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Diel Epipelagic Distribution of Juvenile Salmon, Rockfish, Sablefish and Ecological Interactions with Associated Species in Offshore Habitats of the Northeast Pacific Ocean

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Diel Epipelagic Distribution of Juvenile Salmon, Rockfish, Sablefish and Ecological Interactions with Associated Species in Offshore Habitats of the Northeast Pacific Ocean

Abstract

Diel epipelagic sampling for juvenile Pacific salmon (*Oncorhynchus* spp.), rockfish (*Sebastes* spp.), sablefish (*Anoplopoma fimbria*), and associated species was conducted to identify factors that may affect year-class success of these commercially important species. Surface trawls were fished from 10 to 20 August 2005, in the upper 20 m of the water column along transects up to 78 km offshore in the coastal northeast Pacific Ocean near 58° N. Along two transects, three habitats were sampled over a 24-hr period: the continental shelf (<200 m depth), the continental slope (400-750 m depth), and the abyss (>2,000 m depth). A total of 38,747 fish and squid representing 24 species were sampled in 56 trawl hauls. Of the targeted juvenile fish species, a total of 587 salmon, 11 rockfish, and 70 sablefish were captured. Sampling during day (1500-1900) and night (2200-0200) periods indicated that biomass of fish and squid was 3.9 times higher at night pooled across the habitats in the two transects. No distinct patterns between day or night occurrence were noted for juvenile pink salmon (*O. gorbuscha*), chum salmon (*O. keta*), sockeye salmon (*O. nerka*), or coho salmon (*O. kisutch*); however, juvenile Chinook salmon (*O. tshawytscha*) were encountered only at night. Catches of juvenile rockfish and sablefish were quite low in this study, and larger sample sizes of these fish are needed to adequately determine their diel distribution. Diel differences were apparent with forage species such as Pacific herring (*Clupea pallasi*), capelin (*Mallotus villosus*), and eulachon (*Thaleichthys pacificus*) that were almost exclusively sampled at night. The offshore distribution patterns of target species were distinctly different, with the most common occurrences of juvenile salmon over continental shelf habitats, juvenile sablefish over continental shelf and slope habitats, and juvenile rockfish over slope and abyss habitats. Pacific herring, capelin, eulachon, and Pacific sardines (*Sardinops sagax*) were found over continental shelf habitats, whereas small squid and myctophids occurred primarily in slope and abyssal habitats. The greatest overall catch biomass was of jellyfish (gelatinous species), which was consistently higher than that of all fish and squid combined, usually by an order of magnitude. Individual fish or squid species with highest average weight per haul were pomfret (*Brama japonica*), adult coho salmon, Humboldt squid (*Dosidicus gigas*), and blue sharks (*Prionace glauca*). The occurrence of the latter two warm-water species and Pacific sardines was of interest because this study occurred during an anomalously warm year and the capture of Pacific sardines and Humboldt squid represent northern range extensions for these species. Stomach content analysis of potential predator species of the target species showed that only adult coho salmon were predating on juvenile salmon and sablefish, and only pomfret were predating on juvenile rockfish. Further sampling of the target species is needed in these habitats during more normal environmental conditions to validate these observations.

Introduction

Juvenile Pacific salmon (*Oncorhynchus* spp.), rockfish (*Sebastes* spp.), and sablefish (*Anoplopoma fimbria*) are commercially important species that utilize epipelagic waters of the northeast Pacific during their early marine life history. Defining their offshore distribution patterns and diel associations with other species at this time is important, because year-class success varies greatly and early marine factors such as ocean variables, foraging success, or predation may affect recruitment during this critical period (Parker 1962, 1971, McFarlane and Beamish 1992, Pearcy 1992, Myers et al. 2000, Sigler et al. 2001, Love et al. 2002, Beamish et al. 2003, Schirripa and Colbert 2006). The effects of climate and climate change on anadromous species (i.e., salmon) and ecologically related species in North Pacific marine ecosystems is a broad scientific question identified in the North Pacific Anadromous Fish Commission (NPAFC) 2006-2010 Science Plan (NPAFC 2006). Moreover, the NPAFC identifies research on trophic linkages and predation rates of juvenile salmon in ocean ecosystems as a key component of the Science Plan. To better understand the distribution, habitat utilization, and interactions of these juveniles and their associations with other species, we initiated a research project to diel sample specific habitats. A primary goal of this study was to gain insight into the diel dynamics of marine ecosystems, and contribute to the implementation of the Ecosystem Approach to Management (EAM, NOAA 2005) for salmon, rockfish, sablefish, and other managed species. Our study approach was to sample fish and ecologically related species during both day and night with a rope trawl in epipelagic waters over shelf, slope, and abyssal habitats in the northeast Pacific Ocean. Specific study objectives were to: 1) evaluate procedures for establishing a trawl indexing survey using the R/V *Medeia* for targeted juvenile species (i.e., salmon, rockfish, and sablefish in their first year at sea); 2) examine diel differences of the targeted and associated species; and 3) determine offshore distribution patterns of the targeted species and their interactions with associated species in different marine habitats.

