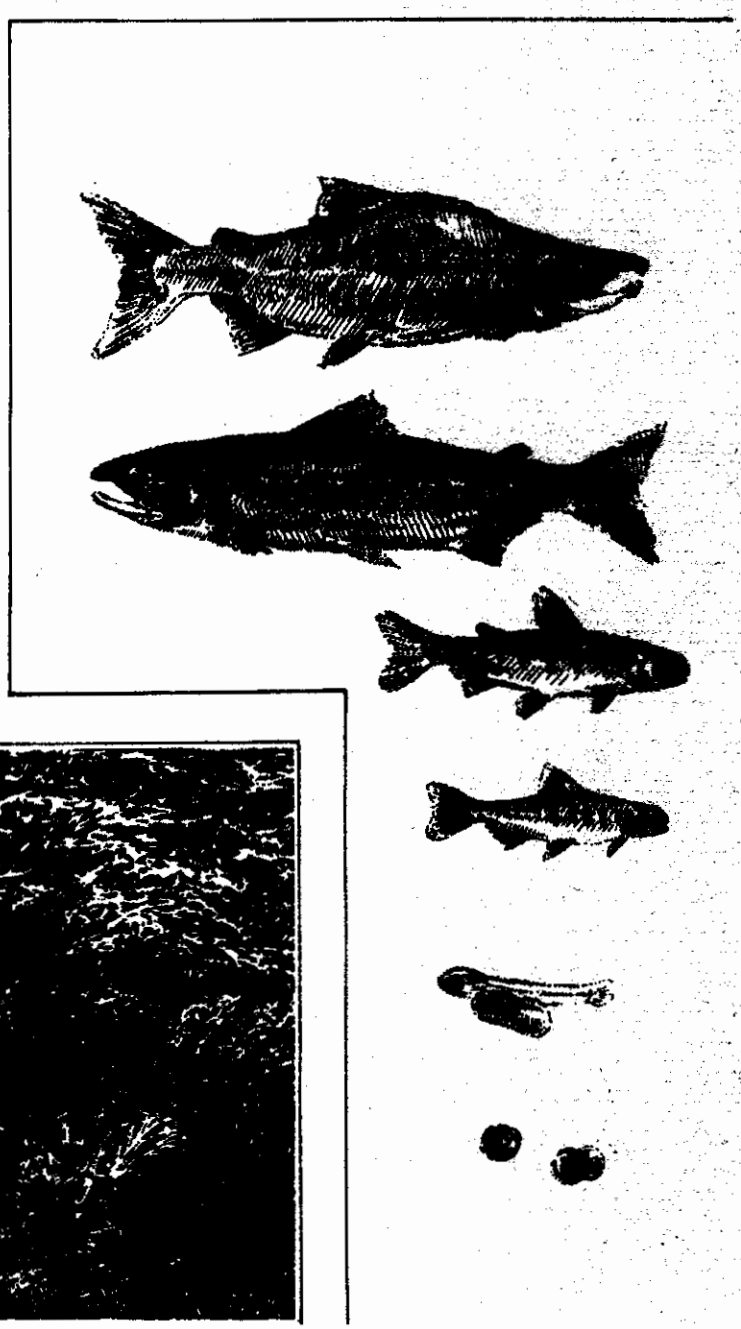
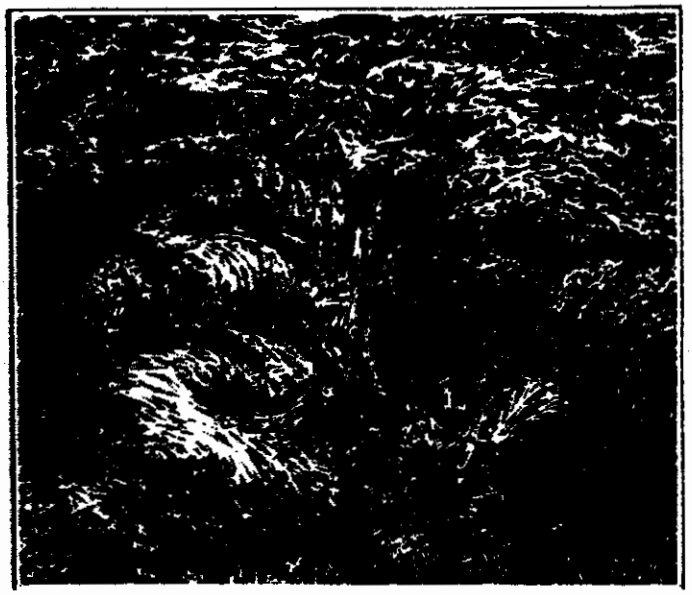
Distribution and Food Habits of Juvenile Salmon in the Nisqually Estuary, Washington, 1979-1980

United States Department of the Interior
U. S. Fish and Wildlife Service
Fisheries Assistance Office
Olympia, Washington





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DISTRIBUTION AND FOOD HABITS OF JUVENILE SALMON IN THE NISQUALLY ESTUARY, WASHINGTON, 1979 - 1980

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by

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ABSTRACT

This paper examines temporal and spatial distribution and food habits of outmigrating juveniles of chum (*Oncorhynchus keta*), chinook (*O. tshawytscha*) and coho salmon (*O. kisutch*) in the Nisqually estuary in southern Puget Sound, Washington, during the spring and summer of 1979 and 1980. The availability of prey items was examined in 1980 and is discussed in relation to food habits of the fish.

Early in the year, in April and May, chum and chinook occupied nearshore areas including tidal sloughs in the marsh. In later months they moved to deeper water in the Nisqually Reach. Chum entered the estuary from adjacent freshwater rivers about one month earlier than chinook.

Diets of chum less than 70 mm consisted mostly of epibenthic crustaceans, while chum greater than 70 mm preyed extensively on pelagic crustaceans. Dipteran flies and spiders were important to the diets of smaller chinook, but crustaceans were somewhat more important to diets of larger chinook. Juvenile fishes were the primary prey item of coho.

Insects were poorly represented in the plankton samples. Crustaceans were found at all substrate types sampled, including silt, sand, sand and gravel and in midwater. Harpacticoid copepods were the most abundant epibenthic prey item collected in the plankton samples.

INTRODUCTION

The Nisqually Delta is located at the mouth of the Nisqually River in southern Puget Sound. The Nisqually River supports runs of chum, chinook, coho and pink salmon plus steelhead and cutthroat trout. The chum run is one of the largest naturally reproducing stocks of this species in the State of Washington. There is presently no information available describing utilization of the Nisqually Delta by salmon. Because of the relatively undisturbed condition of the Delta, this area provides a unique opportunity to gain information on salmon estuarine ecology.

There is growing evidence which points to utilization of salt marshes, tidal sloughs and nearshore shallow beaches by salmon as early estuarine feeding areas. Growth rates in marshes have been found to be fairly rapid. Healey (1979) determined that juvenile chum grew at a rate of approximately 6% body weight per day during their residence in the Nanaimo River estuary. Congleton (1978) studied the feeding behavior of juvenile chum in the Skagit Delta in northern Puget Sound. His studies point to favorable feeding conditions for chum in the Skagit marsh.

The success of salmon feeding and growth in shallow estuarine and marine areas may have an important influence on the early marine mortality of the fish utilizing these areas for rearing. The work of Parker (1968, 1971) on pink salmon from the Bella Coola River in British Columbia indicated very high mortality during the first 40 days in the marine environment. He concluded that this mortality could be attributed to juvenile coho predation and that as the pink fry grew larger, they were better able to avoid this predation. Rapid growth in estuaries prior to entrance into predator-occupied marine areas may increase chances for survival.

A major goal of the U.S. Fish and Wildlife Service (FWS) is to increase the survival of salmon smolts in estuaries. Additional information on the patterns of estuarine use by juvenile salmon is needed in order to make appropriate decisions about release of hatchery raised fish and estuarine land use. As the federal agency responsible for preserving, protecting and enhancing the nation's fish and wildlife resources, the FWS has lead in the development of procedures designed to evaluate the biological importance or quality of fish and wildlife habitat. A Habitat Evaluation Procedure (HEP) is a process that has been used successfully to predict impacts on terrestrial populations resulting from reservoir impoundments. Work is proceeding in an attempt to develop an

estuarine or marine HEP. In order for HEP to be an effective tool in these situations, it will be necessary to have a better understanding of salmon utilization of estuarine habitats and the organisms which serve as prey resources.

The Olympia Fisheries Assistance Office of the FWS initiated a two year study in 1979 at the Nisqually Delta with the purpose of developing additional information pertaining to salmon use of estuaries. This information will be used in the development of an estuarine HEP and toward increasing our general understanding of the importance of estuaries as essential salmon habitat. Primary objectives of the first year of study were to assess the feasability of capturing juvenile salmon in the Nisqually estuary with beach seines and traps, define areas and times of salmon utilization, and acquire some baseline data on salmon food habits in the Delta. After successfully addressing these objectives, the second year of study was directed to more intense study of food habits. Information was also collected relative to the availability of prey resources in the Delta in 1980.

STUDY AREA

Much of the Nisqually estuary is included in the Nisqually National Wildlife Refuge. The major freshwater tributary entering the Delta is the Nisqually River. Two smaller streams, McAllister Creek and Red Salmon Creek, enter on the eastern and western edges of the Delta, respectively. Sequalitchew Creek is a small stream to the northeast of the Nisqually Delta.

Fish and plankton sampling stations are shown in Figure 1. In 1979 sampling was conducted at 4 sites in the Delta (stations N1, N9, N14 and N15) and at 2 sites in the Nisqually Reach (stations N17 and N18). For purposes of this report, the Delta is considered to be the shallow intertidal area at the mouths of the Nisqually River, McAllister Creek, Red Salmon Creek and Sequalitchew Creek. The Reach is defined as the deeper water area adjacent to the Delta. In 1980, some of the sample sites were abandoned and new sites selected because of difficulty in acquiring access to sites located on private property. Sampling efforts in 1980 were concentrated on the western portion of the Delta near the mouth of McAllister Creek at stations N1, N2, N4 and N9, and approximately 2.5 kilometers upstream at stations N5 and N7. Sampling was conducted at stations N1 and N9 in both years of study.

Stations N1, N2 and N4 were located in sloughs near the mouth of McAllister Creek. These sloughs are bordered by salt marsh and have soft silt or clay bottoms with low beach gradients. Sites N1 and N4 were located in sloughs which were exposed at lower tide levels, while N2 was located in a deep slough which retained water at all tidal levels. Algal growth was low at these stations until mid-May. After this date algal cover became quite heavy at N2, was moderate at N1, but remained low at N4.

The substrate at station N9 was predominantly sand with smaller amounts of gravel and mud. There was some growth of the algae Ulva and Fucus. Stations N5 and N7 were situated approximately 2.5 kilometers upstream from N9 and both had soft silt bottoms. Algal growth was sparse at station N5. Site N7 was situated in a blind tidal slough which extended into the salt marsh. The sides of the slough were quite steep and sloped down to a very soft mud and clay bottom. Algal growth at this site was heavy but patchy by mid-summer. This slough was completely dewatered at normal low tides. Salinities at stations N5 and N7 were lower than those at the other sites, but N5 and N7 were still highly influenced by marine waters.

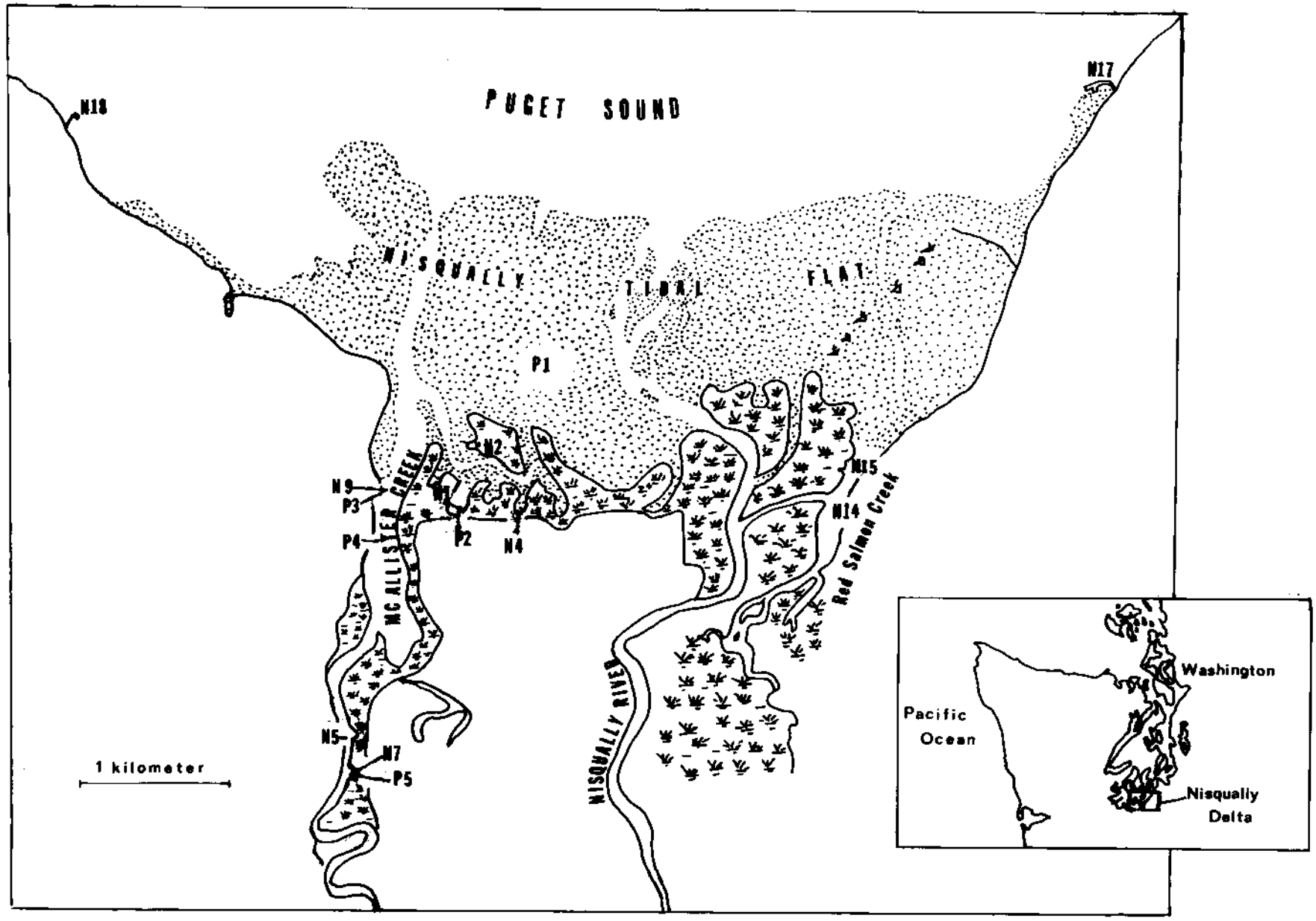

Figure 1. Nisqually Delta study area showing sampling stations. Stations designated with the prefix N are fish sampling stations; prefix P indicates plankton sampling stations.

Stations N14 and N15 were sampled in 1979 and were located in Red Salmon Creek on the east side of the Delta. The substrate was a mixture of sand and gravel and a gradually sloping beach. Algae were present at these sites most of the year.

The two sites sampled in the Nisqually Reach in 1979 had similar characteristics. The site along the eastern shore of the Nisqually Reach (station N17) was located at the Weyerhaeuser-Dupont dock. The other Nisqually Reach site (station N18) was located along the western shore at an abandoned structure known as the Atlas Powder dock. The substrate at these two sites was composed of a mixture of sand, gravel and cobble. The slope of the substrate was steeper than at most of the Delta sites. Algae were present at these two sites in the lower inter-tidal zone. The Nisqually Reach sites were of a more marine character with consistently higher salinities.

Epibenthic and pelagic invertebrates were collected at 5 sites in the Nisqually Delta during 1980 (Figure 1). Three of the plankton sampling sites corresponded to fish sampling stations. Plankton sites P2, P3 and P5 were located at fish sampling stations N1, N9 and N7, respectively. Site P1 was located on the Nisqually tidal flats. The substrate at this site was a mixture of sand and silt. Station P4 was a pelagic site located in the mid-channel of McAllister Creek offshore from P3. Samples at P4 were collected from about 1 meter below the surface to provide an indication of the availability of pelagic plankton in this tidal channel. Epibenthic plankton samples at all other sites were collected directly above the substrate at a tidal level between 1 and 2 meters above mean lower low water.

METHODS

In 1979, samples were collected with a beach seine which measured 18 meters (m) (60 feet) in length and 2 m (6 feet) in depth, with a mesh size of 3 millimeters (mm) (1/8 inch). In 1980, we used a larger beach seine with a larger mesh size which measured 30.5 m (100 feet) in length and 3 m (10 feet) in depth, with a mesh size of 6 mm (1/4 inch) in the wings and 5 mm (3/16 inch) in the center panel. Sampling with beach seines was restricted to areas having smooth bottoms. Fyke traps were also utilized in 1979. However, fyke net catches were relatively small and suitable sites to use the nets were quite limited. It was also suspected that small salmon were being preyed upon by larger predators in the trap. Therefore, fyke traps were not used for sampling in 1980.

In 1980, a purse seine was used which measured 61 m (200 feet) long, 2.1 m (7 feet) deep in the body, 4.6 m (15 feet) deep at the bunt, and had a mesh size of 6 mm (1/4 inch) throughout the net. Purse seine sets were made to assess salmon utilization of the extensive sand/mud flat areas of the Delta. However, purse seine catches were low and the net could not be used in the shallow water along the edge of the mudflat where it was suspected that the fish were present in greatest concentration. Use of the purse seine was abandoned early in the year.

Sampling began in April and was conducted at approximately weekly intervals in 1979 and 1980. In 1979, sampling continued into late September. Because very few fish were captured after late July, fish sampling in 1980 was terminated in early August.

In 1980, all juvenile salmonids caught at a particular site up to a maximum of 50 of each species were measured (fork length) to the nearest millimeter. In both 1979 and 1980, up to 7 specimens of each salmonid species were preserved in 10% formalin for later stomach analysis. The abdominal cavity of individuals larger than 100 mm was opened to allow rapid entrance of preservative to retard digestion of the stomach contents. Occasionally, potential salmon predators were preserved for stomach analysis. Hatchery reared fish that had been tagged with coded-wire tags were taken, although no special effort was made to capture these fish. Those fish that were retained were examined for coded-wire tags.

In the laboratory, fish were weighed, and the stomach removed by severing it at the esophagus and intestine.

Adhering tissue was removed, the stomach was blotted dry and weighed to the nearest 10 milligrams. When the stomach was opened, percent fullness was estimated and the contents were removed. The empty stomach sac was then weighed and its weight was subtracted from the weight when full to give the total weight of the stomach contents.

Stomach contents were sorted and identified to the lowest taxonomic category practicable, considering the stage of digestion, the state of the taxonomic literature, time constraints and ease of identification (i.e., extensive micro-dissection techniques were not employed). The number, life history stage and weight of the prey in each taxonomic category were recorded. The percent digestion of the stomach contents was estimated. For the 1979 samples, a balance was unavailable much of the time, and weights are lacking for a majority of the samples. Weights were taken in milligrams on a Mettler PC 440 toploading balance.

Predator and prey information was recorded on keypunch forms using the Marine Ecosystems Analysis (MESA) format which was developed by the National Marine Fisheries Service. Information was keypunched and analyzed. Prey importance was assessed using the Index of Relative Importance (IRI) developed by Pinkas et al. (1971) and modified by Simenstad and Kinney (1978). IRI diagrams simultaneously display the frequency of occurrence of important items, their percent of the total weight and percentage contribution to the total number of organisms. IRI figures were computed using computer programs developed by Larry Gales and Charles Simenstad at the University of Washington, Fisheries Research Institute. IRI figures for 1979 were computed excluding prey weights.

Plankton samples were taken monthly at or near high slack tide. At high tide, many organisms emerge from within the substrate and occupy the water immediately above the substrate where they are available as prey. Two replicate samples were collected at each plankton sampling site.

Epibenthic and pelagic invertebrates were sampled with a suction pump system similar in design to one developed by the Fisheries Research Institute (Simenstad and Kinney, 1978). This type of sampler was used because it could be utilized over various substrates and is designed to sample marine organisms available to salmon. The sampling head was attached to a wooden pole and passed over the substrate until two hundred liters of water had been pumped through two nested plankton nets of 0.500 mm and 0.209 mm mesh size. Because of the irregular manner in which the sampling head was passed along the bottom, the area sampled could not be

quantified. Material retained by the plankton nets was washed into sample jars, labelled and preserved in 10% formalin. Fifty liters of water were pumped through the sampling apparatus at each new site to flush the system of material from the previous site. The system was not flushed between replicates at the same site. The presence of some benthic organisms in samples from a pelagic site suggests that the system may not have been completely flushed of material from the previous epibenthic site.

Rose bengal stain was added to all plankton samples to dye organisms in order to facilitate the sorting of plankton organisms from other debris in the samples. Samples containing large amounts of sand were stirred and decanted several times until the supernatant liquid appeared free of suspended material. The decanted material was passed through a piece of 0.1 mm mesh plankton net cloth to remove excess liquid. The material retained by the cloth was subsampled if large numbers of organisms were present. Subsampling was accomplished by diluting the sample to a known volume, typically 250 milliliters (ml), with water and using a 5 ml syringe. The sample was agitated before each of five 2 to 5 ml subsamples was withdrawn. Organisms were sorted from debris in the sample and were examined under a dissecting microscope. They were identified, enumerated and weighed to the nearest milligram, when a balance was available.

RESULTS AND DISCUSSION

Fish Distribution

Fish species caught in the Nisqually estuary during sampling in 1979 and 1980 are shown in Table 1. The species encountered in greatest abundance were staghorn sculpins and shiner perch. Salmon encountered in greatest numbers were juvenile chum and chinook. Juvenile salmon catches by station are presented in Appendix A, Tables 1-8. Chum and chinook were widely distributed throughout the estuary utilizing marsh sloughs and channels as well as deeper water nearshore areas of the Reach.

The mean weekly catches of chum, chinook and coho per beach seine set are shown in Figures 2 through 4. There were differences in catches between the two years which could have been influenced by various factors. Sampling was performed at different locations in 1979 and 1980 (except for stations N1 and N9). Mid-summer abundances remained much higher in 1979 when the Nisqually Reach was sampled. Numbers of salmon caught in the Reach remained high after densities in the Delta declined to low levels. This probably indicates movement of juvenile salmon out of estuarine marshes and sloughs in the Delta after a period of rearing in spring and early summer and into shallow nearshore marine areas of the Reach in later summer.

Chum abundance at Delta sampling stations during 1980 was greatest during May and early June. In both 1979 and 1980, the majority of chum appeared to have migrated out of the Delta and into the Reach by late-June. As was expected, juvenile chinook moved from freshwater areas into the Delta later than chum and were present later in the summer. Several peaks in chinook abundance were noted between early May and mid-July, 1980. Coho spent much less time in the Delta and, in 1980, appeared in weekly samples on only two different occasions in May.

Abundances of salmon in the Nisqually Delta appeared to be highly influenced by releases from artificial enhancement facilities. Releases of salmon in 1979 and 1980 into streams draining into the Nisqually estuary are shown in Table 2. The second of two peaks in chum abundance during 1980 may be related to a release of 707,840 fry on May 28-29 by the Nisqually Tribe. This peak was followed by a sharp decline in abundance and may indicate that hatchery fish spent a relatively short period of time in the Delta. The highest catch of coho in 1980 occurred 2 weeks after over 2 million coho were released from Sequalitchew Lake. The greatest

Table 1. Fish species caught in the Nisqually estuary April through September 1979 and April through August 1980.

Common Name	Latin name	Numbers of Fish Caught* 1979	1980
Pacific herring	Clupea harengus pallasi	x**	3
Pink salmon	Oncorhynchus gorbuscha	x	9
Chum salmon	Oncorhynchus keta	4439	406
Coho salmon	Oncorhynchus kisutch	144	124
Chinook salmon	Oncorhynchus tshawytscha	1024	759
Cutthroat trout	Salmo clarki	x	5
Steelhead (Rainbow trout)	Salmo gairdneri	x	
Surf smelt	Hypomesus pretiosus	x	5,197
Walleye pollock	Theregra chalcogrammus	x	
Three spine stickleback	Gasterosteus aculeatus	x	1,020
Buffalo sculpin	Enophrys bison	x	
Staghorn sculpin	Leptocottus armatus	x	25,973
Shiner perch	Cymatogaster aggregata	x	23,962
Pile perch	Rhacochilus vacca		2
Pacific sand lance	Ammodytes hexapterus	x	4,421
Arrow goby	Clevelandia ios		2
Starry flounder	Platichthys stellatus	x	8,204

* "x" indicates presence was noted but not quantified.
** More than 623 Pacific herring were caught in 1979.

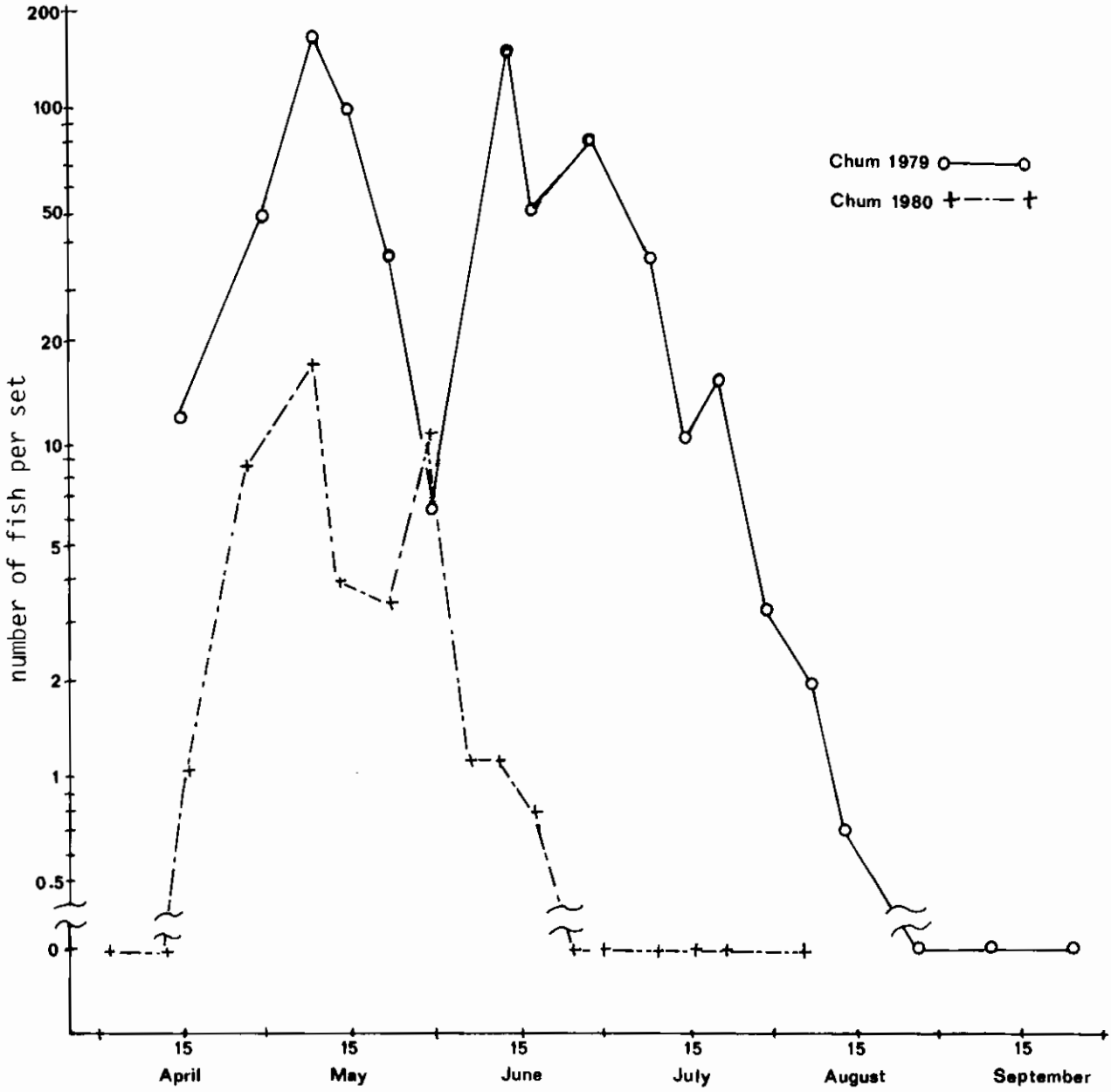

Figure 2. Mean weekly catch of juvenile chum per set at the Nisqually Delta and Reach in 1979, and at the Delta in 1980.

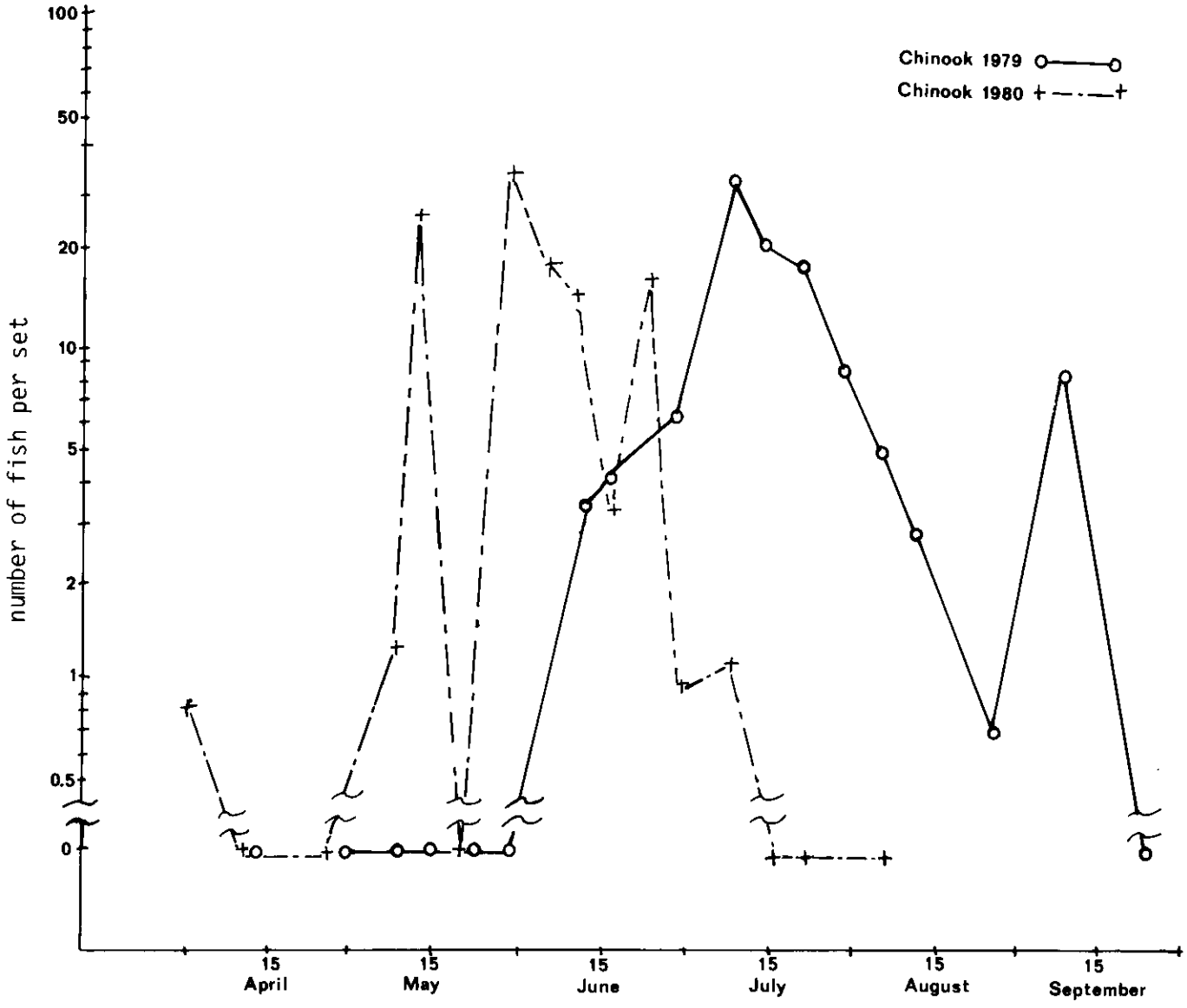

Figure 3. Mean weekly catch of juvenile chinook per set at the Nisqually Delta and Reach in 1979, and at the Delta in 1980.

