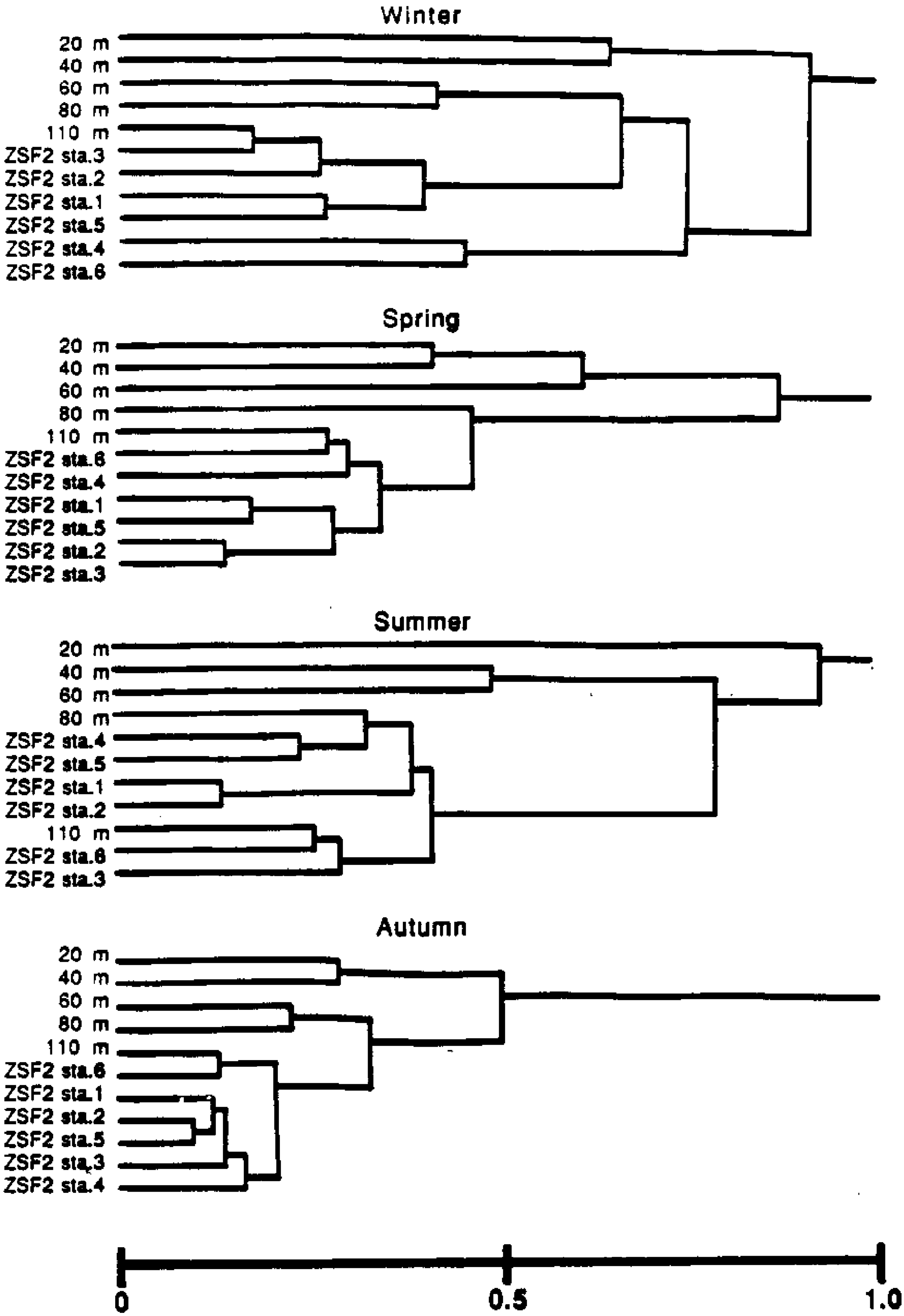

Figure 15. Dendrogram of Bray-Curtis distance measure between stations by season at Ketron Island.

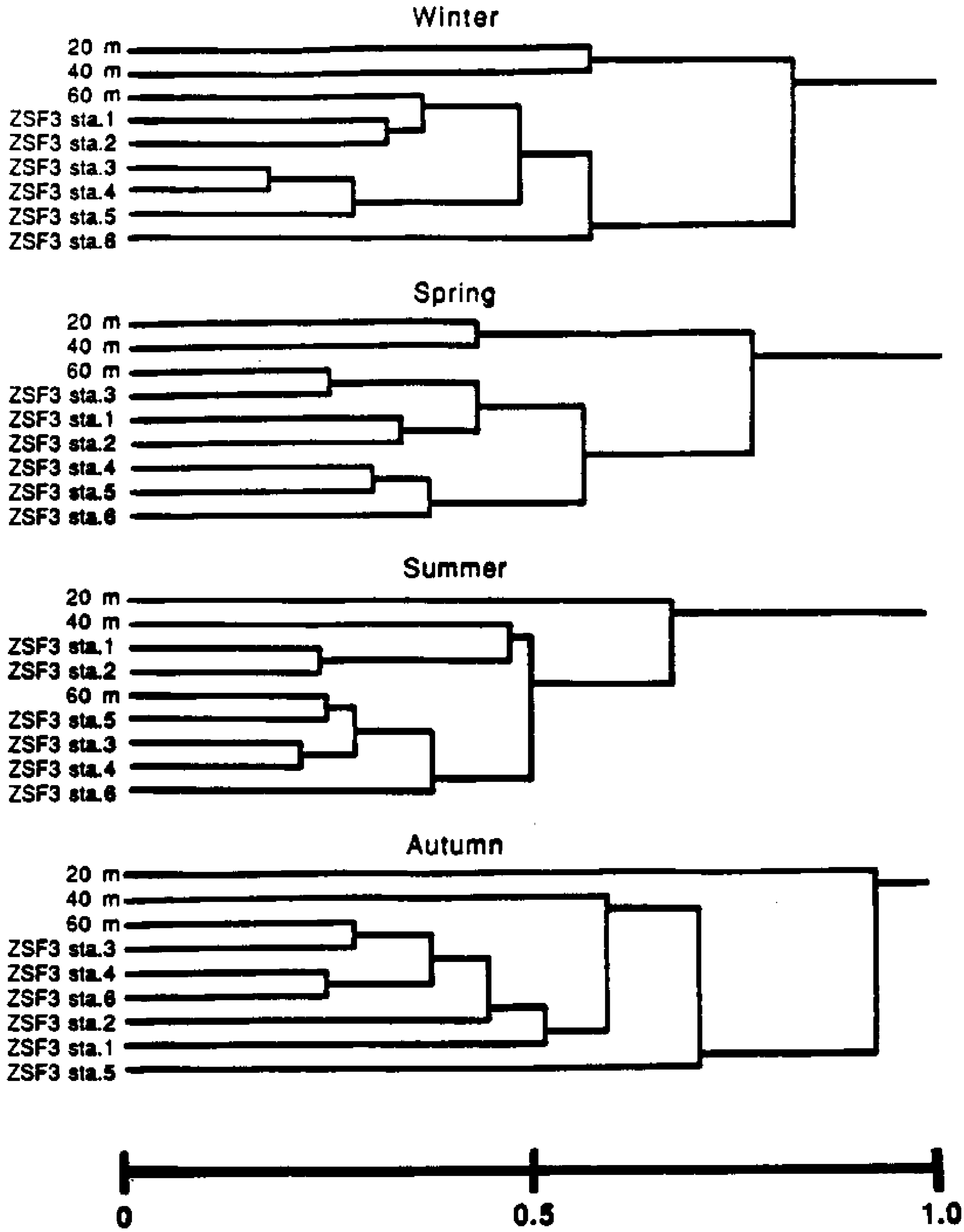

Figure 16. Dendrogram of Bray-Curtis distance measure between stations by season at Devils Head.

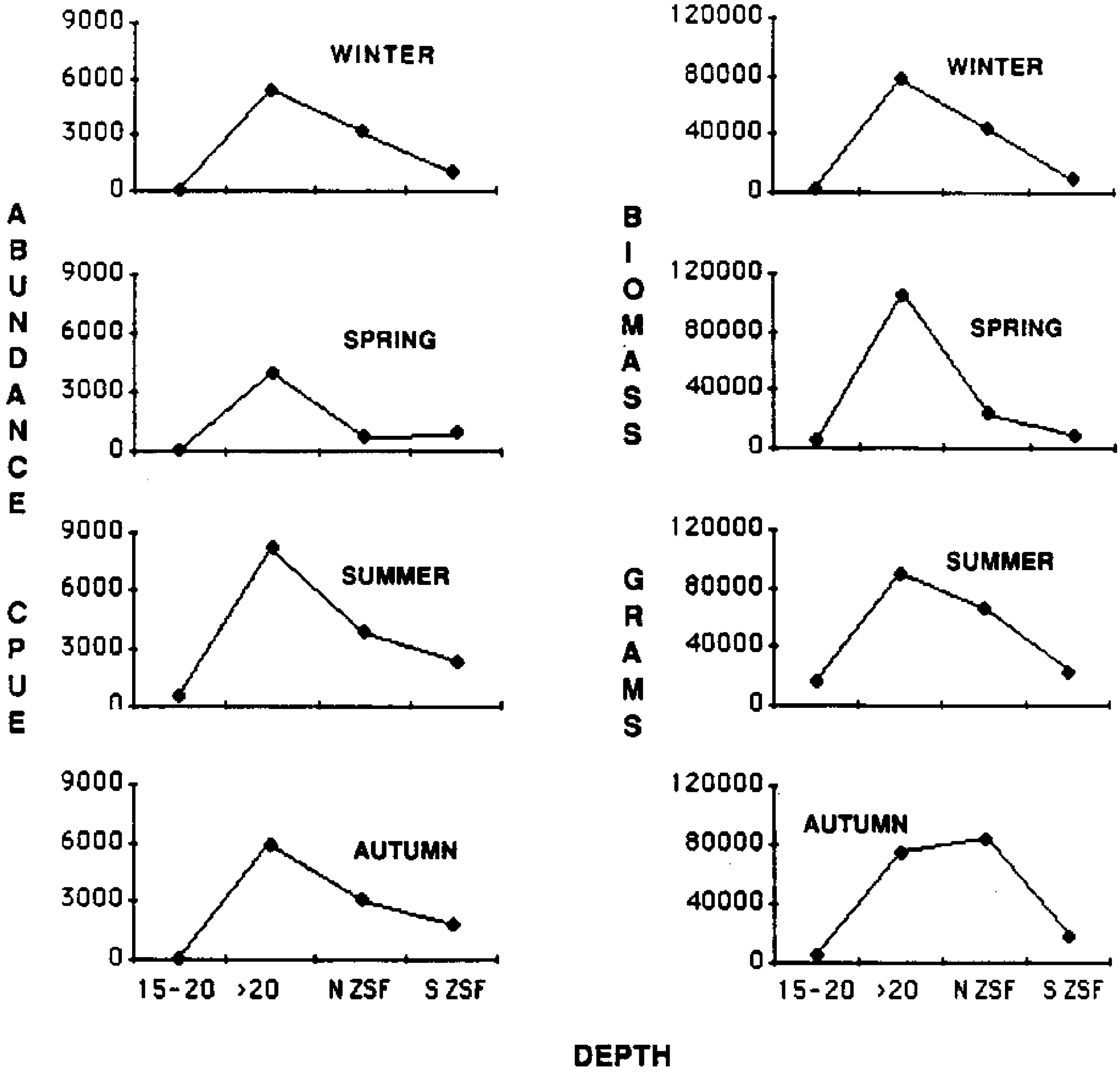

Figure 17. Bellingham Bay abundance (CPUE) and biomass (grams) by depth and season.

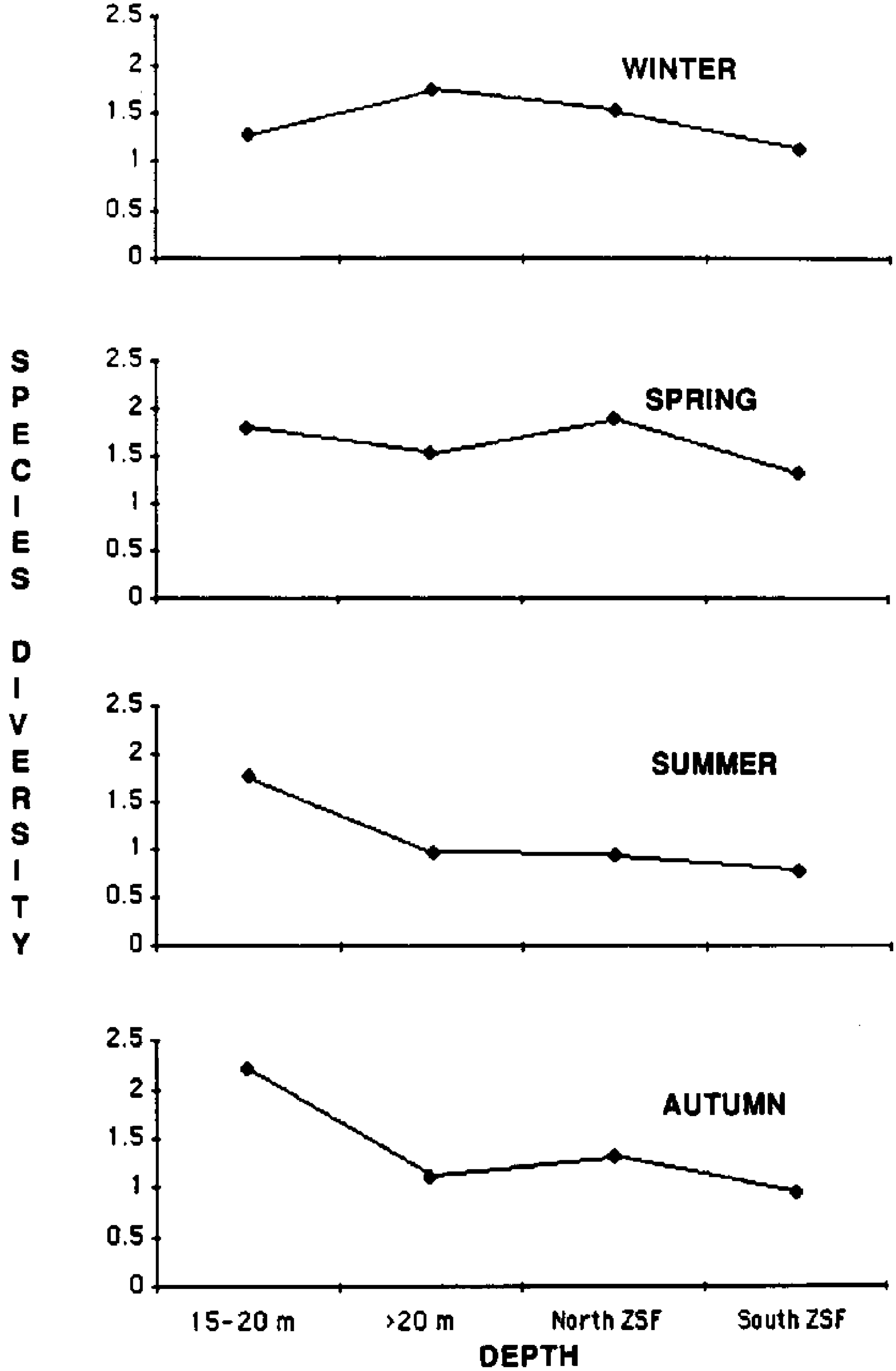

Figure 18. Bellingham Bay species diversity (H') by depth and season.

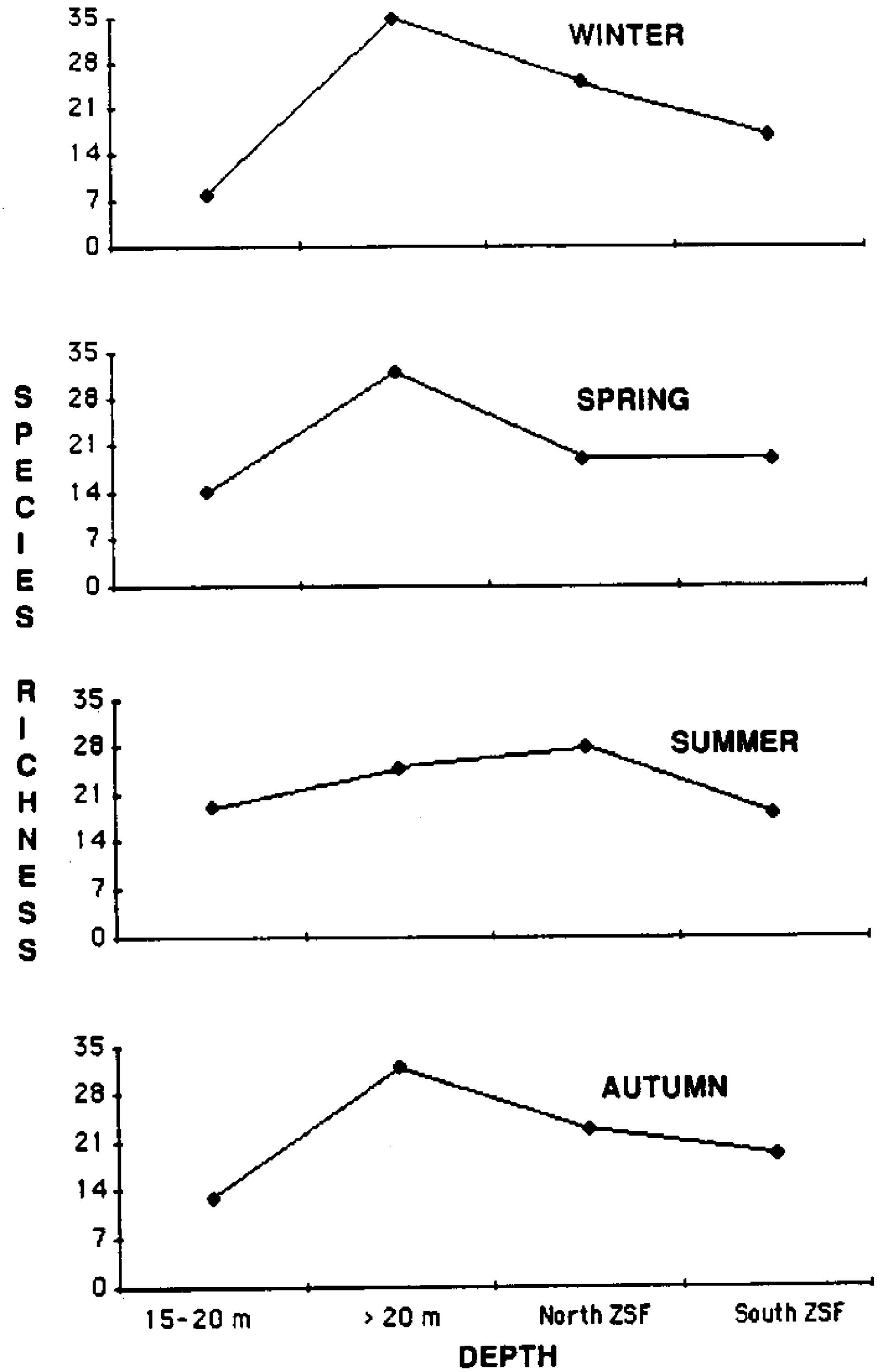

Figure 19. Bellingham Bay species richness by depth and season.