Methods

Experimental design

Scientists from the National Marine Fisheries Service's Auke Bay Laboratory (ABL) conducted a research cruise aboard the Alaska Department of Fish and Game research vessel R/V *Medeia* from 10 to 20 August 2005. The experimental design consisted of sampling fish assemblages and oceanography along three transects seaward of Icy Point, Cape Edward, and Cross Sound in the Gulf of Alaska (Figure 1). The localities of these transect lines were selected due to their varied bathymetric features (i.e., continental shelf width), and close proximity (i.e., 50-75 km) to one another. For example, the Icy Point transect line crossed over a relatively broad continental shelf (~40 km), the Cape Edward line crossed over a narrower (~20 km) continental shelf, and the Cross Sound line crossed over a deep gully between the two transect lines and had minimal continental shelf exposure (Table 1, Figure 1). Three stations were situated along each transect: an inshore station along the continental shelf (100-150 m depth), a middle station on the continental slope (400-800 m depth), and an offshore station in abyssal waters (>2,000 m depth).

The experimental design also consisted of repeated sampling at each station within a 24-hr interval during two distinct periods: one during day (1500-1900) and one during night (2200-0200). Each period was sampled with 30-min trawl hauls, up to four during day and up to three at night. It was assumed that night hauls would take considerably longer to complete because of the increased time required to work the trawl gear during poorer lighting conditions and longer anticipated processing times associated with expected higher catches at night. At each station, tow paths for hauls were situated about 200 m apart and parallel to each other in a grid-like pattern centered on the station coordinate. Thus, all repetitive sampling at each station was offset with successive trawl tracks. This was done to avoid possible depletion effects of repeatedly sampling the same tow path. Trawling direction was predicated on sea state and wind direction.

Trawl sampling

All fishing operations were conducted with a 264 rope trawl fished directly astern the 33.5-m R/V *Medeia* at the surface. The mouth opening of the trawl was approximately 20 m deep and 24 m wide, and spread by a pair of 3.0-m Lite trawl doors. The trawl was fished fully open with 150 m of main warp out for a duration of 30 min at a speed over ground (SOG) of about 1.6 m/sec (3.1 knots). Thus each trawl haul approximately sampled a surface area of 69.1 km^2 and a volume of $1.38 \cdot 10^6$ m^3. The SOG, as well as the vessel RPM measurements, was recorded at the beginning and ending of each haul. To fish the headrope of the trawl at the surface, a cluster of three meshed A-4 Polyform buoys was tethered to each wing tip of the headrope and one A-3 Polyform float was clipped onto the center of the headrope. Mesh sizes ranged from 162.6 cm in the throat of the trawl near the jib lines to 8.9 cm in the codend. A 6.1 m long, 0.8 cm knotless liner was sewn into the codend. Along the jib lines on the top panel of the trawl, between the head rope and the first 162.6 cm of mesh, a small mesh panel of 10.2-cm mesh was incorporated to minimize the loss of fish aft of the headrope.

Processing the catch

After each trawl haul, catches were anaesthetized with tricaine methanesulfonate (if necessary), identified, enumerated, weighed, and measured for individual lengths. Fish and squid species were counted and measured to the nearest mm fork length (FL) or mantle length (ML) with a Limnoterra FMB IV electronic measuring board. Bulk weights of fish species and squid to the lowest taxonomic level were taken on total samples for each haul to the nearest 1 g using a motion-compensated MAREL marine scale. Weights of specimens too large for the scale (i.e., >15 kg) were extrapolated from length-weight relationships. Jellyfish (gelatinous species) were volumetrically measured to the nearest 1 L. Jellyfish weight estimates were computed by using a 1 L = 1 kg conversion factor, which was empirically derived during sampling. If an extremely large number of individuals of a species or taxon were caught in a haul, subsampling was done so that no more than about 200-500 individuals were measured. Juvenile salmon, rockfish, and sablefish were frozen in individually labeled bags for later laboratory analyses. A subsample of at least 50 specimens of each juvenile salmon species was frozen for later laboratory analyses. Samples of several groundfish and forage species were retained for genetic or growth studies. Samples were also kept of unusual or unidentified species.