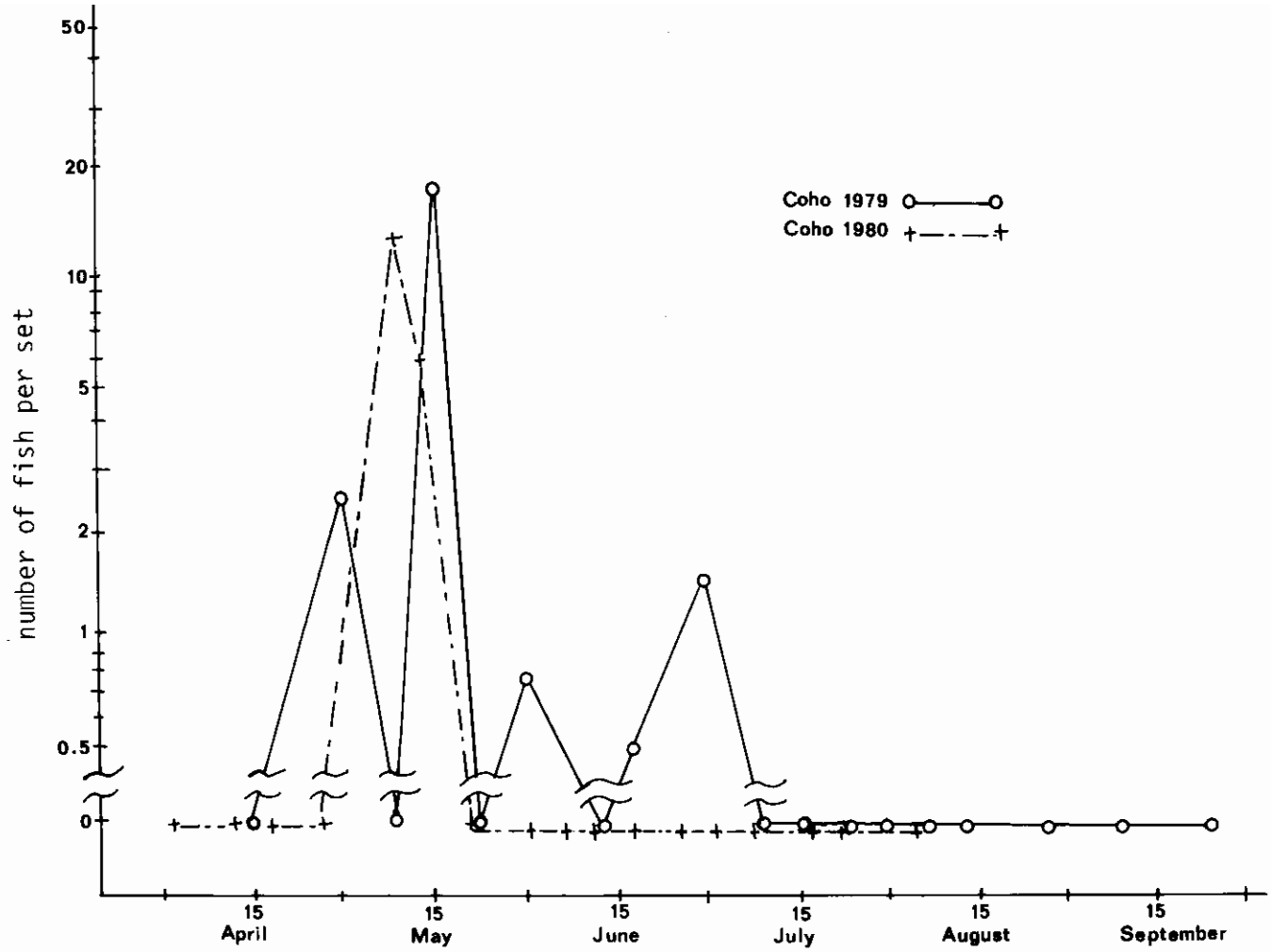

Figure 4. Mean weekly catch of juvenile coho salmon per set at the Nisqually Delta and Reach in 1979, and at the Delta in 1980.

Table 2. Salmon planted in the Nisqually watershed, McAllister Creek and Sequalitchew Creek during 1979 and 1980.

Species	Number Released	Size (No./Lb.)	Date	Release Site	Agency *
Chum	1,688,000	800	16 Mar 1979	McAllister Cr.	WDF
Coho	1,494,800	20	25 Apr 1979	Sequalitchew L.	WDF
Coho	234,645	17	31 May 1979	Kalama Cr.	WDF
Coho	160,264	871	10 May 1979	Murray Cr.	WDF
Coho	162,006	871	10 May 1979	Tanwax Cr.	WDF
Coho	87,100	871	14 May 1979	Beaver Cr.	WDF
Coho	92,326	871	14 May 1979	Taboton Cr.	WDF
Chum	444,000	423	28 May 1979	Nisqually R.	Nisq.
Chum	457,600	442	13 Jun 1979	Nisqually R.	Nisq.
Fall Chinook	491,011	118	15 Jun 1979	Schorno Pond	WDF
Fall Chinook	10,000	1000	7 Feb 1980	Muck Cr.	WDF
Fall Chinook	40,000	1000	7 Feb 1980	Tanwax Cr.	WDF
Fall Chinook	893,000	302	23 Feb 1980	Nisqually R.	WDF
Coho	11,219	1300	14 Mar 1980	Muck Cr.	WDF
Coho	11,218	1300	14 Mar 1980	Tanwax Cr.	WDF
Fall Chinook	251,600	390	12 Apr 1980	Nisqually R.	WDF
Coho	108,250	21	22 Apr 1980	Murray Cr.	WDF
Coho	39,900	21	22 Apr 1980	Taboton Cr.	WDF
Coho	89,260	21	22 Apr 1980	Tanwax Cr.	WDF
Coho	46,200	21	23 Apr 1980	Mashel R.	WDF
Coho	2,387,497	20	25 Apr 1980	Sequalitchew L.	WDF
Coho	147,750	985	25 Apr 1980	Tanwax Cr.	WDF
Fall Chinook	815,810	116	14 May 1980	Kalama Cr.	Nisq.
Coho	91,960	440	22 May 1980	Murray Cr.	WDF
Coho	48,400	440	23 May 1980	Horn Cr.	WDF
Coho	44,000	440	23 May 1980	Lackamas Cr.	WDF
Coho	47,960	440	23 May 1980	Lynch Cr.	WDF
Coho	52,800	440	23 May 1980	Taboton Cr.	WDF
Coho	7,800	20	24 May 1980	Lewis Lake	WDF
Chum	272,160	560	28 May 1980	Muck Cr.	Nisq.
Chum	295,680	560	29 May 1980	Johnson Cr	Nisq.
Chum	140,000	560	29 May 1980	Kalama Cr.	Nisq.
Fall Chinook	243,900	120	6 Jun 1980	Nisqually R.	WDF
Chum	122,936	508	16 Jun 1980	Nisqually R.	Nisq.
Chum	366,776	508	17 Jun 1980	Nisqually R.	Nisq.
Chum	63,500	508	17 Jun 1980	Kalama Cr.	Nisq.

* WDF - Washington Department of Fisheries
Nisq. - Nisqually Tribe

abundance of chinook in 1980 occurred 2 weeks after the release of over 800,000 fingerlings into Kalama Creek, a tributary to the Nisqually River. Another peak in chinook abundance occurred 2.5 weeks after 243,900 chinook were released into the Nisqually River.

Fish that had been marked at a hatchery by removal of the adipose fin were examined for coded-wire tags. Information on tagged fish which we recovered is presented in Appendix B. In 1979, 7 tagged chinook and 1 tagged coho were recovered. Only one tagged chinook was recovered in 1980. The single tagged coho had been released into Sequalitchew Lake on April 25, 1979 and was recovered on May 1, 1979 at station N14 in Red Salmon Creek. None of the tagged chinook which we caught in 1979 had been released in the Nisqually drainage according to their coded-wire tags. Five of the chinook had been released in May 1979 in Soos Creek, a tributary to the Duwamish River in Seattle, Washington. These five chinook were caught on various dates in the Nisqually Reach from June 14 to July 30, 1979 at station N17. One chinook which had been released in May 1979 in Voight Creek, a tributary to the Puyallup River (enters Puget Sound at Tacoma, Washington), was caught June 18 at station N9 in the Nisqually Delta. The other tagged chinook which we caught in 1979 had been released during May in Issaquah Creek, which flows into Lake Washington and enters Puget Sound at Seattle. We caught this chinook on July 23 at station N17. The tagged chinook in 1980 had been released into Kalama Creek, a tributary to the Nisqually River, and was recovered at the Nisqually Delta.

The mean fork lengths of chum and chinook caught in 1980 are shown in Figure 5. Three major influences could be affecting the mean length of juvenile salmon in the estuary: 1) growth of salmon residing in the area; 2) immigration into the area from freshwater streams or from marine areas; 3) emmigration from the area.

The mean fork length of chum caught in the Nisqually Delta increased gradually from mid-April to the end of May. After the first of June, mean length increased rapidly. The rapid increase in chum fork length ocurred shortly after hatchery chum were released into tributaries of the Nisqually River. As noted earlier, there was a rapid decline in abundance of chum in the shallow areas of the Delta about this time. The increase in fork length and subsequent decline in abundance may be attributed to rapid movement of large hatchery chum out of the Delta and into deeper water marine areas. However, without additional studies, we cannot determine differences in residence time for hatchery and wild fish or large and small out-migrants.

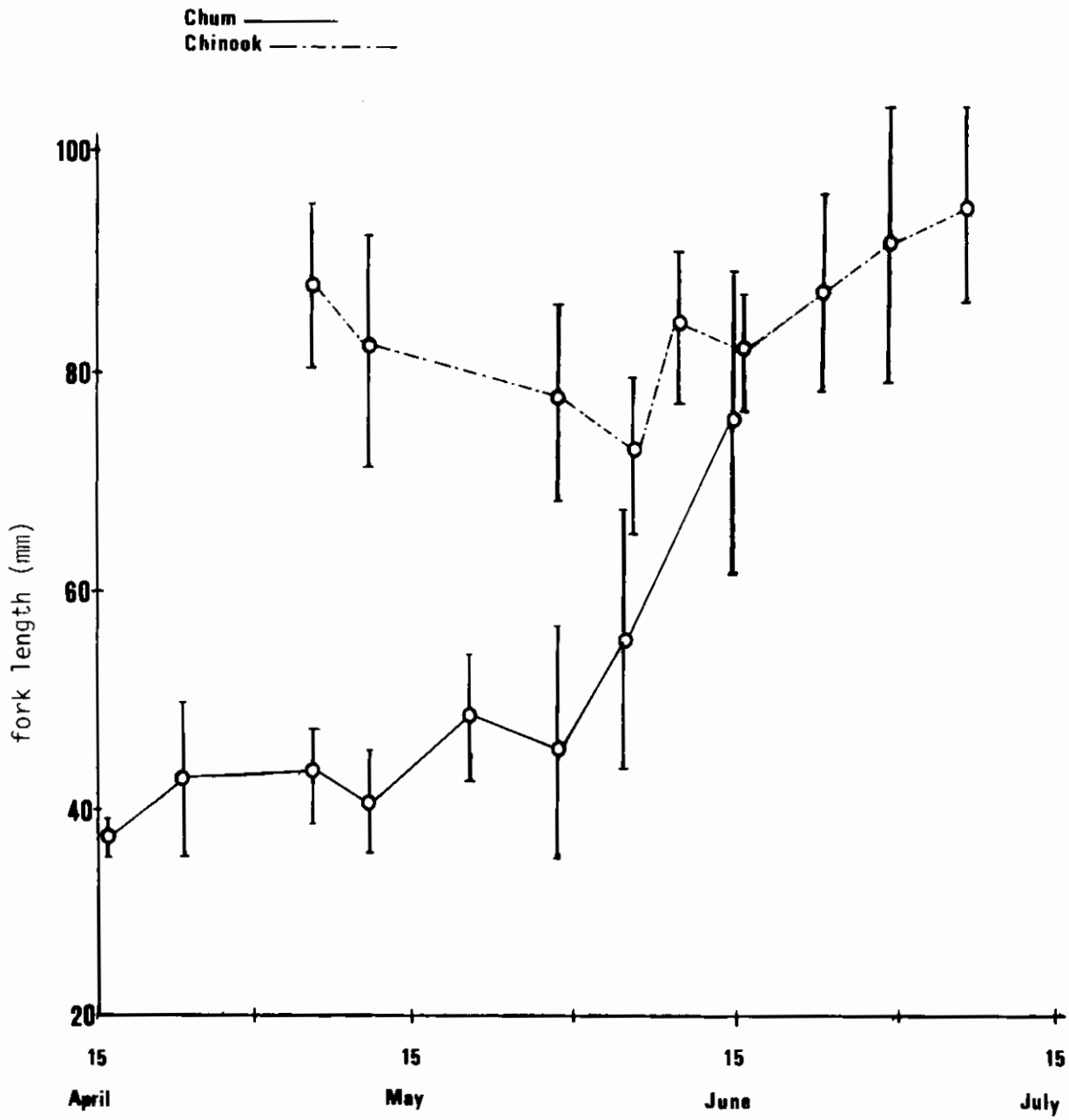

Figure 5. Mean weekly fork lengths of juvenile chum and chinook salmon captured in the Nisqually estuary in 1980.

Chinook mean fork lengths exhibited a declining trend from early May through early June, after which mean length began to increase. These changes in mean length could not be positively correlated with hatchery releases or movements into or out of the Delta.

Food Habit Results

In 1979, the stomach contents of 289 chum, 202 chinook and 22 coho were examined for prey items. In 1980, a total of 138 chum, 194 chinook and 21 coho were examined.

Chum

Prey items important to chum diets in 1979 and 1980 are shown in Appendix C, Figures 1 and 2. Harpacticoid copepods dominated the diet of juvenile chum in both years. Pelagic calanoid and *Corycaeus* copepods were also important.

Chum food habits were examined by month in 1980 (Appendix C, Figures 3 through 5). In April and May harpacticoids were very important to chum caught in the Delta, contributing 86% and 76% of the total IRI for those months. Pelagic organisms increased in importance to chum diets in May and by June *Corycaeus* contributed 50% and calanoids 11% to the total IRI. Pelagic decapods (mostly shrimp zoea) and the larvacean *Oikopleura* (in 1979) also made important contributions to the diet beginning in June.

Chum food habits were also examined by predator size (Appendix C, Figures 6 through 11). Chum between 30 and 90 mm were separated into six size classes of 10 mm. Harpacticoid copepods were the most important prey item to smaller chum contributing 62 to 85% of the total IRI for chum from 29 to 70 mm in length, and insignificant to chum over 80 mm. Chironomids were of some importance to small chum (9% of the IRI in chum 29 to 40 mm) but showed a steady decrease in importance to larger chum. *Corycaeus* copepods were the most important prey item to larger chum, contributing 44 to 47% of the IRI for chum over 70 mm long, but 6% or less to size classes of chum less than 71 mm. Other organisms which made important contributions to larger chum, but were unimportant to smaller fish, include calanoid copepods, decapod zoea, *Cumella* cumaceans and *Neomysis mercedis*.

Chum diet trends by station are shown for 1980 in Appendix C, Figures 12 through 17. Harpacticoid copepods were important prey at all sites except N4 and N18 (in 1979) but they were particularly important at McAllister Creek stations N5, N7 and N9 where 90 to 100% of the chum had consumed them. At stations N1, N2 and N4 along the saltmarsh front, calanoid and *Corycaeus* copepods made important contributions to chum diets. In 1979, pelagic prey was of primary importance to chum at the Nisqualy Reach stations N17 and N18, although harpacticoids were also very important at N17. The pelagic diatom Coscinodisceae was consumed at station N17.

There was a small amount of predation on juvenile fishes by chum less than 60 mm fork length captured in April and May at the salt marsh front stations or in the Reach. One of 9 juvenile fishes eaten by chum was identified as a salmon species.

Chinook

Principal chinook prey items for 1979 and 1980 are shown in Appendix C, Figures 18 and 19. Insects, primarily dipteran flies, played an important role in chinook diets. Of the Diptera eaten in 1980, the family Ephydridae was most commonly consumed (15% total IRI). Other less important diptera include the families Dolichopodidae, Chironomidae and Heleidae. Other prey of some importance were spiders, Cumella sp., Neomysis mercedis, juvenile malacostracans particularly decapod zoea, harpacticoid copepods and Corophium amphipods.

Chinook diets for April through July are presented by month in Appendix C, Figures 20 through 23. Mysids and gammarid amphipods dominated the diets of a small sample of chinook in April. In later months, insects, mostly diptera, and pelagic crustaceans became more important in the diet. Ephydrids gradually increased in importance from 4% of the IRI in May, to 19% in June, and to 48% in July. Gammarids and the mysid, N. mercedis, remained important throughout the season. There was a change in the predominant gammarids from Eogammarus confervicolus in April, to Corophium spp. in later months. Cumella made important contributions to the diet in May and June (12 to 19% total IRI).

Chinook diets were examined in three 10 mm size classes from 61 to 90 mm fork length (Appendic C, Figures 24 to 26). Ephydridae and Heleidae were the predominant families of dipteran insects eaten by small chinook from 61 to 70 mm in length (25 and 17% total IRI, respectively), and they continued in importance in chinook up to 90 mm. Spiders were also of importance (13% total IRI). Harpacticoids were less important than insects but were the most important crustacean to small chinook. As chinook became larger, the importance of other crustaceans increased. Neomysis mercedis comprised 16 to 18% of the IRI in chinook 71 to 90 mm. The importance of Cumella in chinook diets increased from 3% of the IRI in small chinook to between 14 and 20% in chinook 71 to 90 mm in length. Malacostracan juveniles, including decapod and euphausiid zoea were more important to chinook larger than 81 mm. Corophium spp. were relatively unimportant to the smallest size class of chinook (2% of the IRI in chinook 61

to 70 mm), but increased in importance to larger chinook (10 to 12% of the total IRI for chinook 71 to 90 mm).

Chinook diets at each station sampled in 1980 are shown in Appendix C, Figures 27 through 32. In McAllister Creek (N5 and N7), insects, mostly dipteran flies, were somewhat more important in chinook diets than at the stations at the front of the salt marsh (N1, N2 and N4). Insects were unimportant at the downstream McAllister Creek station (N9). Neomysis mercedis was eaten by chinook mostly at stations N1 and N4 (22 to 30% total IRI). Cumella sp. was consumed by chinook caught at N1 (34% of the IRI) and N9 (36% of the IRI). Decapod zoea (including crab and shrimp zoea) were eaten mostly at the saltmarsh front stations near the mouth of McAllister Creek (59% of the IRI at N2, 16% at N4 and 13% at N9). Gammarids were important to chinook at the Nisqually Reach stations in 1979.

Twenty percent of the juvenile fishes preyed upon by chinook were identified as juvenile sand lance. None of the others were identified as salmonid juveniles. Juvenile fishes made up 11% of the total IRI in chinook diets in May. Most predation occurred at the main channel McAllister stations, N5 and N9. Juvenile fishes made up 18% of the total IRI at N9. Most of the predation on juvenile fishes was by chinook larger than 90 mm fork length.

Coho

Prey items in coho diets in 1979 and 1980 are shown in Appendix C, Figures 33 and 34. Sand lance was of primary importance to diets of juvenile coho in 1980, contributing 64% to the total IRI. Of the other juvenile fishes consumed by coho, none was identified as a salmonid. Gammarid amphipods (primarily Corophium spp.), harpacticoid copepods, dipteran flies and Cumella sp. also contributed to the diet.

Coho were infrequently caught in the Nisqually Delta. Our relatively small sample did not allow us to examine the effects of timing, station and predator size on changes in coho diets.

Food Habits Discussion

Noted differences in food habits of chum in 1979 and 1980 are probably due to the differences in sampling sites for the two years. In 1979, most sample sites were located on shorelines in Nisqually Reach where chum fed to a greater extent on pelagic organisms. In 1980, sample sites were located in areas of shallower water, adjacent to salt marsh and tidal flats, where more epibenthic organisms were eaten. Chinook did not show obvious diet differences between the two sampling years. Insects and pelagic crustaceans which comprised the bulk of chinook diets were apparently available at the areas sampled in both years.

We did observe differences in diet between the species of salmon examined in this study. Chinook diets were more diverse than chum diets. Insects were the primary diet item of chinook, while chum consumed mostly crustaceans. When crustaceans were eaten by chinook, those of greatest importance differed from those most important to chum. Chum ate gammarid amphipods at silty sites while the gammarids eaten by chinook were largely from non-silty sites. Coho diets appeared to consist largely of non-salmonid juvenile fish which chum and chinook rarely ate. These differences in diet suggest that the salmon populations sampled in this study were not competing for food resources.

It was expected that changes in chum food habits associated with predator size would parallel monthly trends since chum increased in mean fork length with time. Indeed, diet trends associated with the two factors were similar. Furthermore, temporal and spatial patterns of feeding also appear interrelated. Chum utilized areas within McAllister Creek earlier in the year and moved out into the Delta and Reach areas later in the year. Observed chinook fork lengths did not consistently increase with time, and diet trends by month, predator size and station do not appear to be directly related.

Small chum ate primarily epibenthic organisms. However, there was a change to a pelagic diet when chum were about 70 mm long. The change in chum diet from epibenthic to pelagic prey has been documented by other workers, although the size at which this shift occurs is not always the same in the reported studies. Fresh *et al*. (1979) suggest that until Nisqually chum are greater than at least 50 mm, they occupy and feed in shallow habitats. Simenstad *et al*. (1980) report that in Hood Canal, most chum between 50 and 60 mm are transcending from epibenthic to pelagic feeding behaviors. Allen (1974) found chum in Big Qualicum estuary, British Columbia, moved offshore at about 75 mm, but the size at

which the diet shifted from epibenthic to pelagic is not made clear. Shepard (1981) reports that many variations in chum diets are due to "...habitat and seasonal differences, fish size, position of the prey in the water column, relative abundance and size of prey, and diel patterns in feeding." It would appear that a complex interaction of factors including length affects the point at which chum diets shift from epibenthic to pelagic prey.

Other studies on juvenile salmon food habits corroborate our finding that harpacticoids are a predominant prey item, especially to juvenile chum. However, certain organisms which have been documented as important to salmon diets in other areas were less important to the salmon in this study.

Anderson *et al.* (1980) working in the Fraser estuary found that both chum and chinook ate mostly chironomid larvae. Lipovsky (1977) found chironomid larvae to be important to chinook in her studies of the Columbia estuary. Congleton (1978) reports chironomid pupae and adults made up 67% of chum diets by weight in the salt marsh of the Skagit River, Washington. Although we found some utilization, chironomids were not a major prey item of juvenile salmon in the Nisqually estuary.

Gammaridean amphipods, particularly *Corophium* spp. and *Eogammarus confervicolus* have been identified as important in salmon diets. *Corophium* spp. were found to be important crustaceans eaten by both chum and chinook in upper Grays Harbor, Washington (Herrmann 1971) and in the Fraser estuary (Dunford 1975). Meyer *et al.* (1980) studying the Duwamish estuary found *Corophium* spp. to be very important to both chum and chinook. Mason (1974) found heavy predation by chum on *Eogammarus confervicolus* in Lynn Creek estuary, British Columbia. Conversely, in the present study, gammarids made only modest contributions to chinook diets, and were not a major food item.

Prey Availability

Abundances of selected zooplankton sampled at five stations in the Nisqually estuary in 1980 are shown in Table 3. A complete list of the groups encountered, and the seasonal abundances of selected categories during five sampling periods throughout the late spring and mid-summer are shown in Appendix D, Tables 1 and 2.

In comparing samples from the pelagic site with those of the epibenthic site, we noted that the pelagic site P4 had greater abundances of calanoid copepods and slightly higher abundances of other pelagic plankton such as cyclopoid copepods, crab and euphausiid zoea. Epibenthic organisms were present in much smaller quantities. The presence of some epibenthic organisms in samples from P4 may represent contamination of the sampler from other sites, or suspension of these organisms due to tidal mixing.

Harpacticoid copepods were the most abundant zooplankton organism sampled at the Nisqually Delta. Other organisms present in large numbers were the polychaete *Manayunkia aestuarine*, foraminifera protozoans and nematode worms. These latter groups of organisms are of less importance to salmon diets in the Nisqually estuary and their distributions will be discussed only briefly.

Manayunkia aestuarine, a benthic polychaete, was present in large numbers at the stations which had silt or fine sand substrate. Foraminifera are shelled protozoans which live on the substrate. They were taken in large numbers at all epibenthic sites, and particularly at P3 and P5 (stations with slightly more freshwater influence). Nematodes were also present in appreciable quantities at all sites except the pelagic site. Oligochaete abundance is similar to that for *Manayunkia aestuarine*. Oligochaetes were taken in mud (silt or fine sand) substrates, but particularly at the upstream slough site (N7), which is subject to more freshwater influence.

Insects are of interest because of their importance in juvenile salmon diets. However, few insects were taken in plankton pump samples. The plankton pump will take insects which live epibenthically in the intertidal zone, as do the larvae and adults of the coleopteran beetle families Melyridae and Staphylinidae, and the larvae and pupae of the dipteran families Chironomidae and Ephydridae. The plankton pump will not sample insects which are available to salmon at the water's surface.

Staphylinid adults and melyrid larvae were taken in moderate numbers at the sand/gravel site (P3). The

Table 3. Abundance of epibenthic and pelagic zooplankton collected at the Nisqually Delta, Washington, from April through August 1980 showing relative number and percent composition of organisms for each site.

		Station									
		P1		P2		P3		P4		P5	
Species	Life History**	Sandflat Abund*	%	Slough Abund.	%	Sand/Gravel Abund.	%	Mid-water Abund.	%	Slough Abund.	%
Foraminifera protozoan	J/A	F	1.3	A	7.0	F	14.2	C	2.0	A	13.4
Nematode worm	J/A	F	1.8	A	5.4	F	7.6	U	0.8	A	20.9
Polychaete worm	J/A	F	3.5	F	1.6	C	1.4	C	3.6	F	1.6
Manayunkia aestuarine	J/A	A	20.7	A	32.7	F	8.1	C	8.1	A	9.9
Oligochaete worm	J/A	F	6.8	F	3.2	C	0.8	U	0.9	A	18.5
Gastropod	E J	U	0.1	U	<0.1	C	2.2	C	2.8	U	<0.1
Mite (Acari)	J/A	C	0.2	F	1.3	C	1.4	U	0.2	C	0.4
Ostracod	J/A	A	14.6	F	4.0	F	2.6	U	1.7	F	1.3
Calanoid copepod	J/A	F	4.5	F	2.0	F	17.0	F	38.0	F	2.7
Harpacticoid copepod	J/A	A	33.7	A	39.9	A	33.9	C	2.8	A	26.3
Cyclopoid copepod	J/A	F	1.7	F	0.7	F	3.4	F	27.5	C	0.7
Barnacle (Cirripedia)	L A M	U	<0.1	C	0.4	C	1.4	C	2.8	C	0.7
Mysid	J A	C	0.1	-	0.0	C	0.6	U	0.2	C	0.3
Cumacean	J/A	-	0.0	C	0.2	U	0.2	-	0.0	-	0.0
Gammarid amphipod	J A	U	<0.1	C	0.2	U	0.1	-	0.0	C	0.6
Corophium spp.	J A	F	10.2	F	1.1	C	0.8	U	0.8	F	4.3
Eogammarus spp.	J A	C	0.3	U	<0.1	U	<0.1	-	0.0	F	6.9
Euphausiid	Z	U	0.1	U	<0.1	U	0.2	C	1.7	U	<0.1
Shrimp (Caridea)	Z	C	0.1	U	<0.1	U	0.1	U	0.8	U	<0.1
Crab (Brachyura)	Z	C	0.1	C	<0.1	C	0.4	C	4.5	U	<0.1
Beetle (Coleoptera)	L A	-	0.0	-	0.0	F	3.4	U	0.6	-	0.0
Fly (Diptera)	L P A	-	0.0	C	0.2	U	0.1	-	0.0	C	0.1
Total organisms		47,595		124,315		21,090		3,195		57,555	

** Life history symbols:

E	egg	J	juvenile
Z	zoea	A	adult
L	larva	M	molt
P	pupa	J/A	juvenile or adult

* Abundance symbols (number per cubic meter of water sampled):

-	Not detected	0
U	Uncommon	1 - 50
C	Common	51 - 500
F	Frequent	501 - 5000
A	Abundant	5001 - 50000

occurrence of beetle larvae at the pelagic site probably represents contamination of the sampling equipment. Dipteran larvae, pupae and rarely adults were taken at the silty slough sites and at the sand/gravel beach. Ephydrid shore fly larvae and pupae were taken at the downstream salt marsh site (P2) while dolichopodid long-legged fly larvae and pupae were taken at the upstream slough site (P5).

Some aquatic fly adults skim or fly low over the surface of the water (Merritt and Schlinger 1978) and would be available as prey to juvenile salmon. Terrestrial winged insects may fall or be blown onto the water's surface, while those without wings may fall onto the water from overhanging vegetation, or become inundated by the incoming tide if they are in the intertidal zone during low tide.

Crustaceans as a group were the predominant zooplankton encountered in the Nisqually estuary plankton samples. Harpacticoid copepods are epibenthic and were the most abundant zooplankton at all of the epibenthic sites. Calanoid and cyclopoid copepods are pelagic and were encountered in moderate numbers at all stations (except cyclopoids, which were fewer in number at the upstream slough site). They also made up a large percentage of the organisms at the pelagic site, which had a lower total number of organisms. Gammaridean amphipods of the genus Corophium build tubes of silt (Kozloff 1973) and were captured in moderate numbers at the stations with silt or fine sand substrates (P1, P2, P5). Eogammarus confervicolus was encountered most abundantly at the upstream slough site (P5).

There was a general increase in the numbers of organisms taken by the plankton pump as the season progressed at all stations except the pelagic site which had more or less consistently low numbers of organisms. However, abundances of some organisms decreased in August. Eogammarus confervicolus became less numerous in August at stations P1 and P2, but was markedly more abundant at station P5. In contrast to a general increasing trend over the summer, crab zoea became less numerous at the pelagic station (P4) and mysids were not as plentiful at the upstream slough site (P5), in August.

The seasonal trends of some of the copepods and gammarid amphipods are of particular interest because of their importance to juvenile salmon diets. Harpacticoid copepods and Corophium amphipods increased dramatically in abundance in August compared to their July totals, while numbers of calanoids and cyclopoids, both pelagic copepods, decreased at several of the stations. Most juvenile salmon had migrated out of the Delta into marine areas by this time.

SUMMARY

Juvenile chum, chinook and coho salmon plus steelhead and cutthroat trout utilized the Nisqually estuary in the spring and early summer of 1979 and 1980. The Delta appeared to provide an initial rearing area for juvenile chum and chinook prior to entrance into marine rearing areas. Chum and chinook appeared to utilize all accesible portions of the estuary, including tidal sloughs which were dewatered at normal low tide levels. Chum entered the Delta about one month earlier than chinook and were present in appreciable quantities from late April through June. Chinook were most abundant from early May through July. Coho were present for brief periods apparently moving rapidly through the Delta. Insufficient numbers of steelhead and cutthroat were captured to describe their distribution. After juvenile salmon migrated out of the Nisqually Delta in 1979, they continued to be present in large numbers in marine areas of the Reach. Abundance and size of salmon in the Delta appears to be highly influenced by hatchery releases into tributary streams. There is some evidence that relatively large hatchery fish moved rapidly through the Delta. Recoveries of hatchery fish bearing coded-wire tags indicates that salmon from streams outside of the Nisqually drainage also utilized the shallow nearshore areas of the Nisqually Reach.

Food habits of juvenile salmon varied between sample site, sample date and predator size. Crustaceans, particularly harpacticoid copepods, dominated the diet of juvenile chum. There was a trend for smaller chum to consume epibenthic prey while chum greater than about 70 mm fork length ate more pelagic prey such as cyclopoid and calanoid copepods. Chinook consumed both insects and crustaceans and demonstrated less prey selection than chum did. Dipteran flies, especially Ephydridae, and spiders were important in the diet of smaller chinook, but larger chinook consumed more crustaceans such as mysids and cumaceans. The crustaceans most important to chum were different from those most important to chinook. Coho preyed heavily on juvenile fish, primarily sand lance. Diet differences suggest that the salmon species were not competing for food resources.

Pelagic and epibenthic prey important to juvenile salmon appeared to be widely distributed throughout the estuary. In some cases, abundances of important salmon prey appeared to be comparable between sand flats, sloughs and sand/gravel beaches. Harpacticoid copepods were the most abundant epibenthic prey item in the plankton samples. Other crustaceans important in salmon diets and which were frequently encountered were the gammaridean amphipods

Corophium spp. and at one station, *Eogammarus confervicolus*. Plankton samples from mid-channel generally showed about the same abundances of pelagic calanoid and cyclopoid copepods as the other stations, but had lower abundances of other prey. Insects were poorly represented in the plankton samples, probably because the plankton sampler was not designed to capture them.