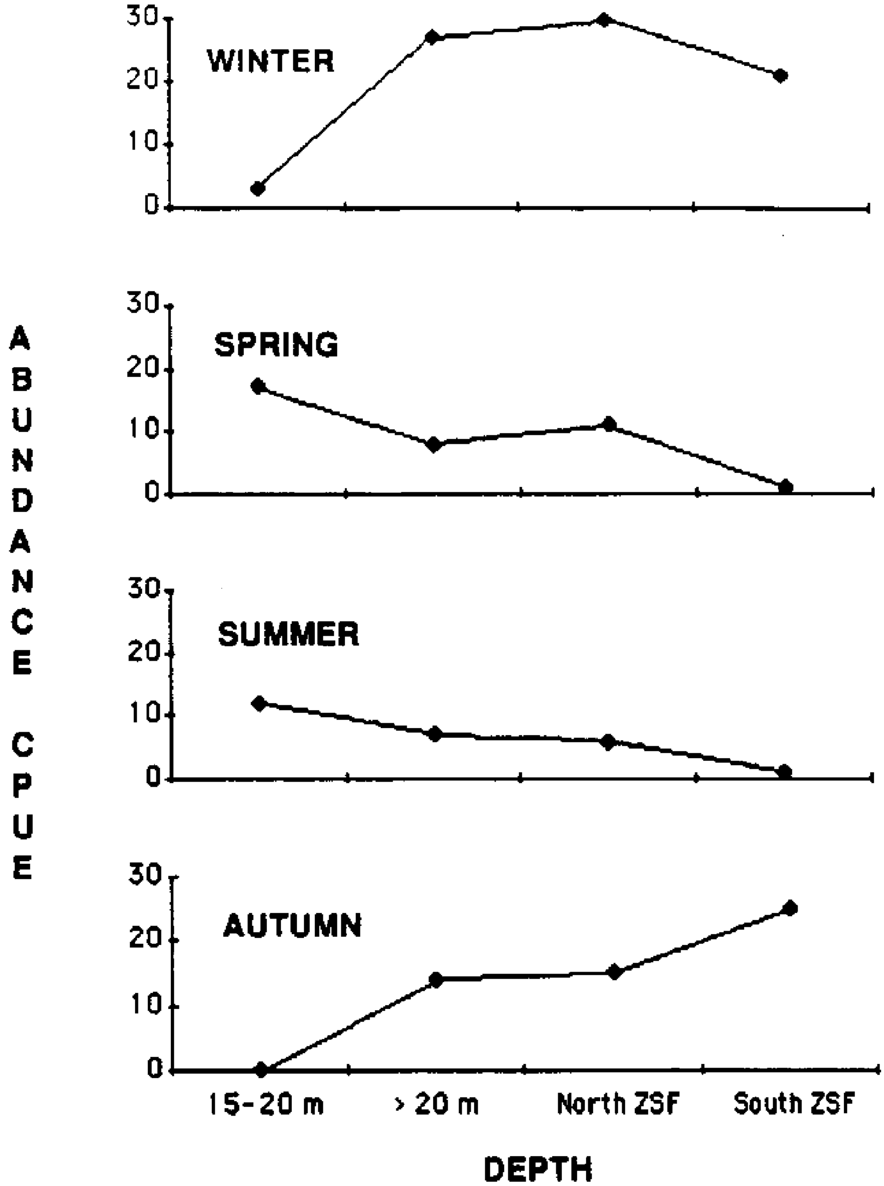

Figure 20 . Bellingham Bay butter sole abundances (CPUE) by depth and season.

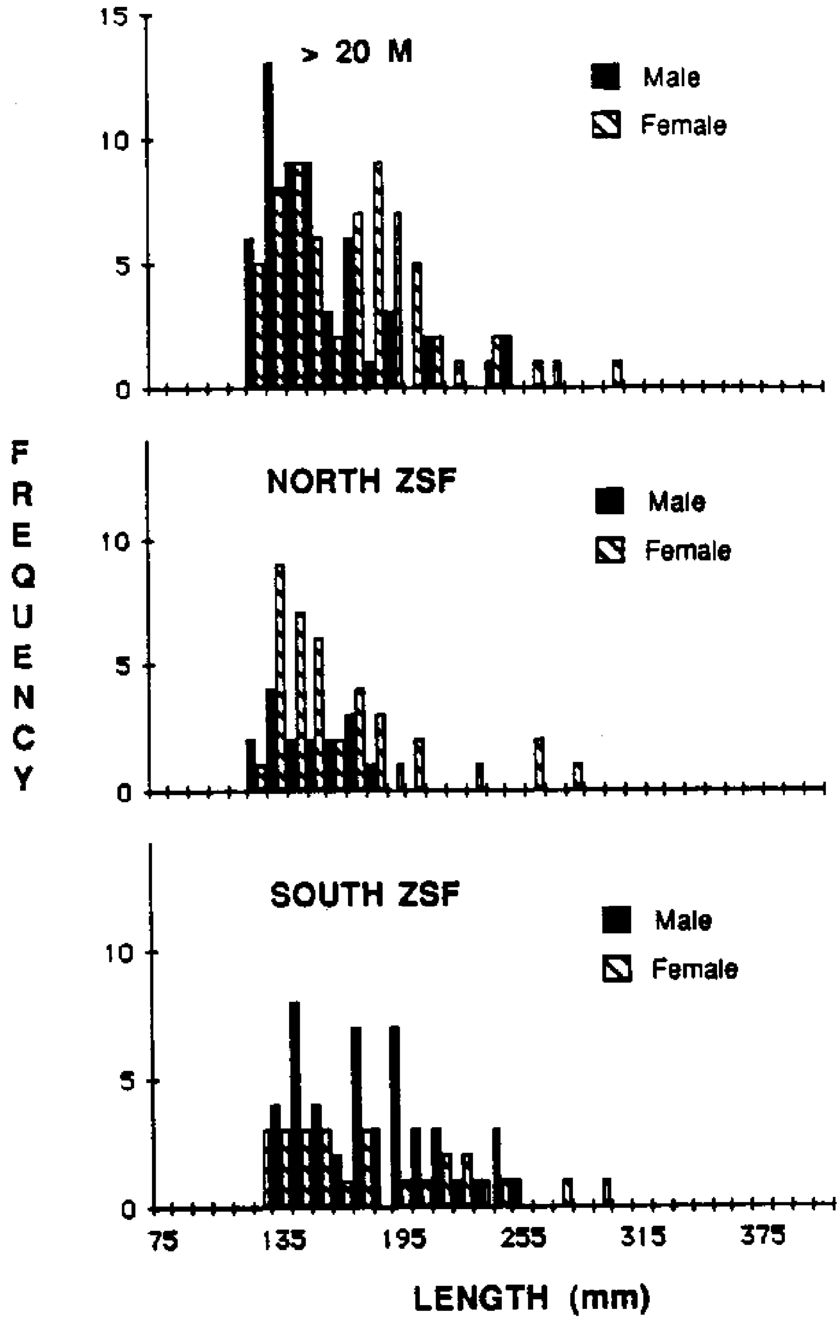

Figure 21. Bellingham Bay butter sole length-frequencies.

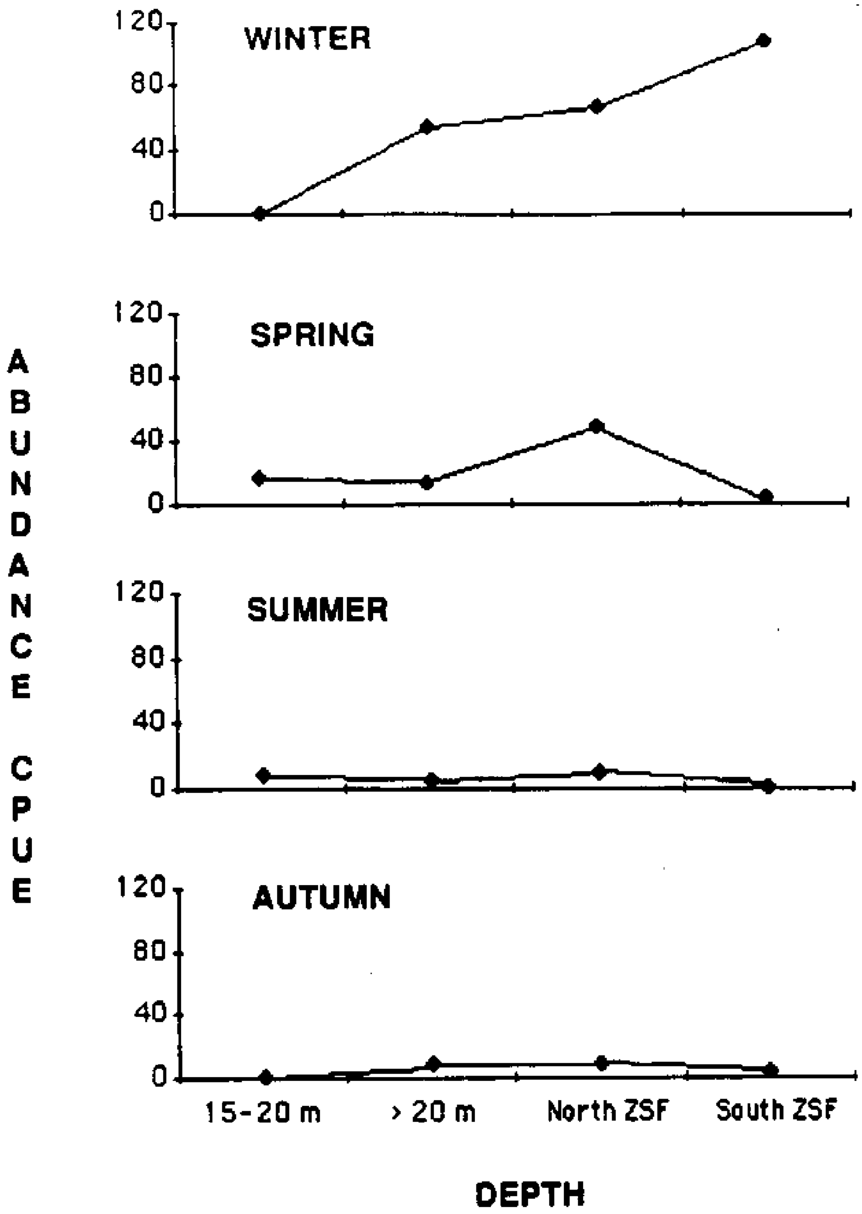

Figure 22. Bellingham Bay English sole abundances (CPUE) by depth and season.

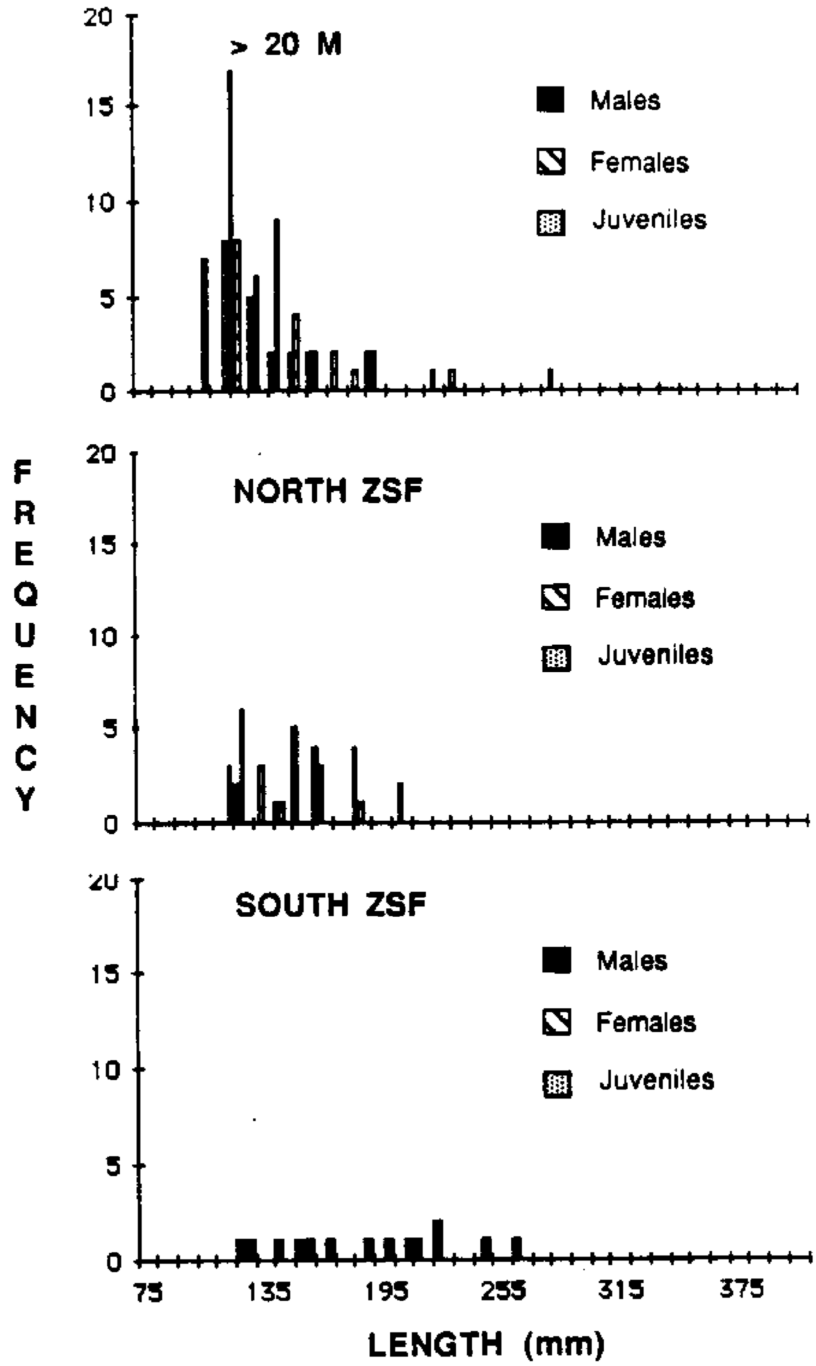

Figure 23. Bellingham Bay English sole length-frequencies.

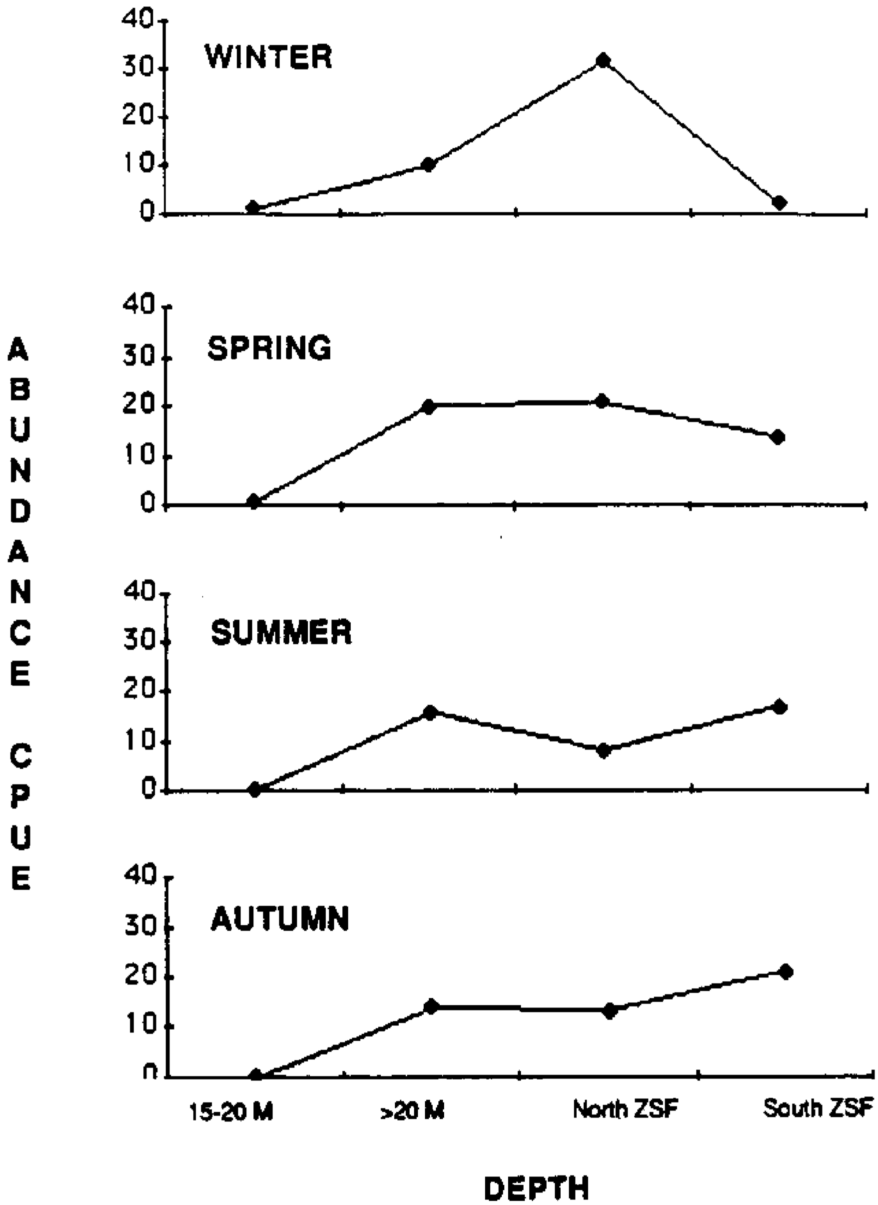

Figure 24. Bellingham Bay flathead sole abundances (CPUE) by depth and season.