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

To identify possible predation events on the target species, stomachs from potential predators were excised, weighed, and classified by fullness. The weight of the stomach contents was determined as the difference between the weight of the stomach and contents minus the weight of the empty stomach. Stomach contents were removed and prey was generally identified to species or major taxon and their contribution estimated to the nearest 10% of total volume. The analyses of stomach contents were principally done onboard the vessel; however, a limited number were done at the laboratory from frozen specimens.

Juvenile salmon were screened for stock information onboard. All Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*) lacking adipose fins were flagged and later examined at the laboratory for coded-wire tags (CWTs). Other species of juvenile salmon were later screened at ABL using a CWT detector for the possible presence of CWTs.

Oceanographic sampling

Oceanographic sampling included physical and biological monitoring at each station. To examine horizontal water structure, temperature and salinity readings were continuously logged at 1-minute intervals from a 3-m depth using a SeaBird SBE-21 thermosalinograph (TSG) mounted on the R/V *Medeia* hull. The SBE-21 was purchased by the ABL and specifically installed on the vessel for this cruise. To examine vertical water structure, a Seabird SBE-25 conductivity-temperature-depth (CTD) profiler was deployed to 200 m or within 10 m of the bottom. This was typically done at the beginning and end of a diel sampling series to characterize vertical profiles of temperature, salinity, density, and fluorimetry. Secchi depth readings were made during day operations by observing the CTD upon deployment. Bottom depth and position coordinates were recorded at the beginning and ending of each trawl haul. Bottom depth readings in abyss localities were in excess of the depth sounder capability of 2,000 m and therefore recorded as 2,000+ m. Ambient light was measured with a Li-Cor Model LI-189 radiometer in W/m^2.

Results and Discussion

Favorable weather conditions enabled fish and oceanographic sampling to be successfully completed at most stations. Predetermined stations were fully completed along the Icy Point and Cape Edward transects; however, marginal weather toward the latter part of the cruise did not allow the Cross Sound transect to be sampled as planned. Therefore, a revised sampling for this transect was implemented that included diel sampling at stations in Cross Sound, Lisianski Strait, and the Spencer Gully (Figure 2).

A total of nine 24-hr diel sampling intervals were completed on the cruise. This included a complete sampling of all the scheduled stations along the Icy Point and Cape Edward transects (three intervals each), as well as diel sampling intervals in Cross Sound, the Spencer Gully, and Lisianski Strait (Table 2). Trawl speed for each haul ranged between 0.95 and 2.13 m/s and averaged 1.57 m/s. Light measurements taken over the sampling intervals ranged from 33.9 to 886.8 W/m^2 for day sampling and 0.0 to 0.01 W/m^2 for night sampling (Table 2).

Total rope trawl sampling included 56 hauls fished: 31 day hauls, 24 night hauls, and 1 test haul. A total of 38,747 fish and squid were caught, representing 24 species (Table 3). Size data from all species were sampled and grouped into three categories: target species, forage species, and predator species (Table 4). Of the juvenile fish species targeted for this cruise, a total of 587 salmon, 11 rockfish, and 70 sablefish were captured. Notable non-target species captured were 87 Pacific sardines (*Sardinops sagax*), 29 Humboldt squid (*Dosidicus gigas*), and 6 blue sharks (*Prionace glauca*). The capture of Pacific sardines and Humboldt squid represent northern range extensions for these species (Mecklenburg et al. 2002).