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APPENDIX A

Juvenile Salmon Catch by Station at Nisqually Estuary

Table

1 Salmon occurrence and catch per set by Station, 1979

2 Salmon occurrence and catch per set by station, 1980

3 Mean Weekly Chum Catch per Set by Station, 1979

4 Mean Weekly Chum Catch per Set by Station, 1980

5 Mean Weekly Chinook Catch per Set by Station, 1979

6 Mean Weekly Chinook Catch per Set by Station, 1980

7 Mean Weekly Coho Catch per Set by Station, 1979

8 Mean Weekly Coho Catch per Set by Station, 1980

APPENDIX A, TABLE 1. Percent (%) of sets in which salmon occurred and mean number caught per set at each station at the Nisqually Delta and Reach, 1979.

station name	number sets	Chum		Chinook		Coho	
		%	mean	%	mean	%	mean
N1	19	68.4	13.8	31.6	1.1	0.05	0.05
N9	19	31.6	47.7	63.2	4.8	0.0	0.0
N14	21	38.1	28.8	23.8	0.7	19.0	4.8
N15	14	28.6	2.6	42.9	1.4	14.3	0.5
N17	49	69.4	40.5	81.6	16.1	14.3	0.6
N18	13	30.8	7.9	46.2	6.5	0.0	0.0

APPENDIX A, TABLE 2. Percent (%) of sets in which salmon occurred, and mean number caught per set at each station at the Nisqually Delta, 1980.

station name	number sets	Chum		Chinook		Coho	
		%	mean	%	mean	%	mean
N1	17	41.2	2.5	29.0	6.6	14.0	0.2
N2	19	32.0	1.9	32.0	7.4	0.0	0.0
N4	16	19.0	0.7	38.0	3.9	0.0	0.0
N5	16	31.0	4.2	50.0	8.8	6.0	2.6
N7	19	21.0	1.3	32.0	2.3	0.0	0.0
N9	19	37.0	11.5	53.0	13.2	16.0	4.1

APPENDIX A, TABLE 3. Mean weekly chum catch per set by station at Nisqually Delta and Reach, 1979. Dashes indicate no set.

	April		May			June			July					August		September		
Stn	15	30	9	15	22	31	13	18	28	10	16	23	31	7	13	27	10	25
N1	19	0	38	--	--	3	0	--	0	4	1	--	0	0	0	0	0	0
N9	--	--	700	100	75	15	0	1	0	0	0	--	0	0	0	0	0	0
N14	--	80	--	100	--	1	1	1	0	--	1	--	0	0	0	0	0	0
N15	--	--	--	--	--	16	2	0	2	0	0	--	0	0	0	0	0	0
N17	--	--	--	--	--	--	600	200	2	212	71	16	4	6	3	0	0	0
N18	--	--	--	--	--	--	--	--	33	1	0	--	1	0	1	0	0	0

APPENDIX A, TABLE 4. Mean weekly catch per set by station at Nisqually Delta, 1980. Dashes indicate no set.

	April				May				June				July			August	
Stn	2	11	16	25	8	13	22	30	6	11	17	24	1	8	16	22	5
N1	--	0	0	8	19	0	2	1	0	3	0	1	1	0	0	0	0
N2	0	0	0	0	4	26	2	1	3	0	0	1	--	0	0	0	0
N4	--	0	0	0	2	0	6	0	0	3	0	--	0	0	0	0	0
N5	--	1	0	--	58	0	0	3	1	0	4	0	0	0	0	0	0
N7	0	0	0	11	0	1	0	2	0	0	1	0	0	0	0	0	0
N9	0	0	13	56	22	0	11	58	3	1	0	0	0	0	0	0	0

APPENDIX A, TABLE 5. Mean weekly chinook catch per set by station at Nisqually Delta and Reach, 1979. Dashes indicate no set.

	April		May			June				July				August		September		
Stn	15	30	9	15	22	31	13	18	28	10	16	23	31	7	13	27	10	25
N1	0	1	0	--	--	0	0	--	2	7	2	--	5	0	3	0	0	0
N9	--	--	0	3	0	2	3	12	2	1	3	--	0	0	1	0	56	0
N14	--	0	--	0	--	1	6	0	3	--	0	--	0	0	0	2	0	0
N15	--	--	--	--	--	0	4	0	5	0	3	--	2	2	0	0	0	0
N17	--	--	--	--	--	--	4	5	15	181	77	19	15	6	10	1	0	0
N18	--	--	--	--	--	--	--	--	3	0	63	--	1	6	3	1	0	0

APPENDIX A, TABLE 6. Mean weekly chinook catch per set by station at Nisqually Delta, 1980. Dashes indicate no set.

	April			May				June					July			August	
Stn	2	11	16	25	8	13	22	30	6	11	17	24	1	8	16	22	5
N1	--	0	0	0	0	0	0	25	21	45	0	20	0	2	0	0	0
N2	0	0	0	0	0	0	0	16	34	0	6	40	--	3	0	1	0
N4	--	0	0	1	0	0	0	11	10	30	10	--	1	0	0	0	0
N5	--	0	0	--	4	0	0	94	30	4	2	4	2	0	0	0	1
N7	0	0	0	0	0	0	0	32	1	2	5	0	2	2	0	0	0
N9	2	0	0	0	4	181	2	29	15	8	0	7	0	0	0	0	0

APPENDIX A, TABLE 7. Mean weekly coho catch per set by station at Nisqually Delta and Reach, 1979. Dashes indicate no set.

	April		May			June				July				August		September		
Stn	15	30	9	15	22	31	13	18	28	10	16	23	31	7	13	27	10	25
N1	0	0	0	--	--	1	0	--	0	0	0	--	0	0	0	0	0	0
N9	--	--	0	0	0	0	0	0	0	0	0	--	0	0	0	0	0	0
N14	--	6	--	34	--	1	0	1	0	--	0	--	0	0	0	0	0	0
N15	--	--	--	--	--	3	0	1	0	0	0	--	0	0	0	0	0	0
N17	--	--	--	--	--	--	0	0	--	0	0	1	0	6	0	0	0	0
N18	--	--	--	--	--	--	--	--	0	0	0	--	0	0	0	0	0	0

APPENDIX A, TABLE 8. Mean weekly coho catch per set by station at Nisqually Delta, 1980. Dashes indicate no set.

	April				May				June				July			August	
Stn	2	11	16	25	8	13	22	30	6	11	17	24	1	8	16	22	5
N1	--	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
N2	0	0	0	0	0	0	0	0	0	0	0	0	--	0	0	0	0
N4	--	0	0	0	0	0	0	0	0	0	0	--	0	0	0	0	0
N5	--	0	0	--	42	0	0	0	0	0	0	0	0	0	0	0	0
N7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N9	0	0	0	0	35	42	1	0	0	0	0	0	0	0	0	0	0

APPENDIX B

Recoveries of Coded-Wire Tags at Nisqually Estuary

APPENDIX B, TABLE 1. Recoveries of coded wire tags from juvenile salmon in Nisqually Estuary, 1979 and 1980.

Species	Tag Number	Release Date	Release Site	Recovery Date	Recovery Sample Site
Coho	63-18- 7	25 Apr 1979	Sequalitchew L.	1 May 1979	N14
Chinook	63-19-36	May 1979	Soos Cr.	14 Jun 1979	N14
Chinook	63-18-14	May 1979	Voights Cr.	18 Jun 1979	N9
Chinook	63-19-45	May 1979	Soos Cr.	2 Jul 1979	Nisqually Estuary
Chinook	63-19-45	May 1979	Soos Cr.	10 Jul 1979	N17
Chinook	63-19-40	May 1979	Issaquah Cr.	23 Jul 1979	N17
Chinook	63-19-45	May 1979	Soos Cr.	23 Jul 1979	N17
Chinook	63-19-45	May 1979	Soos Cr.	30 Jul 1979	N17
Chinook	5- 7-22	Apr 1980	Kalama Cr.	6 Jun 1980	Nisqually Delta

APPENDIX C

IRI Diagrams of Diets of Salmon Caught at Nisqually Estuary

Figure	
1	Prey of chum caught in 1979
2	Prey of chum caught in 1980
3	Prey of chum caught in April, 1980
4	Prey of chum caught in May, 1980
5	Prey of chum caught in June, 1980
6	Prey of chum with forklengths of 29-40 mm, 1980
7	Prey of chum with forklengths of 41-50 mm, 1980
8	Prey of chum with forklengths of 51-60 mm, 1980
9	Prey of chum with forklengths of 61-70 mm, 1980
10	Prey of chum with forklengths of 71-80 mm, 1980
11	Prey of chum with forklengths of 81-90 mm, 1980
12	Prey of chum caught at station N1 in 1980
13	Prey of chum caught at station N2 in 1980
14	Prey of chum caught at station N4 in 1980
15	Prey of chum caught at station N5 in 1980
16	Prey of chum caught at station N7 in 1980
17	Prey of chum caught at station N9 in 1980
18	Prey of chinook caught in 1979
19	Prey of chinook caught in 1980
20	Prey of chinook caught in April, 1980
21	Prey of chinook caught in May, 1980
22	Prey of chinook caught in June, 1980
23	Prey of chinook caught in July, 1980
24	Prey of chinook with forklengths of 61-70 mm, 1980
25	Prey of chinook with forklengths of 71-80 mm, 1980
26	Prey of chinook with forklengths of 81-90 mm, 1980
27	Prey of chinook caught at station N1 in 1980
28	Prey of chinook caught at station N2 in 1980
29	Prey of chinook caught at station N4 in 1980
30	Prey of chinook caught at station N5 in 1980
31	Prey of chinook caught at station N7 in 1980
32	Prey of chinook caught at station N9 in 1980
33	Prey of coho caught in 1979
34	Prey of coho caught in 1980

INDEX OF RELATIVE IMPORTANCE (I.R.I.) TABLE
USING FILEID= NISQ79, STATION= ALL FOR PLOT
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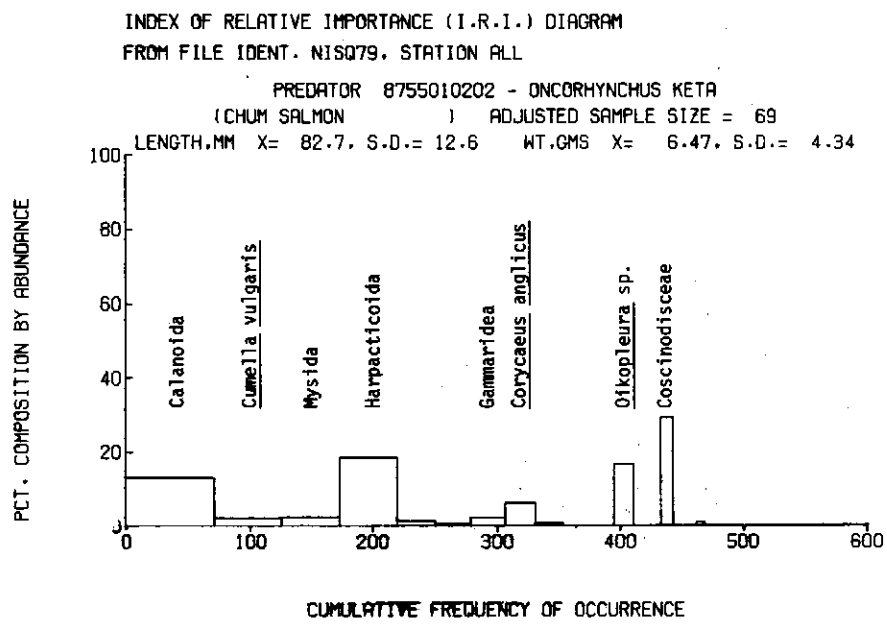
PREY ITEM	FREQ OCCUR	NUM. COMP.	PERCENT TOTAL IRI
CALANOIDA	71.01	13.13	31.47
CUMELLA VULGARIS	55.07	2.33	4.33
MYSIDA	47.83	2.51	4.05
HARPACTICOIDA	46.38	18.58	29.08
DECAPODA-BRACHYURA	30.43	1.59	1.63
POLYCHAETA	28.99	.88	.86
GAMMARIDEA	27.54	2.43	2.26
CORYCAEUS ANGLICUS	24.64	6.43	5.35
PLEOCYEMATA-CARIDEA	21.74	1.15	.84
DIPTERA-CHIRONOMIDAE	21.74	.45	.33
AMPHIPODA-HYPERIIDEA	20.29	.20	.14
OIKOPLEURA SP.	15.94	16.82	9.05
COROPHIUM SP.	11.59	.23	.09
APHIDIDAE	10.14	.05	.02
COSCINODISCEAE	10.14	29.45	10.08
CAPRELLIDEA	10.14	.14	.05
CIRRIPEDIA	8.70	.09	.03
OSTRACODA	7.25	1.21	.29
HEMIPTERA	5.80	.03	.01
OLIGOCHAETA	5.80	.05	.01
DIPTERA	5.80	.02	.00
NEMATOCERA	5.80	.03	.01
TURBELLARIA	5.80	.04	.01
PSOCOPTERA	5.80	.06	.01

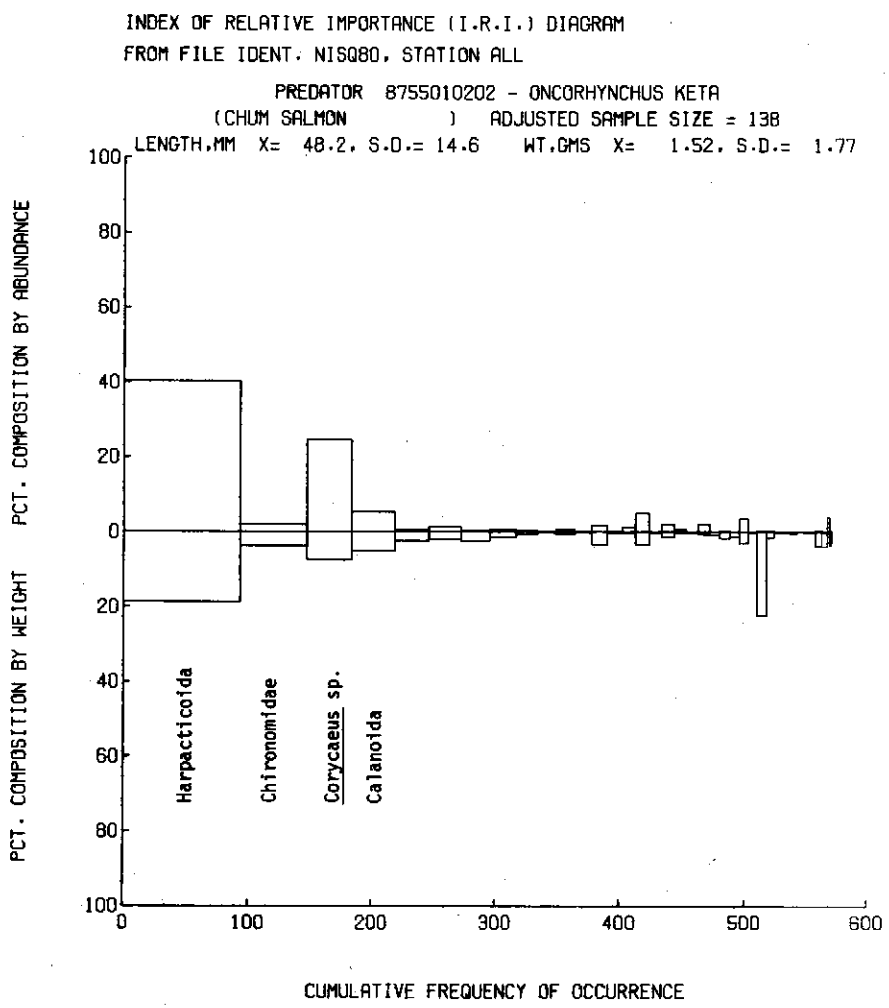
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT



Appendix C, Figure 1. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary in 1979.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	93.48	40.20	18.85	5519.9	66.91
DIPTERA-CHIRONOMIDAE	53.62	1.86	3.72	299.2	3.63
CORYCAEUS SP.	36.96	24.49	7.42	1179.2	14.29
CALANOIDA	34.78	5.44	5.07	365.3	4.43
COROPHIUM SP.	27.54	.54	2.30	78.2	.95
GAMMARIDEA	26.09	1.45	1.80	84.7	1.03
DIPTERA	23.19	.39	2.42	65.1	.79
INSECTA	21.74	.67	1.48	46.7	.57
NEMATOCERA	16.67	.32	.58	15.1	.18
OSTRACODA	15.22	.15	.07	3.4	.04
CRANGONIDAE	14.49	.64	.66	18.8	.23
COLLEMBOLA	13.77	.11	.09	2.7	.03
CUMELLA SP.	13.04	1.79	3.21	65.2	.79
CIRRIPEDIA	11.59	.25	.08	3.9	.05
COPEPODA	10.87	1.29	.08	14.9	.18
DECAPODA	10.87	5.14	3.21	90.7	1.10
COLEOPTERA	10.14	.09	.08	1.7	.02
MALACOSTRACA	10.14	2.04	1.28	33.7	.41
EUPHAUSIACEA	9.42	.74	.31	9.9	.12
APHIDIDAE	9.42	.08	.22	2.8	.03
OIKOPLEURA SP.	9.42	2.05	.54	24.4	.30
COROPHIUM SALMONIS	7.97	.06	.82	7.0	.09
DECAPODA-BRACHYURA	7.97	.21	1.51	13.8	.17
ROCK	7.97	.05	1.20	10.0	.12
PLEOCYEMATA-CARIDEA	7.25	3.63	2.88	47.2	.57
ARANEAE	7.25	.06	.07	.9	.01
NEOMYSIS MERCEDIS	7.25	.24	22.29	163.3	1.98
COROPHIUM BREVIS	6.52	.18	1.38	10.1	.12
CERCOPIDAE	6.52	.04	.16	1.3	.02
TANAIDACEA	6.52	.07	.21	1.8	.02
COROPHIUM INSIDIOSUM	5.80	.09	.47	3.3	.04
ACARINA	5.07	.03	.02	.3	.00
DOLICHOPODIDAE	5.07	.07	.15	1.1	.01
CRUSTACEA	5.07	.10	.06	.8	.01
COROPHIUM ASCHERUSICUM	5.07	.44	3.83	21.6	.26
MYSIDA	4.35	.08	3.98	17.7	.21
UNIDENTIFIED EGG	2.17	3.88	.01	8.4	.10
PONTOGENEIA IVANOVI	1.45	.18	3.38	5.2	.06

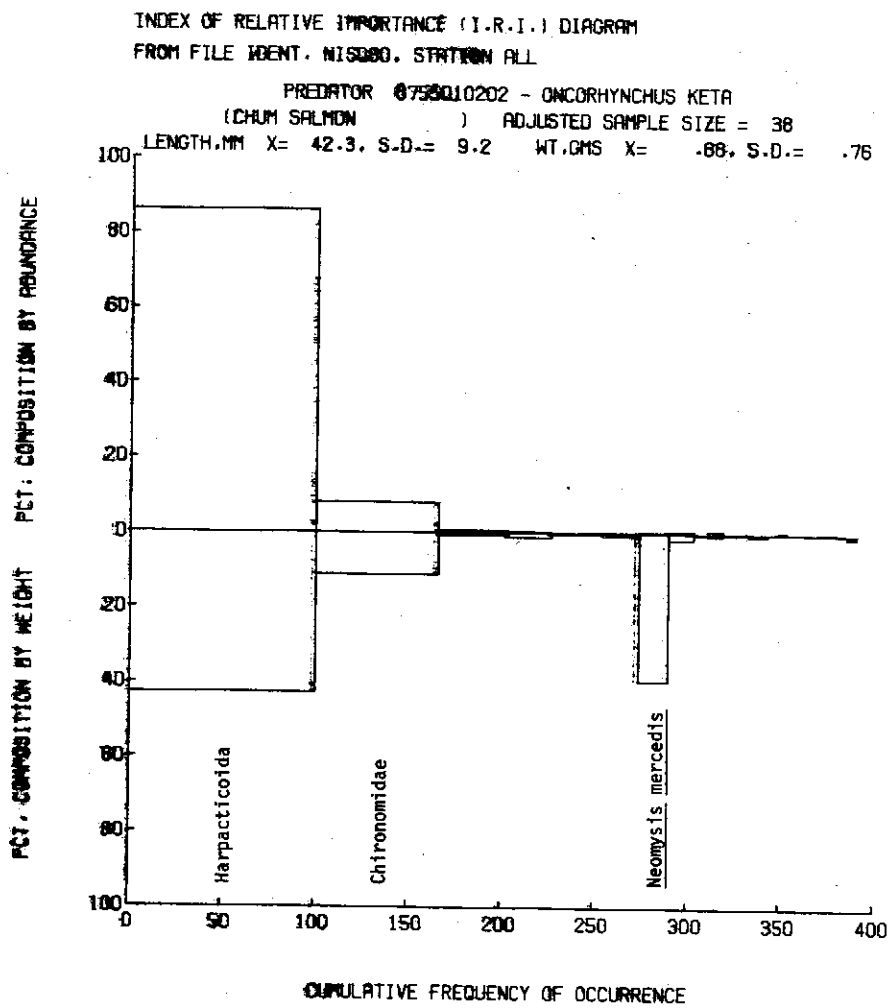
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 2. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	100.00	86.20	42.64	12883.2	86.19
DIPTERA-CHIRONOMIDAE	65.79	8.06	11.11	1261.5	8.44
GAMMARIDEA	36.84	.68	.68	50.0	.33
CORDPHIUM SP.	23.68	.31	1.15	34.7	.23
COLLEMBOLA	15.79	.15	.20	5.4	.04
COLEOPTERA	15.79	.29	.08	5.8	.04
DIPTERA	15.79	.27	.57	13.3	.09
NEOMYSIS MERCEDIS	15.79	.46	39.43	629.8	4.21
INSECTA	13.16	.82	1.59	31.8	.21
CERCOPIDAE	7.89	.07	.16	1.8	.01
EOGAMMARUS CONFERVICOLUS	7.89	.65	.40	8.4	.06
MYSIDA	7.89	.10	.16	2.0	.01
NEMATOCERA	7.89	.24	.04	2.2	.01
TANAIDACEA	7.89	.10	.42	4.1	.03
ACARINA	5.26	.05	.03	.4	.00
COPEPODA	5.26	.34	.03	1.9	.01
ARANEAE	5.26	.07	.03	.5	.00
APHIDIDAE	5.26	.05	.03	.4	.00
LEPTOCHELIA SP.	5.26	.07	.03	.5	.00
OITHONA SP.	5.26	.17	.03	1.0	.01
CIRRIPEDIA	5.26	.19	.03	1.2	.01
MALACOSTRACA	5.26	.05	.03	.4	.00
OSTEICHTHYES	5.26	.12	.80	4.8	.03

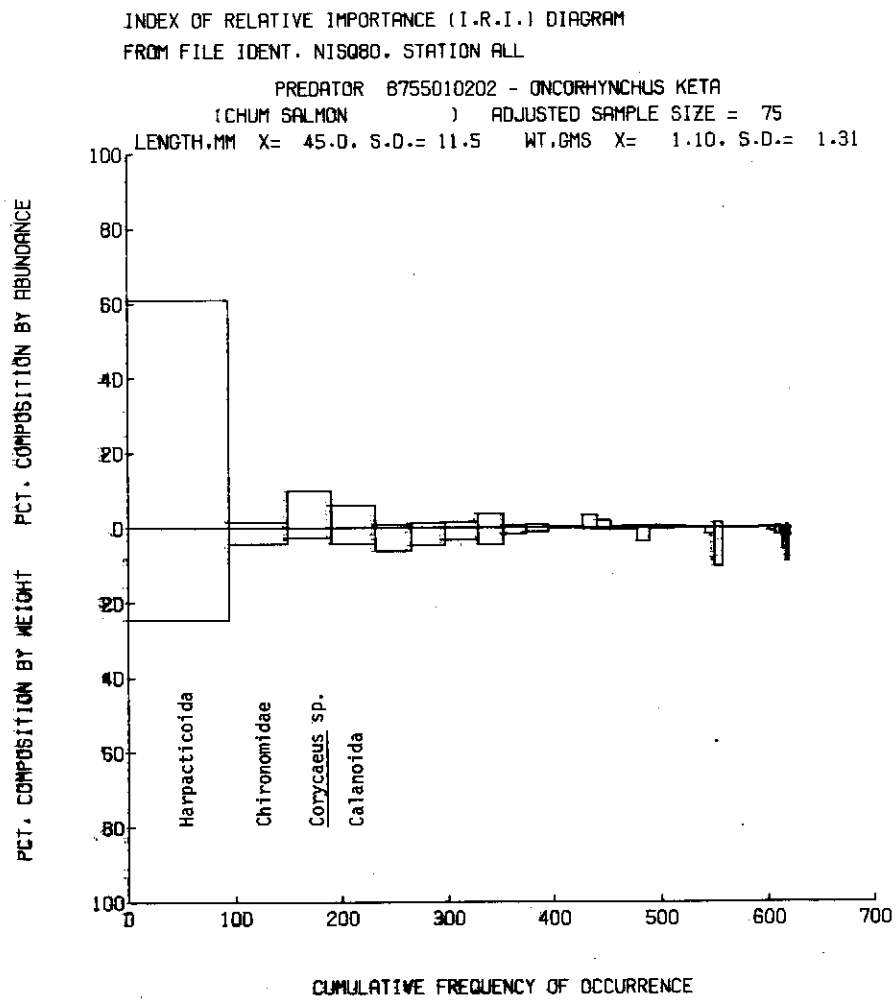
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 3. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary in April, 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	94.67	60.89	24.49	8082.8	76.39
DIPTERA-CHIRONOMIDAE	54.67	1.53	4.26	316.1	2.99
CORYCAEUS SP.	41.33	9.92	2.68	521.0	4.92
CALANOIDA	41.33	6.06	4.28	427.2	4.04
DIPTERA	33.33	.98	6.12	236.9	2.24
COROPHIUM SP.	32.00	1.24	4.58	186.1	1.76
INSECTA	32.00	1.54	3.15	150.0	1.42
GAMMARIDEA	24.00	3.79	4.46	198.1	1.87
NEMATOCERA	21.33	.75	1.52	48.5	.46
CRANGONIDAE	21.33	.92	1.11	43.3	.41
COLLEMBOLA	17.33	.24	.14	6.7	.06
OSTRACODA	14.67	.18	.07	3.7	.03
COPEPODA	13.33	3.47	.18	48.8	.46
EUPHAUSIACEA	13.33	1.98	.61	34.6	.33
APHIDIDAE	12.00	.18	.43	7.3	.07
CUMELLA SP.	12.00	.36	.49	10.2	.10
COROPHIUM BREVIS	12.00	.51	3.69	50.4	.48
CIRRIPEDIA	12.00	.52	.18	8.4	.08
DECAPODA	10.67	.30	.24	5.8	.05
DIKOPLEURA SP.	10.67	.25	.05	3.3	.03
MALACOSTRACA	9.33	.14	.11	2.3	.02
COLEOPTERA	9.33	.11	.05	1.5	.01
COROPHIUM SALMONIS	8.00	.12	1.72	14.8	.14
COROPHIUM ASCHERUSICUM	8.00	1.24	10.20	91.5	.86
POLYCHAETA	8.00	.09	.04	1.0	.01
CERCOPIDAE	6.67	.07	.16	1.5	.01
ROCK	6.67	.07	.03	.7	.01
STAPHYLINIDAE	5.33	.04	.27	1.7	.02
TANAIDACEA	5.33	.12	.22	1.8	.02
THYSANOPTERA	5.33	.04	.03	.4	.00
ARANEAE	5.33	.07	.03	.5	.00
COROPHIUM INSIDIOSUM	5.33	.15	.86	5.4	.05
PHOTIS BREVIPES	5.33	.35	1.78	11.4	.11
DECAPODA-BRACHYURA	2.67	.30	1.26	4.1	.04
MYSIDA	2.67	.11	5.72	15.6	.15
PONTOGENEIA IVANOVI	2.67	.52	9.08	25.6	.24
NEOMYSIS MERCEDIS	1.33	.02	2.24	3.0	.03

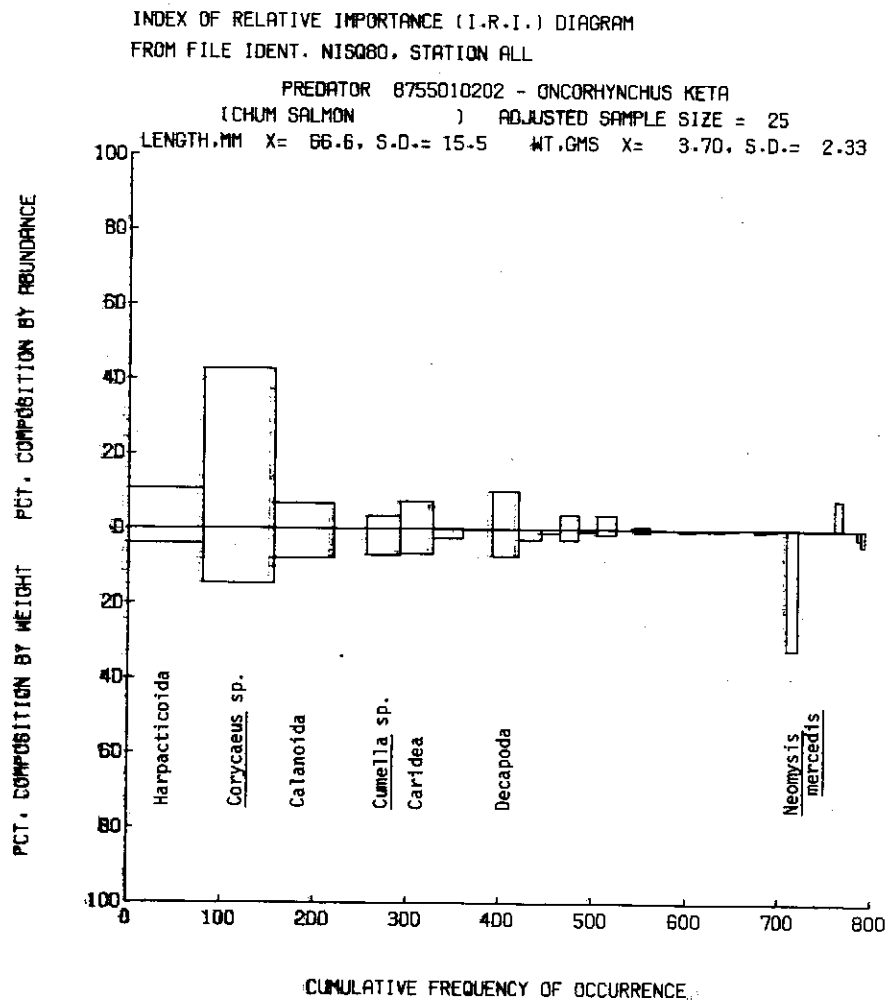
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 4. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary in May, 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	80.00	10.62	3.89	1161.1	13.20
CORYCAEUS SP.	76.00	42.75	16.60	4358.4	49.56
CALANOIDA	64.00	6.75	7.79	930.5	10.58
OSTRACODA	36.00	.16	.10	9.5	.11
CUMELLA SP.	36.00	3.37	6.90	369.8	4.20
PLEOCYEMATA-CARIDEA	36.00	7.37	8.55	500.9	5.70
DECAPODA-BRACHYURA	32.00	.21	2.37	82.7	.94
DIPTERA-CHIRONOMIDAE	32.00	.09	.09	6.0	.07
DECAPODA	28.00	10.23	7.10	485.4	5.52
ROCK	24.00	.06	2.70	66.3	.75
COROPHIUM SP.	20.00	.13	.85	19.5	.22
MALACOSTRACA	20.00	4.03	2.81	136.8	1.56
EPHYDRIDAE	20.00	.21	.62	16.6	.19
DIKOPLEURA SP.	20.00	3.99	1.18	103.3	1.17
CIRRIPEDIA	20.00	.08	.03	2.1	.02
CRANGONIDAE	16.00	.64	.56	19.2	.22
CRUSTACEA	16.00	.16	.07	3.7	.04
NEMATOCERA	16.00	.04	.02	1.0	.01
COROPHIUM SALMONIS	16.00	.03	.40	6.8	.08
DOLICHOPODIDAE	16.00	.09	.23	5.2	.06
COROPHIUM INSIDIOSUM	16.00	.08	.34	6.7	.08
ARANEAE	16.00	.05	.13	2.8	.03
GAMMARIDEA	16.00	.03	.02	.9	.01
CYCLORRHAPHA	12.00	.03	.50	6.4	.07
HELEIDAE	12.00	.06	.40	5.5	.06
COPEPODA	12.00	.05	.02	.8	.01
NEOMYSIS MERCEDIS	12.00	.32	31.98	387.6	4.41
ACARINA	8.00	.02	.01	.3	.00
EUPHAUSIACEA	8.00	.09	.17	2.1	.02
PSOCOPTERA	8.00	.02	.06	.6	.01
APHIDIDAE	8.00	.02	.12	1.1	.01
TANAIDACEA	8.00	.02	.12	1.1	.01
UNIDENTIFIED EGG	8.00	7.87	.01	63.0	.72
PLANTS AND PLANT PARTS	8.00	.05	.01	.5	.01
ISOPODA	8.00	.02	.01	.2	.00
COSCINODISCEAE	4.00	.01	2.23	9.0	.10
MYSIDA	4.00	.06	4.13	16.8	.19