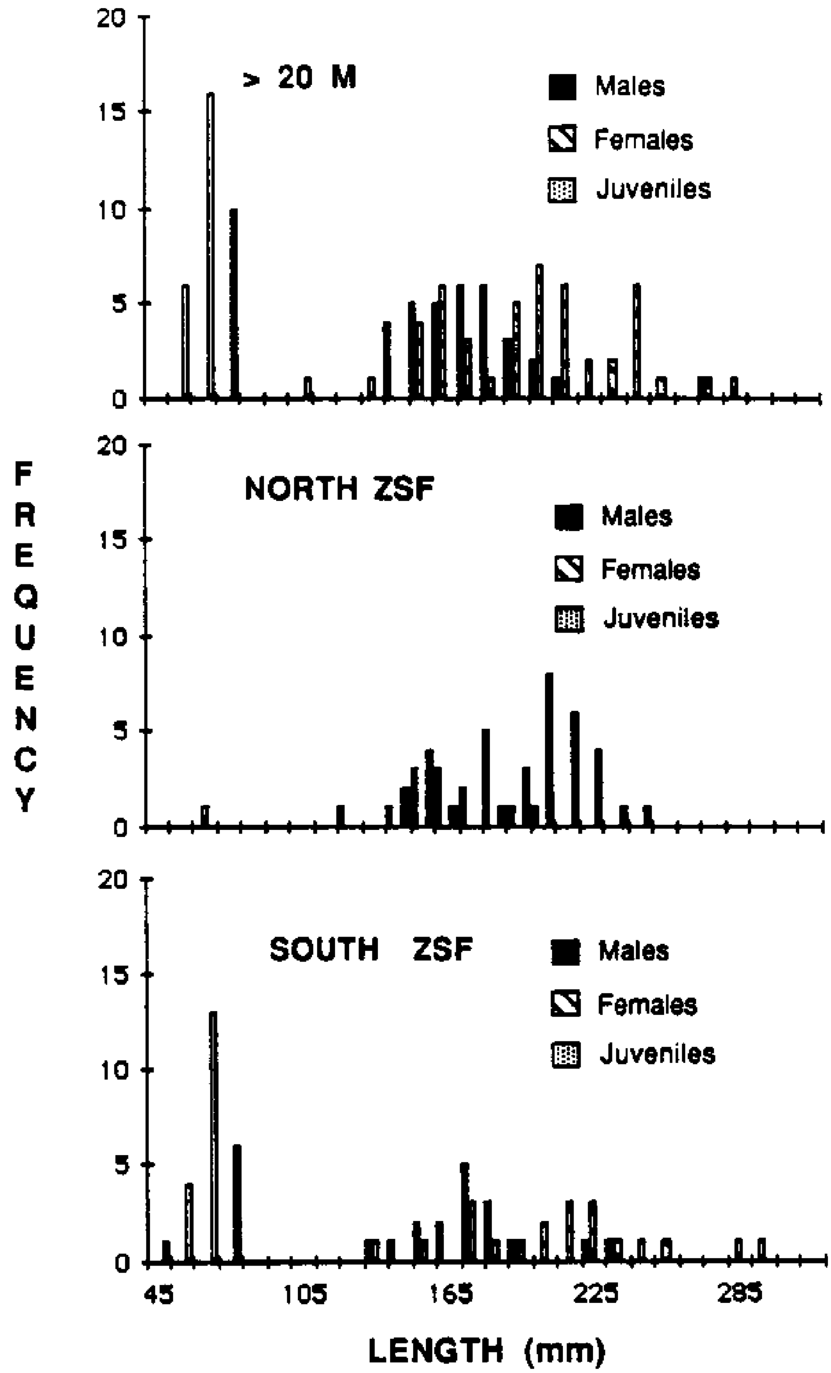

Figure 25. Bellingham Bay flathead sole length-frequencies

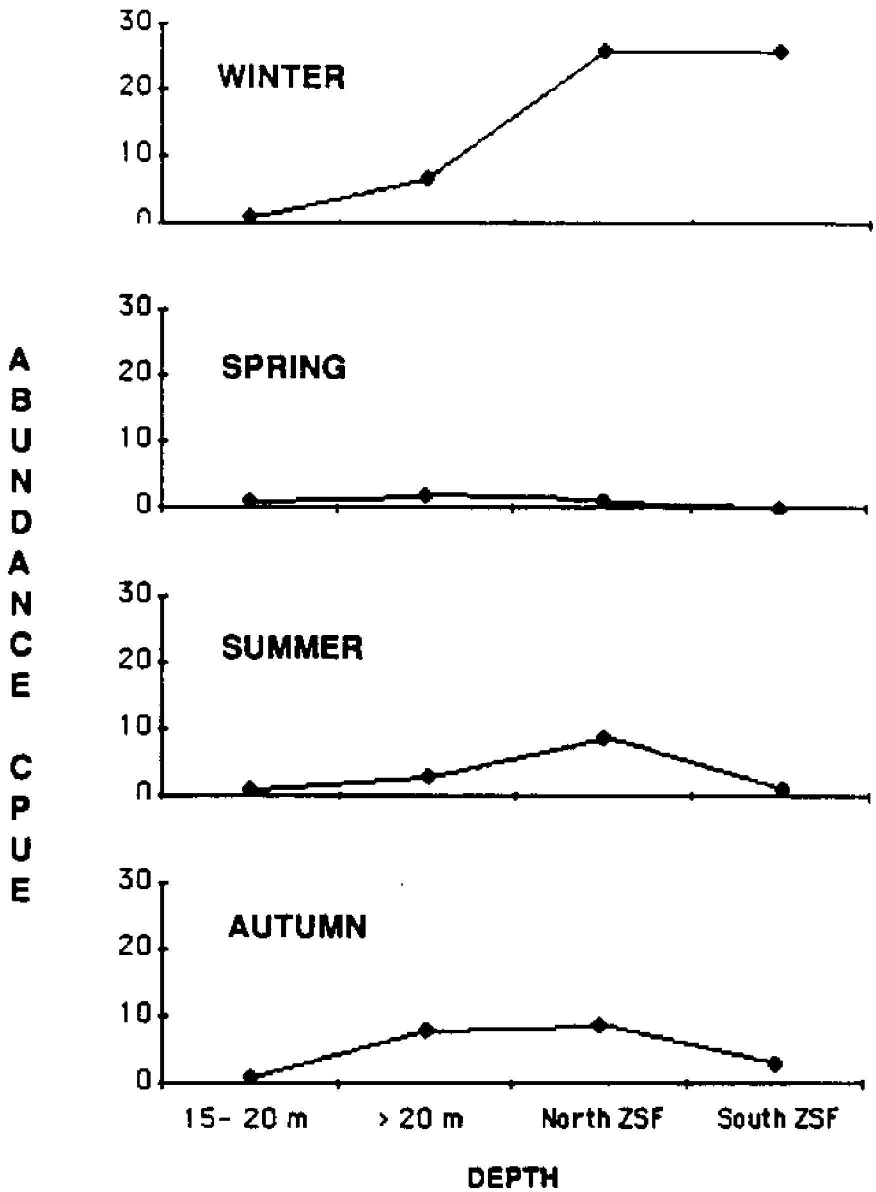

Figure 26. Bellingham Bay starry flounder abundances (CPUE) by depth and season.

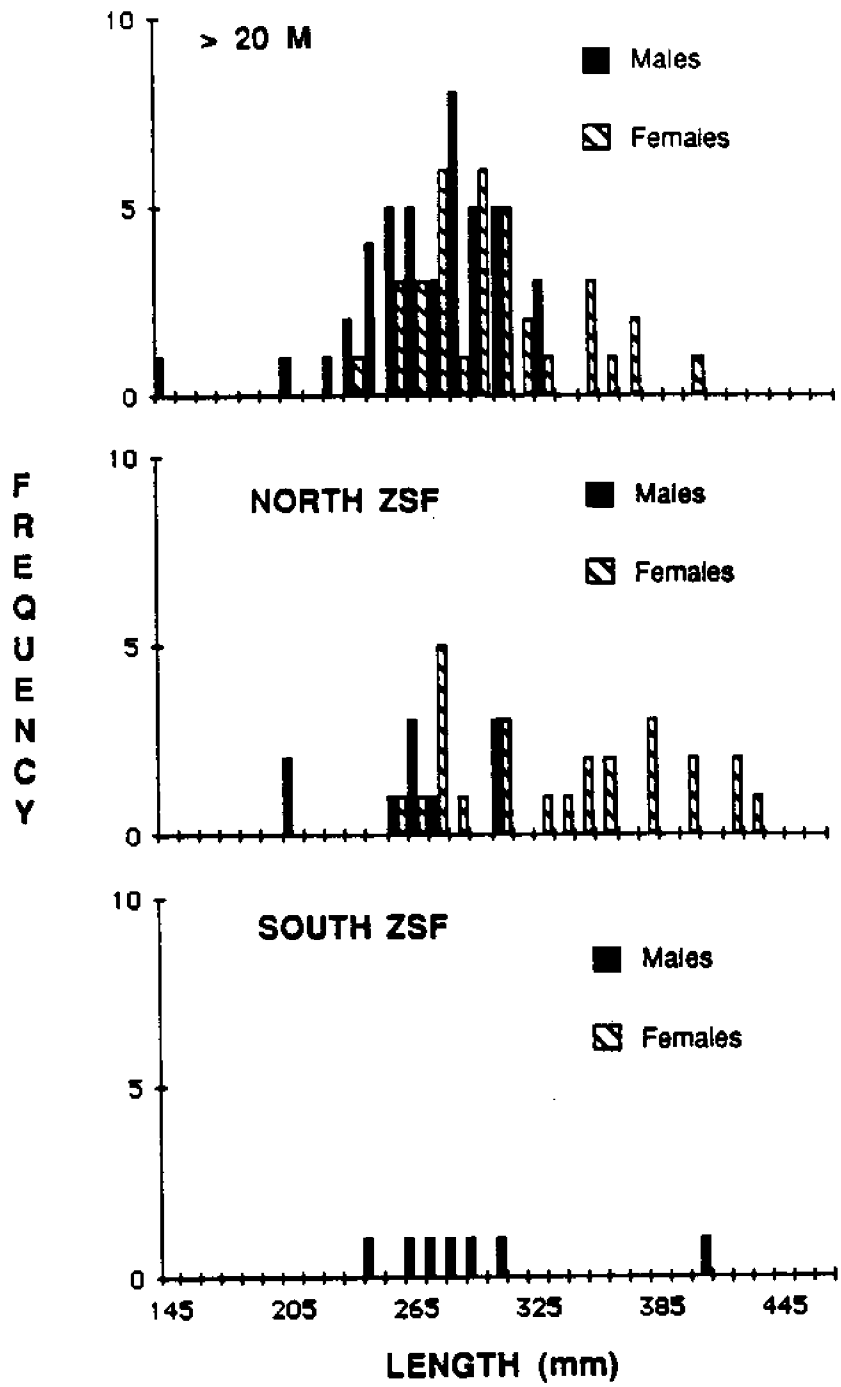

Figure 27. Bellingham Bay starry flounder length-frequencies.

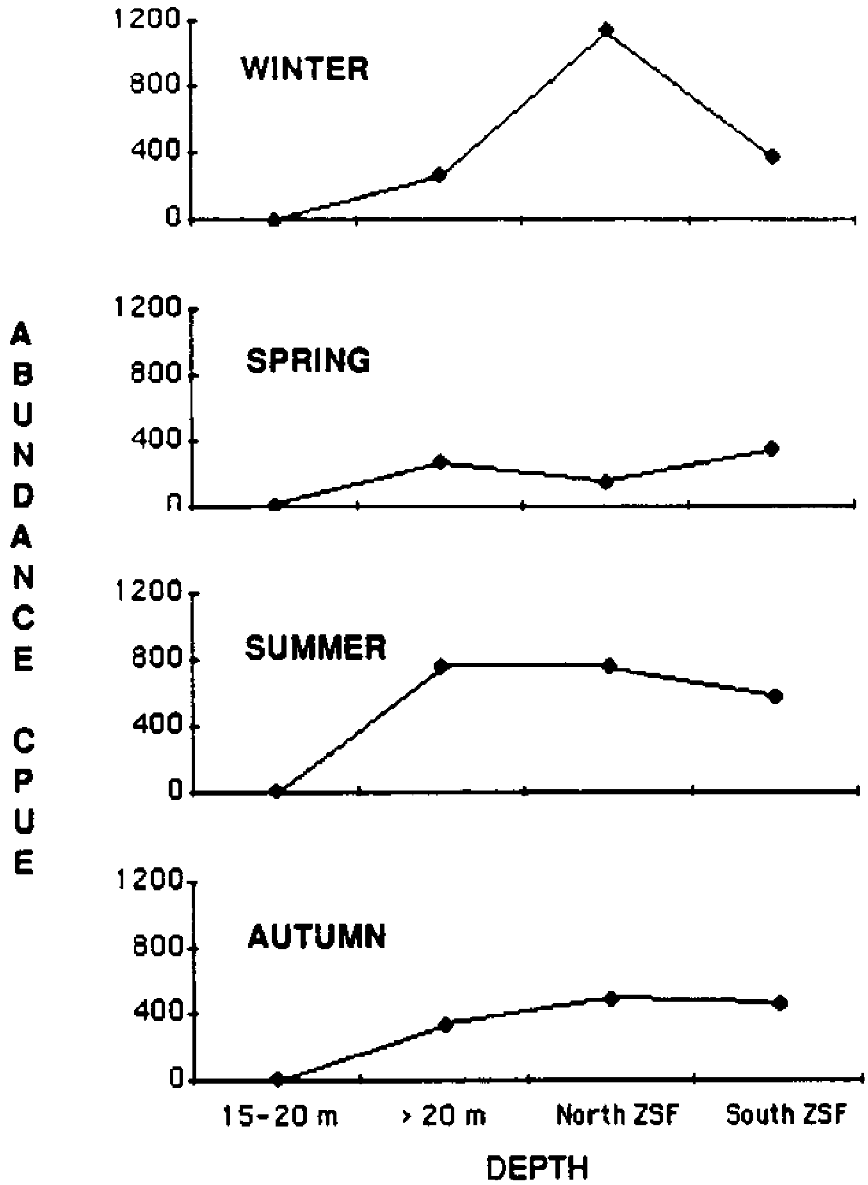

Figure 28. Bellingham Bay longfin smelt abundances (CPUE) by depth and season.

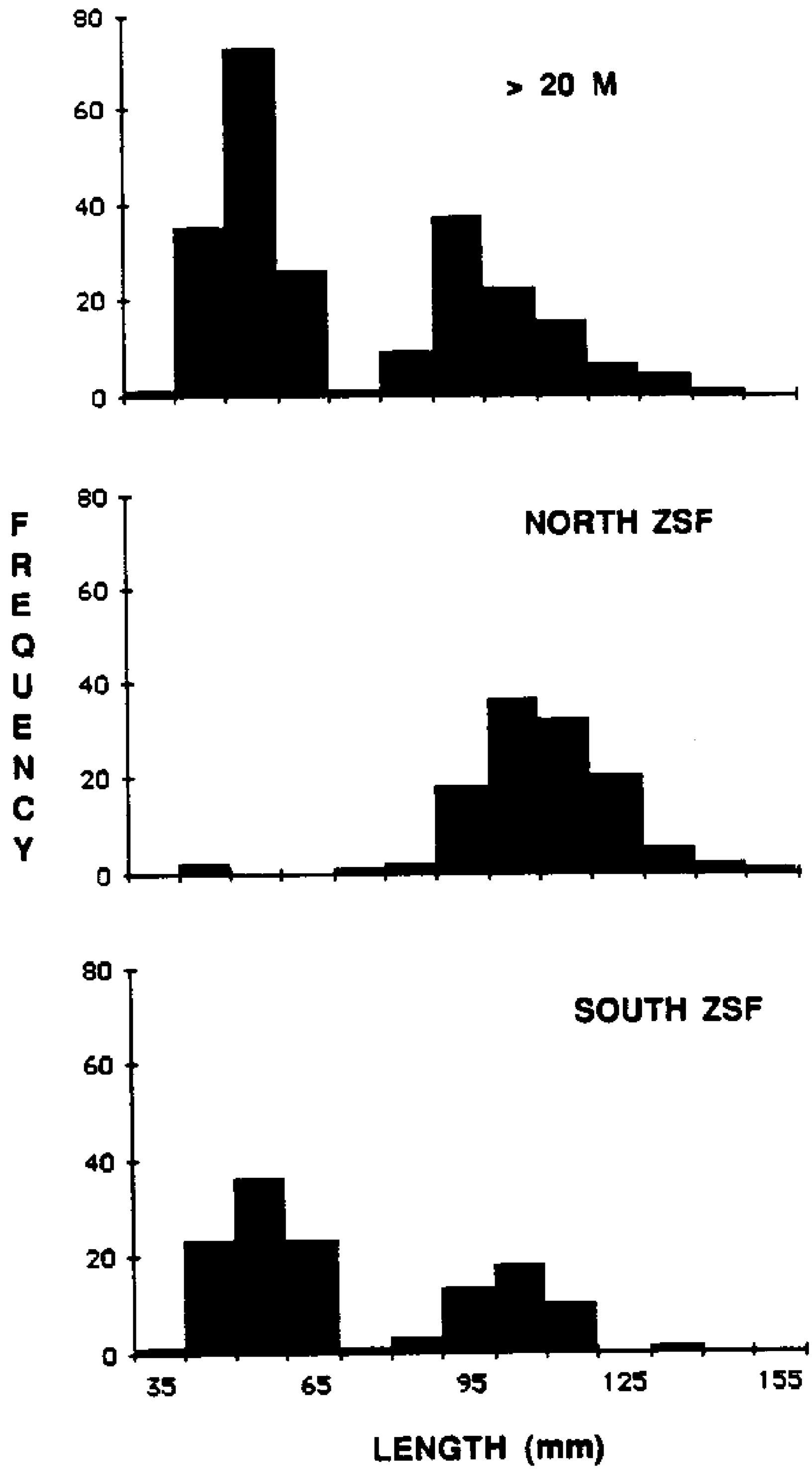

Figure 29. Bellingham Bay longfin smelt length-frequencies.