Average weight estimates of fish, squid, and jellyfish per haul were calculated from day and night fishing periods along the Icy Point and Cape Edward transects where representative sampling occurred over shelf, slope, and abyss habitats (Tables 5 and 6). Shark weight exceeded the scale limit so weight was estimated from length-weight relationships listed in Kohler et al. (1996). Because no length-weight relationship was available in this reference for salmon shark (*Lamna ditropis*), the length-weight relationship for porbeagle shark (*Lamna nasus*, which is in the same genus) was substituted. Biomass of fish and squid was 3.9 times higher at night than during day at all habitat types pooled across the two transects (Figure 3). The fish or squid species with highest average weight per haul were pomfret (*Brama japonica*), Humboldt squid, and blue sharks. Biomass of jellyfish was consistently higher than that of all fish and squid combined, usually by an order of magnitude at each of the habitat types. However, jellyfish have higher water content than most fish. For example Uye and Shimauchi (2005) found *Aurelia aurita* to have a dry weight as a percentage of wet weight of 3.6%, an order of magnitude lower than dry weight as a percentage of wet weight measured for 10 Pacific sardines in this study (36.9%, S.D. 6.3). Diel patterns for jellyfish varied also; they were more abundant during day at the shelf station, similar between day and night at the slope stations, and more abundant at night at the abyss stations (Figure 3).

Catch rates of species and their frequency of occurrence (FO) were calculated for target species, forage species, and predator species sampled from day and night fishing periods along the Icy Point and Cape Edward transects where representative sampling occurred over shelf, slope, and abyss habitats (Tables 7 and 8). Of the target species captured along both transects, juvenile salmon occurred almost exclusively at shelf stations: the one exception was juvenile chum salmon at the slope station on the Cape Edward transect. No distinct pattern in diel occurrence was noted for juvenile pink salmon, chum salmon, sockeye salmon, or coho salmon. Pink salmon, chum salmon, sockeye salmon were more abundant at night at the Icy Point transect, and during day at the Cape Edward transect. The opposite was observed for juvenile coho salmon, which were more abundant at day at the Icy Point transect, and during night at the Cape Edward transect. However, juvenile Chinook salmon were encountered only at night at both the Icy Point and Cape Edward transects. Juvenile rockfish were rare in the catches, and occurred only during day at slope and abyss stations on the Icy Point transect. Juvenile sablefish were captured at shelf and slope stations on the Icy Point transect; none were captured at the Cape Edward transect. Juvenile sablefish also did not have a distinct difference in diel occurrence; they were more abundant at night at the Icy Point shelf station, and during day at the slope station.

Forage species were almost exclusively captured at night. Forage species such as Pacific herring (*Clupea pallasi*), Pacific sardine, eulachon, and capelin (*Mallotus villosus*) occurred primarily at shelf stations, whereas small squid and myctophids occurred primarily at slope and abyssal stations.

Dominant predator species differed by transect and station. Adult and immature salmon combined were the most abundant predator species at the shelf stations of both transects. At the Icy Point slope station, pomfret had the highest FO and blue shark had the highest biomass, while at the Icy Point abyss station, pomfret had the highest biomass and FO. At the Cape Edward slope and abyss stations, pomfret and Humboldt squid had high FO, but Humboldt squid had the highest biomass.

Stomach analysis was completed on 183 specimens of potential predators of juvenile salmon, rockfish, and sablefish (Table 9). All species were examined for stomachs onboard, with the exception of 10 Pacific sardines that were sampled at the laboratory. A total of 12 different species of predators were examined: 53 pomfret, 37 Pacific hake (*Merluccius productus*), 35 adult pink salmon (*O. gorbuscha*), 21 adult coho salmon, 10 Humboldt squid, 10 Pacific sardines, 8 immature Chinook salmon, 3 immature sockeye salmon (*O. nerka*), 2 adult chum salmon (*O. keta*), 2 adult black rockfish (*Sebastes melanops*), 1 adult walleye pollock (*Theragra chalcogramma*), and 1 adult steelhead (*O. mykiss*). Of these potential predators examined, 8 of the 12 species consumed fish prey in excess of 25 percent of the stomachs examined. Predation events on the target species were identified in five instances for juvenile salmon and three instances for juvenile rockfish and sablefish (Table 10). The only observed predator of juvenile salmon and sablefish was coho salmon and the only observed predator of juvenile rockfish was pomfret.