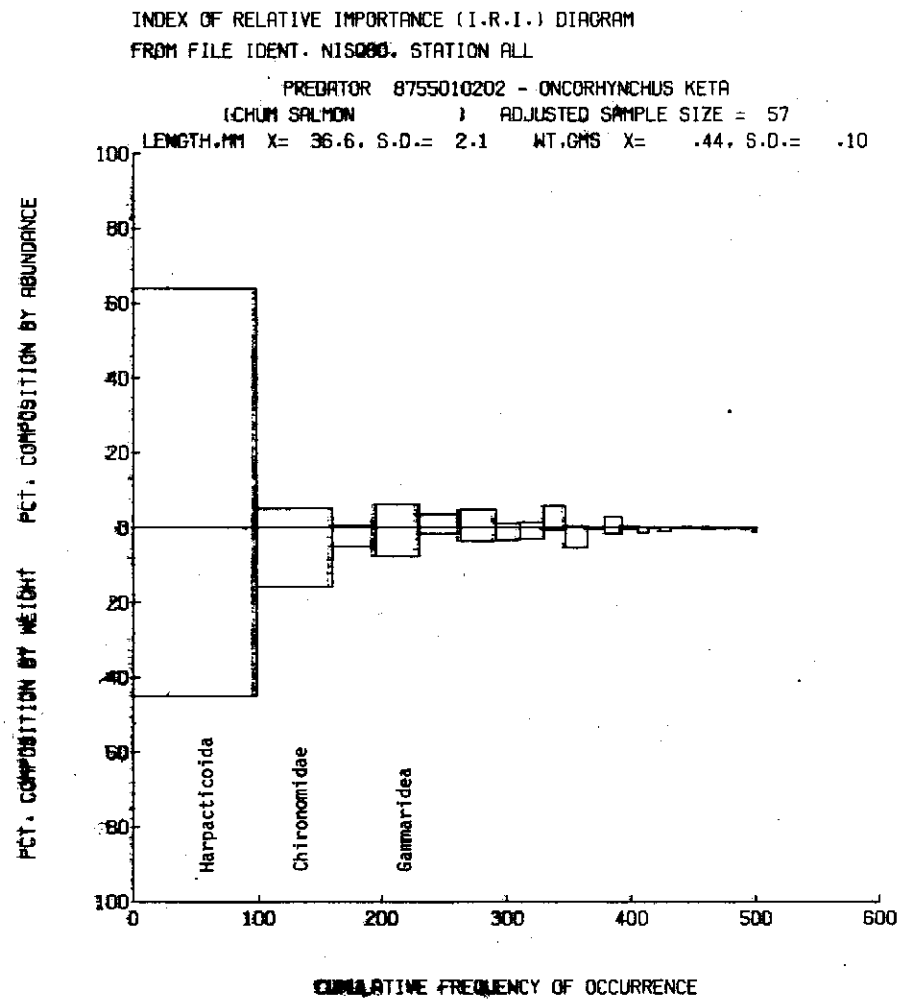
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 5. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary in June, 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	98.25	64.03	44.93	10705.6	78.64
DIPTERA-CHIRONOMIDAE	61.40	5.22	15.79	1290.3	9.48
COROPHIUM SP.	35.09	.75	4.90	198.5	1.46
GAMMARIDEA	35.09	6.28	7.60	487.2	3.58
CORYCAEUS SP.	33.33	3.70	1.57	175.6	1.29
CALANOIDA	28.07	5.03	3.53	240.2	1.76
NEMATOCERA	19.30	1.06	3.36	85.3	.63
INSECTA	19.30	1.37	2.92	82.8	.61
COPEPODA	17.54	5.94	.53	113.4	.83
DIPTERA	17.54	.37	5.36	100.4	.74
COLLEMBOLA	14.04	.21	.32	7.5	.05
EUPHAUSIACEA	14.04	2.87	1.55	62.0	.46
CIRRIPEDIA	12.28	.50	.47	11.9	.09
COROPHIUM BREVIS	8.77	.23	1.34	13.8	.10
COLEOPTERA	8.77	.17	.09	2.3	.02
COROPHIUM SALMONIS	8.77	.15	.98	10.0	.07
POLYCHAETA	8.77	.10	.09	1.7	.01
MALACOSTRACA	8.77	.17	.09	2.3	.02
OSTRACODA	7.02	.08	.08	1.1	.01
CRANGONIDAE	7.02	.21	.25	3.2	.02
LEPTOCHELIA SP.	5.26	.12	.23	1.8	.01
APHIDIDAE	5.26	.06	.06	.6	.00
CRUSTACEA	5.26	.12	.23	1.8	.01
DECAPODA	5.26	.10	.06	.8	.01
ARANEAE	5.26	.10	.06	.8	.01
TANAIDACEA	5.26	.08	.60	3.6	.03
DIKOPLEURA SP.	5.26	.08	.06	.7	.01
ONCORHYNCHUS SP.	1.75	.02	1.32	2.4	.02

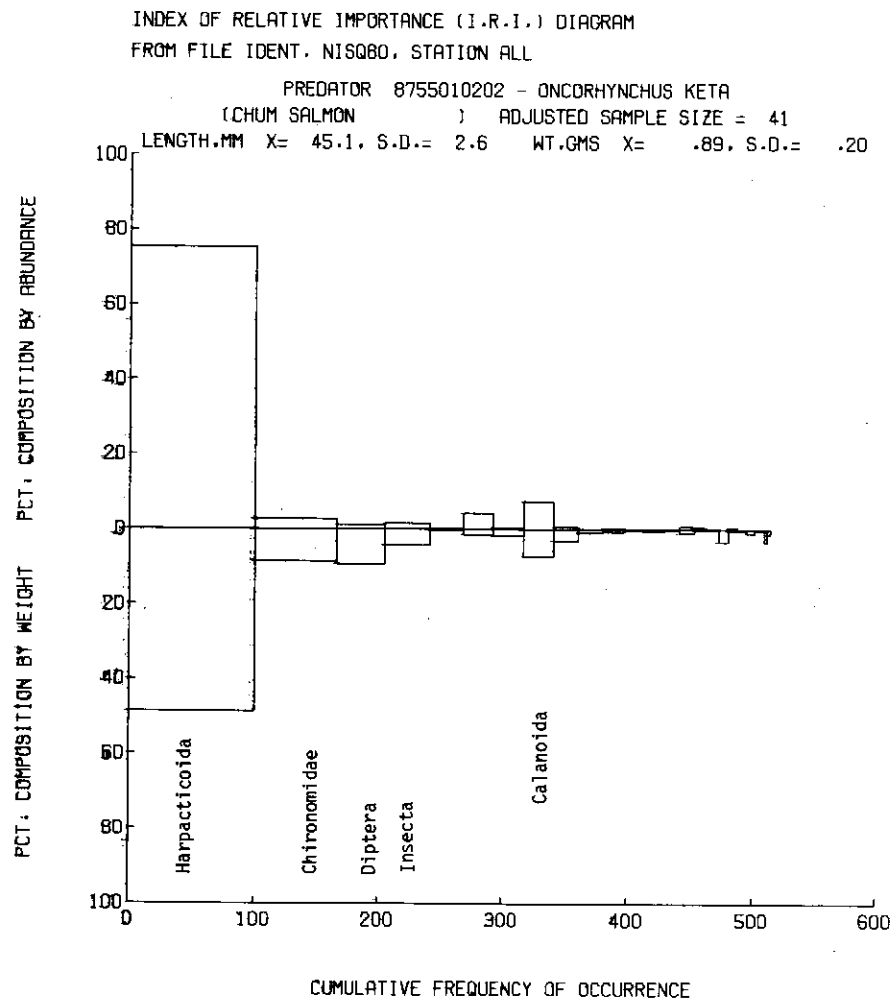
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 6. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary with fork lengths of 29-40 mm.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	100.00	75.30	48.72	12401.6	85.06
DIPTERA-CHIRONOMIDAE	65.85	2.83	8.53	748.3	5.13
DIPTERA	39.02	1.36	9.48	423.2	2.90
INSECTA	36.59	1.56	4.29	213.9	1.47
COLLEMBOLA	26.83	.30	.29	15.9	.11
CORYCAEUS SP.	24.39	4.34	1.37	139.2	.96
GAMMARIDEA	24.39	.34	1.54	46.0	.32
CALANOIDA	24.39	7.44	7.25	358.2	2.46
CORDPHIUM SP.	19.51	.73	2.94	71.8	.49
APHIDIDAE	19.51	.27	.79	20.7	.14
NEMATOCERA	17.07	.38	.66	17.8	.12
OSTRACODA	17.07	.22	.10	5.4	.04
CERCOPIDAE	14.63	.13	.49	9.0	.06
COLEOPTERA	12.20	.18	.07	3.1	.02
CRANGONIDAE	12.20	1.02	.89	23.4	.16
CIRRIPEDIA	9.76	.52	.06	5.6	.04
DIKOPLEURA SP.	9.76	.23	.06	2.8	.02
COROPHIUM SALMONIS	7.32	.09	3.33	25.1	.17
EUPHAUSIACEA	7.32	.56	.17	5.3	.04
ARANEAE	7.32	.07	.04	.8	.01
CYCLORRHAPHA	7.32	.07	.08	7.0	.05
CUMELLA SP.	7.32	.11	.32	3.1	.02
NEOMYSIS MERCEDIS	2.44	.02	3.32	8.1	.06
INSECTA-LEPIDOPTERA	2.44	.02	1.15	2.9	.02

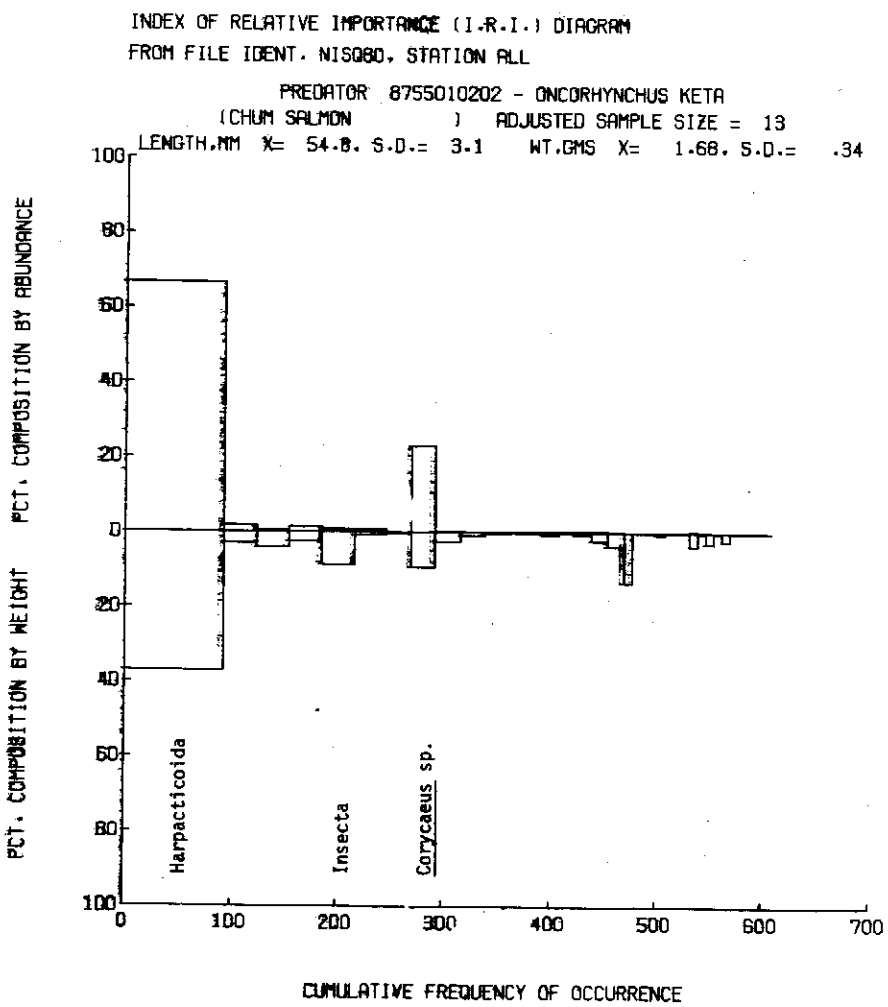
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 7. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary with fork lengths of 41-50 mm.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	92.31	66.59	36.99	9561.6	83.06
CALANOIDA	30.77	1.74	3.03	147.0	1.28
COROPHIUM SP.	30.77	.60	4.14	145.9	1.27
CRANGONIDAE	30.77	1.47	2.45	120.7	1.05
INSECTA	30.77	.87	8.75	296.1	2.57
DIPTERA-CHIRONOMIDAE	30.77	.76	.76	46.8	.41
ACARINA	23.08	.16	.18	7.8	.07
CORYCAEUS SP.	23.08	23.00	9.39	747.5	6.49
DIPTERA	23.08	.22	2.39	60.2	.52
NEMATOCERA	23.08	.27	.70	22.4	.19
ARANEAE	23.08	.22	.18	9.1	.08
COLEOPTERA	15.38	.11	.12	3.5	.03
DECAPODA	15.38	.49	.12	9.3	.08
CUMELLA SP.	15.38	.38	.64	15.7	.14
MALACOSTRACA	15.38	.49	.12	9.3	.08
DOLICHOPODIDAE	15.38	.22	.64	13.2	.11
EPHYDRIDAE	15.38	.49	2.33	43.4	.38
OSTEICHTHYES	15.38	.22	3.56	58.1	.50
NEOMYSIS MERCEDIS	7.69	.11	13.42	104.1	.90
NEMATODA	7.69	.05	.06	.9	.01
THYSANOPTERA	7.69	.05	.06	.9	.01
CERCOPIDAE	7.69	.05	.06	.9	.01
APHIDIDAE	7.69	.05	.58	4.9	.04
TANAIDACEA	7.69	.11	.06	1.3	.01
LEPTOCHELIA SP.	7.69	.11	.06	1.3	.01
ISOPODA	7.69	.05	.06	.9	.01
HELEIDAE	7.69	.33	3.50	29.4	.26
GAMMARIDEA	7.69	.05	.06	.9	.01
DIPTERA-BRACHYCERA	7.69	.11	2.92	23.3	.20
DITHONA SP.	7.69	.11	.06	1.3	.01
CYCLORRHAPHA	7.69	.11	2.33	18.8	.16
AMPHIPODA-HYPERIIDEA	7.69	.11	.06	1.3	.01
HYMENOPTERA	7.69	.05	.06	.9	.01
OSTRACODA	7.69	.05	.06	.9	.01
UNIDENTIFIED EGG	7.69	.11	.06	1.3	.01
ROCK	7.69	.05	.06	.9	.01

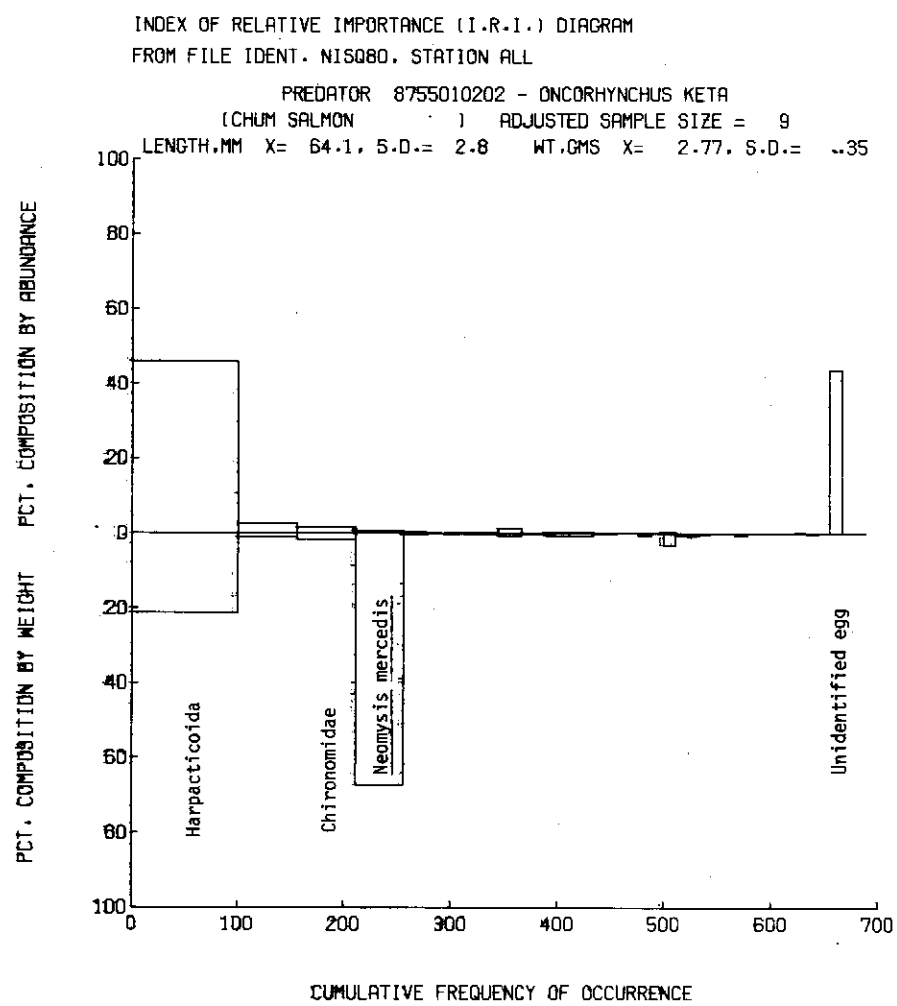
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 8. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary with fork lengths of 51-60 mm.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GPAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	100.00	45.95	21.31	6725.9	62.10
CORYCAEUS SP.	55.56	2.76	.84	199.8	1.85
DIPTERA-CHIRONOMIDAE	55.56	1.53	1.63	175.5	1.62
NEOMYSIS MERCEDIS	44.44	.70	67.17	3016.6	27.85
OSTRACODA	22.22	.31	.29	13.2	.12
CIRRIPEDIA	22.22	.13	.05	4.1	.04
CALANOIDA	22.22	.26	.05	7.0	.06
DECAPODA	22.22	.18	.29	10.3	.10
PLEOCYEMATA-CARIDEA	22.22	1.49	.52	44.7	.41
ACARINA	22.22	.13	.05	4.1	.04
DOLICHOPODIDAE	22.22	.22	.52	16.5	.15
EPHYDRIDAE	22.22	.48	.81	28.8	.27
ROCK	22.22	.13	.05	4.1	.04
CHLOROPHYCEAE	11.11	.09	.03	1.3	.01
CUMELLA SP.	11.11	.04	.03	.8	.01
TANAIDACEA	11.11	.04	.52	6.3	.06
LEPTOCHELIA SP.	11.11	.04	.03	.8	.01
COROPHIUM SP.	11.11	.35	3.15	38.9	.36
COROPHIUM SALMONIS	11.11	.04	.52	6.3	.06
COROPHIUM INSIDIOSUM	11.11	.04	.79	9.2	.09
CRUSTACEA	11.11	.04	.26	3.4	.03
CYCLOPOIDA	11.11	.09	.03	1.3	.01
DECAPODA-BRACHYURA	11.11	.13	.03	1.8	.02
APHIDIDAE	11.11	.04	.52	6.3	.06
COLEOPTERA	11.11	.04	.03	.8	.01
NEMATOCERA	11.11	.04	.03	.8	.01
HELEIDAE	11.11	.04	.03	.8	.01
GASTROPODA	11.11	.13	.03	1.8	.02
OITHONA SP.	11.11	.22	.03	2.7	.03
CYCLORRHAPHA	11.11	.04	.26	3.4	.03
COPEPODA	11.11	.04	.03	.8	.01
UNIDENTIFIED EGG	11.11	43.76	.03	486.6	4.49
PLANTS AND PLANT PARTS	11.11	.22	.03	2.7	.03
MALACOSTRACA	11.11	.22	.03	2.7	.03

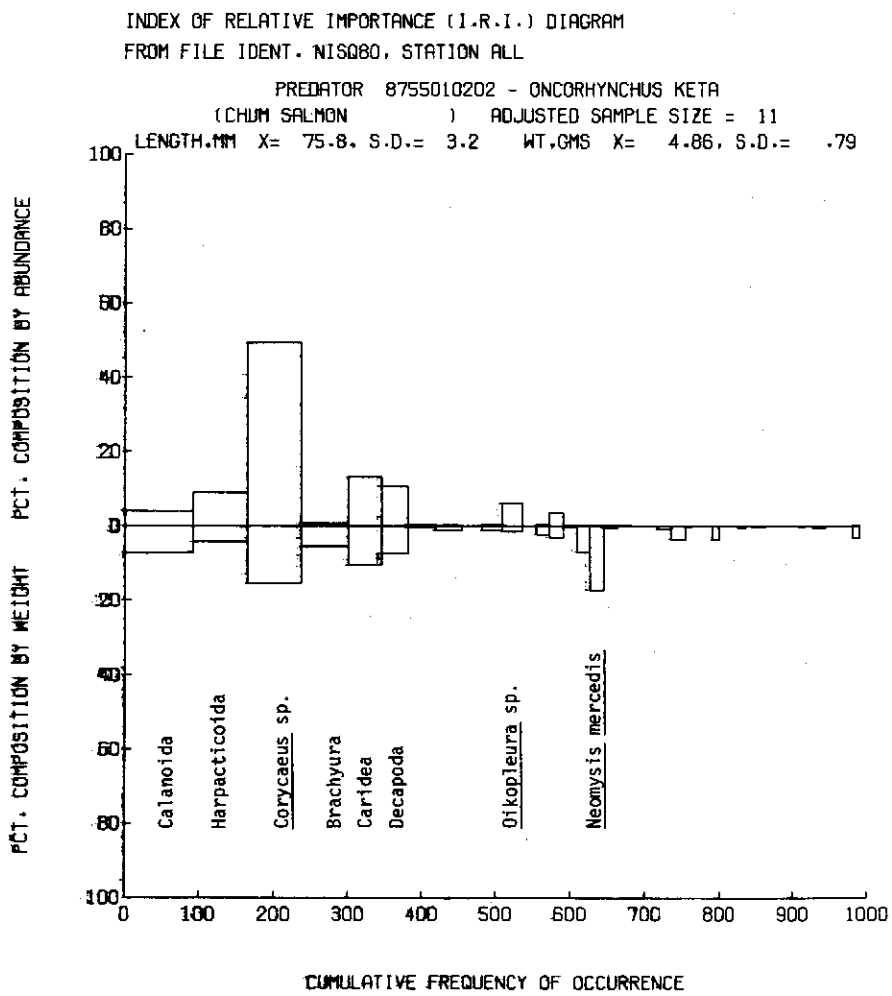
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 9. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary with fork lengths of 61-70 mm.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
CALANOIDA	90.91	4.11	7.26	1034.2	10.37
HARPACTICOIDA	72.73	8.92	4.14	949.9	9.52
CORYCAEUS SP.	72.73	49.24	15.40	4701.3	47.14
DECAPODA-BRACHYURA	63.64	.65	5.53	393.3	3.94
PLEOCYEMATA-CARIDEA	45.45	13.11	10.54	1075.0	10.78
DECAPODA	36.36	10.62	7.34	652.8	6.55
CUMELLA SP.	36.36	.41	.30	26.0	.26
COROPHIUM INSIDIOSUM	36.36	.28	1.11	50.5	.51
OSTRACODA	27.27	.06	.03	2.4	.02
COROPHIUM SP.	27.27	.40	1.11	41.1	.41
DIKOPLEURA SP.	27.27	6.15	1.56	210.2	2.11
CIRRIPEDIA	18.18	.06	.02	1.4	.01
COROPHIUM ASCHERUSICUM	18.18	.35	2.29	48.1	.48
MALACOSTRACA	18.18	3.58	3.12	121.9	1.22
EUPHAUSIACEA	18.18	.18	.28	8.4	.08
MYSIDA	18.18	.13	7.05	130.6	1.31
NEOMYSIS MERCEDIS	18.18	.22	17.22	317.0	3.18
CRANGONIDAE	18.18	.18	.56	13.4	.13
CRUSTACEA	18.18	.25	.02	4.9	.05
PSOCOPTERA	18.18	.03	.10	2.4	.02
DIPTERA-CHIRONOMIDAE	18.18	.06	.10	2.9	.03
GAMMARIDEA	18.18	.07	.74	14.8	.15
ROCK	18.18	.04	3.67	67.6	.68
ANISOGAMMARUS PUGETTENSIS	9.09	.01	.27	2.6	.03
EOGAMMARUS CONFERVICOLUS	9.09	.01	.01	.2	.00
PHOTIS BREVIPES	9.09	.04	.18	2.1	.02
CAPRELLIDAE	9.09	.01	.01	.2	.00
COSCINODISCEAE	9.09	.01	3.66	33.4	.34
TANAIDACEA	9.09	.03	.01	.4	.00
POLYCHAETA	9.09	.04	.01	.5	.00
COPEPODA	9.09	.04	.01	.5	.00
NEREIDAE	9.09	.01	.46	4.3	.04
PINNOTHERIDAE	9.09	.03	.09	1.1	.01
COROPHIUM BREVIS	9.09	.04	.27	2.9	.03
CERCOPIDAE	9.09	.01	.27	2.6	.03
COLEOPTERA	9.09	.01	.18	1.8	.02
STAPHYLINIDAE	9.09	.01	.18	1.8	.02
DIPTERA	9.09	.01	.01	.2	.00
NEMATOCERA	9.09	.01	.01	.2	.00
HELEIDAE	9.09	.01	.09	1.0	.01
COROPHIUM SALMONIS	9.09	.01	.27	2.6	.03
DOLICHOPODIDAE	9.09	.06	.18	2.2	.02
CYCLORRHAPHA	9.09	.01	.37	3.5	.03
EPHYDRIDAE	9.09	.10	.37	4.3	.04
HYMENOPTERA-CHALCIDOIDEA	9.09	.04	.18	2.1	.02
CYNIPIDAE	9.09	.03	.09	1.1	.01
ARANEAE	9.09	.03	.18	1.9	.02
UNIDENTIFIED EGG	9.09	.04	.01	.5	.00
PONTOGENEIA IVANOVI	9.09	.15	3.11	29.6	.30

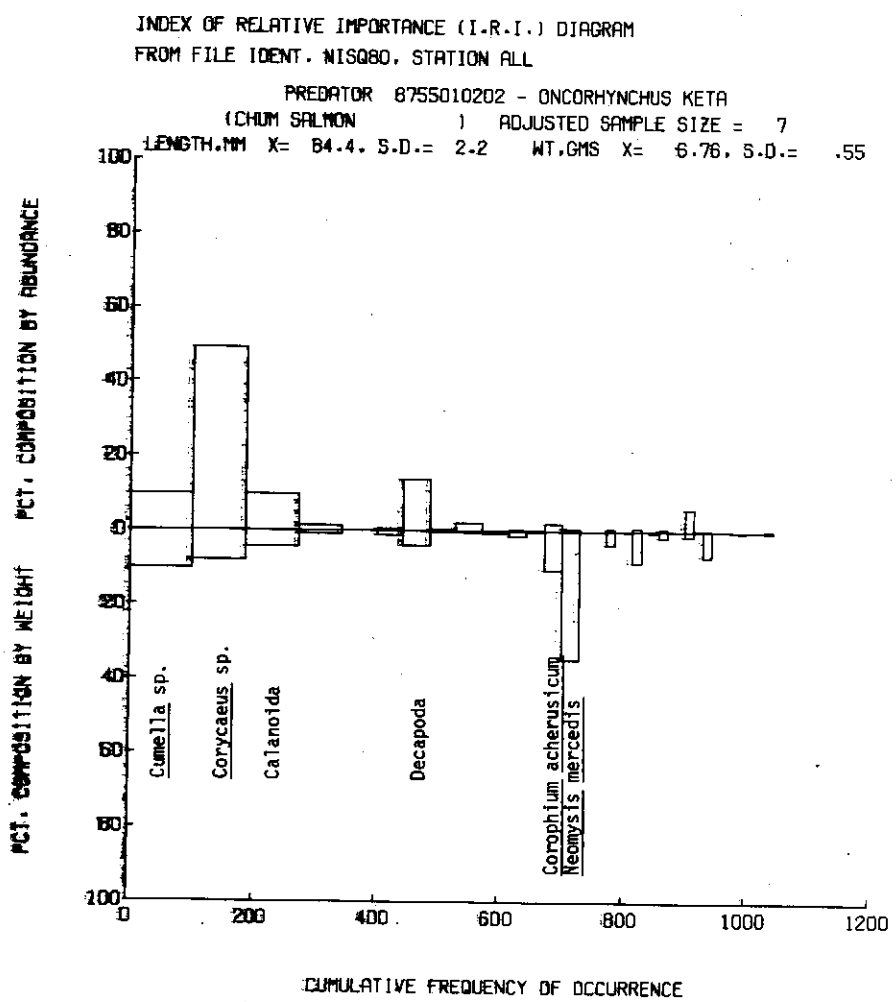
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 10. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary with fork lengths of 71-80 mm.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
CUMELLA SP.	100.00	9.90	10.20	2009.2	17.93
CORYCAEUS SP.	85.71	49.22	8.04	4908.0	43.81
CALANOIDA	85.71	9.80	4.38	1215.8	10.85
CRANGONIDAE	71.43	1.37	.75	151.4	1.35
OSTRACODA	57.14	.24	.03	15.4	.14
GAMMARIDEA	42.86	.57	1.17	74.6	.67
DECAPODA	42.86	13.78	4.07	765.1	6.83
HARPACTICOIDA	42.86	.45	.26	30.2	.27
DIKOPLEURA SP.	42.86	2.29	.35	112.8	1.01
ROCK	42.86	.07	.68	32.1	.29
COROPHIUM SP.	28.57	.35	1.32	47.9	.43
DECAPODA-BRACHYURA	28.57	.16	.09	7.3	.07
COROPHIUM ASCHERUSICUM	28.57	2.00	10.59	359.9	3.21
NEOMYSIS MERCEDIS	28.57	.66	34.65	1008.8	9.00
CRUSTACEA	14.29	.05	.01	.8	.01
CALIGOIDA	14.29	.02	.01	.5	.00
CIRRIPEDIA	14.29	.07	.01	1.1	.01
COROPHIUM BREVIS	14.29	.66	3.64	61.4	.55
COROPHIUM SALMONIS	14.29	.02	.01	.5	.00
COROPHIUM INSIDIOSUM	14.29	.05	.08	1.9	.02
PONTOGENEIA IVANOVI	14.29	.37	8.60	135.3	1.21
ANISOGAMMARUS PUGETTENSIS	14.29	.02	.01	.5	.00
ALLORCHESTES ANGUSTUS	14.29	.02	.30	7.4	.07
PHOTIS BREVIPES	14.29	.52	1.65	31.0	.28
SYNCHELIDIUM SHOEMAKERI	14.29	.02	.01	.5	.00
AMPHIPODA-HYPERIIDEA	14.29	.02	.01	.5	.00
MALACOSTRACA	14.29	6.08	1.32	105.7	.94
PLEOCYEMATA-CARIDEA	14.29	.14	.01	2.1	.02
MYSIDA	14.29	.21	6.95	102.3	.91
COPEPODA	14.29	.05	.01	.8	.01
DIPTERA	14.29	.02	.01	.5	.00
DIPTERA-CHIRONOMIDAE	14.29	.02	.01	.5	.00
EPHYDRIDAE	14.29	.02	.25	3.9	.03
ONCAEA SP.	14.29	.05	.08	1.9	.02
PLANTS AND PLANT PARTS	14.29	.02	.01	.5	.00
TANAIDACEA	14.29	.16	.25	3.9	.05