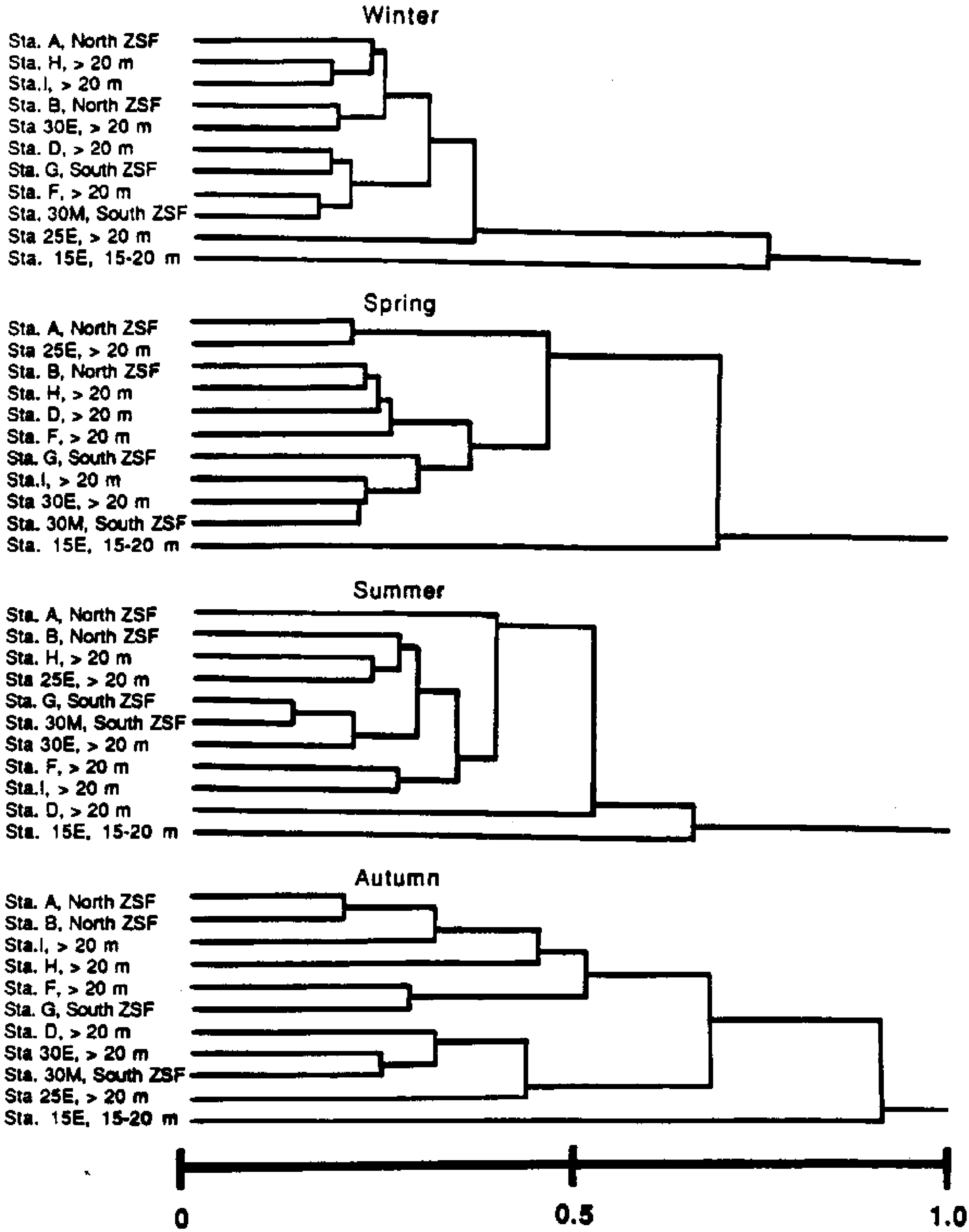

Figure 30. Dendrogram of Bray-Curtis distance measure between stations by season in Bellingham Bay.

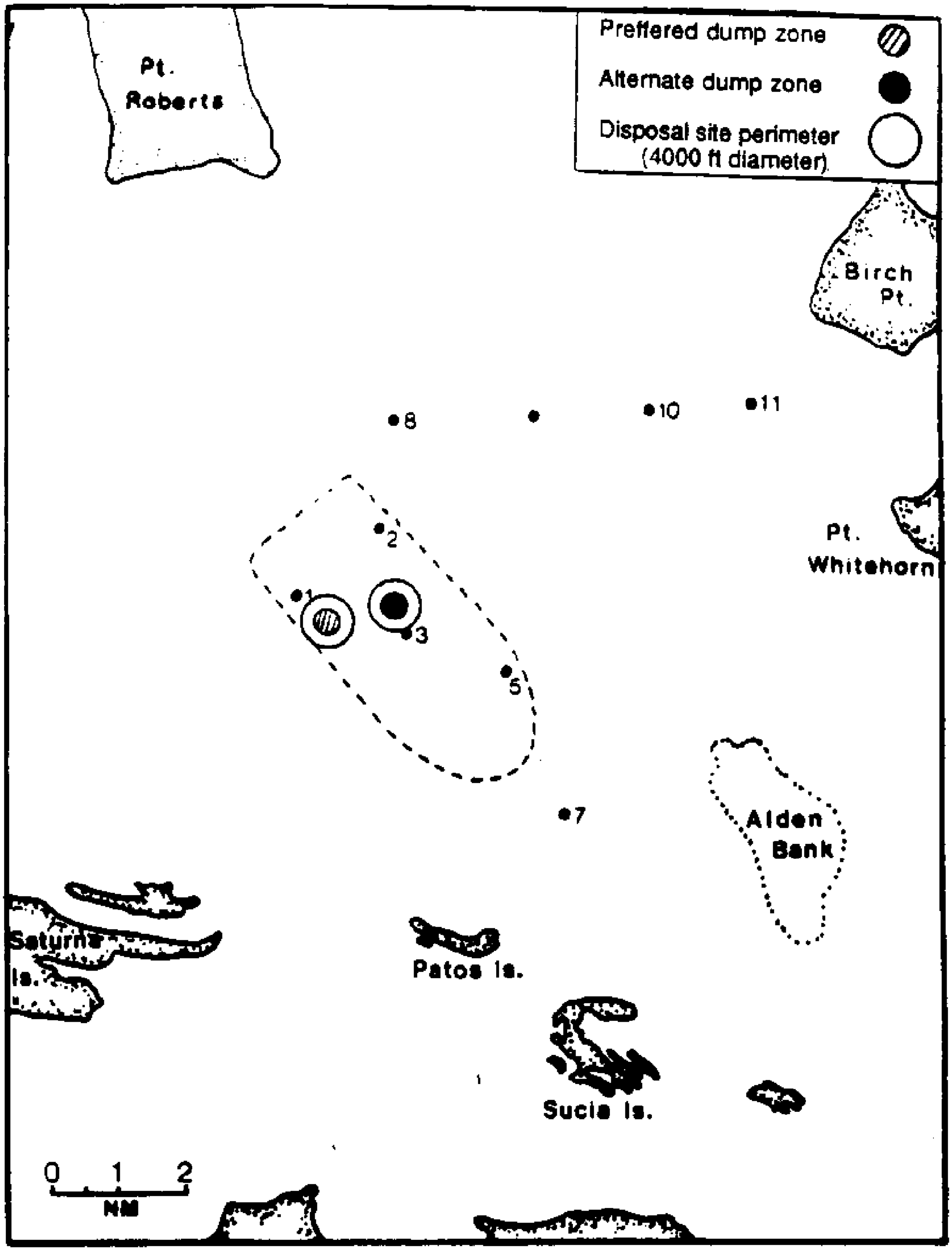

Figure 31. Map of Point Roberts and the Southern Strait of Georgia area showing the location of the Zone of Siting Feasibility (ZSF) and the stations sampled.

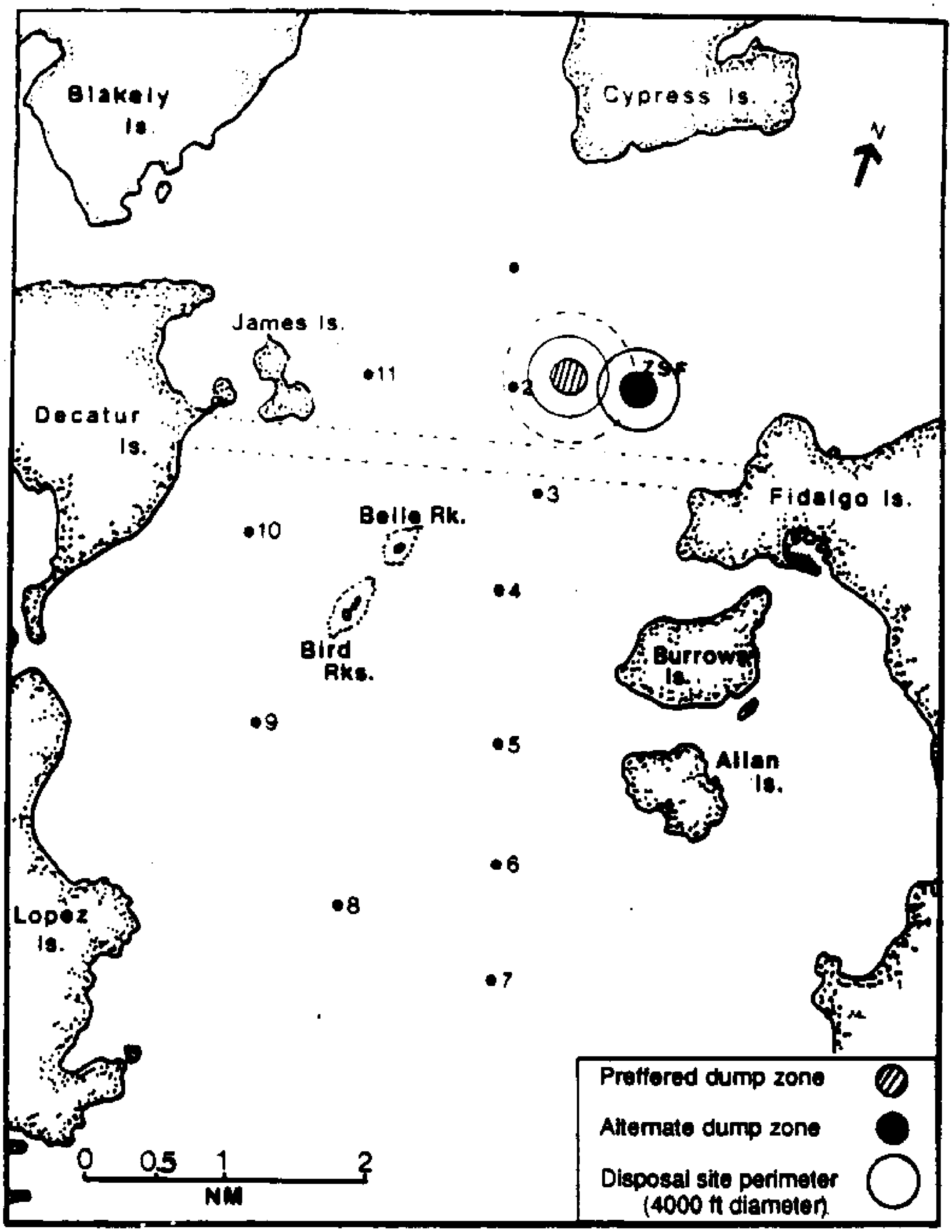

Figure 32. Map of Rosario Strait showing the location of the Zone of Siting Feasibility (ZSF) and the stations sampled.

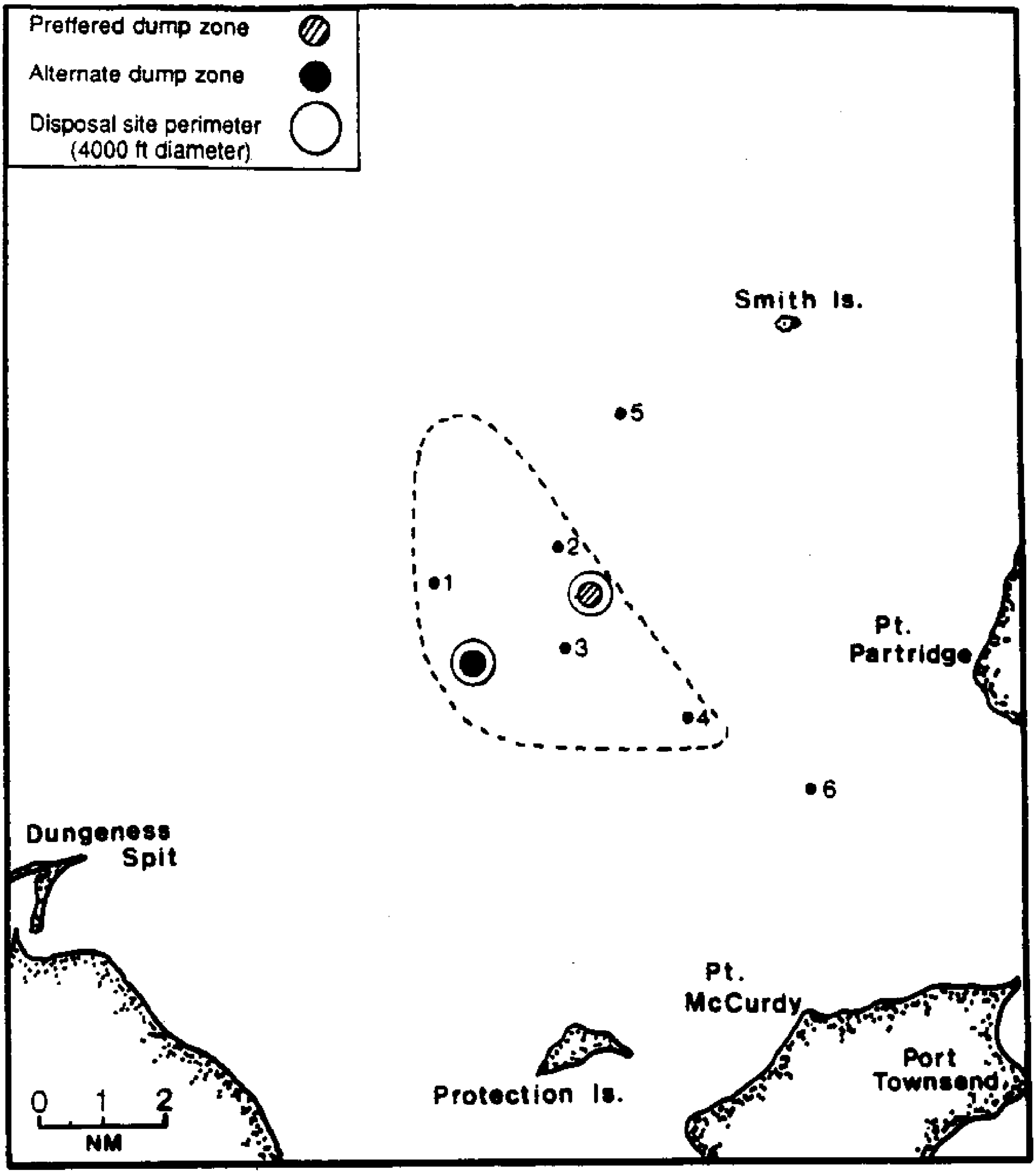

Figure 33. Map of the Port Townsend portion of the Strait of Juan de Fuca showing the location of the Zone of Siting Feasibility (ZSF) and the stations sampled.

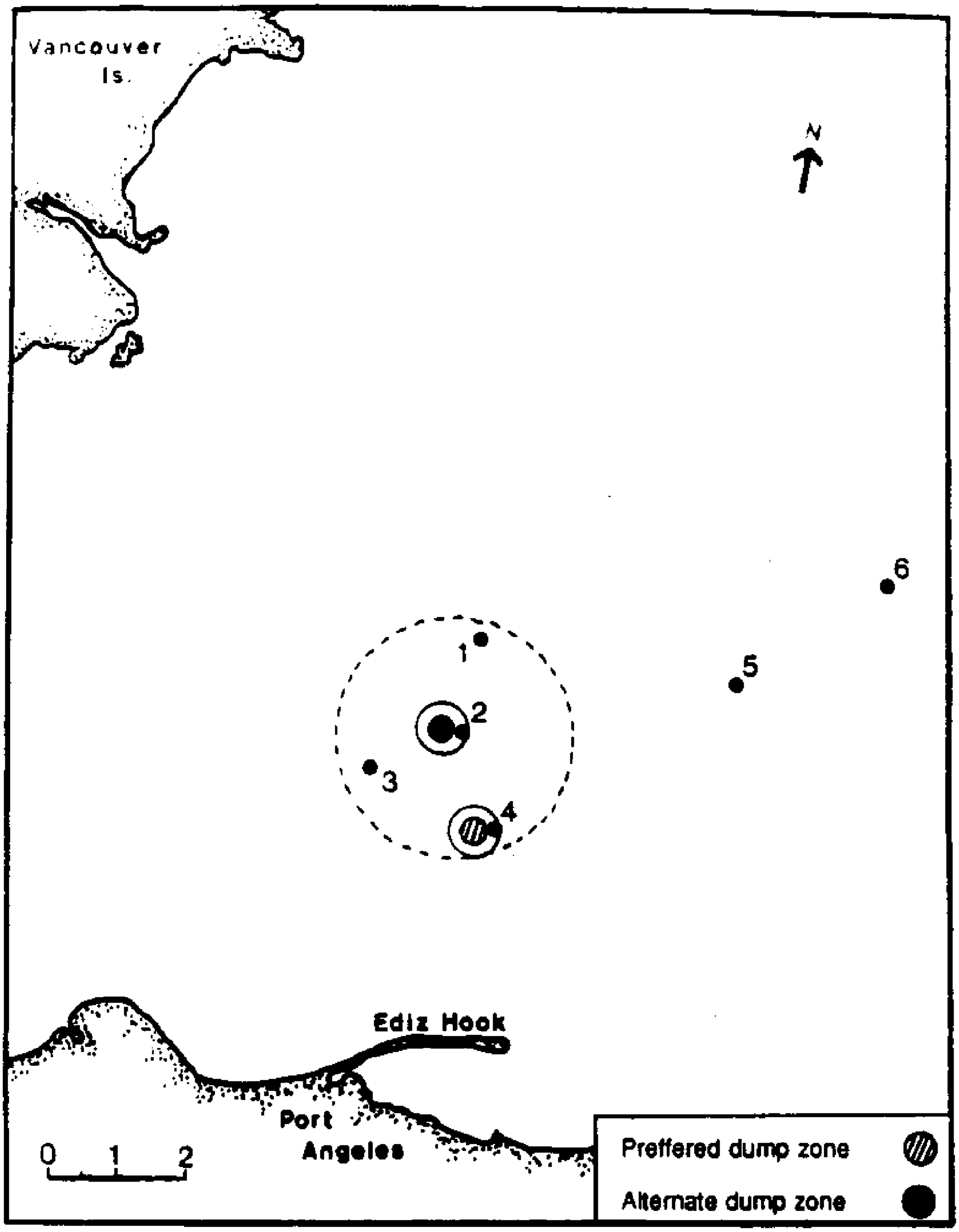

Figure 34. Map of the Port Angeles portion of the Strait of Juan de Fuca showing the location of the Zone of Siting Feasibility (ZSF) and the stations sampled.