Five juvenile salmon with missing adipose fins and all other salmon were screened at the laboratory for coded-wire tags. Stock identification information was available from two juvenile Chinook salmon that lacked the adipose fin and contained CWTs; other salmon, including three adipose-fin-clipped juvenile coho salmon did not contain CWTs. Of the two CWT Chinook salmon, one was from Alaska and the other was from the Columbia River Basin (Table 11). The Alaska juvenile Chinook salmon was released from Medvejie hatchery in Bear Cove near Sitka, Alaska at a size of 77.6 g on 20 May 2005 and had migrated about 80 km in a northwest direction in 91 days. The Columbia River Basin juvenile Chinook salmon was released from the Imnaha River (tributary of the Snake River) in Oregon at a size of 18.4 g on 12 March 2005 and had migrated about 1,800 km in a northwest direction in 154 days.

The large sharks caught in the trawl were viable, and therefore were tagged and released. All sharks were females. A total of 7 blue sharks and 1 salmon shark were tagged and released (Table 12).

For the oceanographic sampling, surface (3-m) TSG data were logged at the onset of the 56 trawl hauls, and a total of 31 CTD casts were made (Figure 2). Surface temperature and salinity TSG observations during the hauls ranged from 12.7 to 16.4ºC and 30.6 to 31.8 PSU (Table 2). This range of observations did not include the test haul made further inshore in Icy Strait where the salinity was substantially lower (19.7 PSU). The highest temperatures were observed along the Cape Edward transect, particularly at the furthest offshore stations. The lowest temperatures were observed over the Spencer Gully near Cross Sound. Salinities were generally highest off the Icy Point slope and abyss stations and lowest over the Spencer Gully and the Icy Point shelf stations. Due to software problems, the onboard TSG only logged observations at the sampling stations, and did not log continuous data along the vessel's trackline. The CTD data will be reported at a later date.

Findings from this study will support implementation of the EAM by providing a conceptual framework of species interactions in epipelagic waters of the Northeast Pacific Ocean. These species interactions involve: predator-prey dynamics, spatial offshore distribution patterns, and species-specific vertical diel migration behavior. For example, several instances of predation on the targeted juveniles of this study were evident: juvenile salmon and sablefish were preyed on by adult coho salmon and juvenile rockfish were preyed on by pomfret. The offshore distribution patterns of target species also differed, with the most common occurrences of juvenile salmon over shelf stations, juvenile sablefish over shelf and slope stations, and juvenile rockfish over slope and abyss stations. Other species such as Pacific herring and capelin occurred primarily over shelf stations, whereas pomfret and Humbolt squid occurred primarily over slope and abyssal stations. There were also dramatic effects of diel period on catch composition, particularly during night sampling where Pacific herring, capelin, squid, and myctophids were nearly exclusively encountered. Fish and squid biomass was always substantially higher at night than during day in the epipelagic zone sampled. Average catch weight was generally higher by an order of magnitude or greater for jellyfish than for other fauna at most stations. Species with the next highest average weight were pomfret, adult coho salmon, blue shark, and Humboldt squid. Our study year of 2005 was anomalously warm, which may have contributed to the occurrences of Humboldt squid and Pacific sardines in what were northward extensions for these species. Also, catches of juvenile rockfish and juvenile sablefish were quite low in this study, and larger sample sizes of these fish are needed to adequately determine their diel distribution. We plan to repeat diel sampling at these stations during a year with more normal environmental conditions to validate the observed catch patterns.

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Table 1.—Localities and station coordinates scheduled for sampling in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from10 to 20 August 2005.

Locality	Station	Latitude	Longitude	Offshore distance (km)	Bottom depth (m)
Icy Point transect					
Icy Point abyssal	IPABYSS	57° 48.5' N	137º 50.8' W	78	1,300+
Icy Point slope	IPSLOPE	57° 54.6' N	137º 41.8' W	63	400
Icy Point shelf	IPSHELF	58° 12.7' N	137º 17.0' W	24	100-200
Cape Edward transect					
Cape Edward abyssal	CEABYSS	57° 28.8' N	136º 56.6' W	70	1,300+
Cape Edward slope	CESLOPE	57° 34.4' N	136º 38.3' W	54	400
Cape Edward shelf	CESHELF	57° 38.3' N	136º 25.8' W	7	100-200
Cross Sound transect[2]					
Cross Sound abyssal	CSABYSS	57° 38.5' N	137º 24.5' W	46	1,300+
Cross Sound slope	CSSLOPE	57° 46.3' N	137º 12.8' W	26	400
Cross Sound shelf	CSSHELF	58° 06.0' N	136º 41.6' W	11	100-200

[2] Actual locations sampled off Cross Sound were modified during the cruise due to weather.