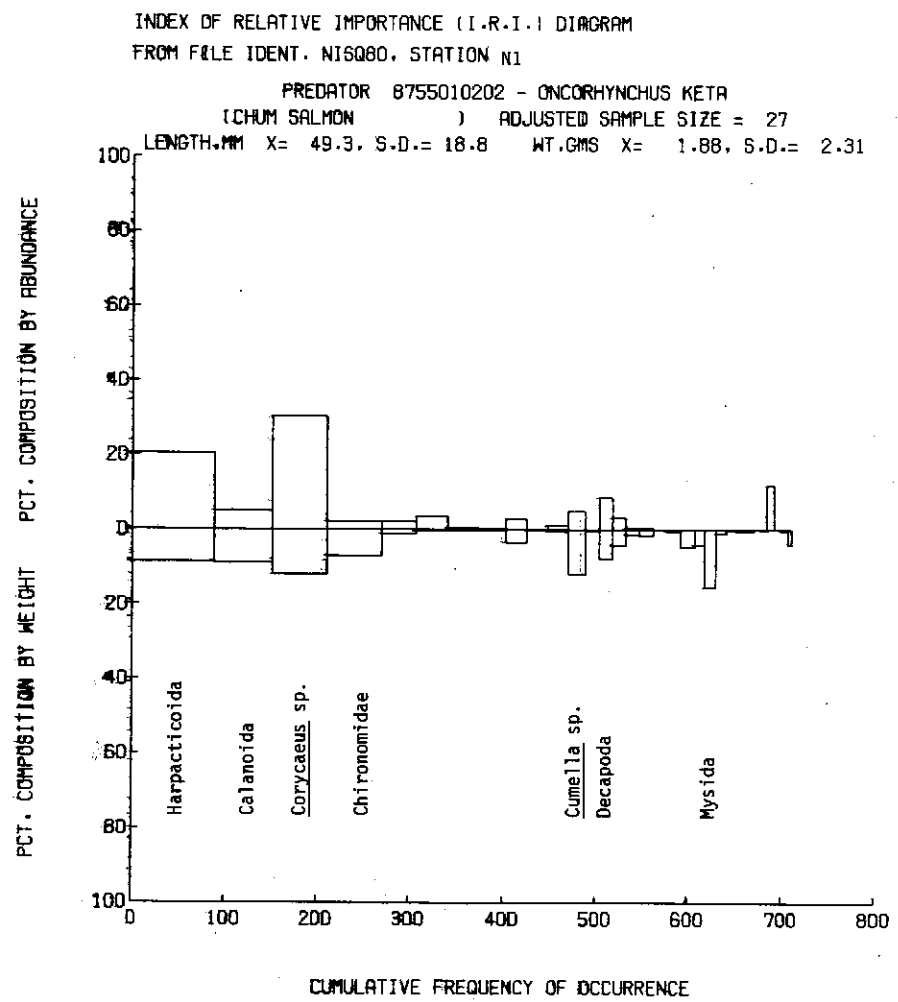
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 11. IRI diagram ant table showing major prey of juvenile chum caught in the Nisqually Estuary with fork lengths of 81-90 mm.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	88.89	20.37	8.58	2573.9	31.70
CALANOIDA	62.96	5.06	8.70	866.0	10.67
CORYCAEUS SP.	59.26	30.26	11.91	2498.7	30.78
DIPTERA-CHIRONOMIDAE	59.26	2.34	6.95	550.7	6.78
EUPHAUSIACEA	37.04	2.23	1.10	123.1	1.52
COPEPODA	33.33	3.69	.26	131.9	1.62
CIRRIPEDIA	33.33	.56	.26	27.3	.34
GAMMARIDEA	29.63	.18	.36	15.9	.20
MALACOSTRACA	22.22	3.00	3.44	143.0	1.76
OSTRACODA	22.22	.14	.15	6.4	.08
DIKOPLEURA SP.	22.22	1.23	.44	37.1	.46
CUMELLA SP.	18.52	4.92	11.88	311.1	3.83
CRUSTACEA	14.81	.06	.21	4.0	.05
DECAPODA	14.81	8.54	7.59	238.9	2.94
PLEOCYEMATA-CARIDEA	14.81	3.24	4.11	109.0	1.34
INSECTA	14.81	.40	1.18	23.4	.29
NEMATOCERA	14.81	.38	1.39	26.2	.32
POLYCHAETA	14.81	.05	.04	1.3	.02
COROPHIUM SP.	14.81	.12	.42	7.9	.10
ROCK	14.81	.07	4.68	70.5	.87
DECAPODA-BRACHYURA	11.11	.14	3.91	45.0	.55
MYSIDA	11.11	.21	15.37	173.1	2.13
EPHYDRIDAE	11.11	.21	.97	13.2	.16
COLLEMBOLA	11.11	.04	.12	1.7	.02
DIPTERA	11.11	.04	.20	2.7	.03
CYCLORRHAPHA	7.41	.02	.49	3.8	.05
ONCAEA SP.	7.41	.02	.02	.3	.00
HELEIDAE	7.41	.02	.11	1.0	.01
UNIDENTIFIED EGG	7.41	11.87	.02	88.1	1.09
PLANTS AND PLANT PARTS	7.41	.07	.02	.7	.01
CRANGONIDAE	7.41	.25	.30	4.1	.05
COSCINODISCEAE	3.70	.01	3.89	14.4	.18

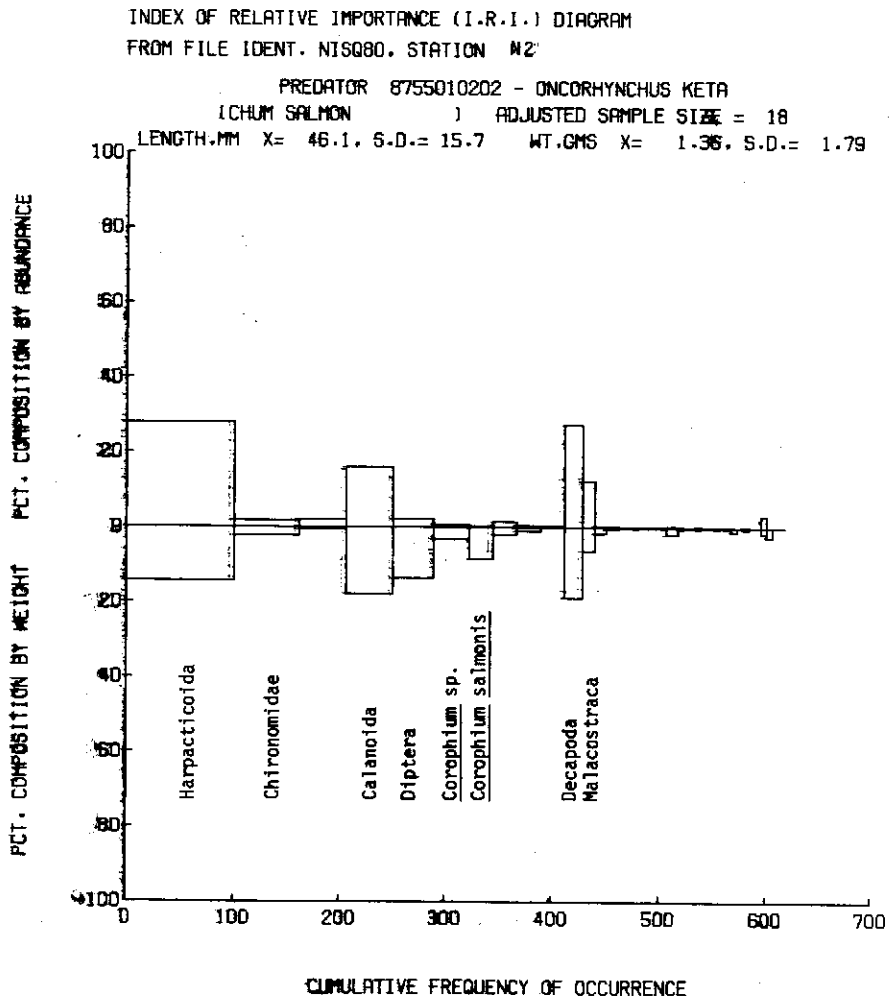
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 12. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary at station N1 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	100.00	27.97	14.31	4228.5	51.12
DIPTERA-CHIRONOMIDAE	61.11	1.75	2.23	242.7	2.93
CORYCAEUS SP.	44.44	2.12	.65	123.3	1.49
CALANOIDA	44.44	16.08	17.73	1502.8	18.17
DIPTERA	38.89	2.17	13.51	609.7	7.37
COROPHIUM SP.	33.33	.80	3.11	130.3	1.58
COROPHIUM SALMONIS	22.22	.38	8.48	196.8	2.38
CRANGONIDAE	22.22	1.70	2.00	82.1	.99
CUMELLA SP.	22.22	.52	.88	31.1	.38
OSTRACODA	22.22	.38	.15	11.8	.14
DECAPODA	16.67	27.50	18.88	773.0	9.34
MALACOSTRACA	11.11	12.55	6.18	208.1	2.52
COROPHIUM BREVIS	11.11	.38	1.57	21.7	.26
INSECTA	11.11	.47	.42	9.9	.12
APHIDIDAE	11.11	.09	.08	1.9	.02
COLEOPTERA	11.11	.14	.08	2.4	.03
GAMMARIDEA	11.11	.09	.08	1.9	.02
NEMATOCERA	11.11	.09	.08	1.9	.02
COROPHIUM INSIDIOSUM	11.11	.33	1.92	25.0	.30
EUPHAUSIACEA	5.56	.09	.38	2.7	.03
TANAIDACEA	5.56	.05	.04	.5	.01
COPEPODA	5.56	.09	.04	.7	.01
DECAPODA-BRACHYURA	5.56	.28	.38	3.7	.04
CIRRIPEDIA	5.56	.14	.04	1.0	.01
COLLEMBOLA	5.56	.05	.04	.5	.01
COROPHIUM ASCHERUSICUM	5.56	.05	.38	2.4	.03
ARANEAE	5.56	.05	.04	.5	.01
STAPHYLINIDAE	5.56	.05	.38	2.4	.03
MYSIDA	5.56	.05	1.15	6.7	.08
POLYCHAETA	5.56	.05	.04	.5	.01
HELEIDAE	5.56	.19	.38	3.2	.04
EOGAMMARUS CONFERVICOLUS	5.56	.05	.04	.5	.01
HYMENOPTERA	5.56	.05	.04	.5	.01
OIKOPLEURA SP.	5.56	3.11	1.53	25.8	.31
ONCORHYNCHUS SP.	5.56	.05	2.69	15.2	.18
PLANTS AND PLANT PARTS	5.56	.05	.04	.5	.01
ROCK	5.56	.05	.04	.5	.01

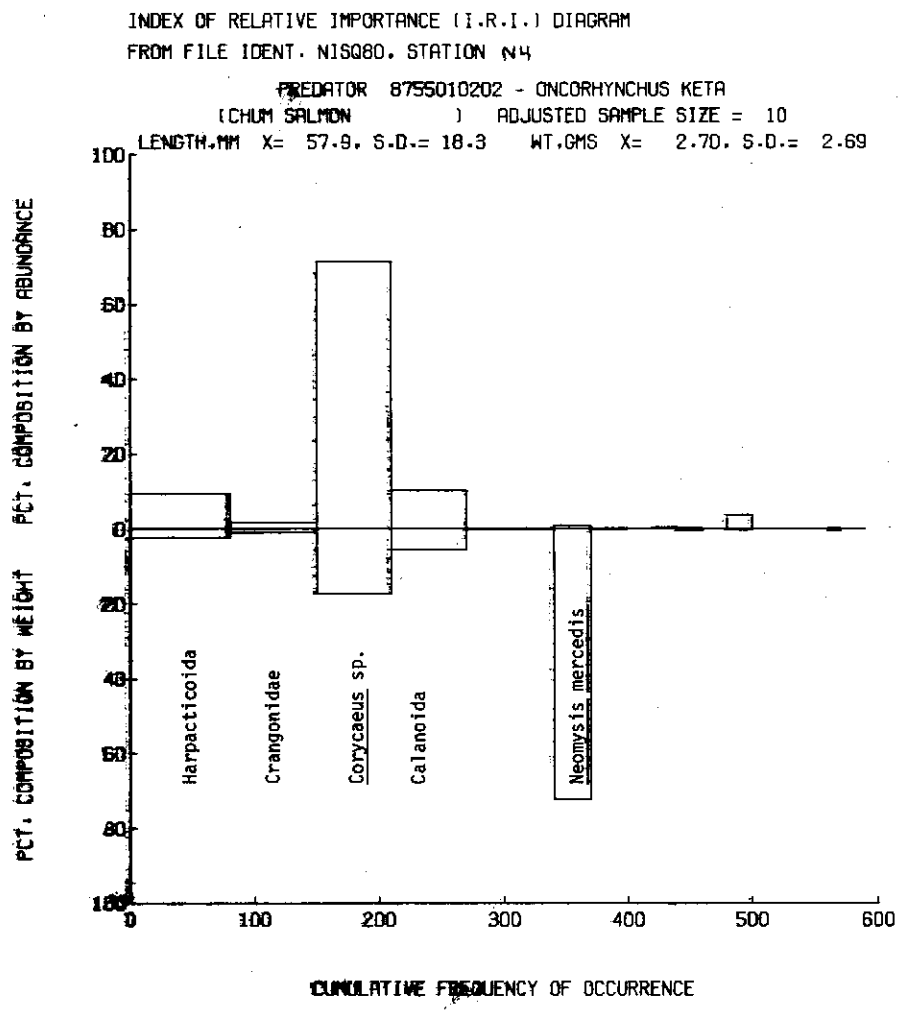
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 13. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary at station N2 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	80.00	9.45	2.17	929.0	9.53
CRANGONIDAE	70.00	1.81	1.03	198.7	2.04
CORYCAEUS SP.	60.00	71.54	17.29	5329.8	54.65
CALANOIDA	60.00	10.31	5.42	943.6	9.68
OSTRACODA	40.00	.25	.05	11.9	.12
CUMELLA SP.	30.00	.22	.04	7.8	.08
NEOMYSIS MERCEDIS	30.00	1.01	72.17	2195.4	22.51
DIPTERA-CHIRONOMIDAE	30.00	.20	.15	10.5	.11
DECAPODA	20.00	.10	.03	2.5	.03
CRUSTACEA	20.00	.45	.03	9.4	.10
INSECTA	20.00	.22	.52	14.8	.15
COROPHIUM SP.	20.00	.05	.14	3.8	.04
DIKOPLEURA SP.	20.00	3.83	.26	81.9	.84
COROPHIUM SALMONIS	10.00	.02	.01	.4	.00
DECAPODA-BRACHYURA	10.00	.02	.01	.4	.00
AMPHIPODA-HYPERIIDEA	10.00	.02	.01	.4	.00
NEMATOCERA	10.00	.07	.01	.9	.01
NEMATODA	10.00	.02	.01	.4	.00
DOLICHOPODIDAE	10.00	.02	.13	1.5	.02
PLEOCYEMATA-CARIDEA	10.00	.25	.50	7.5	.08
OSTEICHTHYES	10.00	.07	.01	.9	.01
UNIDENTIFIED EGG	10.00	.05	.01	.6	.01

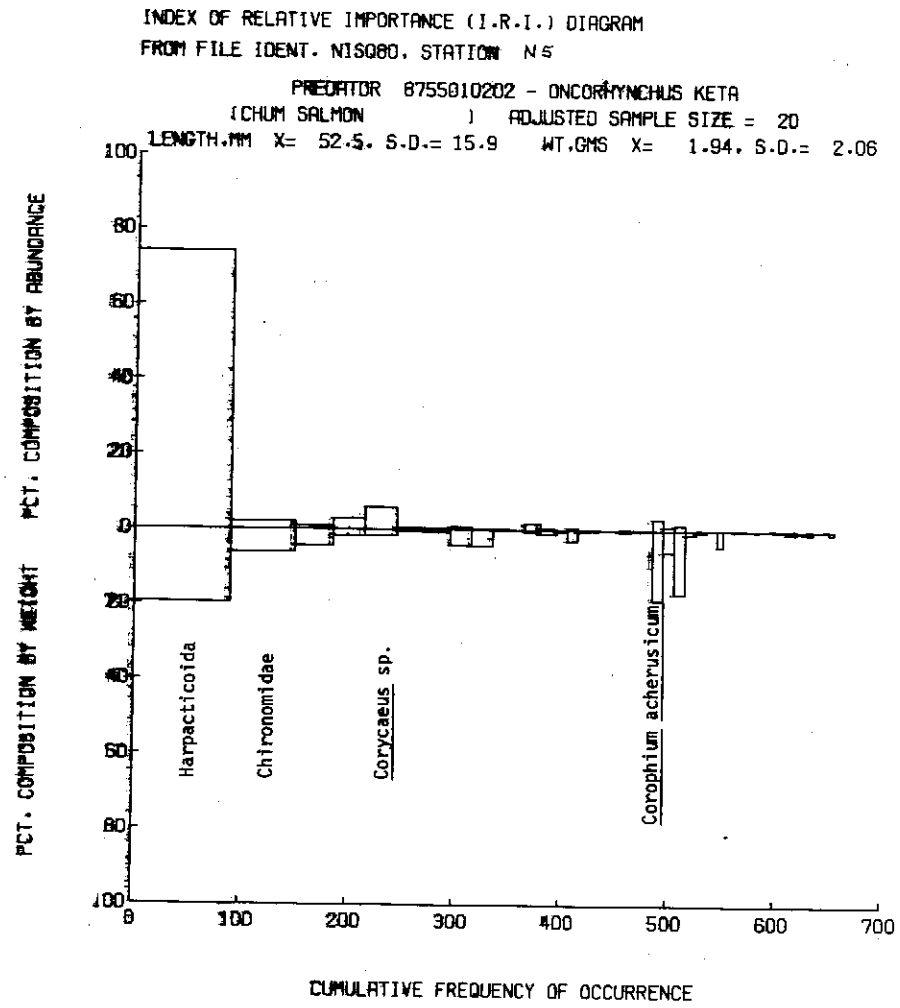
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 14. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary at station N4 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	90.00	74.15	19.51	8429.9	81.30
DIPTERA-CHIRONOMIDAE	60.00	2.09	6.12	492.6	4.75
COROPHIUM SP.	35.00	1.00	4.33	186.6	1.80
CALANOIDA	30.00	3.00	1.51	135.3	1.31
CORYCAEUS SP.	30.00	5.92	1.62	226.1	2.18
TANAIDACEA	25.00	.38	.42	20.0	.19
DOLICHOPODIDAE	25.00	.44	.52	23.9	.23
GAMMARIDEA	20.00	.88	4.05	98.6	.95
DIPTERA	20.00	.29	4.29	91.7	.88
CIRRIPEDIA	15.00	.18	.04	3.2	.03
NEMATOCERA	15.00	.09	.04	1.9	.02
PLEOCYEMATA-CARIDEA	15.00	1.80	.61	36.1	.35
CRANGONIDAE	15.00	.44	1.12	23.4	.23
ANISOGAMMARUS PUGETTENSIS	10.00	.06	.38	4.4	.04
PHOTIS BREVIPES	10.00	.74	2.70	34.3	.33
DECAPODA	10.00	.15	.38	5.3	.05
LEPTOCHELIA SP.	10.00	.12	.13	2.5	.02
ACARINA	10.00	.09	.02	1.1	.01
DECAPODA-BRACHYURA	10.00	.12	.02	1.4	.01
INSECTA	10.00	.24	.37	6.0	.06
COLEOPTERA	10.00	.06	.26	3.2	.03
ARANEAE	10.00	.06	.02	.8	.01
COROPHIUM ASCHERUSICUM	10.00	3.15	18.64	217.9	2.10
COROPHIUM BREVIS	10.00	.91	5.76	66.8	.64
PONTOGENEIA IVANOVI	10.00	1.38	16.92	183.1	1.77
CYCLORRHAPHA	10.00	.09	1.10	11.9	.11
EPHYDRIDAE	10.00	.26	.49	7.6	.07
ROCK	10.00	.06	.02	.8	.01
NEOMYSIS MERCEDIS	5.00	.06	4.17	21.1	.20
CAPRELLIDAE	5.00	.03	.01	.2	.00
EUPHAUSIACEA	5.00	.03	.01	.2	.00
CUMELLA SP.	5.00	.15	.12	1.3	.01
COPEPODA	5.00	.15	.01	.8	.01
GASTROPODA	5.00	.09	.01	.5	.00
ISOPODA	5.00	.03	.01	.2	.00
PINNOTHERIDAE	5.00	.06	.12	.9	.01
POLYCHAETA	5.00	.09	.01	.5	.00
PSOCOPTERA	5.00	.03	.01	.2	.00
CYCLOPOIDA	5.00	.24	.01	1.2	.01
STAPHYLINIDAE	5.00	.03	.25	1.4	.01
ONCAEA SP.	5.00	.06	.12	.9	.01
NEREIDAE	5.00	.03	.61	3.2	.03
HELEIDAE	5.00	.18	.74	4.6	.04
COROPHIUM SALMONIS	5.00	.03	.25	1.4	.01
DIPTERA-BRACHYCERA	5.00	.06	.61	3.4	.03
COROPHIUM INSIDIOSUM	5.00	.21	.74	4.7	.05
CALIGOIDA	5.00	.03	.01	.2	.00
CRUSTACEA	5.00	.09	.01	.5	.00
DIKOPLEURA SP.	5.00	.18	.01	.9	.01
ALLORCHESTES ANGUSTUS	5.00	.03	.74	3.8	.04

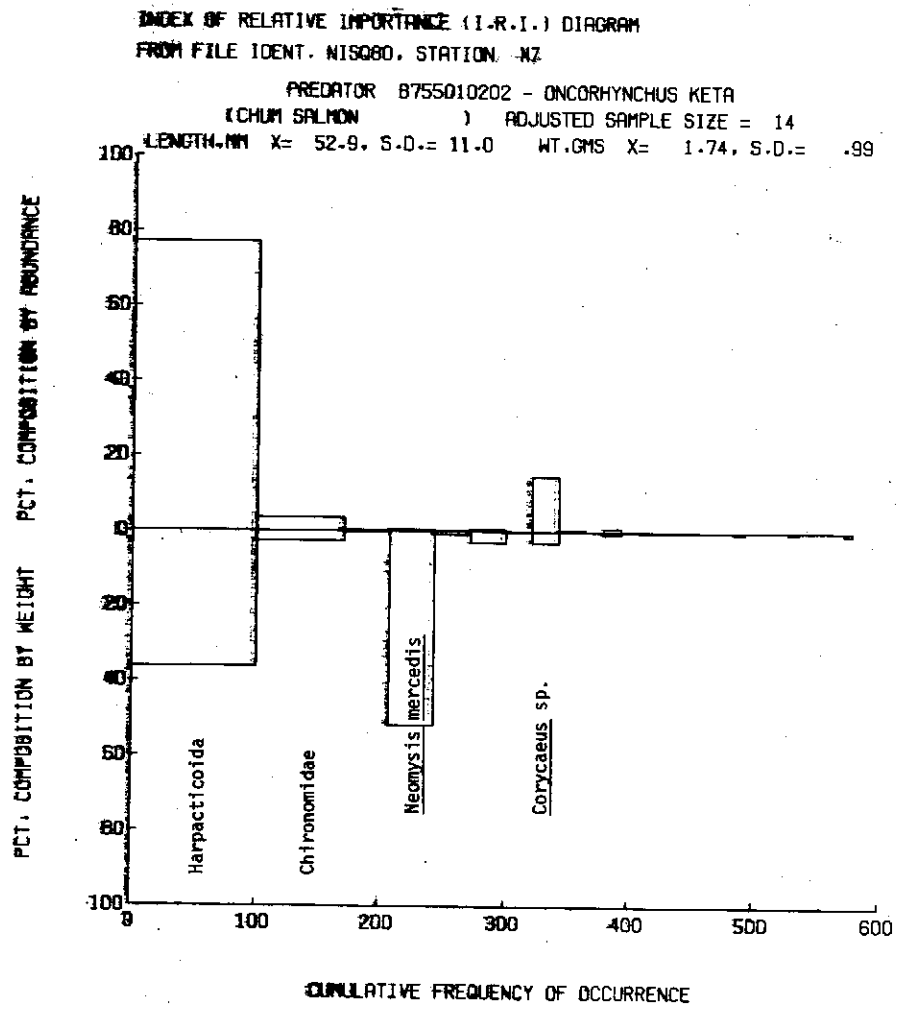
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 15. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary at station N5 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	100.00	77.07	36.22	11329.4	79.55
DIPTERA-CHIRONOMIDAE	71.43	3.63	2.69	451.7	3.17
COLEOPTERA	35.71	.39	.09	17.2	.12
NEOMYSIS MERCEDIS	35.71	.60	51.77	1870.4	13.13
DIPTERA	28.57	.25	.78	29.3	.21
COROPHIUM SP.	28.57	.56	3.01	102.0	.72
ACARINA	21.43	.11	.06	3.5	.02
CORYCAEUS SP.	21.43	14.60	2.99	376.9	2.65
DECAPODA	21.43	.35	.06	8.8	.06
GAMMARIDEA	14.29	.11	.04	2.0	.01
CALANOIDA	14.29	1.02	.58	22.8	.16
OITHONA SP.	14.29	.25	.04	4.1	.03
INSECTA	14.29	.07	.04	1.5	.01
MALACOSTRACA	14.29	.07	.04	1.5	.01
ARANEAE	14.29	.11	.04	2.0	.01
LEPTOCHELIA SP.	14.29	.11	.04	2.0	.01
HYMENOPTERA	14.29	.07	.04	1.5	.01
AMPHIPODA-HYPERIIDEA	7.14	.07	.02	.6	.00
TANAIDACEA	7.14	.04	.87	2.9	.02
CRANGONIDAE	7.14	.04	.02	.4	.00
DECAPODA-BRACHYURA	7.14	.11	.02	.9	.01
COPEPODA	7.14	.04	.02	.4	.00
COLLEMBOLA	7.14	.04	.02	.4	.00
THYSANOPTERA	7.14	.04	.02	.4	.00
APHIDIDAE	7.14	.04	.87	2.9	.02
CYCLOPOIDA	7.14	.07	.02	.6	.00
OSTRACODA	7.14	.04	.02	.4	.00
NEMATOCERA	7.14	.04	.02	.4	.00
COROPHIUM SALMONIS	7.14	.04	.02	.4	.00
EPHYDRIDAE	7.14	.04	.02	.4	.00
COROPHIUM INSIDIOSUM	7.14	.04	.36	4.2	.03

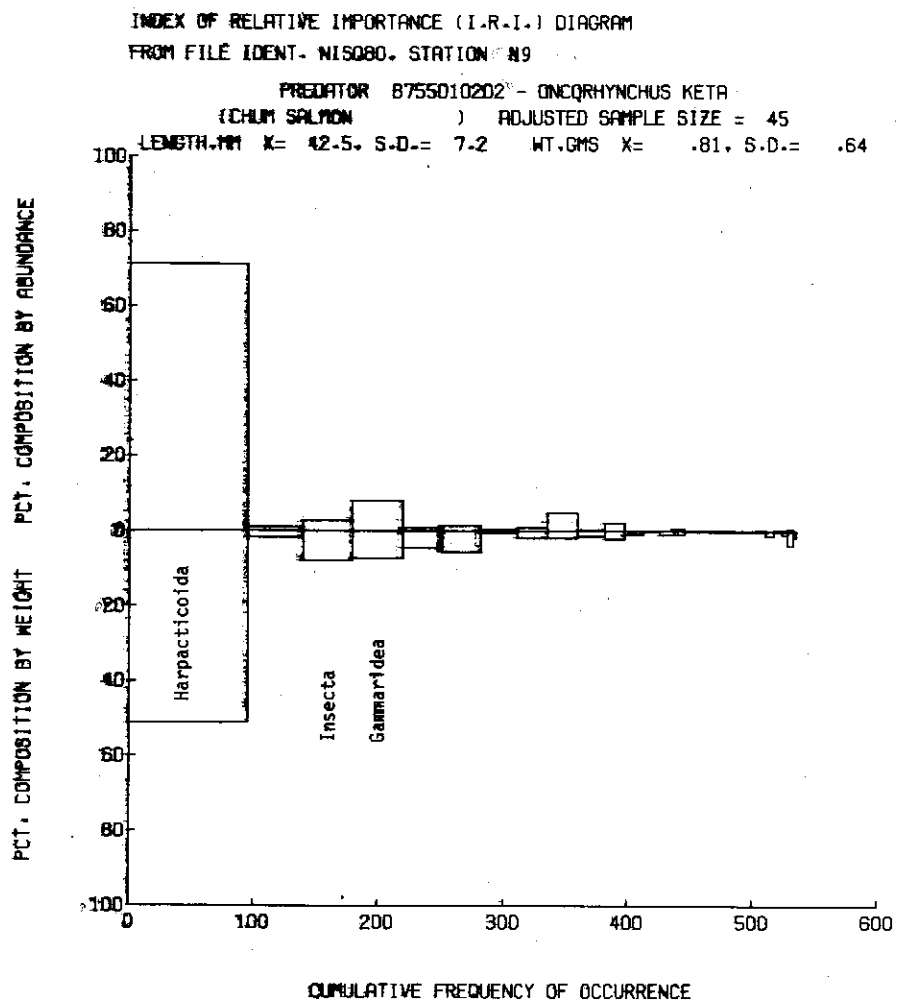
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 16. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary at station N7 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	95.56	71.04	51.27	11687.2	85.16
DIPTERA-CHIRONOMIDAE	44.44	1.06	1.69	122.2	.89
INSECTA	40.00	2.79	8.00	431.7	3.15
GAMMARIDEA	40.00	8.04	7.28	612.7	4.46
DIPTERA	31.11	.90	4.44	166.1	1.21
COROPHIUM SP.	31.11	1.43	5.56	217.7	1.59
COLLEMBOLA	28.89	.55	.44	28.8	.21
NEMATOCERA	24.44	.88	1.75	64.4	.47
CORYCAEUS SP.	24.44	4.95	1.75	163.8	1.19
APHIDIDAE	22.22	.43	1.33	39.1	.28
CALANOIDA	15.56	2.29	2.10	68.2	.50
CERCOPIDAE	15.56	.20	.71	14.1	.10
OSTRACODA	13.33	.18	.12	4.0	.03
COROPHIUM BREVIS	11.11	.18	1.01	13.2	.10
EOGAMMARUS CONFERVICOLUS	8.89	.70	.83	13.6	.10
COLEOPTERA	8.89	.15	.08	2.1	.01
ARANEAE	8.89	.18	.08	2.3	.02
MALACOSTRACA	8.89	.20	.08	2.5	.02
CUMELLA SP.	8.89	.23	.44	6.0	.04
ROCK	8.89	.13	.08	1.8	.01
STAPHYLINIDAE	6.67	.08	.24	2.1	.02
THYSANOPTERA	6.67	.08	.06	.9	.01
CRANGONIDAE	6.67	.48	.24	4.8	.03
COROPHIUM SALMONIS	6.67	.10	1.23	8.9	.06
COPEPODA	6.67	.35	.06	2.7	.02
PHOTIS BREVIPES	4.44	.18	1.01	5.3	.04
DECAPODA-BRACHYURA	4.44	.63	3.85	19.9	.15
INSECTA-LEPIDOPTERA	2.22	.03	1.61	3.6	.03

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 17. IRI diagram and table showing major prey of juvenile chum caught in the Nisqually Estuary at station N9 in 1980.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) TABLE
USING FILEID= NISQ79, STATION= ALL FOR PLOT
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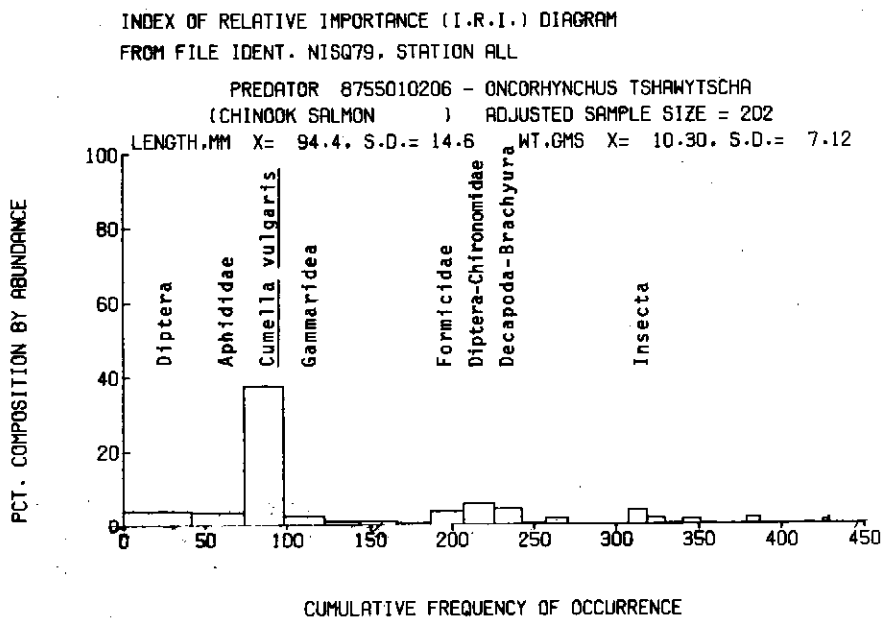
PREY ITEM	FREQ OCCUR	NUM. COMP.	PERCENT TOTAL IRI
DIPTERA	41.09	3.85	8.59
APHIDIDAE	32.67	3.64	6.46
CUMELLA VULGARIS	24.26	37.74	49.73
GAMMARIDEA	24.26	2.81	3.70
HEMIPTERA	21.78	1.31	1.55
CERCOPIDAE	21.78	1.44	1.70
NEMATOCERA	20.79	1.00	1.13
FORMICIDAE	20.30	4.11	4.53
DIPTERA-CHIRONOMIDAE	18.32	6.26	6.23
DECAPODA-BRACHYURA	17.33	4.81	4.53
EMPIDIDAE	14.36	.87	.68
MYSIDA	13.37	2.21	1.61
CIRRIPEDIA	12.87	.50	.35
ARANEAE	12.38	.37	.25
COLEOPTERA	11.39	.22	.14
INSECTA	11.39	4.47	2.77
HARPACTICOIDA	10.89	2.27	1.34
COROPHIUM SP.	10.89	.81	.48
PSOCOPTERA	10.89	2.00	1.18
OSTRACODA	9.41	.75	.38
HYMENOPTERA	9.41	.31	.16
EOGAMMARUS CONFERVICOLUS	9.41	.45	.23
PSYLLIDAE	7.43	2.46	.99
APOCRITA	6.93	.40	.15
CALANOIDA	6.93	.31	.12
EPHYDRIDAE	6.44	.46	.16
AMPHIPODA-HYPERIIDEA	6.44	.16	.06
NEREIDAE	5.94	1.03	.33
PORCELLANIDAE	5.45	.73	.22
PLEOCYEMATA-CARIDEA	2.97	1.55	.25
COROPHIUM BREVIS	.50	2.39	.06
OIKOPLEURA SP.	.50	2.23	.06

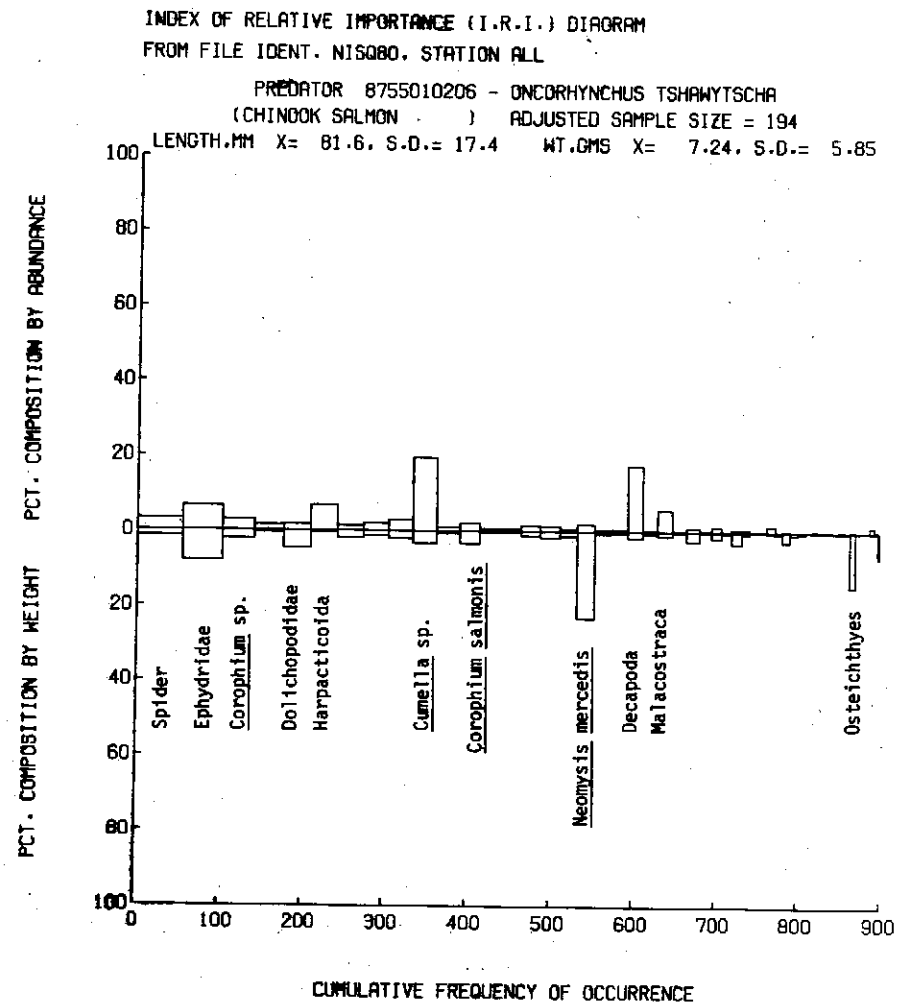
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT.