Rock Dredge

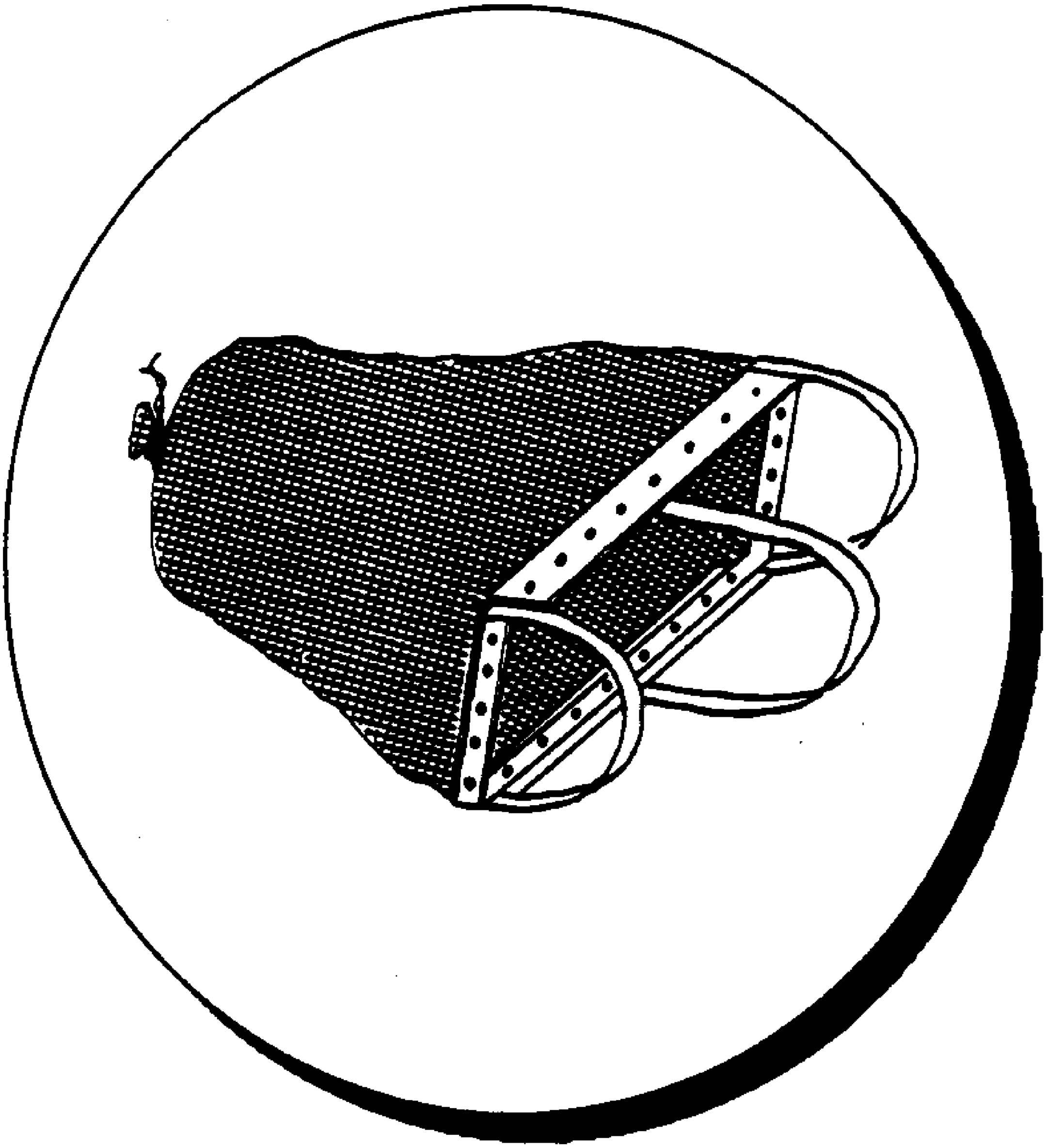

Figure 35. Diagram of the rock dredge used for sampling Rosario Strait.

DATA APPENDIX

Keron Island abundances, Winter. Sta. = Station, A = Adult, J = Juvenile.											
						ZSF2	ZSF2	ZSF2	ZSF2	ZSF2	ZSF2
Species	20 m	40 m	60 m	80 m	110 m	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6
blacktip poacher	'		6	7		2			1	1	
brown rockfish						1		1	1	1	1
buffalo sculpin	3	5									
C-O sole (A)	1	6	13								
C-O sole (J)		1									
Dover sole (A)					5	2	2	3		17	1
English sole (A)		26	86	9	5	13	6	4	3	6	3
English sole (J)	1	1									
flathead sole (A)									13		3
great sculpin		14									
greenstripe rockfish			1								
longfin smelt (J)		2									
longnose skate	1					1			2	4	
northern spearnose poacher		1									
Pacific sanddab (A)		1									
Pacific tomcod (A)		7	38	4	1	2					5
Pacific tomcod (J)		4									
pile perch (A)		10									
plainfin midshipman			2			5	1		8	4	1
quillback rockfish			20	1	1	3	3	1		3	1
ratfish (A)	6	4	55	6	6	2	2	2	2	4	9
ratfish (J)									1		
red brotula						1					
rex sole (A)					3	1	1	1	7	2	2
rex sole (J)						1					
rock sole (A)	16	495	2								
rock sole (J)		48	1								
roughback sculpin	4	93	8								
sailfin sculpin		1									
sand sole (J)				1							
shiner perch (A)		4	15	1							
shiner perch (J)		5									
slender sole (A)		1	4		5	31	10	2		6	
snake prickleback		1									
speckled sanddab (A)		10									
speckled sanddab (J)	3	5									
staghorn sculpin		15									
striped seaperch		5									
sturgeon poacher		6									
walleye pollock (A)			3								
walleye pollock (J)		1									
whitespotted greenl	1	2									

Ketron Island abundances, Spring. Sta. = Station, A = Adult, J = Juvenile.																
	20 m	20 m	40 m	40 m	60 m	60 m	80 m	80 m	110 m	110 m	ZSF2	ZSF2	ZSF2	ZSF2	ZSF2	ZSF2
COMMON NAME	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6
buffalo sculpin	2		1	1												
C-O sole (A)			1	2		2										
Dover sole (A)					1				1		3	2	1		3	
English sole (A)	1	1	23		47	28	12	19	6	23	116	118	163	27	34	10
English sole (J)			1													
great sculpin				3	1											
greenstripe rockfish					1											
longnose skate						1					1		1			
northern ronquil			1													
Pacific hake (A)										1	10	15	11	2	3	1
Pacific tomcod (A)							1		2	3			1	3	1	5
pile perch (A)					2											
pile perch (J)					1					6						
plainfin midshipman								1			2	7	5			1
quillback rockfish			1	1	2	1		2	2	2	4	3	5	4	6	
ratfish (A)	9	3	5	3	7	1		6	1		2	5	5	1	2	1
ratfish (J)												7				
rex sole (A)											2	3	3	3	1	1
rex sole (J)												2	1	3		
rock sole (A)	7	3	18	30	16	1										
rock sole (J)	1		1													
roughback sculpin	1	3	18	6	6	2										
sailfin sculpin				1												
shiner perch (A)						1	1	2								
slender sole (A)					3	3	3		5	3	26	55	54	23	16	6
slender sole (J)					1											
slim sculpin			1	1												
Snailfish UID														1		
snake prickleback			3													
speckled sanddab (A	1	11	11	3		1		1								
sturgeon poacher			1		3											
walleye pollock (A)														1		
whitespotted greenling				1												

Ketron Island abundance, Summer. Sta. = Station, A = Adult, J = Juvenile.

Species	20 m Rep 1	20 m Rep 2	40 m Rep 1	40 m Rep 2	60 m Rep 1	60 m Rep 2	80 m Rep 1	80 m Rep 2	110 m Rep 1	110 m Rep 2	ZSF2 Sta 1	ZSF2 Sta 2	ZSF2 Sta 3	ZSF2 Sta 4	ZSF2 Sta 5	ZSF2 Sta 6
Blacktip poacher							4				2					
Brown rockfish			2	7	1				2	1					1	
Butter sole							1									
Dover sole (A)				3		1						1	3		3	
Dover sole (J)				1												
English sole (A)		2	7	5	16	8	17	12	19	16	57	48	35	13	32	12
Longnose skate										1		0	2			
Northern ronquil				1												
Northern spearnose Poacher			1													
Pacific hake (A)														1	1	
Pacific hake (J)														1		
Pacific tomcod (A)			1		1		1	1						1	3	
Pacific tomcod (J)			1													1
Plainfin midshipman		2														1
Quillback rockfish				4	10		6	2		1	1	1	2	2	3	2
Ratfish (A)					3	1	6	6	11	8	1	1	4	4	8	9
Rex sole							3				5	2	3	1	1	1
Rock sole (A)	5	2	8	4		3										
Roughback sculpin			6	16												
Sailfin sculpin				1												
Shiner perch (A)				1												
Slender sole (A)			1	1	8	2	1	6	10	4	19	10	33	9	17	5
Slim sculpin					1											
Snailfish UID							1				1	1			1	
Soft sculpin														1		
Speckled sanddab (	1															
Spiny dogfish					1				2							
Sturgeon poacher	1		1													
Tubesnout	16	6														
Walleye pollock (A)											2	1		3		
Walleye pollock (J)	36															

Ketron island abundance, Autumn. Sta. = Station, A = Adult, J = Juvenile.															
	20 m	20 m	40 m	60 m	60 m	80 m	80 m	110 m	110 m	ZSF2	ZSF2	ZSF2	ZSF2	ZSF2	ZSF2
Species	Rep 1	Rep 2	Rep 1	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Stat. 1	Stat. 2	Stat. 3	Stat. 4	Stat. 5	Stat. 6
Bay pipefish	11														
Blackbelly eelpout										1	4		2	1	
Blacktip poacher			2	2		1	3	1		1					
Brown rockfish			11						2				1		1
Buffalo sculpin	1														
butter sole						6									
C-O sole (A)						1									
Dover sole										8	2	6	0		
English sole (A)			4	18	11	18	33	25	16	143	166	172	23	118	13
English sole (J)		12	1	1											
Flathead sole (A)											1	1			
Great sculpin	1														
Greenstripe rockfish						1									
Longfin smelt											2				
Longnose skate							1			1	1		1		
Marbled snailfish													2		
Northern ronquil											1				
Pacific cod							0						1		
Pacific hake (A)								1		3	8	3	3	7	1
Pacific sanddab (A)			1												
Pacific sanddab (J)		12													
Pacific tomcod (A)			8	28	21	44	60	8	2	16	22	132	20	67	11
Pacific tomcod (J)			7	47	20	9	21	1				1			
Pile perch (A)		1	3												
Pile perch (J)		2													
Plainfin Midshipman						13	5	1	1	27	22	15	11	10	
Pygmy poacher					1										
Quillback rockfish			2	4	2	8	3		2	9	2		2	4	1
Ratfish (A)						1	5	6	3	1	10	10	5	19	9
Ratfish (J)									1						
Rex sole (A)								1		3		1	0	1	
Rock sole	7	13	119	8	9						1			1	
Rock sole (J)	3	10													
Rockfish UID												3			
Roughback sculpin	4	1	48		1										
Sand sole (A)		1													
Shiner perch (A)			16		1		1								
Shiner perch (J)	28	133	9	2	2										
Shortspine thornyhead												1			
Showy snailfish						2									
Slender sole (A)				1	1	4	2	13	5	40	46	53	18	59	11
Slender sole (J)										1					
Snailfish UID								1							
Speckled sanddab (A	1		6												
Speckled sanddab (J	8		10												
Spiny dogfish				2						1				1	
Staghorn sculpin			5	1											
Striped seaperch		1	2												
Tubesnout		9													
Walleye pollock (A)					4										
Walleye pollock (J)				3	1										

Ketron Island biomass, Winter 1987. Biomass given in grams. Sta. = Station, A = Adult, J = Juvenile.						ZSF2	ZSF2	ZSF2	ZSF2	ZSF2	ZSF2
Species	20 m	40 m	60 m	80 m	110 m	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6
blacktip poacher	0.00	0.00	56.50	6.50	0.00	15.00	0.00	0.00	12.30	8.00	0.00
brown rockfish						160.00	0.00	2600.00	182.70	900.00	105.00
buffalo sculpin	585.00	883.60	0.00	0.00	0.00						
C-O sole (A)	298.00	842.60	2100.00	0.00	0.00						
C-O sole (J)	0.00	2.00	0.00	0.00	0.00						
Dover sole (A)	0.00	0.00	0.00	0.00	1010.00	2644.00	310.00	770.00	0.00	2915.00	156.00
English sole (A)	0.00	1945.30	8430.00	2250.00	1490.00	3730.00	1180.00	1150.00	1350.00	2150.00	1500.00
English sole (J)	7.00	10.00	0.00	0.00	0.00						
flathead sole (A)						0.00	0.00	0.00	502.50	0.00	99.00
great sculpin	0.00	1633.50	0.00	0.00	0.00						
greenstripe rockfish	0.00	0.00	22.80	0.00	0.00						
longfin smelt (J)	0.00	1.50	0.00	0.00	0.00						
longnose skate	28.60	0.00	0.00	0.00	0.00	3800.00	0.00	0.00	400.00	1968.70	0.00
northern spearnose poach	0.00	26.00	0.00	0.00	0.00						
Pacific sanddab (A)	0.00	115.80	0.00	0.00	0.00						
Pacific tomcod (A)	0.00	152.70	38.00	736.00	70.00	288.40	0.00	0.00	0.00	0.00	702.00
Pacific tomcod (J)	0.00	4.00	0.00	0.00	0.00						
pile perch (A)	0.00	192.80	0.00	0.00	0.00						
plainfin midshipman	0.00	0.00	78.60	0.00	0.00	200.00	500.00	0.00	1100.00	450.00	38.00
quillback rockfish	0.00	0.00	4020.00	800.00	240.00	1150.00	1360.00	280.00	0.00	750.00	462.00
ratfish (A)	5600.00	4100.00	43600.00	3000.00	6100.00	1300.00	1360.00	1260.00	1060.00	1360.00	6660.00
ratfish (J)						0.00	0.00	0.00	5.10	0.00	0.00
red brotula						250.00	0.00	0.00	0.00	0.00	0.00
rex sole (A)	0.00	0.00	0.00	0.00	390.00	466.80	130.10	10.60	875.00	162.00	421.00
rex sole (J)						1.35	0.00	0.00	0.00	0.00	0.00
rock sole (A)	1270.00	34415.00	218.70	0.00	0.00						
rock sole (J)	0.00	612.00	14.00	0.00	0.00						
roughback sculpin	14.60	1485.50	168.00	0.00	0.00						
sailfin sculpin	0.00	13.00	0.00	0.00	0.00						
sand sole (J)	0.00	0.00	0.00	7.70	0.00						
shiner perch (A)	0.00	84.00	450.00	8.70	0.00						
shiner perch (J)	0.00	42.40	0.00	0.00	0.00						
slender sole (A)	0.00	0.00	163.00	0.00	220.00	2046.00	490.00	70.00	0.00	249.10	0.00
snake prickleback	0.00	16.50	0.00	0.00	0.00						
speckled sanddab (A)	0.00	320.70	0.00	0.00	0.00						
speckled sanddab (J)	7.60	73.40	0.00	0.00	0.00						
staghorn sculpin	0.00	883.40	0.00	0.00	0.00						
striped perch	0.00	182.00	0.00	0.00	0.00						
sturgeon poacher	0.00	302.80	0.00	0.00	0.00						
walleye pollock (A)	0.00	0.00	590.00	0.00	0.00						
walleye pollock (J)	0.00	10.80	0.00	0.00	0.00						
whitespotted greenling	101.50	296.30	0.00	0.00	0.00						

Ketron Island biomass, Spring 1987. Biomass given in grams. Sta. = Station, A = Adult, J = Juvenile.

Species	20 m Rep 1	20 m Rep 2	40 m Rep 1	40 m Rep 2	60 m Rep 1	60 m Rep 2	80 m Rep 1	80 m Rep 2	110 m Rep 1	110 m Rep 2	ZSF2 Sta 1	ZSF2 Sta 2	ZSF2 Sta 3	ZSF2 Sta 4	ZSF2 Sta 5	ZSF2 Sta 6
blacktip poacher					9.20						2.60	0.00	0.00	0.00	0.00	0.00
brown rockfish										311.60	0.00	275.00	1525.00	0.00	0.00	0.00
buffalo sculpin	357.00		154.90	42.50												
C-O sole			70.20	400.00		555.00										
Dover sole (A)	4.20				36.70				246.20		405.50	239.70	183.00	0.00	258.20	0.00
English sole (A)	251.00	234.00	1860.00	2020.00	6250.00	4090.00	2600.00	3560.00	1450.00	5910.00	18250.00	26770.80	27063.00	7110.00	4400.00	2120.00
English sole (J)			10.50													
great sculpin				142.10	520.00											
greenstripe rockfish					18.80											
longnose skate			1250.00			5300.00					250.00	0.00	1650.00	0.00	0.00	0.00
northern ronquil			24.40													
Pacific hake (A)										35.70	1950.00	3635.00	1870.00	82.50	389.80	48.90
Pacific tomcod (A)							91.50		233.70	266.40	0.00	0.00	64.00	210.00	98.60	294.70
pile perch (A)					38.00											
pile perch (J)					6.60				39.00							
plainfin midshipman								66.00			155.50	687.00	595.00	0.00	0.00	61.10
quillback rockfish			287.70	153.60	140.00	150.00		440.00	645.80	620.00	1550.00	1275.00	1125.00	950.00	2155.30	0.00
ratfish (A)	5465.00	1500.00	4485.00	2800.00	2650.00	580.00		2925.00	800.00		1400.00	2765.00	4650.00	575.00	1150.00	880.00
ratfish (J)											0.00	4.90	0.00	0.00	0.00	0.00
rex sole (A)											450.00	370.00	600.00	390.00	114.20	79.70
rex sole (J)											0.00	6.00	6.50	17.50	0.00	0.00
rock sole (A)	1140.00	860.00	1250.00	2480.00	1770.00	141.00										
rock sole (J)	19.00		6.70													
roughback sculpin	2.50	13.70	201.80	85.40	79.50	41.90										
sailfin sculpin				17.60												
shiner perch (A)						22.50	21.20	38.40								
slender sole (A)					117.50	138.00	150.00		167.00	111.20	1320.00	2531.60	2590.00	1130.00	250.00	227.80
slender sole (J)					6.70											
slim sculpin			2.70	5.20												
snake prickleback			18.00													
speckled sanddab	4.50	54.20	188.70	49.20		31.20		60.70								
sturgeon poacher			11.30		78.40											
UID snailfish											0.00	0.00	0.00	2.00	0.00	0.00
walleye pollock											0.00	0.00	0.00	39.00	0.00	0.00
whitespotted greenling				175.00												

Ketron Island biomass, Summer 1987. Biomass given in grams. Sta. = Station, A = Adult, J = Juvenile.