Appendix C, Figure 18. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary in 1979.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
ARANEAE	54.12	3.08	1.46	245.6	5.43
EPHYDRIDAE	47.94	6.70	7.90	700.1	15.47
COROPHIUM SP.	39.18	2.86	2.16	196.3	4.34
DIPTERA-CHIRONOMIDAE	35.05	1.58	.42	70.1	1.55
DOLICHOPODIDAE	32.99	1.81	4.54	209.3	4.63
HARPACTICOIDA	32.47	6.96	.40	239.1	5.28
DIPTERA	31.96	1.44	1.73	101.0	2.23
INSECTA	30.41	2.12	1.19	100.5	2.22
HELEIDAE	29.90	2.92	1.91	144.3	3.19
CUMELLA SP.	28.35	19.64	3.24	648.9	14.34
APHIDIDAE	27.32	1.06	.50	42.5	.94
COROPHIUM SALMONIS	24.74	2.16	3.34	136.0	3.01
LEPTOCHELIA SP.	24.23	.75	.32	26.1	.58
NEMATOCERA	24.23	.64	.21	20.5	.45
COROPHIUM INSIDIOSUM	23.20	1.64	1.10	63.5	1.40
DECAPODA-BRACHYURA	23.20	1.41	1.65	71.1	1.57
CYCLORRHAPHA	21.13	.67	1.20	39.4	.87
NEOMYSIS MERCEDIS	21.13	1.93	23.22	531.5	11.75
DIPTERA-BRACHYCERA	20.10	.57	.50	21.6	.48
MYCETOPHILOIDEA	19.59	.67	.21	17.3	.38
DECAPODA	18.56	17.68	1.52	356.3	7.87
COLEOPTERA	18.04	.46	.50	17.3	.38
MALACOSTRACA	18.04	5.77	1.11	124.1	2.74
PSOCOPTERA	17.53	.44	.16	10.6	.23
GAMMARIDEA	15.98	1.16	2.42	57.2	1.26
HYMENOPTERA	14.43	.25	.12	5.4	.12
COROPHIUM ASCHERUSICUM	12.37	1.47	1.83	40.8	.90
HEMIPTERA	12.37	.28	.34	7.7	.17
EOGAMMARUS CONFERVICOLUS	11.86	.64	3.13	44.7	.99
PINNOTHERIDAE	10.31	.66	.67	13.7	.30
HYMENOPTERA-CHALCIDOIDEA	10.31	.21	.07	2.9	.06
PLANTS AND PLANT PARTS	10.31	.17	.08	2.5	.06
PLEOCYEMATA-CARIDEA	9.79	1.75	.33	20.3	.45
CRUSTACEA	9.28	.25	.37	5.8	.13
MYSIDA	9.28	.41	2.67	28.6	.63
SALDIDAE	8.76	.24	.69	8.1	.18
CERCOPIDAE	8.76	.18	.17	3.0	.07
ROCK	8.76	.19	.02	1.9	.04
CYMIPIDAE	8.25	.37	.08	3.7	.08
TANAIDACEA	8.25	.23	.07	2.5	.05
CORYCAEUS SP.	8.25	.47	.01	4.0	.09
PARAPHOXUS SPINOSUS	7.22	.13	.08	1.6	.03
EMPIDIDAE	7.22	.30	.31	4.4	.10
AMPHIPODA-HYPERIIDEA	6.70	.16	.05	1.4	.03
OSTEICHTHYES	6.19	.17	14.62	91.5	2.02
STAPHYLINIDAE	6.19	.12	.04	1.0	.02
COLLEMBOLA	6.19	.14	.03	1.0	.02
ACARINA	5.15	.11	.01	.6	.01
CRANGONIDAE	5.15	1.38	.32	8.8	.19
PORCELLANIDAE	5.15	.19	.05	1.2	.03
AMMODYTES HEXAPTERUS	1.55	.04	6.77	10.5	.23

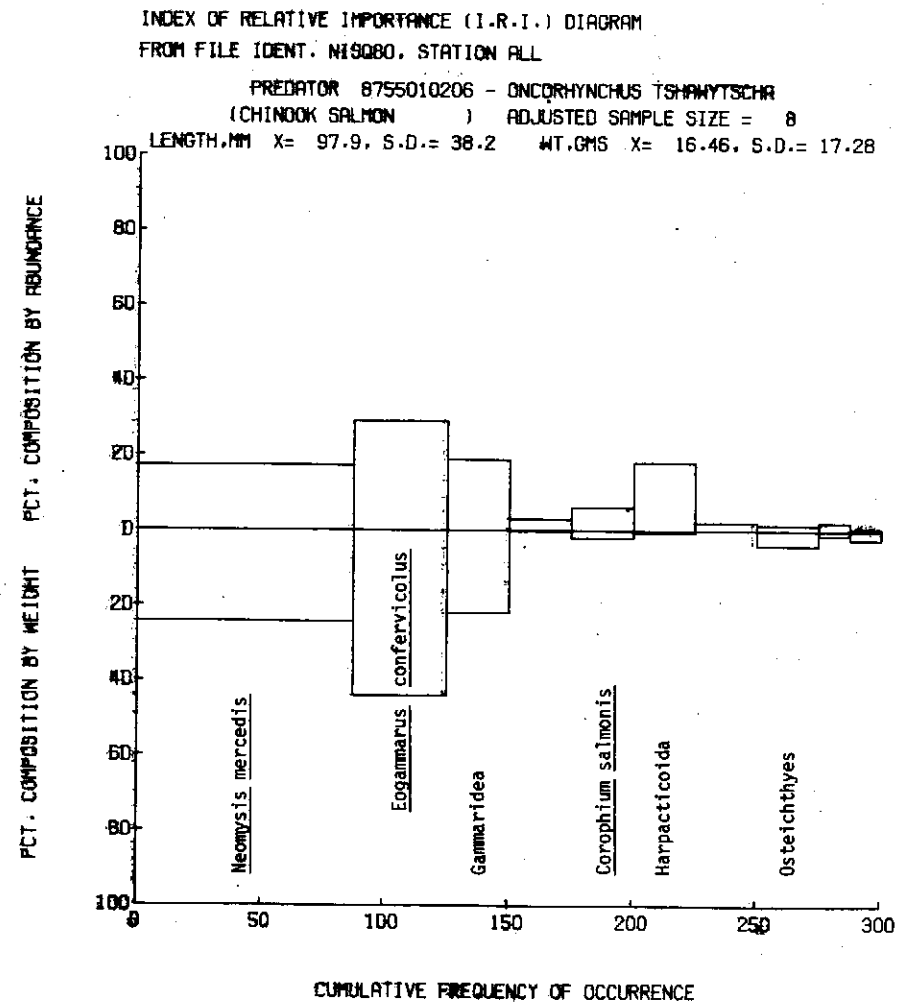
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 19. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
NEOMYSIS MERCEDIS	87.50	17.32	24.27	3639.5	43.16
EOGAMMARUS CONFERVICOLUS	37.50	29.13	44.00	2742.5	32.52
GAMMARIDEA	25.00	18.90	21.94	1021.0	12.11
COROPHIUM SP.	25.00	3.15	.12	81.8	.97
COROPHIUM SALMONIS	25.00	6.30	1.88	204.6	2.43
HARPACTICOIDA	25.00	18.11	.44	463.8	5.50
PHASCOLOSOMA SP.	25.00	2.36	.02	59.6	.71
OSTEICHTHYES	25.00	1.57	3.99	139.1	1.65
MALACOSTRACA	12.50	2.36	1.11	43.4	.51
DOLICHOPODIDAE	12.50	.79	2.22	37.5	.45

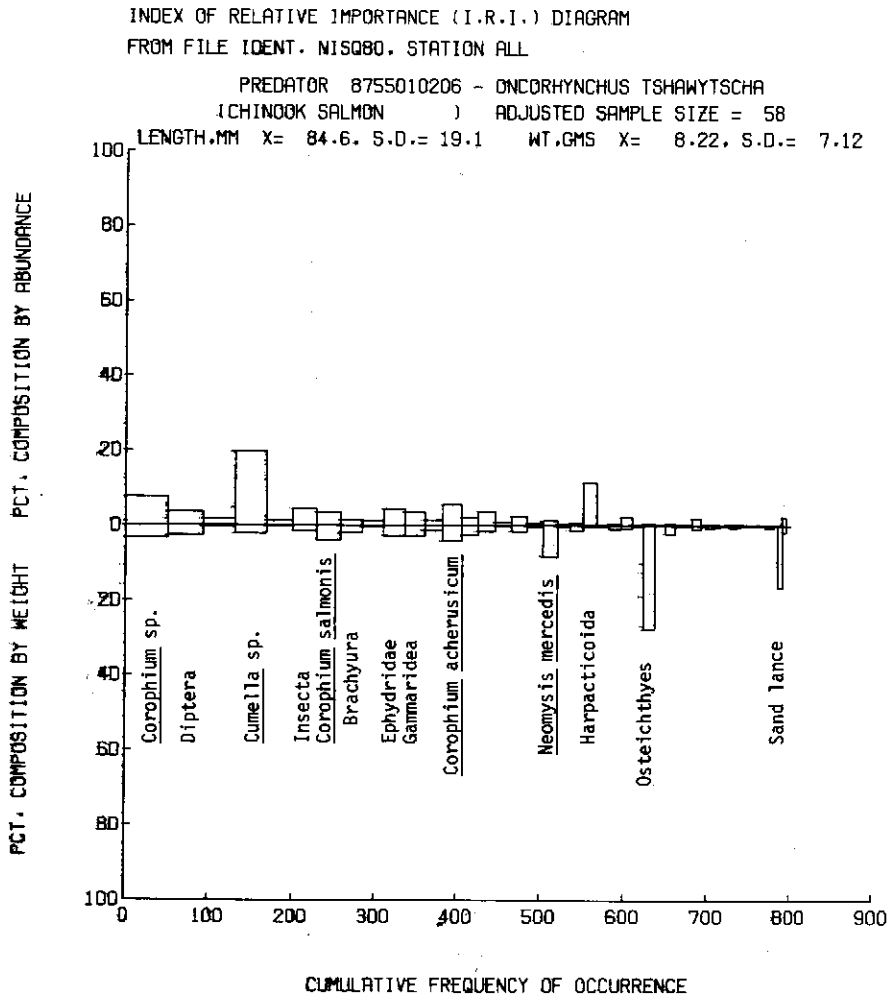
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 20. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary in April, 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
COROPHIUM SP.	50.00	7.67	3.36	551.8	12.69
DIPTERA	43.10	3.57	2.55	263.9	6.07
ARANEAE	37.93	1.73	.49	84.4	1.94
CUMELLA SP.	37.93	19.88	2.10	833.8	19.18
LEPTOCHELIA SP.	31.03	1.17	.16	41.2	.95
INSECTA	29.31	4.47	1.40	171.9	3.95
COROPHIUM SALMONIS	29.31	3.60	3.99	222.6	5.12
EOGAMMARUS CONFERVICOLUS	25.86	1.50	2.02	91.1	2.10
DIPTERA-CHIRONOMIDAE	25.86	1.23	.21	37.3	.86
EPHYDRIDAE	25.86	4.50	2.79	188.6	4.34
GAMMARIDEA	24.14	3.54	2.80	152.9	3.52
CYCLORRHAPHA	22.41	1.47	1.18	59.3	1.36
COROPHIUM ASCHERUSICUM	22.41	5.70	4.04	218.4	5.02
DECAPODA-BRACHYURA	20.69	2.33	2.50	100.1	2.30
COROPHIUM INSIDIOSUM	20.69	3.80	1.51	109.9	2.53
TANAIDACEA	18.97	.87	.14	19.1	.44
PINNOTHERIDAE	18.97	2.43	1.54	75.3	1.73
NEMATOCERA	18.97	.83	.23	20.2	.46
NEOMYSIS MERCEDIS	17.24	1.40	8.27	166.7	3.83
COLEOPTERA	15.52	.37	.28	10.1	.23
DOLICHOPODIDAE	15.52	.67	1.32	30.8	.71
HARPACTICOIDA	15.52	11.44	.47	184.8	4.25
CERCOPIDAE	15.52	.43	.14	8.9	.20
CRUSTACEA	13.79	.53	.84	18.9	.44
HELEIDAE	13.79	2.20	.76	40.8	.94
AMPHIPODA-HYPERIIDEA	13.79	.47	.07	7.5	.17
OSTEICHTHYES	13.79	.63	27.65	390.1	8.97
HYMENOPTERA	12.07	.27	.03	3.6	.08
MYSIDA	12.07	.60	2.14	33.1	.76
HEMIPTERA	10.34	.33	.27	6.2	.14
DECAPODA	10.34	.43	.28	7.4	.17
COROPHIUM BREVIS	10.34	2.03	.97	31.0	.71
CAPRELLIDAE	8.62	.20	.24	3.8	.09
MALACOSTRACA	6.90	.47	.75	8.4	.19
SALDIDAE	6.90	.27	.46	5.0	.12
DIPTERA-BRACHYCERA	6.90	.13	.08	1.5	.03
EMPIDIDAE	6.90	.50	.34	5.8	.13
CRANGONIDAE	6.90	.47	.57	7.2	.16
APHIDIDAE	6.90	.40	.21	4.2	.10
PARAPHOXUS SPINOSUS	6.90	.23	.07	2.1	.05
CALANOIDA	6.90	.13	.02	1.0	.02
COROPHIUM SPINICORNE	6.90	.17	.15	2.2	.05
PLANTS AND PLANT PARTS	6.90	.17	.04	1.5	.03
PLEOCYEMATA-CARIDEA	5.17	.20	.50	3.6	.08
ANISOGAMMARUS PUGETTENSIS	5.17	.17	.55	3.7	.09
COLLEMBOLA	5.17	.20	.00	1.1	.02
AMMODYTES HEXAPTERUS	5.17	.20	16.55	86.6	1.99
PONTOGENEIA IVANOVI	5.17	2.30	1.78	21.1	.49
ROCK	5.17	.13	.00	.7	.02

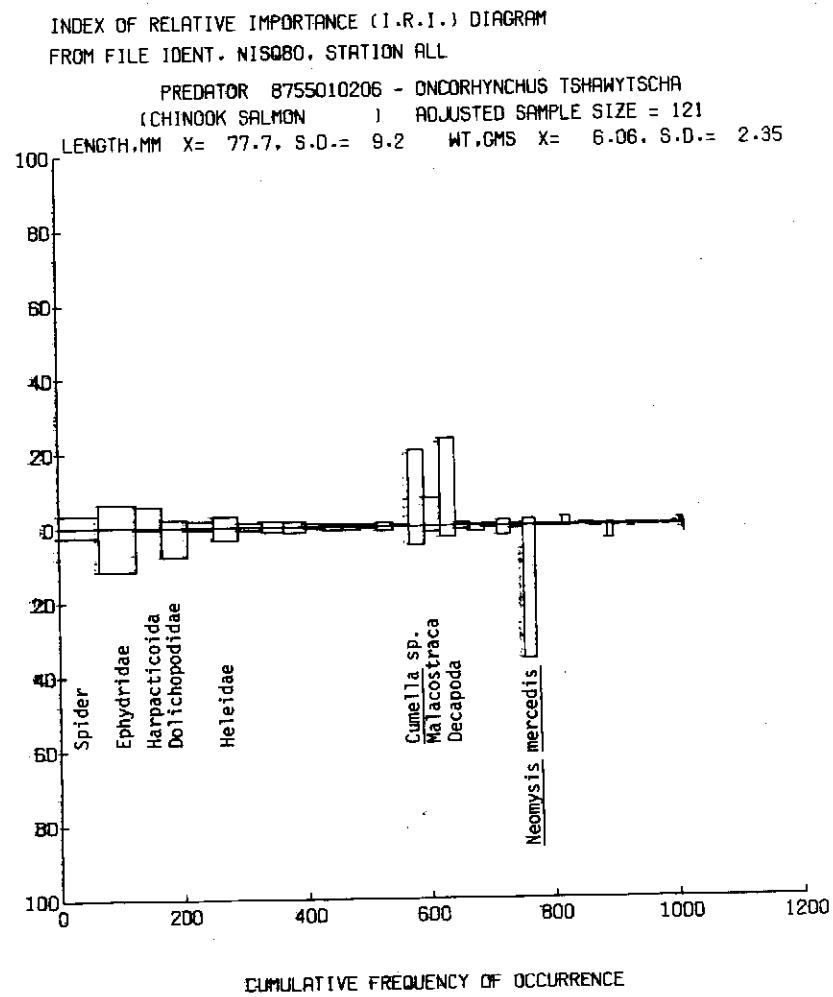
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 21. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary in May, 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
ARANEAE	64.46	3.46	2.46	382.8	6.77
EPHYDRIDAE	60.33	6.41	11.54	1082.9	19.16
HARPACTICOIDA	42.98	5.72	.39	262.3	4.64
DOLICHOPODIDAE	42.15	2.17	7.92	425.3	7.53
DIPTERA-CHIRONOMIDAE	42.15	1.72	.64	99.4	1.76
HELEIDAE	39.67	3.15	3.29	255.7	4.53
APHIDIDAE	36.84	1.27	.83	81.6	1.44
INSECTA	34.71	1.51	1.26	97.0	1.72
CORPHIUM SP.	34.71	1.42	1.54	102.7	1.82
MYCETOPHILOIDEA	30.58	.89	.43	40.6	.72
DIPTERA-BRACHYCERA	28.93	.73	.97	49.2	.87
DIPTERA	28.10	.75	.94	47.5	.84
PSOCOPTERA	27.27	.59	.33	25.0	.44
DECAPODA-BRACHYURA	26.45	1.13	1.14	60.1	1.06
NEMATOCERA	26.45	.56	.23	20.7	.37
CUMELLA SP.	25.62	20.43	4.94	649.9	11.50
MALACOSTRACA	24.79	7.59	1.55	226.4	4.01
DECAPODA	24.79	23.62	2.92	658.1	11.65
CORPHIUM INSIDIOSUM	23.14	.92	.89	42.1	.74
CYCLORRHAPHA	22.31	.43	1.48	42.5	.75
LEPTOCHELIA SP.	21.49	.62	.50	24.0	.42
CORPHIUM SALMONIS	21.49	1.32	2.50	82.2	1.45
COLEOPTERA	21.49	.51	.79	28.0	.49
NEOMYSIS MERCEDIS	18.18	1.66	35.57	677.0	11.98
HYMENOPTERA-CHALCIDOIDEA	16.53	.28	.15	7.0	.12
HYMENOPTERA	15.70	.23	.22	7.1	.13
HEMIPTERA	13.22	.22	.43	8.6	.15
PLEOCYEMATA-CARIDEA	13.22	2.29	.26	33.6	.60
PLANTS AND PLANT PARTS	13.22	.18	.12	4.0	.07
CORYCAEUS SP.	12.40	.62	.03	8.0	.14
CYNIPIDAE	11.57	.47	.13	7.0	.12
GAMMARIDEA	11.57	.26	.41	7.8	.14
ROCK	11.57	.22	.05	3.1	.05
MYSIDA	9.09	.38	3.73	37.3	.66
CORPHIUM ASCHERUSICUM	8.26	.27	.35	5.1	.09
CRUSTACEA	8.26	.18	.06	2.0	.04
PORCELLANIDAE	8.26	.26	.10	2.9	.05
SALDIDAE	8.26	.21	.89	9.0	.16
ACARINA	8.26	.15	.01	1.3	.02
COLLEMBOLA	7.44	.13	.05	1.3	.02
PINNOTHERIDAE	7.44	.16	.08	1.8	.03
PARAPHOXUS SPINOSUS	7.44	.10	.10	1.5	.03
EMPIDIDAE	7.44	.24	.34	4.3	.08
STAPHYLINIDAE	6.61	.08	.04	.8	.01
CICADELLIDAE	5.79	.07	.15	1.2	.02
PSYLLIDAE	5.79	.25	.27	3.0	.05
NEMATODA	5.79	.10	.02	.7	.01
CUMACEA	5.79	.48	.05	3.1	.05
CERCOPIDAE	5.79	.10	.19	1.7	.03
CRANGONIDAE	4.96	1.71	.18	9.4	.17
EUPHAUSIACEA	1.65	.45	1.66	3.5	.06
OSTEICHTHYES	.83	.01	2.32	1.9	.03

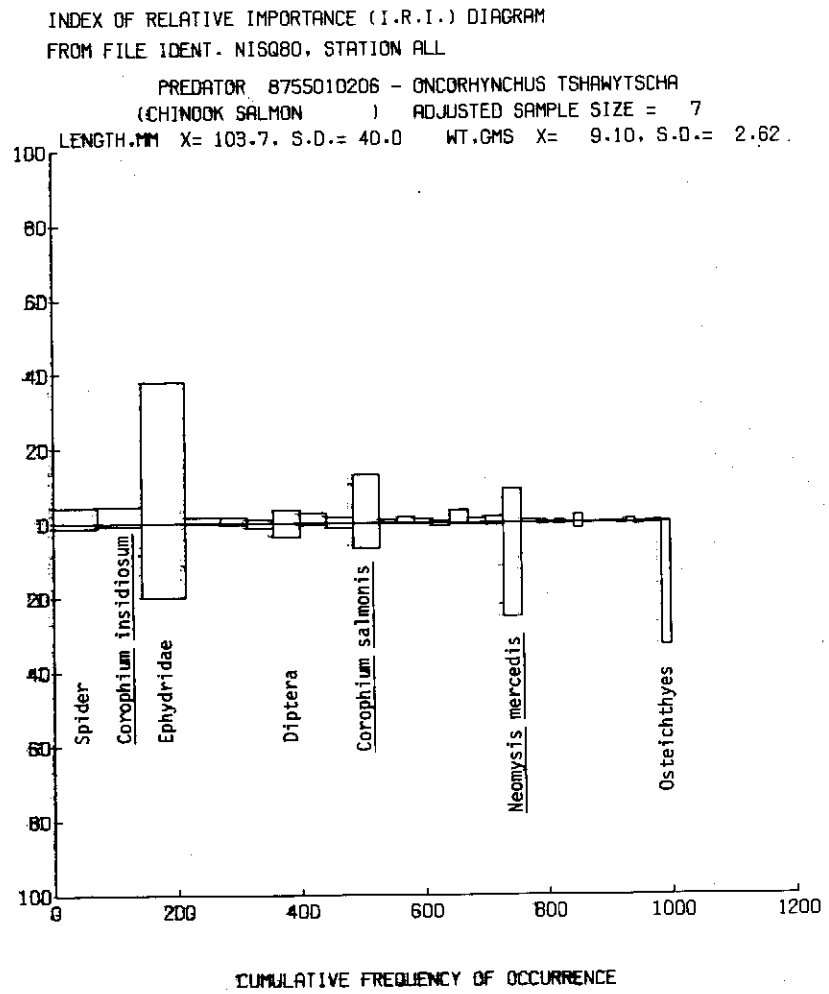
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 22. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary in June, 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
ARANEAE	71.43	4.23	1.25	391.4	4.56
COROPHIUM INSIDIOSUM	71.43	4.53	.81	381.3	4.44
EPHYDRIDAE	71.43	38.07	19.78	4132.1	48.10
NEMATOCERA	57.14	1.51	.12	92.9	1.08
LEPTOCHELIA SP.	42.86	1.51	.28	76.9	.90
SALDIDAE	42.86	.91	1.24	92.0	1.07
DIPTERA	42.86	3.63	3.72	315.0	3.67
COROPHIUM SP.	42.86	2.72	.55	140.1	1.63
DOLICHOPODIDAE	42.86	1.51	1.25	118.3	1.38
COROPHIUM SALMONIS	42.86	12.99	6.65	841.8	9.80
APHIDIDAE	28.57	.91	.19	31.2	.36
STAPHYLINIDAE	28.57	1.51	.18	48.2	.56
CUMELLA SP.	28.57	1.21	.10	37.3	.43
EOGAMMARUS CONFERVICOLUS	28.57	.60	.71	37.5	.44
HELEIDAE	28.57	3.32	.27	102.6	1.19
DIPTERA-CHIRONOMIDAE	28.57	1.21	.36	44.9	.52
HEMIPTERA	28.57	1.61	.44	64.5	.75
NEOMYSIS MERCEDIS	28.57	9.06	25.10	976.0	11.36
HYMENOPTERA	28.57	.91	.02	26.4	.31
COROPHIUM SPINICORNE	14.29	.60	.44	15.0	.17
COROPHIUM ASCHERUSICUM	14.29	.30	.09	5.6	.06
HETEROCERIDAE	14.29	.60	.53	16.2	.19
PARAPHOXUS SPINOSUS	14.29	.30	.09	5.6	.06
DECAPODA-BRACHYURA	14.29	2.11	1.33	49.2	.57
GAMMARIDEA	14.29	.30	.09	5.6	.06
TANAIDACEA	14.29	.30	.09	5.6	.06
MYCETOPHILOIDEA	14.29	.30	.01	4.4	.05
EMPIDIDAE	14.29	.30	.18	6.8	.08
CERCOPIDAE	14.29	.30	.27	8.1	.09
CYCLORRHAPHA	14.29	.91	.09	14.2	.17
CICADELLIDAE	14.29	.30	.44	10.6	.12
PSYLLIDAE	14.29	.30	.18	6.8	.08
FORMICIDAE	14.29	.60	.27	12.4	.14
OSTEICHTHYES	14.29	.30	32.90	474.3	5.52

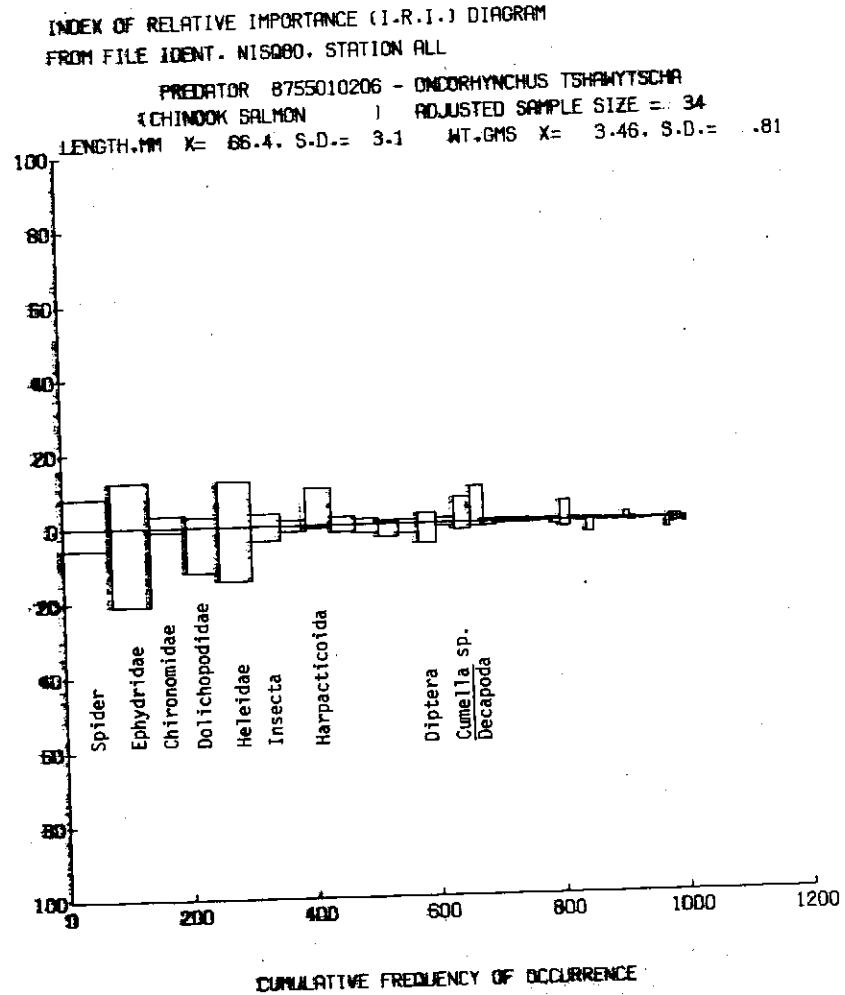
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 23. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary in July, 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
ARANEAE	76.47	8.05	5.57	1042.1	12.69
EPHYDRIDAE	61.76	12.42	21.04	2066.4	25.17
DIPTERA-CHIRONOMIDAE	58.82	3.19	1.19	257.6	3.14
DOLICHOPODIDAE	52.94	2.68	12.13	784.4	9.55
HELEIDAE	52.94	12.30	14.47	1417.5	17.26
INSECTA	47.06	3.41	3.82	340.1	4.14
COROPHIUM SP.	41.18	1.51	1.47	122.5	1.49
HARPACTICOIDA	41.18	10.23	.58	445.3	5.42
APHIDIDAE	38.24	2.18	1.73	149.4	1.82
DIPTERA-BRACHYCERA	38.24	1.57	2.18	143.0	1.74
CYCLORRHAPHA	32.35	.89	3.41	139.1	1.69
COLEOPTERA	32.35	1.12	2.37	112.9	1.37
DIPTERA	29.41	2.80	5.29	237.8	2.90
MYCETOPHILOIDEA	29.41	1.34	.86	64.8	.79
CUMELLA SP.	26.47	6.82	1.79	228.0	2.78
DECAPODA	20.59	9.62	1.13	221.2	2.69
HEMIPTERA	20.59	.45	.99	29.6	.36
PSOCOPTERA	17.65	.67	.41	19.1	.23
DECAPODA-BRACHYURA	17.65	.50	.46	17.0	.21
LEPTOCHELIA SP.	17.65	.67	.48	20.2	.25
HYMENOPTERA-CHALCIDOIDEA	17.65	.50	.28	13.8	.17
CYNIPIDAE	17.65	.50	.22	12.8	.16
GAMMARIDEA	14.71	.62	1.00	23.7	.29
MALACOSTRACA	14.71	5.31	1.58	101.4	1.23
NEMATOCERA	14.71	.67	.21	12.9	.16
HYMENOPTERA	11.76	.34	.46	9.4	.11
SALDIDAE	11.76	.73	3.26	46.9	.57
COLLEMBOLA	11.76	.39	.14	6.3	.08
PLANTS AND PLANT PARTS	11.76	.28	.27	6.4	.08
ACARINA	8.82	.39	.02	3.6	.04
CICADELLIDAE	8.82	.17	.39	4.9	.06
STAPHYLINIDAE	8.82	.17	.14	2.7	.03
UNIDENTIFIED EGG	8.82	1.79	.08	16.5	.20
PSYLLIDAE	8.82	.62	.65	11.2	.14
ROCK	8.82	.22	.08	2.7	.03
CERCOPIDAE	5.88	.11	.33	2.6	.03
PARAPHOXUS SPINOSUS	5.88	.11	.07	1.1	.01
EMPIDIDAE	5.88	.28	.27	3.2	.04
CALANOIDA	5.88	.11	.01	.7	.01
CRUSTACEA	5.88	.17	.14	1.8	.02
PINNOTHERIDAE	5.88	.22	.13	2.1	.03
TANAIDACEA	5.88	.17	.20	2.1	.03
INSECTA-LEPIDOPTERA	5.88	.17	2.74	17.1	.21
COROPHIUM ASCHERUSICUM	5.88	.78	1.50	13.4	.16
COROPHIUM SALMONIS	5.88	.84	1.11	11.5	.14
COROPHIUM INSIDIOSUM	5.88	.78	.98	10.4	.13
EOGAMMARUS CONFERVICOLUS	5.88	.11	.40	3.0	.04
NEOMYSIS MERCEDIS	2.94	.11	1.30	4.2	.05