Species	20 m Rep 1	20 m Rep 2	40 m Rep 1	40 m Rep 2	60 m Rep 1	60 m Rep 2	80 m Rep 1	80 m Rep 2	110 m Rep 1	110 m Rep 2	ZSF2 Sta 1	ZSF2 Sta 2	ZSF2 Sta 3	ZSF2 Sta 4	ZSF2 Sta 5	ZSF2 Sta 6
Blacktip poacher							28.00				38.00					
Brown rockfish			490.00	1720.00	225.00				975.00	350.00					100.00	
Butter sole							43.60									
Dover sole (A)				310.00		98.00						168.00	300.00		495.00	
Dover sole (J)																
English sole		210.00	1390.00	300.00	2180.00	1400.00	3980.00	2780.00	3600.00	3000.00	8860.00	6770.00	5110.00	2120	3800.00	2810.00
Longnose skate										75.00			1850.00			
Northern ronquil				36.60												
Northern spearnose Poacher			2.00													
Pacific hake (A)														74.2	93.00	
Pacific hake (J)														0.7		
Pacific tomcod (A)			21.00		79.00		85.70	78.00						67.5	280.00	
Pacific tomcod (J)	48.60		12.60													1.30
Plainfin midshipman		71.70						1200.00								138.00
Quillback rockfish				620.00	1734.00		2825.00			250.00	174.00	196.00	1200.00	1325	1275.00	284.00
Ratfish					2500.00	400.00	5300.00	8100.00	4100.00	4900.00	550.00	550.00	1450.00	1600	4100.00	5050.00
Rex sole (A)		300.00	1180.00				88.00				690.00	405.00	350.00	36	68.00	102.00
Rock sole	821.00			460.00		730.00										
Roughback sculpin			85.20	245.30												
Sailfin sculpin				16.00												
Shiner perch				20.70												
Slender sole (A)			58.50	44.00	480.00	63.00	47.60	370.00	800.00	290.00	940.00	450.00	1500.00	550	720.00	340.00
Slim sculpin					9.40											
Snailfish UID							3.00				1.50	0.50			3.00	
Soft sculpin														0.3		
Speckled sanddab	12.50															
Spiny dogfish					5600.00				7750.00							
Sturgeon poacher	44.40		74.00													
Tubesnout	111.50	35.60														
Walleye pollock (A)											247.00	160.00		428		
Walleye pollock (J)	205.00															

Katron Island biomass, Autumn 1997. Biomass given in grams. Sta. = Station, A = Adult, J = Juvenile.

Species	20 m Rep 1	20 m Rep 2	40 m Rep 1	60 m Rep 1	60 m Rep 2	80 m Rep 1	80 m Rep 2	110 m Rep 1	110 m Rep 2	ZSF2 Sta 1	ZSF2 Sta 2	ZSF2 Sta 3	ZSF2 Sta 4	ZSF2 Sta 5	ZSF2 Sta 6
Bay pipefish	75.00														
Blackbelly eelpout										38.30	219.00		112.00	39.00	
Blacktip poacher			5.00	34.50		14.00	38.00	9.30		7.00					
Brown rockfish			2500.00						600.00				250.00		376.00
Buffalo sculpin	150.00														
Butter sole						640.00									
C-O sole						200.00									
Dover sole										1500.00	490.00	650.00			
English sole (A)			760.00	1650.00	1340.00	910.00	8250.00	6250.00	4750.00	27020.00	23980.00	19280.00	8760.00	18750.00	4440.00
English sole (J)		109.00	14.50	67.60											
Flathead sole											140.00	119.00			
Great sculpin	110.00														
Greenstripe rockfish						275.00									
Longfin smelt											12.00				
Longnose skate							300.00			2700.00	102.00		500.00		
Marbled snailfish													9.00		
Northern ronquil											61.00				
Pacific cod													2200.00		
Pacific hake (A)								160.00		1500.00	2300.00	1200.00	431.00	1400.00	39.00
Pacific sanddab (A)			128.00												
Pacific sanddab (J)		223.00													
Pacific tomcod (A)			124.50	830.00	450.00	1380.00	1890.00	540.00	186.00	2256.00	3000.00	16580.00	5420.00	8215.00	1210.00
Pacific tomcod (J)			64.00	600.00	200.00	87.00	260.00	11.60				7.20			
Pile perch (A)			102.50												
Pile perch (J)		13.00													
Plainfin midshipman						800.00	216.00	35.60	35.00	2420.00	2200.00	450.00	660.00	750.00	
Pygmy poacher					7.00										
Quillback rockfish			200.00	1200.00	326.00	3900.00	2100.00		400.00	5700.00	800.00		1200.00	1700.00	250.00
Ratfish (A)						1400.00	4500.00	5200.00	8050.00	650.00	5900.00	6000.00	4350.00	10600.00	5600.00
Ratfish (J)									4.00						
Rex sole								38.90		430.00		138.00		270.30	
Rock sole (A)	1660.00	2650.00	6430.00	1160.00	1270.00						160.30			30.50	
Rock sole (J)	10.00	82.50													
Rockfish UID												700.00			
Roughback sculpin	156.00	1.00	1050.00		22.00										
Sand sole		33.50													
Shiner perch (A)			370.00		27.00		24.00								
Shiner perch (J)	148.00	711.70	56.00	31.20	12.00										
Shortspine thornyhead												500.00			
Showy snailfish						8.00									
Slender sole (A)				60.00	74.00	220.00	104.00	840.00	450.00	1950.00	2260.00	2460.00	1250.00	2220.00	640.00
Slender sole (J)										0.80					
Snailfish spp.								3.50							
Snake prickleback															
Speckled sanddab (J)	99.00		193.50												
Speckled sanddab (A)	59.00		169.50										250.00		
Spiny dogfish				5600.00						4500.00				550.00	
Staghorn sculpin			400.00	30.50											
Striped seaperch		34.00	72.00												
Sturgeon poacher															
Tubesnout		48.20													
Walleye pollock (A)					71.00										
Walleye pollock (J)				30.50	6.00										

Devils Head abundances, Winter. Sta. = Station, A = Adult, J = Juvenile.

Species	20 m	40 m	Sta A	Sta B	Sta C	ZSF3 Sta 1	ZSF3 Sta 2	ZSF3 Sta 3	ZSF3 Sta 4	ZSF3 Sta 5	ZSF3 Sta 6
arrowtooth flounder					1						
blackbelly eelpout		20	53			565	200				
blacktip poacher			6	5	11	1	13	3	1	13	11
butter sole (A)					8					1	
C-O sole (A)	1										
copper rockfish				1							
Dover sole (A)									1		
English sole (A)	3	118	51	2	13	22	73	18	17	24	10
English sole (J)		386									
flathead sole (A)			20			1					5
flathead sole (J)			1								
longnose skate		1		1		2		3	4	1	
Pacific hake (A)			1			1	2	1			
Pacific herring					1	6	2	2	1	1	
Pacific tomcod (A)		58	20	27	47	4	33	45	65	39	44
Pacific tomcod (J)		9	1		1			2	1		
Pacific sanddab					1						
pile perch (A)		4	1				1	1		1	
plainfin midshipman		3		4	5	2	1	14	8	4	
pygmy poacher					1						
quillback rockfish					4				3	1	
ratfish (A)			5	12				4	3	6	6
rex sole (A)				1					1		
rock sole (A)	9	30		1	2				2		
rock sole (J)	3	4									
roughback sculpin	8	27	2		3	5	12	1	2	5	1
sand sole (A)		32									
sand sole (J)	3	27									
shiner perch (A)		8	190		1	51	45	37	59	19	7
shiner perch (J)	1	2	8	6		3		12	6		1
slender sole (A)				32	7	19	49	17	17	4	
slender sole (J)		2				8					
slim sculpin		1			1	3					2
snake prickleback		2	1			1					
speckled sanddab (A)	5	73				1					
speckled sanddab (J)		40									
spiny dogfish			1	1		1	5	3	3	9	
staghorn sculpin	1	62									
starry flounder (A)		1									
sturgeon poacher		1									
walleye pollock (A)							6	1			

Devils Head abundances, Spring. Sta = Station, A = Adult, J = Juvenile

Species	20 m Rep 1	20 m Rep 2	40 m Rep 1	40 m Rep 2	Sta A	Sta B	Sta C	ZSF3 Sta 1	ZSF3 Sta 2	ZSF3 Sta 3	ZSF3 Sta 4	ZSF3 Sta 5	ZSF3 Sta 6
arrowtooth flounder												1	
big skate												1	
blackbelly eelpout					41	19		207	122	11	26	2	
blacktip poacher					3			2	1		2	1	2
brown rockfish							1						2
buffalo sculpin	1												
C-O sole (A)			2										
daubed shanny			6										
English sole (A)	6	6	120	103	56	76	31	83	86	55	105	134	46
English sole (J)	1		114	103									
flathead sole (A)								1					
great sculpin	1		1										
hybrid sole			1										
longnose skate	1										1		
northern ronquil	1												
Pacific hake (A)								1			1		1
Pacific herring								2					
Pacific tomcod													
plainfin midshipman			1	1	4	5		1		3	10	5	5
quillback rockfish							2						
ratfish (A)							1		4		2	4	1
rex sole (J)								3					
rock sole (A)	6	5	25	18			24	1			1		15
roughback sculpin		1	8	9	31		1	27	7	1	10	15	4
sand sole (A)			13	5					1				
shiner perch (A)	2			26		4		2		3	1		
shiner perch (J)		2											
slender sole (A)			1		13	1		6	14	5	11	3	1
slender sole (J)					8		1	10	7	1			
slim sculpin			1										
snake prickleback	1		37	69				8			1	1	
speckled sanddab (A)	8	5	13	12	1						2		
staghorn sculpin					2								
sturgeon poacher			1	2	1								

Devils Head abundances, Summer. Sta. = Station, A = Adult, J = Juvenile.

	20 m	20 m	40 m	40 m			ZSF3	ZSF3	ZSF3	ZSF3	ZSF3	ZSF3
Species	Rep 1	Rep 2	Rep 1	Rep 2	Sta A	Sta B	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6
Blackbelly eelpout	2		4	4	87	8	303	224	29	24	5	7
Blacktip poacher		1					5	8				6
Buffalo sculpin	1											
combfish UID			2									
Daubbed shanny	1	1	1				1					1
English sole (A)	9	8	43	28	42	10	56	67	37	32	29	43
Flathead sole (A)							2	0				
Longnose skate							3	1		1		
Longspine combfish			1									
Pacific hake (J)						1						
Pacific herring					3						5	1
Pacific tomcod (A)			2	2	5	15	3	18	19	21	34	14
Pacific tomcod (J)	1	3	115	56	45	3	27	28	13	8	61	5
Plainfin midshipman	2				1	1	3	1		1	5	
Quillback rockfish					1							1
Ratfish (A)					13	1			1	7	6	9
Rex sole							3	2				
Rex sole (J)								3				
Rock sole (A)	3	4	6	4						1		5
Roughback sculpin	2	4	1	4			5	9	2	2	3	8
Sand sole (A)			1	2			8					
Shiner perch (A)	1	1	5	4	1	1	1		1		1	1
Slender sole (A)			2	1		1	26	64	4	8	4	14
Slender sole (J)			1	2			17	7				1
Slim sculpin			1									
Snailfish UID						1	1					
Snake prickleback	6	3										
Spiny dogfish					1			4		1	4	
Staghorn sculpin							1					
Sturgeon poacher		1						1				
Tubesnout	4	3										
Whitespotted greenling	1											

Devils Head abundances, Autumn. Sta. = Station, A = Adult, J = Juvenile.	20 m	20 m	40 m	40 m				ZSF3	ZSF3	ZSGF3	ZSF3	ZSF3	ZSF3
Species	Rep 1	Rep 2	Rep 1	Rep 2	Sta A	Sta B	Sta C	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6
Arrowtooth flounder			8		1							2	
Blackbelly eelpout			5		17			131	216	28	21	5	1
Blacktip poacher					3	1			1			1	3
C-O sole (A)										1			
Dover sole									1				
English sole (A)	1		277	557	153	48	26	95	125	100	2	194	131
English sole (J)	1		1				1					3	
Longnose skate			1				1		1			1	1
Longspine combfish			2										
Pacific cod													1
Pacific hake (A)							2		2	10	6	9	
Pacific herring							1	9					
Pacific sanddab (A)	4	4	15			1						1	
Pacific sanddab (J)			20	1									
Pacific tomcod (A)			10		10	25	37	6		27		11	25
Pacific tomcod (J)			4		10	15	87	5	12	52		229	163
Pile perch (A)		10			1		1				1		
Plainfin Midshipman	2				3		2		1	5	19	3	5
Quillback rockfish						1							
Ratfish (A)					8	3					16	2	3
Rex sole (A)									3			2	5
Rock sole (A)	9	6	7	2	1		3					4	3
Rock sole (J)	4	3											
Roughback sculpin	4		42	2	8		2		12	9	7	14	13
Sand sole (A)	1	1	3						3	1			
Shiner perch (A)			4		21	16	7		5	35	35	15	
Shiner perch (J)	53	223	33	2	20				1	2	5	1	
Slender sole (A)	1		5		18	2	5	10	17	4	9	13	8
Slender sole (J)								1					
Slim sculpin			1										
Snake prickleback										1			
Speckled sanddab (A)	2												1
Spiny dogfish			1	1	3	2	4	1	4	5		5	8
Staghorn sculpin			27				2	4					1
Sturgeon poacher			1										
Walleye pollock (A)					1	3		20		3	16	8	4
Walleye pollock (J)							1	18			3	10	10

Devils Head biomass, Winter 1987. Biomass in grams. Sta. = Station, A = Adult, J = Juvenile.

Species	Sta A	Sta B	Sta C	20 m	40 m	ZSF3 Sta 1	ZSF3 Sta 2	ZSRF3 Sta 3	ZSF3 Sta 4	ZSF3 Sta 5	ZSF3 Sta 6
arrowtooth flounder		0.00	35.00	0.00	0.00						
blackbelly eelpout	895.00	0.00	0.00	0.00	54.00	8265.90	2500.00	0.00	0.00	0.00	0.00
blacktip poacher	75.30	67.20	127.40	0.00	0.00	7.60	143.30	30.20	8.50	122.00	110.00
butter sole (A)	0.00	0.00	646.00	0.00	0.00	0.00	0.00	0.00	0.00	464.70	0.00
C-O sole (A)	0.00	0.00	0.00	290.00	0.00						
copper rockfish	0.00	129.30	0.00	0.00	0.00						
Dover sole (A)						0.00	0.00	0.00	25.90	0.00	0.00
English sole (A)	4755.00	502.00	2200.00	570.00	4115.00	3555.00	9640.00	3180.00	2450.00	4865.00	1370.00
English sole (J)	0.00	0.00	0.00	0.00	4771.00						
flathead sole (A)	590.00	0.00	0.00	0.00	0.00	272.70	0.00	0.00	0.00	0.00	206.00
flathead sole (J)	6.00	0.00	0.00	0.00	0.00						
longnose skate	0.00	2400.00	0.00	0.00	34.90	200.00	0.00	2900.00	3800.00	250.00	0.00
Pacific hake (A)	9.60	0.00	0.00	0.00	0.00	41.00	76.30	49.50	0.00	0.00	0.00
Pacific herring	0.00	0.00	46.20		0.00	231.50	124.50	66.30	100.00	13.50	0.00
Pacific sanddab (A)	0.00	0.00	128.40	0.00	0.00						
Pacific tomcod (A)	1310.00	1320.00	2130.00	0.00	663.90	400.50	1220.00	1810.00	2845.00	1690.00	1955.00
Pacific tomcod (J)	14.00	0.00	11.70	0.00	100.70	0.00	13.10	27.00	11.30	0.00	0.00
pile perch (A)	56.00	0.00	0.00	0.00	60.80	0.00	20.20	65.50	0.00	61.70	0.00
plainfin midshipman	0.00	144.30	165.50	0.00	80.50	130.20	54.30	690.00	430.70	198.00	0.00
pygmy poacher	0.00	0.00	1.70	0.00	0.00						
quillback rockfish	0.00	0.00	342.50	0.00	0.00	0.00	0.00	0.00	810.00	263.30	0.00
ratfish (A)	3500.00	4400.00	0.00	0.00	0.00	0.00	0.00	2600.00	4000.00	4000.00	5700.00
rex sole (A)	0.00	73.80	0.00	0.00	0.00	0.00	0.00	0.00	125.70	0.00	0.00
rock sole (A)	0.00	207.30	346.00	2975.50	3635.00	0.00	0.00	0.00	261.20	0.00	0.00
rock sole (J)	0.00	0.00	0.00	19.00	63.10						
roughback sculpin	16.80	0.00	54.00	26.50	166.40	73.00	202.00	28.70	58.50	85.70	20.80
sand sole (A)	0.00	0.00	0.00	0.00	1535.00						
sand sole (J)	0.00	0.00	0.00	27.30	351.00						
shiner perch (A)	5300.00	0.00	14.50	0.00	113.40	1180.00	1160.00	980.00	1350.00	428.30	156.00
shiner perch (J)	48.70	16.00	0.00	5.30	13.70	15.50	16.70	88.90	32.90	0.00	7.00
slender sole (A)	0.00	1110.00	317.30	0.00	0.00	475.00	516.00	600.00	620.00	183.80	0.00
slender sole (J)	0.00	6.00	0.00	0.00	10.00	48.30	0.00	0.00	0.00	0.00	0.00
slim sculpin	0.00	0.00	25.00	0.00	2.70	25.00	0.00	0.00	0.00	0.00	21.00
snake prickleback	10.00	0.00	0.00	0.00	24.30	10.50	0.00	0.00	0.00	0.00	0.00
speckled sanddab (A)	0.00	0.00	0.00	29.90	17.40	24.70	0.00	0.00	0.00	0.00	0.00
speckled sanddab (J)	0.00	0.00	0.00	0.00	902.60						
spiny dogfish	200.00	60.60	0.00	0.00	0.00	103.00	1550.00	1000.00	1500.00	4000.00	0.00
staghorn sculpin	0.00	0.00	0.00	45.40	2220.00						
starry flounder (A)	0.00	0.00	0.00	0.00	580.00						
sturgeon poacher	0.00	0.00	0.00	0.00	10.00						
walleye pollock (A)	0.00	0.00	39.50	0.00	0.00	0.00	262.40	44.00	0.00	0.00	0.00

Devils Head biomass, Spring 1987. Biomass in grams. Sta. = Station, A = Adult, J = Juvenile.