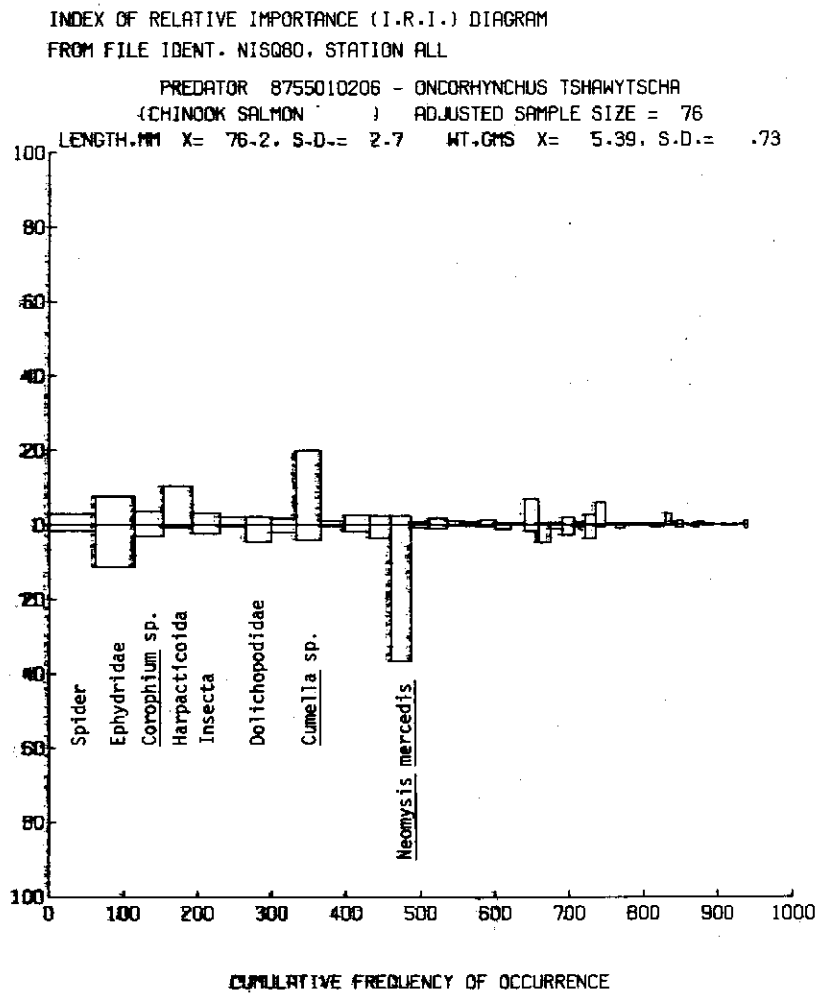
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 24. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary in 1980 with forklengths of 61-70 mm.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
ARANEAE	60.53	2.93	1.57	272.2	4.76
EPHYDRIDAE	52.63	7.65	11.20	992.2	17.34
COROPHIUM SP.	39.47	3.59	2.99	259.6	4.54
HARPACTICOIDA	39.47	10.46	.69	440.3	7.70
INSECTA	36.84	3.27	2.35	207.0	3.62
DIPTERA-CHIRONOMIDAE	35.53	2.17	.47	93.7	1.64
DOLICHOPODIDAE	34.21	2.29	4.49	232.0	4.06
DIPTERA	34.21	1.75	1.93	125.9	2.20
CUMELLA SP.	32.89	19.85	4.00	784.6	13.72
NEMATOCERA	32.89	.98	.33	43.0	.75
HELEIDAE	32.89	2.53	1.89	145.3	2.54
COROPHIUM SALMONIS	28.95	2.45	3.44	170.6	2.98
NEOMYSIS MERCEDIS	26.32	2.47	36.61	1028.5	17.98
DIPTERA-BRACHYCERA	25.00	.70	.70	34.9	.61
COROPHIUM INSIDIOSUM	23.68	1.71	1.19	68.8	1.20
MYCETOPHILOIDEA	22.37	1.06	.34	31.2	.55
LEPTOCHELIA SP.	22.37	.68	.27	21.3	.37
APHIDIDAE	21.05	1.22	.60	38.3	.67
CYCLORRHAPHA	19.74	.62	1.24	36.7	.64
PSOCOPTERA	19.74	.56	.19	14.9	.26
MALACOSTRACA	18.42	6.94	1.83	161.5	2.82
MYSIDA	15.79	.48	4.86	84.4	1.47
CRUSTACEA	15.79	.48	1.10	24.9	.43
GAMMARIDEA	15.79	1.87	2.89	75.2	1.31
DECAPODA-BRACHYURA	15.79	.68	.39	16.8	.29
COROPHIUM ASCHERUSICUM	14.47	2.73	3.64	92.3	1.61
DECAPODA	13.16	5.96	.50	84.9	1.48
HYMENOPTERA-CHALCIDOIDEA	13.16	.28	.09	4.9	.09
SALDIDAE	11.84	.30	1.03	15.8	.28
COLEOPTERA	11.84	.28	.33	7.2	.13
HYMENOPTERA	10.53	.22	.13	3.6	.06
PLANTS AND PLANT PARTS	9.21	.16	.04	1.9	.03
CERCOPIDAE	7.89	.20	.11	2.4	.04
EOGAMMARUS CONFERVICOLUS	7.89	.42	.68	8.7	.15
TANAIDACEA	7.89	.20	.06	2.0	.04
PLEOCYEMATA-CARIDEA	7.89	3.01	.28	25.9	.45
CYNIPIDAE	7.89	.72	.12	6.6	.12
CRANGONIDAE	7.89	1.08	.75	14.4	.25
ROCK	7.89	.14	.01	1.2	.02
COROPHIUM SPINICORNE	6.58	.10	.24	2.2	.04
EMPIDIDAE	6.58	.50	.63	7.4	.13
CORYCAEUS SP.	6.58	.82	.02	5.5	.10
HEMIPTERA	6.58	.22	.27	3.2	.06
PINNOTHERIDAE	6.58	.32	.14	3.0	.05
STAPHYLINIDAE	5.26	.08	.02	.5	.01
CALANOIDA	5.26	.10	.02	.6	.01
PARAPHOXUS SPINOSUS	5.26	.12	.07	1.0	.02
CAPRELLIDAE	5.26	.10	.24	1.8	.03
CICADELLIDAE	5.26	.08	.10	1.0	.02
PSYLLIDAE	5.26	.28	.24	2.7	.05
ACARINA	5.26	.10	.01	.6	.01
NEMATODA	5.26	.12	.01	.7	.01
COROPHIUM BREVIS	3.95	1.02	.95	7.8	.14

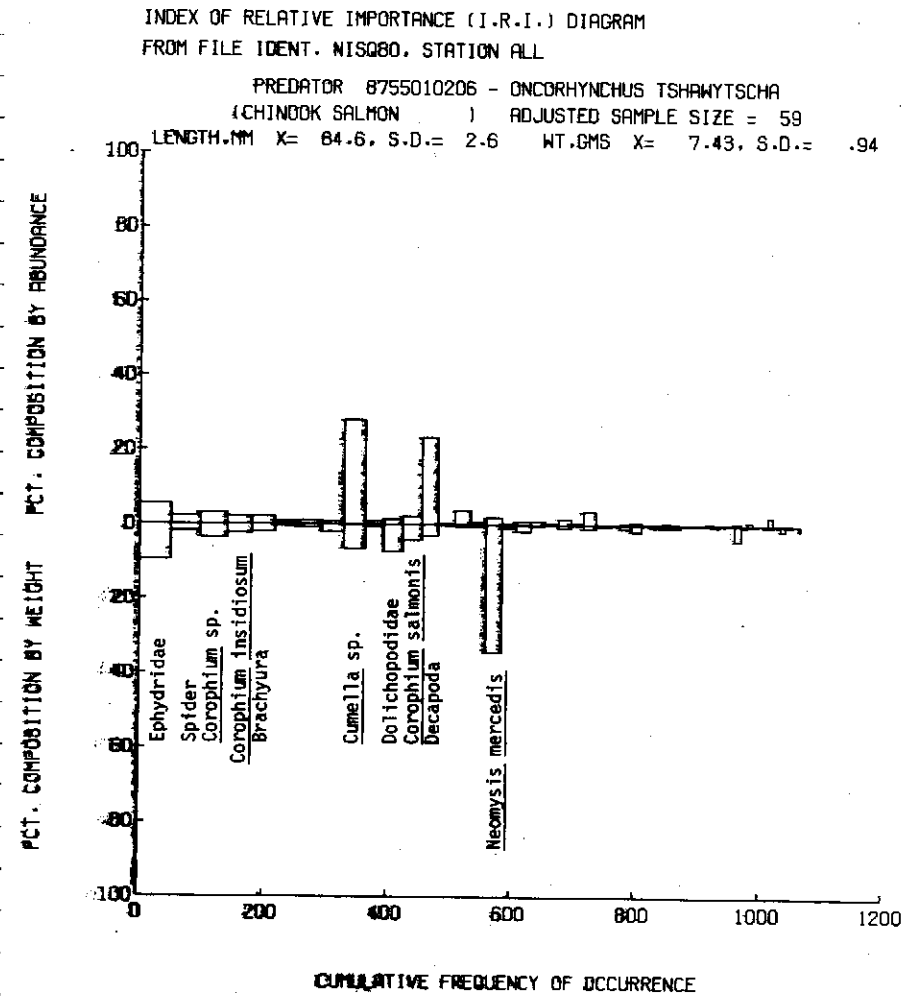
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 25. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary in 1980 with forklengths of 71-80 mm.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
EPHYDRIDAE	50.85	5.62	9.49	768.6	13.23
ARANEAE	47.46	2.19	1.71	185.1	3.18
COROPHIUM SP.	44.07	3.06	3.44	286.2	4.92
COROPHIUM INSIDIOSUM	38.98	2.23	2.24	174.1	3.00
DECAPODA-BRACHYURA	37.29	2.08	1.93	149.3	2.57
APHIDIDAE	37.29	.77	.50	47.3	.81
LEPTOCHELIA SP.	37.29	1.02	.72	65.0	1.12
DIPTERA	35.59	.87	2.02	102.8	1.77
CUMELLA SP.	33.90	28.09	6.52	1173.3	20.19
DIPTERA-CHIRONOMIDAE	30.51	.81	.61	43.4	.75
DOLICHOPODIDAE	30.51	1.49	7.28	267.7	4.61
COROPHIUM SALMONIS	30.51	2.17	4.14	192.6	3.31
DECAPODA	27.12	23.40	2.95	714.5	12.29
HYMENOPTERA	27.12	.32	.16	13.0	.22
HARPACTICOIDA	25.42	3.81	.42	107.6	1.85
HELEIDAE	25.42	.89	.41	32.9	.57
NEOMYSIS MERCEDIS	25.42	2.06	34.20	921.8	15.86
COLEOPTERA	23.73	.43	.70	27.0	.46
CYCLORRHAPHA	23.73	.79	1.85	62.8	1.08
INSECTA	22.03	.98	.33	28.9	.50
NEMATOCERA	22.03	.40	.19	13.0	.22
PLEOCYEMATA-CARIDEA	20.34	1.58	.89	50.3	.87
PSOCOPTERA	20.34	.36	.21	11.6	.20
MALACOSTRACA	20.34	3.55	.94	91.2	1.57
HEMIPTERA	18.64	.30	.48	14.6	.25
MYCETOPHILOIDEA	18.64	.26	.11	7.0	.12
GAMMARIDEA	18.64	.38	.91	23.9	.41
COROPHIUM ASCHERUSICUM	16.95	.72	1.65	40.2	.69
CORYCAEUS SP.	16.95	.40	.02	7.1	.12
CERCOPIDAE	15.25	.23	.39	9.3	.16
PINNOTHERIDAE	15.25	.49	.66	17.6	.30
EOGAMMARUS CONFERVICOLUS	15.25	.25	.82	16.2	.28
PARAPHOXUS SPINOSUS	13.56	.19	.20	5.3	.09
PLANTS AND PLANT PARTS	13.56	.17	.15	4.3	.07
PORCELLANIDAE	11.86	.23	.05	3.3	.06
TANAIDACEA	11.86	.32	.13	5.3	.09
DIPTERA-BRACHYCERA	11.86	.26	.36	7.5	.13
AMPHIPODA-HYPERIIDEA	11.86	.23	.09	3.7	.06
ROCK	11.86	.26	.03	3.5	.06
MYSIDA	10.17	.60	4.12	48.0	.83
EMPIDIDAE	10.17	.17	.30	4.8	.08
CUMACEA	8.47	.83	.05	7.4	.13
STAPHYLINIDAE	8.47	.17	.06	2.0	.03
COLLEMBOLA	8.47	.11	.03	1.2	.02
SALDIDAE	6.78	.08	.34	2.8	.05
CRANGONIDAE	6.78	2.49	.30	18.9	.33
HYMENOPTERA-CHALCIDOIDEA	6.78	.09	.06	1.1	.02
CYMIPIDAE	6.78	.09	.06	1.1	.02
HETEROCERIDAE	6.78	.23	1.27	10.2	.17
CRUSTACEA	6.78	.13	.05	1.2	.02
FORMICIDAE	5.08	.11	.24	1.8	.03
ACARINA	5.08	.06	.01	.3	.01
CALANOIDA	5.08	.06	.02	.4	.01
OSTEICHTHYES	3.39	.04	1.05	3.7	.06

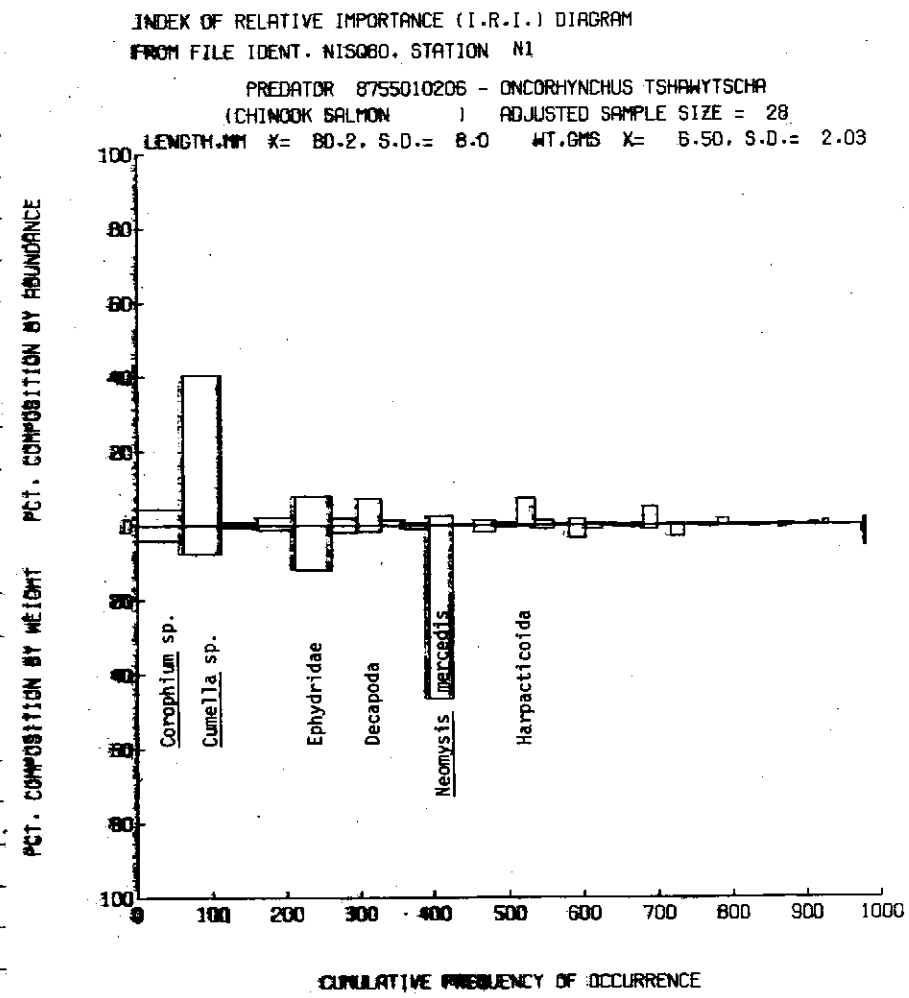
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 26. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary in 1980 with fork lengths of 81-90 mm.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
COROPHIUM SP.	60.71	4.39	3.94	505.7	7.09
CUMELLA SP.	50.00	40.32	7.53	2392.7	33.57
LEPTOCHELIA SP.	50.00	.89	.39	63.5	.89
ARANEAE	50.00	2.28	1.04	165.6	2.32
EPHYDRIDAE	50.00	7.89	11.88	986.2	13.86
COROPHIUM INSIDIOSUM	35.71	1.86	1.72	127.8	1.79
DECAPODA	32.14	7.21	1.64	284.6	3.99
DIPTERA-CHIRONOMIDAE	32.14	1.35	.18	49.1	.69
DOLICHOPODIDAE	32.14	.99	.95	49.4	.69
NEOMYSIS MERCEDIS	32.14	2.61	46.62	1582.6	22.20
APHIDIDAE	28.57	.38	.21	16.8	.24
DIPTERA	28.57	1.48	1.72	91.3	1.28
HELEIDAE	28.57	.76	.40	33.0	.46
HARPACTICOIDA	25.00	7.34	.29	190.7	2.67
INSECTA	25.00	1.39	1.02	60.3	.85
MYCETOPHILOIDEA	21.43	.38	.09	10.1	.14
COROPHIUM ASCHERUSICUM	21.43	1.52	3.27	102.6	1.44
HEMIPTERA	21.43	.51	.94	31.0	.44
HYMENOPTERA-CHALCIDOIDEA	21.43	.42	.17	12.7	.18
EOGAMMARUS CONFERVICOLUS	17.86	.25	.47	13.0	.18
CYCLORRHAPHA	17.86	.34	.39	16.6	.23
MALACOSTRACA	17.86	5.02	1.09	109.2	1.53
HYMENOPTERA	17.86	.30	.09	6.9	.10
MYSIDA	17.86	.51	2.96	61.9	.87
CYNIPIDAE	17.86	.25	.09	6.2	.09
CERCOPIDAE	14.29	.30	.35	9.3	.13
COROPHIUM SALMONIS	14.29	.25	.39	9.2	.13
CUMACEA	14.29	1.81	.09	27.2	.38
PSOCOPTERA	14.29	.21	.05	3.7	.05
GAMMARIDEA	14.29	.30	.16	6.5	.09
SALDIDAE	14.29	.17	.51	9.6	.14
ROCK	14.29	.34	.05	5.5	.08
NEMATOCERA	10.71	.21	.01	2.4	.03
DECAPODA-BRACHYURA	10.71	.51	.63	12.1	.17
TANAIDACEA	10.71	.38	.09	5.0	.07
ACARINA	10.71	.30	.01	3.3	.05
DIPTERA-BRACHYCERA	10.71	.13	.09	2.3	.03
CRUSTACEA	10.71	.63	.16	8.5	.12
STAPHYLINIDAE	7.14	.08	.04	.9	.01
CORYCAEUS SP.	7.14	1.10	.04	8.1	.11
PORCELLANIDAE	7.14	.08	.01	.7	.01
CHLOROPHYTA	7.14	.13	.04	1.2	.02
PINNOTHERIDAE	7.14	.29	.08	2.4	.03
PARAPHOXUS SPINOSUS	7.14	.13	.08	1.5	.02
PLANTS AND PLANT PARTS	7.14	.08	.01	.7	.01
COLEOPTERA	7.14	.08	.01	.7	.01
OSTEICHTHYES	3.57	.04	1.91	7.0	.10
EUPHAUSIACEA	3.57	1.86	5.76	27.2	.38

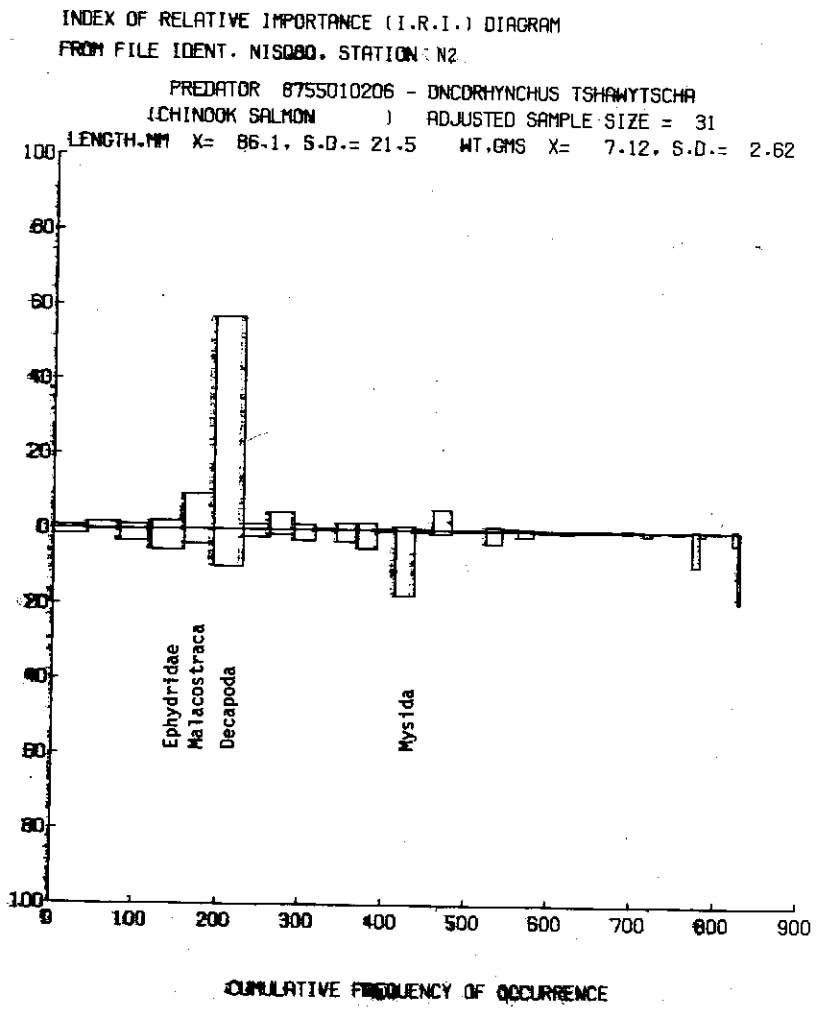
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 27. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary at station N1 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
ARANEAE	41.94	.95	1.45	100.7	1.94
HARPACTICOIDA	38.71	1.81	.15	76.0	1.46
DIPTERA	38.71	1.20	3.12	167.1	3.22
EPHYDRIDAE	38.71	2.24	5.41	296.2	5.70
MALACOSTRACA	35.48	9.48	3.83	472.5	9.09
DECAPODA	35.48	56.74	9.78	2360.2	45.41
DECAPODA-BRACHYURA	32.26	1.41	1.91	107.3	2.06
CUMELLA SP.	29.03	4.66	1.20	170.3	3.28
COROPHIUM SP.	25.81	1.38	2.82	108.3	2.08
NEMATOCERA	25.81	.40	.14	13.8	.27
COROPHIUM INSIDIOSUM	25.81	1.78	3.06	125.0	2.41
COROPHIUM SALMONIS	22.58	1.99	5.00	157.9	3.04
LEPTOCHELIA SP.	22.58	.37	.18	12.5	.24
MYSIDA	22.58	1.07	17.37	416.5	8.01
DIPTERA-CHIRONOMIDAE	22.58	.46	.48	21.2	.41
CRANGONIDAE	22.58	5.58	.84	145.1	2.79
HYMENOPTERA	22.58	.21	.13	7.7	.15
APHIDIDAE	19.35	.21	.21	8.3	.16
CYCLORRHAPHA	19.35	1.14	3.41	88.0	1.69
CORYCAEUS SP.	19.35	.71	.03	14.3	.27
PINNOTHERIDAE	19.35	.58	1.54	41.0	.79
INSECTA	16.13	.21	.27	7.8	.15
AMPHIPODA-HYPERIIDEA	16.13	.25	.17	6.7	.13
COLEOPTERA	16.13	.25	.51	12.2	.23
PLANTS AND PLANT PARTS	16.13	.15	.22	6.0	.12
ROCK	16.13	.25	.07	5.1	.10
HELEIDAE	12.90	.49	.36	11.0	.21
NEMATODA	12.90	.15	.07	2.8	.05
DIPTERA-BRACHYCERA	12.90	.37	.36	9.4	.18
PSOCOPTERA	12.90	.18	.11	3.8	.07
EOGAMMARUS CONFERVICOLUS	9.68	.15	.97	10.9	.21
PARAPHOXUS SPINOSUS	9.68	.12	.25	3.7	.07
GAMMARIDEA	9.68	.09	.02	1.0	.02
CYNIPIDAE	9.68	.12	.16	2.7	.05
FORMICIDAE	9.68	.18	.46	6.3	.12
MYCETOPHILOIDEA	9.68	.12	.11	2.2	.04
NEOMYSIS MERCEDIS	9.68	.46	9.12	92.7	1.78
PLATYNEREIS BICANALICULATA	6.45	.06	.81	5.7	.11
CUMACEA	6.45	.12	.11	1.5	.03
HEMIPTERA	6.45	.09	.16	1.6	.03
CERCOPIDAE	6.45	.06	.16	1.4	.03
CRUSTACEA	6.45	.06	.01	.5	.01
TANAIDACEA	6.45	.06	.01	.5	.01
DOLICHOPODIDAE	6.45	.55	3.16	23.9	.46
OSTEICHTHYES	3.23	.03	18.89	61.0	1.17

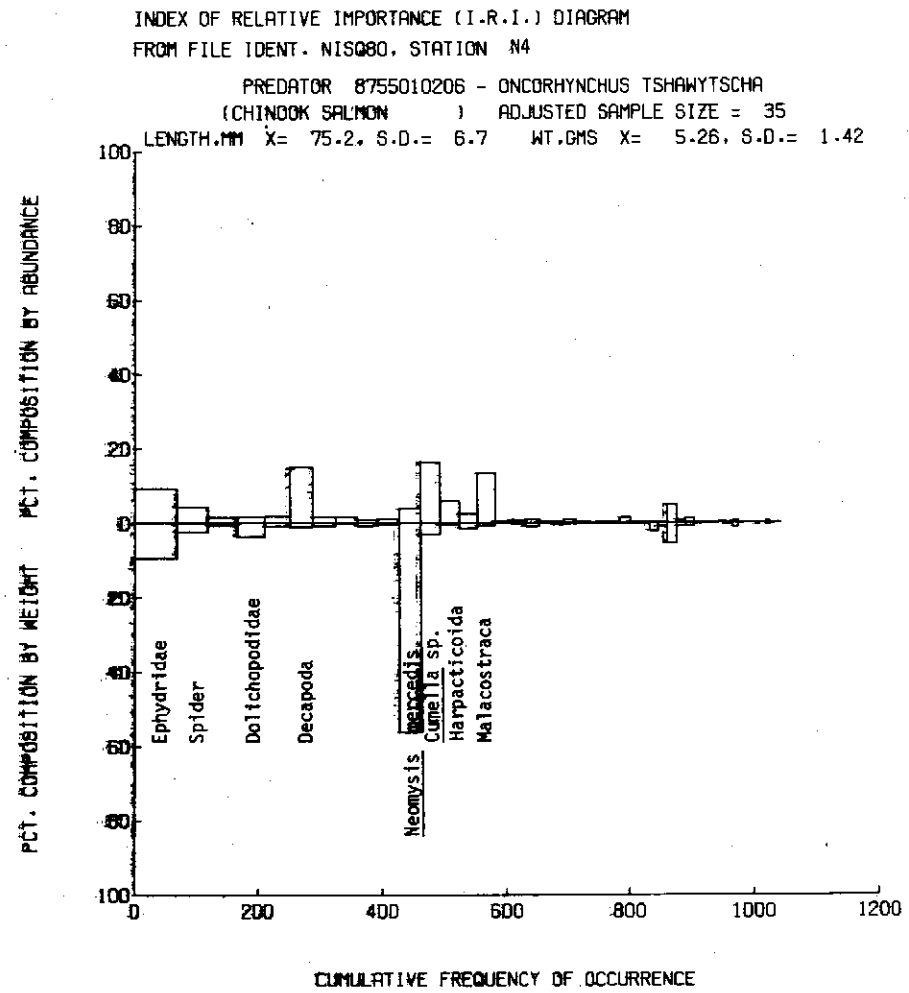
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 28. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary at station N2 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
EPHYDRIDAE	68.57	9.30	9.31	1276.1	18.65
ARANEAE	51.43	4.48	2.34	351.0	5.13
INSECTA	48.57	1.52	.61	103.7	1.52
DOLICHOPODIDAE	42.86	1.65	3.76	231.9	3.39
HELEIDAE	40.00	1.85	.77	104.7	1.53
DECAPODA	37.14	14.93	1.18	598.5	8.75
DECAPODA-BRACHYURA	37.14	1.60	.81	89.5	1.31
DIPTERA-CHIRONOMIDAE	34.29	1.56	.14	58.5	.86
DIPTERA-BRACHYCERA	34.29	.78	.74	52.2	.76
NEMATOCERA	34.29	1.07	.36	49.2	.72
NEOMYSIS MERCEDIS	34.29	3.91	56.24	2062.1	30.14
CUMELLA SP.	31.43	16.33	3.06	609.3	8.91
HARPACTICOIDA	31.43	5.88	.37	196.4	2.87
COROPHIUM SP.	28.57	2.47	1.55	114.8	1.68
MALACOSTRACA	28.57	13.37	.83	405.6	5.93
CRUSTACEA	25.71	.49	.08	14.8	.22
LEPTOCHELIA SP.	22.86	.66	.30	21.9	.32
DIPTERA	22.86	.86	.97	41.8	.61
APHIDIDAE	20.00	.62	.16	15.5	.23
COLEOPTERA	20.00	.33	.48	16.1	.24
PINNOTHERIDAE	20.00	.90	.36	25.2	.37
HYMENOPTERA-CHALCIDOIDEA	20.00	.41	.18	11.8	.17
PSOCOPTERA	17.14	.29	.15	7.5	.11
MYCETOPHILOIDEA	17.14	.41	.07	8.3	.12
PARAPHOXUS SPINOSUS	17.14	.33	.18	8.7	.13
CYNIPIDAE	17.14	1.56	.24	30.9	.45
ROCK	17.14	.33	.04	6.4	.09
GAMMARIDEA	14.29	.29	.04	4.7	.07
MYSIDA	14.29	.33	2.16	35.6	.52
CYCLORRHAPHA	14.29	.25	.93	16.9	.25
COROPHIUM ASCHERUSICUM	14.29	4.94	5.55	149.7	2.19
COROPHIUM SALMONIS	14.29	.90	1.00	27.1	.40
COROPHIUM INSIDIOSUM	14.29	1.44	.85	32.7	.48
PLANTS AND PLANT PARTS	14.29	.21	.07	3.9	.06
CALANOIDA	14.29	.25	.04	4.1	.06
AMPHIPODA-HYPERIIDEA	11.43	.25	.04	3.3	.05
CORYCAEUS SP.	11.43	.37	.01	4.4	.06
SALDIDAE	11.43	.16	.44	6.9	.10
PLEOCYEMATA-CARIDEA	8.57	.62	1.08	14.6	.21
HYMENOPTERA	8.57	.16	.18	2.9	.04
ACARINA	8.57	.12	.01	1.1	.02
PLATYNEREIS BICANALICULATA	5.71	.08	.01	.5	.01
STAPHYLINIDAE	5.71	.08	.03	.7	.01
AMPITHOE SP.	5.71	.08	.67	4.3	.06
COPEPODA	5.71	.08	.01	.5	.01
HEMIPTERA	5.71	.08	.20	1.6	.02
EOGAMMARUS CONFERVICOLUS	5.71	.58	.41	5.6	.08
TRUNC4-UNIDENT.EGG,PLANT OR SP	5.71	.08	.32	2.8	.03
CICADELLIDAE	5.71	.08	.12	1.1	.02
PHOTIS BREVIPES	5.71	.16	.06	1.3	.02

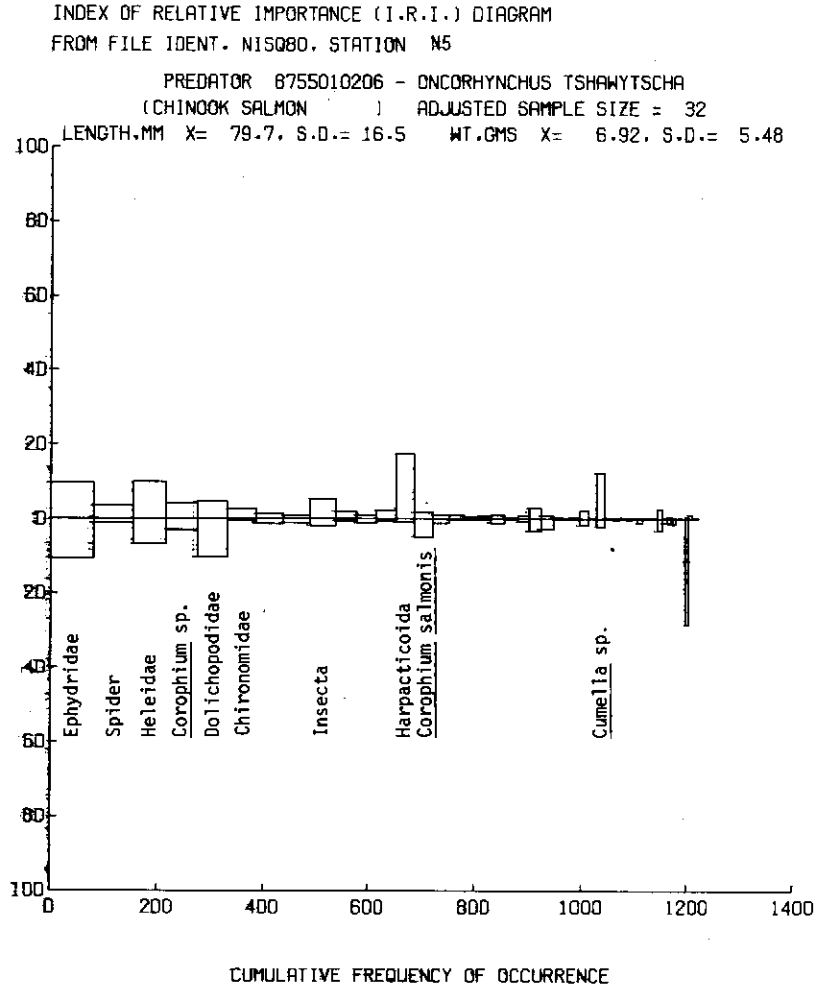
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 29. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary at station N4 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
EPHYDRIDAE	78.13	9.67	10.67	1588.9	21.65
ARANEAE	75.00	3.38	1.32	352.9	4.81
HELEIDAE	62.50	9.93	6.91	1052.4	14.34
COROPHIUM SP.	59.38	4.16	2.99	424.5	5.78
DOLICHOPODIDAE	56.25	4.61	10.43	845.7	11.52
DIPTERA-CHIRONOMIDAE	53.13	2.68	.64	176.3	2.40
DIPTERA-BRACHYCERA	53.13	1.45	1.27	144.5	1.97
CYCLORRHAPHA	50.00	.89	1.13	101.1	1.38
INSECTA	50.00	5.50	1.84	367.1	5.00
MYCETOPHILOIDEA	40.63	2.08	.68	112.0	1.53
DIPTERA	37.50	1.04	1.15	82.0	1.12
APHIDIDAE	37.50	2.19	.68	107.7	1.47
HARPACTICOIDA	34.38	17.47	1.00	635.1	8.65
COROPHIUM SALMONIS	34.38	1.71	4.78	223.2	3.04
COLEOPTERA	31.25	.97	1.10	64.5	.88
PSOCOPTERA	28.13	.97	.26	34.4	.47
TANAIDACEA	25.00	.63	.23	21.6	.29
NEMATOCERA	25.00	.71	.09	19.8	.27
EMPIDIDAE	25.00	1.15	1.16	57.9	.79
HYMENOPTERA	25.00	.41	.19	14.9	.20
COROPHIUM ASCHERUSICUM	21.88	.82	.89	37.4	.51
GAMMARIDEA	21.88	2.90	3.25	134.5	1.83
EOGAMMARUS CONFERVICOLUS	21.88	.82	2.85	80.2	1.09
COROPHIUM INSIDIOSUM	18.75	.33	.15	9.2	.12
HEMIPTERA	15.63	.26	.25	8.0	.11
PSYLLIDAE	15.63	.56	.32	13.8	.19
COROPHIUM BREVIS	15.63	2.23	1.81	63.1	.86
COLLEMBOLA	15.63	.22	.01	3.7	.05
CUMELLA SP.	15.63	12.30	2.23	227.1	3.09
PLANTS AND PLANT PARTS	15.63	.22	.08	4.7	.06
MALACOSTRACA	12.50	.22	.25	5.9	.08
ACARINA	12.50	.19	.01	2.4	.03
CERCOPIDAE	12.50	.19	.27	5.8	.08
CRUSTACEA	9.38	.15	.08	2.1	.03
CRANGONIDAE	9.38	.15	1.07	11.4	.16
DECAPODA-BRACHYURA	9.38	.15	.08	2.1	.03
LEPTOCHELIA SP.	9.38	.30	.10	3.8	.05
COROPHIUM SPINICORNE	9.38	.15	.18	3.0	.04
PONTOGENEIA IVANOVI	9.38	2.57	3.34	55.4	.75
ANISOGAMMARUS PUGETTENSIS	9.38	.19	1.04	11.5	.16
SALDIDAE	9.38	.48	1.29	16.6	.23
NEOMYSIS MERCEDIS	6.25	.22	1.51	10.8	.15
CAPRELLIDAE	6.25	.07	.12	1.2	.02
STAPHYLINIDAE	6.25	.11	.03	.9	.01
CICADELLIDAE	6.25	.07	.10	1.1	.01
OSTEICHTHYES	6.25	.33	28.62	181.0	2.47
UNIDENTIFIED EGG	6.25	1.08	.03	6.9	.09
PLEOCYEMATA-CARIDEA	6.25	.22	.07	1.9	.03
WOOD	6.25	.11	.12	1.5	.02

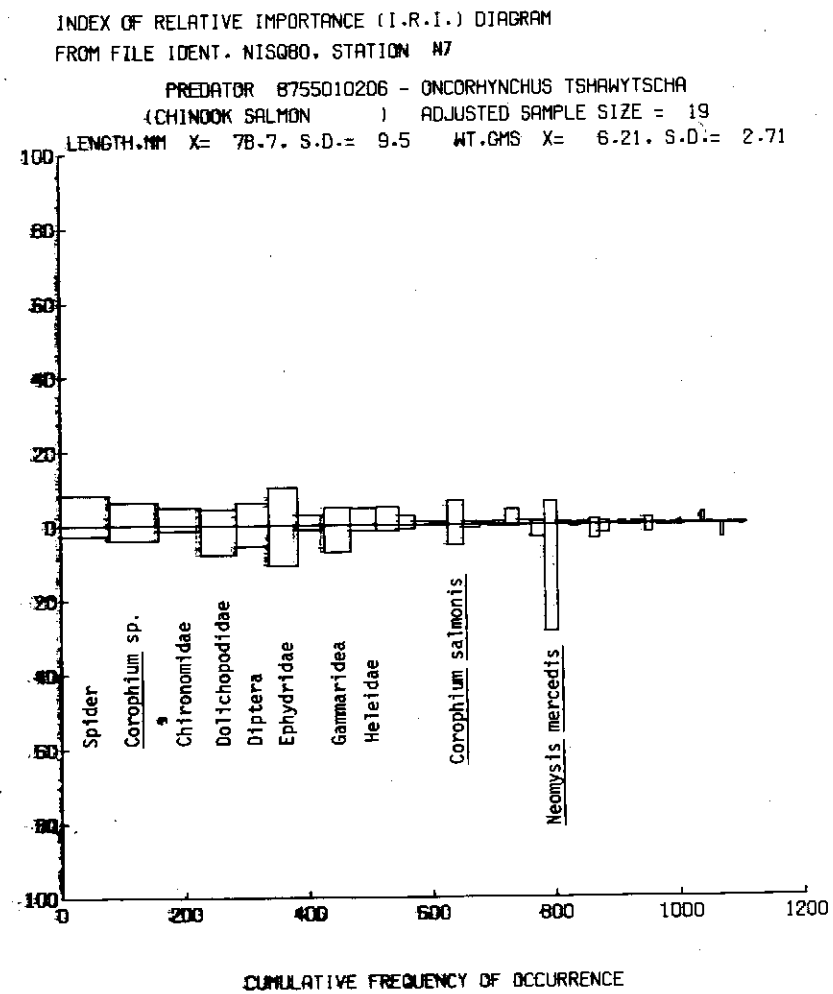
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 30. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary at station N5 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
ARANEAE	78.95	8.19	2.67	857.3	11.59
COROPHIUM SP.	78.95	6.24	3.86	797.6	10.78
DIPTERA-CHIRONOMIDAE	68.42	4.94	1.27	424.7	5.74
DOLICHOPODIDAE	57.89	4.42	7.87	711.6	9.62
DIPTERA	52.63	6.11	5.50	611.4	8.26
EPHYDRIDAE	47.37	10.27	10.74	995.4	13.46
APHIDIDAE	42.11	2.86	1.10	166.8	2.25
GAMMARIDEA	42.11	4.68	7.18	499.4	6.75
HELEIDAE	42.11	4.55	1.42	251.4	3.40
INSECTA	36.84	4.94	1.54	238.8	3.23
COROPHIUM INSIDIOSUM	26.32	2.60	1.03	95.5	1.29
LEPTOCHELIA SP.	26.32	1.04	.09	29.7	.40
PSOCOPTERA	26.32	.65	.15	21.0	.28
COROPHIUM SALMONIS	26.32	6.37	5.38	309.2	4.18
COLEOPTERA	26.32	.91	.84	46.2	.62
NEMATOCERA	21.05	.65	.08	15.4	.21
HEMIPTERA	21.05	.91	.52	30.1	.41
CUMELLA SP.	21.05	4.03	.46	94.6	1.28
COLLEMBOLA	21.05	1.30	.14	30.3	.41
CYCLORRHAPHA	21.05	.91	3.39	90.5	1.22
NEOMYSIS MERCEDIS	21.05	6.24	28.83	738.4	9.98
HYMENOPTERA-CHALCIDOIDEA	21.05	.65	.08	15.4	.21
DIPTERA-BRACHYCERA	15.79	.52	.45	15.3	.21
STAPHYLINIDAE	15.79	.65	.13	12.4	.17
HETEROCERIDAE	15.79	1.43	3.58	79.1	1.07
SALDIDAE	15.79	.91	2.05	46.7	.63
MYCETOPHILOIDEA	15.79	.39	.02	6.5	.09
CERCOPIDAE	10.53	.65	.20	8.9	.12
CICADELLIDAE	10.53	.26	.26	5.4	.07
DECAPODA-BRACHYURA	10.53	.91	.32	12.9	.18
HARPACTICOIDA	10.53	.65	.01	7.0	.09
MALACOSTRACA	10.53	1.82	2.11	41.4	.56
NEMATODA	10.53	.39	.01	4.2	.06
COROPHIUM SPINICORNE	10.53	.39	.45	8.8	.12
CAPRELLIDAE	10.53	.26	.33	6.2	.08
PLANTS AND PLANT PARTS	10.53	.39	.07	4.8	.07
PSYLLIDAE	5.26	.91	.51	7.5	.10
ALLORCHESTES ANGUSTUS	5.26	.13	.19	1.7	.02
SYNCHELIDIUM SHOEMAKERI	5.26	.26	.01	1.4	.02
PARAPHOXUS SPINOSUS	5.26	.13	.06	1.0	.01
ORCHESTIA SP.	5.26	.13	.19	1.7	.02
CHELONITHIDA	5.26	.13	.01	.7	.01
DECAPODA	5.26	.13	.01	.7	.01
PLEOCYEMATA-CARIDEA	5.26	3.12	.13	17.1	.23
GASTROPODA	5.26	.13	.06	1.0	.01
AMPITHOE SP.	5.26	.39	.01	2.1	.03
ADROIDES COLUMBIAE	5.26	.13	.01	.7	.01
EMPIDIDAE	5.26	.13	.13	1.4	.02
MYSIDA	5.26	.13	.18	1.7	.02
CRUSTACEA	5.26	.13	3.77	20.5	.28
CALANOIDA	5.26	.13	.01	.7	.01
HYMENOPTERA	5.26	.13	.13	1.4	.02
TANAIDACEA	5.26	.13	.06	1.0	.01
CYMIPIDAE	5.26	.13	.01	.7	.01
FORMICIDAE	5.26	.13	.01	.7	.01
EOGAMMARUS CONFERVICOLUS	5.26	.13	.38	2.7	.04
ROCK	5.26	.13	.01	.7	.01

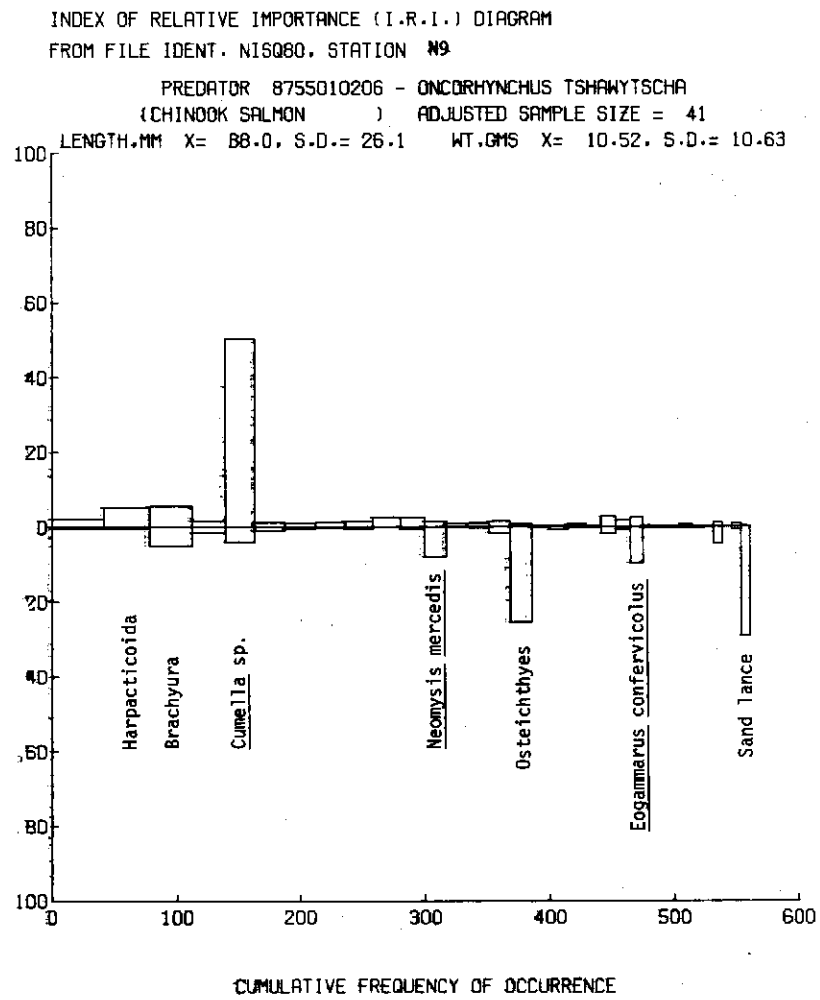
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 31. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary at station N7 in 1980.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
ARANEAE	41.46	2.14	.37	103.9	2.85
HARPACTICOIDA	36.59	5.21	.21	198.2	5.43
DECAPODA-BRACHYURA	34.15	5.54	4.99	359.6	9.85
COROPHIUM SALMONIS	26.83	1.80	1.64	92.3	2.53
CUMELLA SP.	24.39	50.33	3.97	1324.6	36.30
DIPTERA	24.39	1.27	.96	54.3	1.49
NEMATOCERA	24.39	1.07	.36	35.3	.97
DIPTERA-CHIRONOMIDAE	24.39	1.27	.28	37.9	1.04
APHIDIDAE	21.95	1.60	.68	50.0	1.37
PLEOCYEMATA-CARIDEA	21.95	2.67	.11	61.0	1.67
COROPHIUM INSIDIOSUM	19.51	2.47	.54	58.6	1.61
NEOMYSIS MERCEDIS	17.07	1.40	8.03	161.0	4.41
PORCELLANIDAE	17.07	.87	.10	16.5	.45
COROPHIUM SP.	17.07	1.13	.19	22.7	.62
INSECTA	17.07	1.54	1.60	53.5	1.46
OSTEICHTHYES	17.07	.73	25.44	446.8	12.24
MYCETOPHILOIDEA	14.63	.40	.08	7.0	.19
DOLICHOPODIDAE	14.63	.40	.76	17.0	.47
COLEOPTERA	14.63	.73	.19	13.5	.37
CERCOPIDAE	12.20	.33	.10	5.3	.14
PINNOTHERIDAE	12.20	2.80	1.83	56.5	1.55
LEPTOCHELIA SP.	12.20	1.74	.54	27.7	.76
EOGAMMARUS CONFERVICOLUS	9.76	2.54	9.50	117.4	3.22
EMPIDIDAE	9.76	.47	.19	6.4	.17
PSOCOPTERA	9.76	.40	.14	5.3	.14
CYCLORRHAPHA	9.76	.27	.14	4.0	.11
EPHYDRIDAE	9.76	.67	.28	9.2	.25
HEMIPTERA	9.76	.40	.21	6.0	.16
AMPHIPODA-HYPERIIDEA	7.32	.40	.12	3.8	.10
GAMMARIDEA	7.32	1.20	4.39	40.9	1.12
CORYCAEUS SP.	7.32	.27	.01	2.0	.05
COROPHIUM ASCHERUSICUM	7.32	1.13	.58	12.5	.34
AMMODYTES HEXAPTERUS	7.32	.40	26.90	214.4	5.87

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 32. IRI diagram and table showing major prey of juvenile chinook caught in the Nisqually Estuary at station N9 in 1980.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) TABLE
USING FILEID= NISQ79, STATION= ALL FOR PLOT
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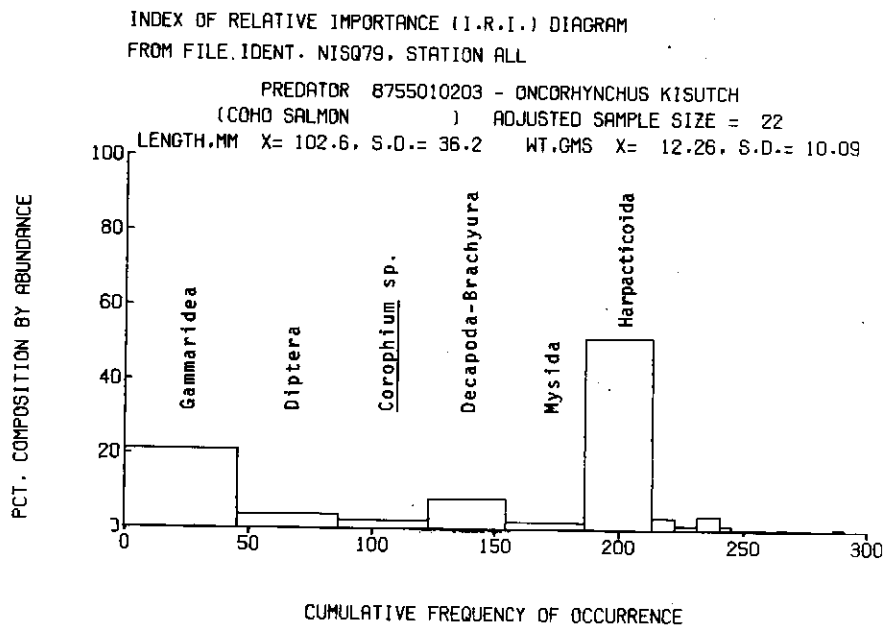
PREY ITEM	FREQ OCCUR	NUM. COMP.	PERCENT TOTAL IRI
GAMMARIDEA	45.45	21.15	31.92
DIPTERA	40.91	3.82	5.19
COROPHIUM SP.	36.36	2.22	2.68
DECAPODA-BRACHYURA	31.82	8.08	8.54
MYSIDA	31.82	1.97	2.08
HARPACTICOIDA	27.27	51.48	46.62
CALANOIDA	9.09	3.21	.97
TALITRIDAE	9.09	1.36	.41
DIPTERA-CHIRONOMIDAE	9.09	3.82	1.15
TURBELLARIA	4.55	1.11	.17
COROPHIUM INSIDIOSUM	4.55	.06	.01
NEOMYSIS MERCEDIS	4.55	.18	.03
CUMELLA VULGARIS	4.55	.25	.04
CERCOPIDAE	4.55	.06	.01
PSYLLIDAE	4.55	.25	.04
APHIDIDAE	4.55	.12	.02
POLYCHAETA	4.55	.25	.04
NEMATOCERA	4.55	.12	.02
AMPITHOE LACERTOSA	4.55	.06	.01
HYPOMESUS PRETIOSUS	4.55	.43	.07

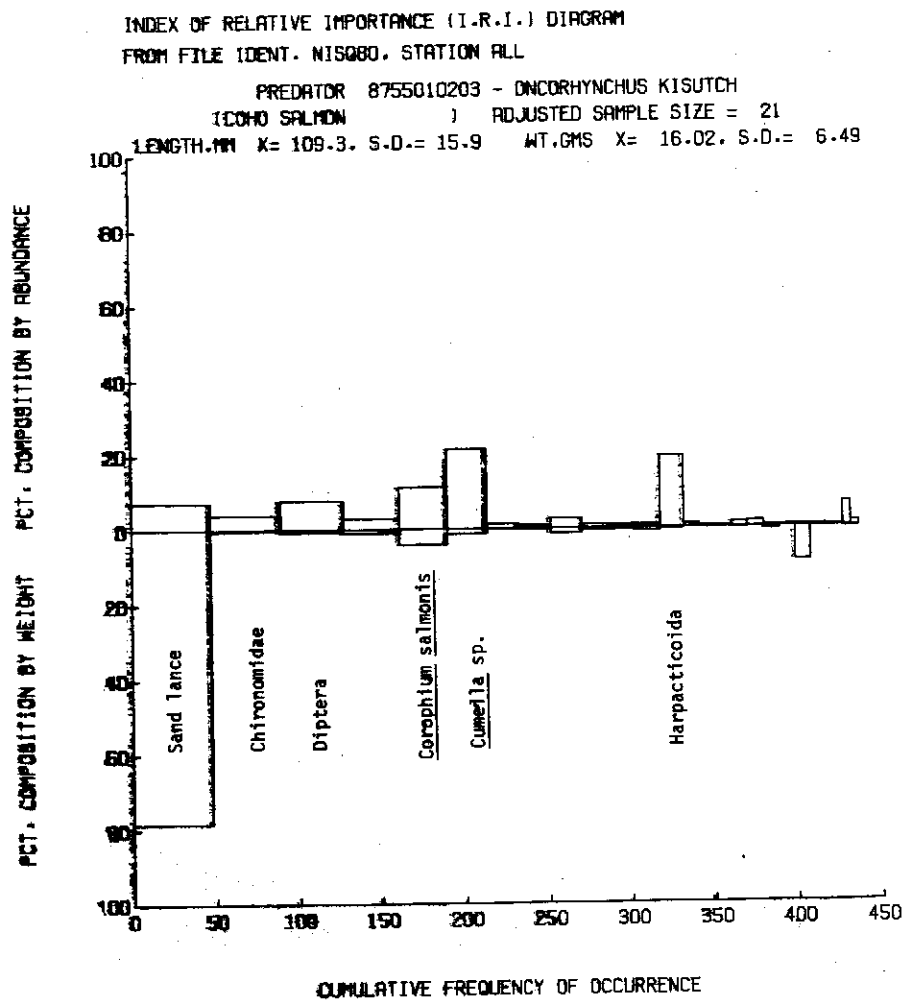
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT



Appendix C, Figure 33. IRI diagram and table showing major prey of juvenile coho caught in the Nisqually Estuary in 1979.

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
AMMODYTES HEXAPTERUS	47.62	7.22	78.56	4084.6	64.04
DIPTERA-CHIRONOMIDAE	42.86	3.95	.20	178.1	2.79
DIPTERA	38.10	7.73	.65	319.2	5.00
INSECTA	33.33	2.92	.87	126.5	1.98
COROPHIUM SALMONIS	28.57	11.34	4.14	442.3	6.93
CUMELLA SP.	23.81	21.31	1.27	537.6	8.43
CERCOPIDAE	19.05	1.20	.14	25.6	.40
EMPIDIDAE	19.05	1.03	.33	25.9	.41
DOLICHOPODIDAE	19.05	2.58	1.28	73.6	1.15
COROPHIUM SP.	19.05	.86	.58	27.5	.43
GAMMARIDEA	14.29	.86	.46	18.8	.29
EOGAMMARUS CONFERVICOLUS	14.29	1.03	.83	26.5	.42
HARPACTICOIDA	14.29	19.07	.25	276.0	4.33
ACARINA	9.52	1.03	.00	9.8	.15
ALLORCHESTES ANGUSTUS	9.52	.34	.09	4.1	.06
NEMATOCERA	9.52	.34	.02	3.4	.05
DECAPODA	9.52	1.20	.04	11.9	.19
PINNOTHERIDAE	9.52	1.55	.00	14.8	.23
MALACOSTRACA	9.52	.34	.54	8.5	.13
CYCLORRHAPHA	9.52	.34	.03	3.5	.06
OSTEICHTHYES	9.52	.52	8.87	89.4	1.40
COLLEMBOLA	9.52	.52	.00	4.9	.08
PLANTS AND PLANT PARTS	9.52	.34	.00	3.3	.05
HELEIDAE	4.76	6.53	.24	32.2	.51
ARANEAE	4.76	1.37	.07	6.9	.11

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)



Appendix C, Figure 34. IRI diagram and table showing major prey of juvenile coho caught in the Nisqually Estuary in 1980.

APPENDIX D

Plankton from the Nisqually Delta, 1980

Table
1 Complete list of organisms encountered

2 Seasonal abundances for selected catagories of plankton

APPENDIX D, TABLE 1. Organisms encountered in plankton samples from the Nisqually Delta, 1980.

Coscinodisceae	Tanaidacea
Algae	*Pancolus* sp.
Chlorophyta	*Leptochelia* sp.
Foraminifera	Isopoda
Nemertea	*Gnorimosphaeroma oregonense*
Nematoda	Gammaridea
Polychaeta	*Ampithoe* sp.
Phyllodocidae	*Corophium* sp.
Eteone longa	*Corophium salmonis*
Nereidae	*Corophium brevis*
Orbiniidae	*Corophium spinicorne*
Spionidae	*Corophium acherusicum*
Polydora kempi japonica	*Corophium insidiosum*
Streblospio sp.	*Eogammarus* sp.
Cirratulidae	*Eogammarus confervicolus*
Capitellidae	*Eogammarus oclairi*
Manayunkia aestuarine	Hyalidae
Oligochaeta	*Allorchestes angusta*
Gastropoda	*Paraphoxus spinosus*
Hermaeina smithi	Stenothoidae
Bivalvia	Hyperiidea
Acari	Caprellidea
Crustacea	Euphausiacea zoea
Cladocera	Caridea zoea
Ostracoda	Pandalidae zoea
Copepoda	Crangonidae
Calanoida	Brachyura zoea
Calanus pacificus	Cancridae zoea
Aetideus armatus	Pinnotheridae zoea
Harpacticoida	Coleoptera
Huntemania sp	Staphylinidae
Cyclopoida	Melyridae
Oncaea sp.	Diptera
Corycaeus sp.	Nematocera
Oithona sp.	Ceratopogonidae
Branchyura	Chironomidae
Cirripedia	Sciaridae
Balanus sp.	Dolichopodidae
Mysida	Ephydridae
Neomysis mercedis	Chaetognath
Cumacea	
Lamprops sp.	
Cumella sp.	

APPENDIX D, TABLE 2. Seasonal abundances of selected plankton categories at the Nisqually Delta, 1980. Number of organisms per 200 liter sample.

	Station, Habitat and Date									
	NP1 (sand/mudflats)					NP2 (slough, east bank of McAllister Creek)				
Organism	4/30	6/6	6/26	7/29	8/21	4/30	6/6	6/26	7/29	8/21
Foraminifera	0	0	5	36	80	0	0	265	13	1470
Nematoda	0	1	37	5	132	0	0	259	5	1074
Polychaeta	1	2	84	17	230	2	1	79	15	298
Manayunkia sp.	0	50	348	41	1535	0	26	2003	52	6039
Oligocheata	0	21	56	67	502	0	2	192	4	610
Gastropoda	1	0	1	0	7	1	0	0	0	0
Acari	0	1	1	5	15	0	0	46	8	280
Ostracoda	3	5	45	465	869	6	0	118	98	772
Calanoida	20	4	181	151	71	14	13	255	187	20
Harpacticoida	9	183	575	515	1924	8	21	1534	346	8014
Cyclopoida	1	3	35	47	80	1	7	28	105	36
Barnacle	1	0	3	0	0	14	0	15	38	21
Mysida	0	0	1	2	0	0	0	0	0	0
Cumacea	2	0	1	2	8	1	0	0	2	51
Gammaridea	1	1	0	0	0	0	0	0	7	42
Corophium spp.	0	2	13	174	779	0	0	6	86	183
Eogammarus spp.	0	0	1	26	3	0	0	0	8	2
Euphausiacea zoea	1	0	4	3	0	1	0	0	3	0
Shrimp zoea	1	0	11	1	0	0	1	1	1	0
Crab zoea	2	1	2	1	5	2	1	8	1	0
Coleoptera	0	0	0	0	0	0	0	0	0	0
Diptera	0	0	0	0	0	0	0	4	3	34

APPENDIX D, TABLE 2. (continued)

Organism	Station, Habitat and Date									
	NP3 (sand/algae, south of Luhr Beach)					NP4 (pelagic, McAllister Creek)				
	4/30	6/6	6/26	7/29	8/21	4/30	6/6	6/26	7/29	8/21
Foraminifera	0	0	101	5	494	0	0	4	3	6
Nematoda	0	3	197	10	111	1	0	2	1	1
Polychaeta	1	1	25	1	32	1	0	11	1	10
Manayunkia	0	0	11	9	321	0	1	12	11	28
Oligocheata	0	1	10	1	22	0	0	4	1	1
Gastropoda	8	4	42	34	6	0	0	0	3	15
Acari	0	0	9	0	51	0	0	0	0	1
Ostracoda	16	22	7	1	64	7	1	1	1	1
Calanoida	5	11	223	451	27	13	8	93	67	62
Harpacticoida	20	148	231	92	941	5	2	1	3	7
Cyclopoida	1	0	103	30	11	1	1	12	70	92
Barnacle	0	0	26	15	16	11	0	1	1	5
Mysida	1	0	19	1	6	0	0	0	0	1
Cumacea	2	0	0	6	0	0	0	0	0	0
Gammaridea	1	0	0	1	2	0	0	0	0	0
Corophium spp.	0	1	2	6	25	0	0	1	3	1
Eogammarus spp.	0	1	0	0	0	0	0	0	0	0
Euphausiacea zoea	0	0	1	7	0	2	0	1	8	0
Shrimp zoea	0	0	5	0	0	0	1	0	3	1
Crab zoea	0	0	13	2	0	2	7	0	18	2
Coleoptera	0	0	1	0	141	0	0	0	0	4
Diptera	0	0	0	0	5	0	0	0	0	0

APPENDIX D, TABLE 2. (continued)

Organism	Station, Habitat and Date NP5 (upstream slough, McAllister Creek) 4/30	6/6	6/26	7/29	8/21
Foraminifera	0	0	1404	13	130
Nematoda	0	0	2251	18	140
Polychaeta	1	0	112	8	63
Manayunkia sp.	0	52	841	63	185
Oligocheata	0	0	1711	51	371
Gastropoda	1	0	3	1	0
Acari	0	0	45	0	4
Ostracoda	4	1	81	6	61
Calanoida	4	10	99	48	152
Harpacticoida	64	21	1505	37	1403
Cyclopoida	1	5	28	52	0
Barnacle	0	1	42	1	39
Mysida	1	0	5	23	0
Cumacea	0	0	0	0	0
Gammaridea	1	0	4	1	65
Corophium spp.	0	0	83	12	396
Eogammarus spp.	0	0	11	3	778
Euphausiacea zoea	0	0	0	1	0
Shrimp zoea	0	1	0	3	0
Crab zoea	0	2	1	1	0
Coleoptera	0	0	0	0	0
Diptera	0	1	8	1	3