Species	Sta A	Sta B	Sta C	20 m Rep 2	20 m Rep 1	40 m Rep 1	40 m Rep 2	ZSF3 Sta 1	ZSF3 Sta 2	ZSF3 Sta 3	ZSRF3 Sta 4	ZSF3 Sta 5	ZSGF3 Sta 6
arrowtooth flounder								0.00	0.00	0.00	0.00	59.80	0.00
big skate								0.00	0.00	0.00	0.00	12.00	0.00
blackbelly eelpout	702.50	178.00						3213.00	1438.50	125.40	337.70	19.20	0.00
blacktip poacher	25.50							14.10	8.00	0.00	17.00	3.40	17.60
brown rockfish			65.00					0.00	0.00	0.00	0.00	0.00	288.60
buffalo sculpin				179.30									
C-O sole (A)						143.40							
daubed shanny						27.50							
English sole (A)	3530.00	6960.00	5285.30	2659.00	520.00	1882.40	3460.00	7250.00	9307.60	5110.00	7170.00	8340.00	6560.00
English sole (J)				7.10		1340.00	1290.00						
flathead sole (A)								133.00	0.00	0.00	0.00	0.00	0.00
great sculpin				1340.00		600.00							
hybrid sole						76.20							
longnose skate				47.20				0.00	0.00	0.00	225.00	0.00	0.00
northern ronquil				26.40									
Pacific hake (A)								38.00	0.00	0.00	33.40	0.00	28.20
Pacific herring								42.00	0.00	0.00	0.00	0.00	0.00
Pacific tomcod (A)	14.60	525.00						0.00	0.00	242.30	0.00	0.00	0.00
plainfin midshipman	140.40	240.00				25.00	53.40	165.70	0.00	142.10	416.70	179.50	316.40
quillback rockfish			298.00										
ratfish (A)			900.00					0.00	2060.00	0.00	1100.00	1725.00	400.00
rex sole (J)								12.30					
rock sole (A)			4570.00	1120.00	947.60	2150.00	1840.00	128.70		0.00	272.00	0.00	3350.00
roughback sculpin	420.00		23.90		3.70	46.70	93.60	345.70	131.20	25.70	164.40	314.00	78.60
sand sole						728.00	348.70	51.00	24.90	0.00	0.00	0.00	0.00
shiner perch (A)		82.70		13.40			310.00	33.60	0.00	58.60	18.60	0.00	0.00
shiner perch (J)				8.20									
slender sole (A)	360.00	43.00				15.40		240.70	100.00	102.80	291.00	130.20	30.50
slender sole (J)	62.00		8.30					69.90	52.90	7.20	0.00	0.00	0.00
slim sculpin						5.70							
snake prickleback				11.40		305.10	665.00	91.60	0.00	0.00	27.00	6.60	0.00
speckled sanddab (A)	16.00			50.70	38.50	273.30	269.70	0.00	0.00	0.00	14.10	0.00	0.00
staghorn sculpin	86.40												
sturgeon poacher	44.70					13.00	56.80						

Devils Head biomass, Summer 1987. Biomass in grams. Sta. = Station, A = Adult, J = Juvenile.

			20 m	20 m	40 m	40 m	ZSF3	ZSF3	ZSF3	ZSF3	ZSF3	ZSF3
Species	Sta A	Sta B	Rep 1	Rep 2	Rep 1	Rep 2	Sta 1	STa 2	Sta 3	Sta 4	Sta 5	Sta 6
Blackbelly eelpout	1575.00	150.00	37.00		37.00	74.00	3790.00	4300.00	495.00	393.00	89.00	118.00
Blacktip poacher				43.00			24.00	75.00				42.00
Buffalo sculpin			114.00									
Combfish UID					150.00							
Daubbed shanny			2.00	2.00	2.00		1.00					1.40
English sole	4640.00	1680.00	1416.00	1455.00	3490.00	1800.00	5500.00	9000.00	4020.00	3355.00	2773.00	5600.00
Flathead sole	308.50						300.00					
Longnose skate							180.00	200.00		74.00		
Pacific hake (J)		1.00										
Pacific herring	155.00										283.00	50.00
Pacific tomcod (A)	325.00	960.00		6.50	50.00	75.80	83.60	700.00	845.00	775.00	1050.00	630.00
Pacific tomcod (J)	460.00	33.00	2.50		782.00	352.00	254.00	229.00	159.00	95.00	700.00	43.00
Plainfin midshipman	31.00	71.00	163.00				90.60	46.00		46.00	239.00	
Quillback rockfish	650.00											67.00
Ratfish	12350.00	550.00							550.00	5450.00	3350.00	4700.00
Rex sole (A)							33.00	26.00				
Rex sole (J)								23.00				
Rock sole			880.00	1050.00	2100.00	1150.00				350.00		1125.00
Roughback sculpin			17.00	27.00	14.00	504.00	75.00	132.00	34.00	38.00	38.00	131.00
Sand sole					289.00	210.00	900.00					
Shiner perch	23.50	36.00	15.00	12.00	78.00	59.00	32.00		20.00		25.00	26.00
Slender sole (A)		46.00			62.00	35.00	646.50	2170.00	205.00	299.00	108.50	460.00
Slender sole (J)					9.00	26.60	183.50	71.00				9.70
Slim sculpin					6.00							
Snailfish UID		8.80					8.70					
Snake prickleback			130.00	67.00								
Spiny dogfish	900.00							4100.00		500.00	3050.00	
Staghorn sculpin							13.50					
Sturgeon poacher				10.00				24.00				
Tubesnout			24.50	18.30								
Whitespotted greenling			410.00									

Devils Head biomass, Autumn 1987. Biomass in grams. Sta. = Station, A = Adult, J = Juvenile.

Species	Sta A	Sta B	Sta C	20 m Rep 1	20 m Rep 2	40 m Rep 1	40 m Rep 2	ZSF3 Sta 1	ZSF3 Sta 2	ZSF3 Sta 3	ZSF3 Sta 4	ZSF3 Sta 5	ZSF3 Sta 6
Arrowtooth flounder	163.00					250.00						355.00	
Blackbelly eelpout	320.00					59.00		1984.00	2920.00	500.00	310.00	63.00	9.80
Blacktip poacher	37.00	13.00							10.00			13.00	39.50
C-O sole										110.00			
Dover sole									22.00				
English sole (A)	13467.00	5100.00	3940.00	150.00		13870.00	24550.00	7810.00	11964.00	9400.00	175.00	13110.00	12300.00
English sole (J)			14.00	8.00		10.00						42.00	
Longnose skate			302.00			1000.00			100.00			12500.00	100.00
Longspine combfish						100.00							
Pacific cod													14.50
Pacific hake			47.00						44.00	200.00	127.00	189.00	
Pacific herring			49.00										
Pacific sanddab (A)					102.50	370.00	13.50						
Pacific sanddab (J)		15.60		54.00		300.00						14.00	
Pacific tomcod (A)	380.00	450.00	690.00			400.00		419.50		510.00		710.00	910.00
Pacific tomcod (J)	112.00	165.00	920.00			57.00		43.00	35.00	160.00		2320.00	1420.00
Pile perch (A)	25.00		73.00		140.00						22.00		
Plainfin midshipman	135.00		33.00	36.00					95.00	95.00	250.00	32.00	78.50
Quillback rockfish		53.00											
Ratfish (A)	8500.00	1500.00									11000.00	2600.00	2000.00
Rex sole									75.00			48.00	134.00
Rock sole (A)	172.00		1040.00	2540.00	2240.00	929.00	310.00					1710.00	850.00
Rock sole (J)				24.00	54.60								
Roughback sculpin	150.00		28.00	53.00		650.00	22.50	79.50	109.00	145.00	92.00	161.00	164.00
Sand sole				166.00	210.00	60.00		693.00	750.00	310.00			
Shiner perch (A)	410.00	460.00	100.00		910.00	109.00	16.50	487.50	80.00	890.00	940.00	348.00	
Shiner perch (J)	172.00			244.00		220.00		157.00	7.00	14.50	37.00	11.00	
Showy snailfish										9.00			
Slender sole (A)	690.00	90.50	200.00	19.00		160.00		283.50	520.00	150.50	250.00	260.00	212.50
Slender sole (J)								6.00					
Slim sculpin						10.00							
Snake prickleback										3.50			
Speckled sanddab (J)													18.50
Speckled sanddab (A)	41.00			13.00									
Spiny dogfish	5200.00	700.00	1600.00			1200.00	1000.00	2500.00	3600.00	3600.00	10400.00	3500.00	3800.00
Staghorn sculpin			64.00			1231.00							98.00
Sturgeon poacher						26.00							
Walleye pollock (A)	48.00	54.50								83.50	300.00	124.00	57.50
Walleye pollock (J)			13.00								50.50	116.00	99.50

Bellingham Bay abundances, Winter 1987. Sta. = Station, A = Adult, J = Juvenile.

Species	Sta A	Sta B	Sta C	Sta D	Sta F	Sta G	Sta H	Sta I	T1 15E	T1 25E	T1 30E	T1 30C	T1 20E
big skate	1												
blackbelly eelpout	5	14			10	1	1	2		4	6	2	
butter sole (A)	38	78	25	10	11	16	6	20		46	13	38	4
butter sole (J)	46	4	10	5	8	2	3	5		8	24	3	
daubed shanny	1	1			1	1	2			3		2	
English sole (A)	22	49	7	53	42	53	13	39		7	20	65	
English sole (J)	30	33	9	66	34	45	10	14		18	22	65	
flathead sole (A)	18	30	5	7	1	6	9	4		3	7	2	2
flathead sole (J)	9	9	3	7	8		2	1			11	2	
gray starsnout poacher	1		1										
longfin smelt (A)	10	113	8	16	7			13		8	31	23	
longfin smelt (J)	648	1070	381	472	223	718	270	483	36			292	
marbled snailfish								1				1	
northern anchovy		1						1			1	1	
northern sculpin					1	1		1					
Pacific hake (J)						1	1	1					2
Pacific herring (A)	25	39	8	3	7	8	18	31			22	10	
Pacific sanddab (A)									2				
Pacific sanddab (J)									1				
Pacific sandlance		1								1			
Pacific tomcod (A)	14	223	4	28	21	12	22	46		24	69	41	17
Pacific tomcod (J)	22	281	26	38	30	29	33	98	7	81	82	84	50
pile perch (A)		2					1	1		1	3		
plainfin midshipman	2		1	8	6	3	2	8		1	6	2	
rex sole (J)					2								
rock sole (A)	1						1				1		
rock sole (J)									1				
saddleback gunnel				1									
sand sole (A)	6		4	2		2		2		2			4
sand sole (J)	1		1							1		1	
shiner perch (A)	2	10		9	21	11	1	4		6	8	33	
shiner perch (A)	111	202	26	58	134	109	30	84	9	314	207	368	179
slender sole (J)				1									1
slim sculpin					2								
snake prickleback				1	1						1		
spiny dogfish	2	1			1		1	1		1		1	3
spinyhead sculpin	1	1		3	1	1	1	1		1	3	0	1
staghorn sculpin	47	9	11	5	3	6	8	8		24	13	12	3
starry flounder (A)	28	26	2	9	11	6	13	3	1		9	23	2
sturgeon poacher		2	1				1		1		3		
surf smelt												3	
Tubesnout	5	8	4								195	15	
walleye pollock (A)	1	7						1		4			
walleye pollock (J)		2									1		
whitespotted greenling	7	8	1			3	2			1	8	1	

Bellingham Bay abundances, Spring 1987. Sta. = Station, A = Adult, J = Juvenile.

Species	Sta A	Sta B	Sta C	Sta D	Sta F	Sta G	Sta H	Sta I	Sta J	T1 15E Rep 1	T1 15E Rep 2	T1 25E Rep 1	T1 25E Rep 2	T1 30E	T1 30C	T1 20E Rep 1	T1 20E Rep 2
Bay anchovy	'	2	1		1												
big skate												1					
blackbelly eelpout	13	84	88	27	98	72	68	24	39			12	11	88	62		
butter sole (A)	9	7	7			1		1		4	10	8	25	2	2	19	14
butter sole (J)	6	1	8					2		3	1	1	11			10	7
daubbed shanny		2	4	1		4	4	2	8			2	2	9	4	2	1
Dover sole (A)						2											
Dover sole (J)														1			
English sole (A)	66	27	18	2	2	3	9	16	2		2	20	37	3	4	21	15
English sole (J)	2	1	1		1		3			2			2			9	14
flathead sole (A)	23	9	18	6	18		22	10	12			13	8	25	19	1	3
flathead sole (J)	6	4	8	1	12	2	7	2	3			6	1	5	5		
gray starsnout poacher			1														
longfin smelt (A)	2	68	27	70	87	70	9	6	20		3		7	56	29		
longfin smelt (J)	47	173	291	644	668	322	68	71	260			29		204	328	10	4
longnose skate				1	1												
northern anchovy		2	1		1												
Pacific hake (J)					1												
Pacific herring (A)	8	6	3	4	8	15	7	4				4	4	5	3		
Pacific tomcod (A)	49	82	14	24	16	12	13	7	18	16	18	53	49	20	18	31	17
Pacific tomcod (J)	8	7	1	4	6	3	6	3		8	8	11			2	13	15
pile perch (A)	1	1															
plainfin midshipman		1				1		1			1		1		2	2	
rex sole (A)		1	1														
rex sole (J)			1	1	7	3	1		1						2		
rock sole (A)						1										1	3
rock sole (J)										4							1
sablefish	2				1			1									
sand sole (A)					1	1	1		1	1	1	2	1	0		4	5
sand sole (J)							1		0								
shiner perch (A)		3	1	2	1		3		1		1						1
shiner perch (J)	1		2					1	2	3		5		1	1		
shortfin eelpout	2	4	37	6	35	15	4	2	8			1	2	13	10		
slender sole (A)						16		1									
slender sole (J)				1		4		1									
slim sculpin				0		5		0							8		
snake prickleback	30	24	45	24	30	32	18	17	46	11	15	12	19	26	33	11	9
speckled sanddab (J)											1	0	1				
Spiny dogfish	1	5		10	1		2								5		
spinyhead sculpin					3	1								1			1
staghorn sculpin			1								2				1	1	1
starry flounder (A)		1	7		1			1		2		2	3	2			1
Sturgeon poacher											1		2				
tadpole sculpin																1	
tubesnout																1	
walleye pollock (A)															1		
whitebait smelt										2							

Bellingham Bay abundances, Summer 1987. Sta. = Station, A = Adult, J = Juvenile.																	
										T1 15E	T1 15E	T1 25E	T1 25E				
Species	Sta. A	Sta. B	Sta. D	Sta. F	Sta. G	Sta. H	Sta. I	Sta. J	Rep 1	Rep 2	Rep 1	Rep 2	TI-30E	TI-30M	T3-26N	T4-25N	T3-30M
American shad	1									0	0	0	0	0	0	0	0
Blackbelly eelpout	* 66	125	698	46	33	60	77	9	5	0	65	73	164	49	3	71	128
Blacktip poacher	1										0	0	0	1	0	0	0
Bluebarred prickleback		6									0	0	0	0	0	0	0
Buffalo sculpin											0	0	0	0	0	0	0
Butter sole (A)	6	4						1	23	4	21	27	0	0	1	5	2
Butter sole (J)	3		1				1	0	5	0	0	0	0	0	0	3	0
Copper rockfish	6									0	0	0	0	0	0	0	0
Daubbed shanny	2	4	1	1	12	2	1	5		0	0	18	12	9	8	17	11
Dover sole (A)			1	1				1		0	0	0	1	0	0	0	0
Dover sole (J)		1								0	0	0	0	0	0	0	0
English sole (A)	6	10	4	2	1	6	4		11	4	14	8	2	3	8	17	1
Flathead sole (A)	6	16	13	8	11	13	2	2		0	13	12	30	9	2	7	18
Flathead sole (J)				16		1				0	2	0	0	0	0	0	0
Longfin smelt (A)	52	152	6	67	29	52	93	110		0	4	7	80	15	71	20	202
Longfin smelt (J)	481	1341	6	176	282	379	214	192	214	0	57	713	1089	3150	519	438	1132
Longnose skate		1	2					1		0	0	0	1	0	0	0	0
Marbled snailfish		1								0	0	0	0	0	0	0	0
Pacific herring (A)	1		1	2	3	1	3			1	3	1	2	3	5	4	2
Pacific sandfish	1							1		0	2	0	0	0	0	1	0
Pacific tomcod (A)	21	40	1	3	4	6	7		57	17	6	16	21	13	35	12	47
Pacific tomcod (J)		16	2	16	8		3		30	23	1	0	1	14	11	0	0
Plainfin midshipman			1				1			0	0	0	2	0	0	0	0
Quillback rockfish	9		0							0	0	0	0	0	0	0	0
Rex sole (A)			2							0	0	0	0	0	0	0	0
Rock sole (A)									2	3							
Rock sole (J)										2							
Roughback sculpin										2		6					
Sablefish		2															
Saddleback gunnel		1															
Sand sole (A)	1	1				1	1		1			1					
Shiner perch (A)		1							3	6	2	1				1	
Shiner perch (J)																1	
Shortfin eelpout		8	10	6	3	32		5	1		12	106	13	4	4	3	7
Showy snailfish	5														2	5	
Slender sole (A)								1									
Slim sculpin				2	6		1	3						5			3
Snake prickleback	47	63	1	7	9	16	6	4	27	40	13	22	64	51	25	33	53
Speckled sanddab (A)										6							
Speckled sanddab (J)									2								
Spiny dogfish	1	2		1	4	2	2		3	1	1	1	6	3			2
Spinyhead sculpin		1	1	2	1			2			3		1	1			1
Staghorn sculpin			1			1			1							1	
Starry flounder		22			1	8					1	2	10	6	5	9	3
Stickleback													25				
Sturgeon poacher									4								
Tubesnout									1	6							
Whitespotted greenling										6							

Bellingham Bay abundances, Autumn 1987. Sta. = Station, A = Adult, J = Juvenile																		
										T1 15E	T1 15E	T1 25E	T1 25 E					
Species	Sta. A	Sta. B	Sta. C	Sta. D	Sta. F	Sta. G	Sta. H	Sta. I	Sta. J	Rep 1	Rep 2	Rep 1	Rep 2	T1 30 E	T1 30M	T3 25 N	T4 25 N	T3 30M
Bay anchovy		1																
Bay pipefish	*														1			
Blackbelly eelpout	8	15	8	3	12	2	4	19	15			1	4	9	7	29	19	12
Butter sole (A)	18	15	40	2	4	7	2	7	17			4	14	34	15	6	24	50
Butter sole (J)			1															
Chinook salmon														1				
Daubed shanny		1	3										1		2			
Dover sole (A)														1				
English sole (A)	16	8	7	1	4	2		10	6			21	13	8	3	4	8	5
English sole (J)	1			0								9	6			1	1	
Flathead sole (A)	12	8	23	5	7	6	7	8	10			4	2	14	8	18	11	22
Flathead sole (J)	1		4	10	8	13			6			1	7	4	2			6
Great sculpin											1	1	1	2				
Greenling UID			1															
Grunt sculpin											1							
Longfin smelt (A)	369	388	22		237	1241	128	6	16			2		128		740	485	31
Longfin smelt (J)			184	754	1652			184	41			13	3	253	873			83
Pacific hake																		1
Pacific herring (A)	17	58	15	2			6	4	1	1	3			9	2	10	17	1
Pacific herring (J)	6	25	3				68	8				3	31	3	6	8	4	
Pacific sanddab													1					
Pacific tomcod (A)	17	23	19	3	4	3	5	12	1				3	9	7	91	26	2
Pacific tomcod (J)	8	30	5	16	8	6		18	7	8	2	77	40	6	10	37	22	5
Padded sculpin											1						1	
Pile perch (A)	2	1	1					2										
Plainfin midshipman		1	1	1	2	3	2	2				1		1	2			1
Ratfish															1			
Rex sole (A)																		
Rock sole (A)			1			2				2		1	2					
Sablefish							1											
Saddleback gunnel														1				
Sand sole (A)		2	2			2	1		1				2	1				
Shiner perch (A)	23	29	26	3	64	44	5	16						27	13	73	27	18
Shiner perch (J)	33	35	28	20					12	4	2	141	86	46	13	109	56	43
Shortfin eelpout	3	2	6	1				3	1			1				1		
Showy snailfish	1							1								1		
Slender sole (A)																		
Slim sculpin						2			1									
Snake prickleback		1	3	3	2	3	1	2	5		1		5	8	4	1	1	10
Speckled sanddab (A)	1		1								2		1					
Speckled sanddab (J)											1		1					
Spiny dogfish	2	5	1		1	1									3	6	3	
Spinyhead sculpin			1	3	3	1			2						1			1
Staghorn sculpin			5	1					1	1		3	3	6	2	2	1	4
Starry flounder	6	9	38	3			1	7	3		1	1	1	15	15	12	10	5
Stickleback	1																	
Sturgeon poacher												1						
Tubesnout											1	1	1					
Walleye pollock (A)	1				1			1				1						
Walleye pollock (J)		5	3					7					1		2			
Whitespotted greenling											1							2

Bellingham Bay biomass Winter 1987 Biomass in grams Sta = Station, A = Adult, J = Juvenile

Species	Sta A	Sta B	Sta C	Sta D	Sta F	Sta G	Sta H	Sta I	T1 15E	T1 20E	T1 25E	T1 30E	T1 30C
big skate	2000.00												
blackbelly eelpout	19.40	84.90			29.00	4.80	3.00	3.50			18.00	41.10	8.30
butter sole (A)	1985.70	3881.00	2200.00	1080.00	880.00	1910.00	550.00	1200.00	188.00	800.00	7240.00	3950.00	2205.00
butter sole (J)	290.10	37.80	82.80	28.00	40.50	8.20	11.30	22.70			110.00	80.00	24.00
daubed shanny	2.80	4.50			4.00	3.80	6.50				35.00		8.00
English sole (A)	975.80	1482.80	180.70	1190.00	1410.00	1200.00	271.80	1000.00			110.00	1100.00	1555.80
English sole (J)	250.50	284.80	94.40	810.00	70.00	424.80	88.00	120.00			100.00	240.00	520.70
flathead sole (A)	298.50	1770.00	288.20	512.00	88.00	200.00	400.00	330.00		18.00	10.00	65.00	18.00
flathead sole (J)	55.30	55.80	18.20	47.40	52.00		8.40	4.80				70.00	11.00
gray starsnout poacher	2.00		1.30						2.50				
longfin smelt (A)	95.00	978.00	58.00	134.00	88.50			120.00			110.00	815.00	52.00
longfin smelt (J)	785.80	1483.80	580.10	782.50	841.00	1381.80	348.90	542.80					550.00
marbled snailfish								7.30					18.00
northern anchovy		2.80						2.30				18.50	7.20
northern sculpin					8.00	2.20		12.50					52.00
Pacific hake (J)						3.90	4.60	6.80	58.00	89.00			5.50
Pacific herring	154.00	298.00	55.10	25.00	80.00	70.00	181.00	313.80				1480.00	107.50
Pacific sanddab (A)									82.50				
Pacific sanddab (J)									3.50				
Pacific sandlance		3.70									5.60		
Pacific tomcod (A)	351.40	3827.00	115.30	645.00	395.00	150.00	250.00	620.00	58.50	120.00	75.00	330.00	1220.00
Pacific tomcod (J)	128.80	3032.80	277.40	383.50	279.00	180.00	327.80	870.00	43.50	258.50	80.00	290.00	813.50
pile perch		40.00					700.00	700.00			45.00	258.00	
plainfin midshipman	147.20		61.00	188.50	33.70	80.00	93.50	220.00			15.00	228.80	145.00
rex sole (J)					8.80								700.00
rock sole (A)	84.80						72.00					15.50	
rock sole (J)								18.00					
saddleback gunnel				11.00									18.00
sand sole (A)	288.00		790.00	810.00		100.00		150.00	5.30	27.00	10.00		
sand sole (J)	5.70		11.10								8.00		8.38
shiner perch (A)	48.70	178.50		155.50	391.50	150.00	12.00	100.00			20.00	27.50	783.00
shiner perch (J)	377.80	1352.20	158.00	400.50	917.00	720.00	187.50	470.00	37.30	229.50	480.70	341.20	2382.50
slender sole (J)				1.50						300.00			
slim sculpin					8.00								
snake prickleback				5.00	19.30							121.40	
spiny dogfish	800.00	265.50			800.00		600.00	600.00		38.00	6.00		700.00
spinyhead sculpin	44.00	58.50		20.10	3.30	80.00	38.50	38.00		5.00	15.00	87.60	145.00
staghorn sculpin	791.50	411.80	380.00	298.50	138.00	280.00	351.00	380.00		55.50	340.00	320.00	750.00
starry flounder (A)	8815.00	7140.00	400.00	2550.00	1310.00	1800.00	1170.00	815.00		85.00		213.00	8315.00
surf smelt													52.00
sturgeon poacher		5.70	3.70				3.00					7.90	
tubenose poacher	2.00	2.50	1.80								75.00	8.20	
walleye pollock (A)	12.40	83.30						18.80	3.00		30.00		
walleye pollock (J)		11.50										123.90	
whitespotted greenling	537.00	344.80	56.90			280.00	188.50				8.40	19.90	61.50

Bellingham Bay biomass, Spring 1987. Biomass in grams. Sta = Station, A = Adult, J = Juvenile																	
										T1 15E	T1 15E		T1 30C	T1 25E	T1 25E	T1 20E	T1 20E
Species	Sta A	Sta B	Sta C	Sta D	Sta F	Sta G	Sta H	Sta I	Sta J	Rep 1	Rep 2	T1 30 E	T1 30C	Rep 1	Rep 2	Rep 1	Rep 2
	*																
Anchovy					5.20												
big skate														39.70			
blackbelly eelpout	113.30	525.10	610.00	188.20	201.80	245.00	388.50	149.00	202.00			431.10	285.00	78.70	95.20		
butter sole (A)	389.60	848.00	540.00			28.50		82.10		180.20	540.00	78.50	85.50	450.00	1003.60	690.00	580.00
butter sole (J)	24.50	6.30	44.70					7.40		20.40	11.60			3.50	47.90	65.50	87.00
daubbed shanny		14.00	18.70	9.80		19.50	20.70	13.20	48.00			389.70		13.00	12.70	15.00	7.00
dogfish	2800.00	6600.00		10800.00	1000.00		2400.00						5600.00				
Dover sole (A)						55.70											
Dover sole (J)												5.00					
English sole (A)	2517.80	1150.00	700.00	188.20	72.40	105.20	353.70	580.70	92.60		44.40	80.40	223.20	570.00	950.00	546.00	180.00
English sole (J)	27.50	8.40	13.70		11.70		38.40			21.30				91.00	20.60	91.00	165.00
flathead sole (A)	823.70	220.00	1350.00	289.20	640.00		870.00	240.00	454.70			823.30	770.00	720.00	350.20	71.00	280.00
flathead sole (J)	53.50	33.00	74.80	8.50	107.80	20.30	47.40	12.20	29.70			38.00	40.40	35.50	8.50		
gray starsnout poacher			1.70														
longfin smelt (A)	24.50	718.60	285.80	700.00	648.00	210.00	85.70	41.30	180.00		21.80	577.80	322.50		21.80		
longfin smelt (J)	147.30	628.50	925.40	2389.10	2033.00	1182.80	238.10	231.60	1051.40			728.40	1245.40	88.50		39.20	14.00
longnose skate				50000.00	1050.00												
northern anchovy		52.70	28.30		5.20												
Pacific hake (J)					7.10												
Pacific herring	86.70	74.50	57.80	57.50	163.40	284.40	118.50	63.60	128.40			144.00	75.20	49.80	60.20		
Pacific tomcod (A)	1370.80	2530.00	810.00	1000.00	800.00	520.00	323.20	303.00	1258.20	287.50	450.00	1564.90	1070.00	1288.50	911.80	620.00	440.00
Pacific tomcod (J)	80.50	68.70	8.30	80.00	54.80	35.40	64.80	38.80		87.20	104.40		20.50	124.00		154.00	180.00
pile perch (A)	22.10	23.10											19.10				
plainfin midshipman		25.50				38.80		16.30			5.70		105.10		29.60	49.00	
rex sole (A)		28.50	141.00														
tvt sole (J)			7.00	7.70	350.00	13.00	4.00		4.90				11.70				
rock sole (A)						78.10										89.50	290.00
ruck sole (A)										31.40							19.00
sablefish	825.00				420.00			318.80									
sand sole (A)					400.00	149.00	180.50		124.60	81.30	63.00			112.50	81.50	149.70	500.00
sand sole (J)							7.70										
shiner perch (A)		58.80	25.00	23.80	24.80		80.20		23.70		5.30						23.00
shiner perch (J)	10.10		18.50					5.00	14.50	17.50		9.70	8.40	35.20			
shortfin eelpout	30.40	47.40	513.50	51.40	100.00	155.00	48.80	18.60	170.20			153.00	104.30	8.30	29.60		
slender sole (A)						510.00		18.50									
slender sole (J)				13.80		31.80		12.20									
slim sculpin						19.50							21.70				
snake prickleback	533.10	380.60	820.50	327.70	275.00	205.00	281.50	258.60	810.00	180.30	183.80	371.70	175.00	208.70	212.00	128.20	110.00
speckled sanddab (J)											5.50				7.40		
spinyhead sculpin					43.00	12.80						13.10					51.50
staghorn sculpin			115.80								118.00		73.80			16.10	91.00
starry flounder (A)		350.00	1440.00		210.00			275.00		1930.00		400.00		400.00	470.00		220.00
Sturgeon poacher											13.80				32.40		
tadpole sculpin																	
tubesnout poacher																1.50	
walleye pollock (A)													34.50			2.00	
whitebait smelt										12.00							

Bellingham Bay biomass, Summer 1987. Biomass in grams. Sta = Station, A = Adult, J = Juvenile

Species	Sta A	Sta B	Sta D	Sta F	Sta G	Sta H	Stat J	Stat I	15E Rep 1	15E Rep 2	25E Rep 1	25E Rep 2	T1 30m	T1 30E	T3 25N	T3 30m	T4 25N
American shad	58.00																
Blackbelly eelpout	451.50	1548.00	1518.20	102.30	322.70	468.00	6.90	317.50	75.00		808.50	778.00	530.00	1528.98	38.00	1040.00	385.90
Blacktip poacher	3.80												4.00				
Bluebarred prickleback		24.00															
Buffalo sculpin										800.00							
Butter sole (A)	250.00	137.00	14.50				120.50	169.70	1840.00	315.00	1670.00	2120.00			65.70	84.00	86.00
Butter sole (J)	37.00							8.60	45.00								41.00
Copper rockfish	3350.00																
Daubed shanny	18.80	38.00	10.50	3.00	146.70	20.00	1.40	14.10				20.00	88.00	116.00	3.42	98.00	36.60
Dover sole (A)			50.20	15.00			69.50							14.00			
Dover sole (J)		12.00															
English sole (A)	350.00	880.00	700.00	83.50	89.50	288.70		210.00	475.00	186.00	940.00	440.00	263.00	126.00	664.00	141.00	1200.00
Flathead sole (A)	300.00	885.00	800.00	410.80	387.00	520.00	820.00	87.60			800.00	1175.00	420.00	1080.00	123.00	987.50	410.00
Flathead sole (J)				5.00		11.50	0.50				9.40						
Longfin smelt (A)	420.00	1447.00	47.80	557.70	107.50	482.52	225.90	815.40			48.70	59.00	148.00	436.31	182.00	1208.20	159.00
Longfin smelt (J)	430.24	381.00	28.50	408.00	817.00	845.48	13.80	74.20	18.43		13.30	221.00	5300.00	396.15	185.30	531.80	148.40
Longnose skate		8000.00	6200.00				3800.00							5400.00			
Marbled snailfish		3.70															
Pacific herring	34.00		28.70	48.00	91.50	48.50		120.50		4.00	67.90	42.00	31.50	63.00	9.50	8.70	125.00
Pacific sandfish	23.50						4.50				19.70						16.00
Pacific tomcod (A)	1254.00	2913.00	108.00	198.00	408.00	410.00		411.00	2745.00	980.00	450.00	1110.00	1230.00	1865.00	1790.00	928.00	1030.00
Pacific tomcod (J)		84.00	6.00	32.00	11.80			3.20	86.00	54.00	5.00		20.00	1.00	14.82		
Plainfin midshipman			32.50					28.50						63.00			
Quillback rockfish	7500.00																
Rex sole			18.70														
Rock sole (A)									231.00	129.00							
Rock sole (J)										14.00							
Roughback sculpin										39.00		12.00					
Sablefish		1300.00															
Saddleback gunnel		8.00															
Sand sole	97.00	80.00				103.60		68.00	32.00			148.00					
Shiner perch (A)									51.00	112.00	23.00	17.00					22.50
Shiner perch (J)		1.40															1.50
Shortfin eelpout		19.00	131.00	79.80	24.70	178.00	4.60		18.50		180.00	151.00	59.00	160.00	20.40	117.00	38.00
Showy snailfish	18.00														10.00		17.50
Slender sole (J)							4.00										
Slim sculpin				15.00	38.60		20.50	2.40					29.00			20.00	
Snake prickleback	301.70	1730.00	18.00	210.70	238.20	500.00	420.00	158.50	428.50	850.00	330.00	820.00	1181.00	1500.00	500.00	1430.00	780.00
Speckled sanddab (A)										97.00							
Speckled sanddab (J)									28.00								
Spiny dogfish	2000.00	3800.00		1200.00	4300.00	3600.00		1700.00	3000.00	3000.00	1300.00	2700.00	2500.00	7200.00		2000.00	
Spinyhead sculpin		1.70	19.00	55.00	68.50		43.40				5.00		24.00	2.00		24.00	
Staghorn sculpin			15.00			23.00			300.00								75.00
Starry flounder		12800.00			308.00	5800.00					450.00	1340.00	3600.00	6100.00	2800.00	1225.00	4375.00
Stickleback														10.70			
Sturgeon poacher									45.00								
Tubesnout									4.00	42.00							
Whitespotted greenling										240.00							

Bellingham Bay biomass, Autumn 1987 Biomass in grams Sta = Station, A = Adult, J = Juvenile

Species	Sta A	Sta B	Sta C	Sta D	Sta F	Sta G	Sta H	Sta I	Sta J	T1 15E Rep 1	T1 15E Rep 2	T1 25E Rep 1	T1 25E Rep 2	T1 30E	T1 30m	T3 25N	T3 30m	T4 25N
Anchovy		1.00																
Bay pipefish															0.00			
Blackbelly eelpout	204.80	87.00	30.00	30.00	69.00	23.00	22.80	93.50	49.00			4.00	8.00	73.00	29.00	130.00	108.00	200.00
Butter sole (A)	540.00	800.00	2210.00	70.00	210.00	630.00	200.00		1550.00			120.50	1050.00	1900.00	800.00	198.80	1040.00	1370.00
Butter sole (J)			15.00					340.00										
Chinook salmon														15.00				
Daubed shanny		15.00	14.00										8.90		28.50			
Dover sole														0.00				
English sole (A)	895.00	180.00	180.00	40.00	410.00	190.20		390.00	410.00			500.00	340.00	250.00	300.00	182.00	198.00	310.00
English sole (J)	15.00											185.50	80.00			18.00		14.00
Flathead sole (A)	880.00	390.00	1500.00	480.00	570.00	500.00	500.00	500.00	880.00			390.00	300.00	870.00	600.00	1410.00	1500.00	450.00
Flathead sole (J)	2.00	3.00	10.00	25.00	17.80	30.00			15.00			4.00	34.00	13.00	4.50		17.60	
Great sculpin											1500.00	1500.00	51.00	133.30				
Greenling UID			86.00															
Grunt sculpin											2.50							
Longfin smelt (A)	2271.10	2320.00	356.88		251.84			102.29	104.00			20.00		1045.69		2157.58	189.00	1503.40
Longfin smelt (J)	812.80	830.00	1107.14	882.00	1812.00	1117.00	140.00	286.21	82.00			30.00	16.00	498.81	1298.00	4212.42	107.00	2918.60
Pacific hake																		6.00
Pacific herring (A)	730.00	2319.00	710.00	17.00			43.00	200.00	33.00		13.00			364.60	45.00	410.00	7.30	670.00
Pacific herring (J)	37.00	147.00	14.80				148.00	88.00		8.00		12.50	153.00	28.40	29.00	52.20		29.00
Pacific sanddab													50.00					
Pacific tomcod (A)	1270.00	1900.00	1800.00	308.00	310.00	180.00	700.00	1270.00	87.00				200.00	850.00	550.00	4530.00	290.00	2000.00
Pacific tomcod (J)	65.00	236.00	51.00	120.00	53.50	8.00		124.00	52.00	18.00	6.00	412.00	170.00	55.20	78.50	340.00	56.00	154.00
Padded sculpin											11.00							3.00
Pile perch (A)	50.00	27.00	24.50					53.00								17.00		
Plainfin midshipman		0.00	14.00	19.00	185.00	277.50	52.00	25.50				12.50		9.50	57.00		130.00	
ratfish															1.50			
Rock sole			159.00			800.00				860.00		100.00	110.00					
Sablefish							140.00											
Saddleback gunnel														3.00				
Sand sole		460.00	200.00			130.00	88.00		0.00				70.00	350.00				
Shiner perch (A)	440.00	800.00	820.00	19.00	810.00	101.33								810.00	400.00	2053.00	530.00	500.00
Shiner perch (J)	251.00	918.39	451.61	185.00		108.70	40.50	254.60	123.70	29.00	18.00	800.00	600.00	450.00	130.00	414.00	360.00	370.00
Shortfin eelpout	39.00	29.00	78.00	13.00				39.00	13.00			2.00				13.00		
Showy snailfish	3.20							3.20								3.20		
Slim sculpin						10.00			7.00									
Snake prickleback		10.00	31.00	30.00	37.00	32.50	8.80	19.00	47.00		9.80		48.76	123.50	98.50	9.80	190.00	18.00
Speckled sanddab (A)	28.50		19.00								68.00		3.00					
Speckled sanddab (J)											18.00		3.00					
Spiny dogfish	2100.00	5200.00	500.00		600.00	500.00									2350.00	8700.00		2600.00
Spinyhead sculpin			40.00	45.00	9.50	15.00			30.00						10.00		3.60	
Staghorn sculpin			310.00	51.00					48.50	38.00		163.00	90.00	600.00	123.00	88.00	450.00	73.00
Starry flounder	4500.00	4200.00	12850.00	880.00			300.00	3910.00	1390.00		1700.00	250.00	610.00	4800.00	4700.00	8600.00	2100.00	3410.00
Stickleback	1.00																	
Sturgeon poacher												15.50						
Tubesnout											3.20	3.40	3.20					
Walleye pollock (A)	10.00				0.00							50.00						
Walleye pollock (J)		30.00	29.50					5.00					4.00		13.00			
Whitespotted greenling			85.00								100.00						810.00	