Table 2.—Physical data collected at stations sampled in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. Start latitude and longitude were recorded when trawl was set in a full fishing position. Trawl speed is the average speed (1 knot = 0.5144 m/s) determined from two measurements: one was recorded when the trawl was in the initial fishing position and the other was recorded when haul back was initiated. Bottom depth was the average of two readings taken at the same time as the trawl speed recordings. Temperature and salinity readings were from the vessel thermosalinograph at the time trawling was initially set.

Haul number	2005 Date	Station code	Start latitude (dec-deg)	Start longitude (dec-deg)	Event	Start time	Haul time (min)	Trawl speed (m/s)	Ambient light (W/m^2)	Secchi depth (m)	CTD depth (m)	Bottom depth (m)	Temp (ºC) (3-m)	Salinity PSU (3-m)
20001	10-Aug	ISC	58.25487	135.4386	*Test	16:30	18	1.62	520.0	6.5	200	253	14.2	19.7
20002	11-Aug	IPABYSSAL	57.79407	137.8417	Day	15:11	30	1.39	241.0	8.5	200	2,000+	15.3	31.8
20003	11-Aug	IPABYSSAL	57.81210	137.8653	Day	16:40	30	1.44	233.0	-	-	2,000+	15.5	31.7
20004	11-Aug	IPABYSSAL	57.79893	137.8299	Day	17:50	30	1.49	134.5	-	-	2,000+	15.5	31.7
20005	11-Aug	IPABYSSAL	57.81527	137.8491	Day	18:55	30	1.57	79.9	7	200	2,000+	15.3	31.7
20006	11-Aug	IPABYSSAL	57.80467	137.8212	Night	22:15	30	1.36	0.0	-	-	2,000+	15.5	31.7
20007	11-Aug	IPABYSSAL	57.82170	137.8453	Night	23:45	30	1.41	0.0	-	-	2,000+	15.2	31.8
20008	12-Aug	IPABYSSAL	57.81057	137.8141	Night	01:25	30	1.47	0.0	-	200	2,000+	15.4	31.7
20009	12-Aug	IPSLOPE	57.88587	137.6866	Day	15:15	30	1.62	210.0	5.5	200	758	15.4	31.7
20010	12-Aug	IPSLOPE	57.91395	137.7097	Day	16:30	30	1.59	174.0	-	-	640	15.4	31.8
20011	12-Aug	IPSLOPE	57.89875	137.6867	Day	17:33	30	1.70	129.9	-	-	583	15.5	31.7
20012	12-Aug	IPSLOPE	57.91838	137.7005	Day	18:37	30	1.52	64.3	5.5	200	512	15.4	31.8
20013	12-Aug	IPSLOPE	57.90313	137.6755	Night	21:59	30	1.72	0.0	-	-	421	15.4	31.8
20014	12-Aug	IPSLOPE	57.92490	137.6883	Night	23:16	30	1.41	0.0	-	-	448	15.3	31.8
20015	13-Aug	IPSLOPE	57.91022	137.6687	*Failed	00:36	-	-	0.0	-	-	405	15.4	31.7
20016	13-Aug	IPSLOPE	57.92210	137.6739	Night	01:28	31	1.44	0.0	-	200	524	15.5	31.8
20017	13-Aug	IPSHELF	58.19272	137.2946	Day	15:18	30	1.39	886.8	5.5	110	123	15.4	30.9
20018	13-Aug	IPSHELF	58.21035	137.3092	Day	16:55	30	1.85	202.4	-	-	125	15.4	30.8
20019	13-Aug	IPSHELF	58.20689	137.2981	Day	18:10	33	1.31	114.6	-	-	122	15.2	31.0
20020	13-Aug	IPSHELF	58.21692	137.2815	Day	19:22	31	2.06	33.9	6	115	124	15.0	31.0
20021	13-Aug	IPSHELF	58.20468	137.2756	Night	22:13	32	1.18	0.0	-	-	122	15.0	30.9
20022	13-Aug	IPSHELF	58.21399	137.2596	Night	23:27	32	2.06	0.0	-	-	123	15.2	30.9
20023	14-Aug	IPSHELF	58.19670	137.2594	Night	01:21	30	0.95	0.0	-	110	125	15.1	31.0
20024	14-Aug	CEABYSSAL	57.46043	136.9523	Day	15:10	30	1.65	141.0	9	200	2,000+	16.0	31.7
20025	14-Aug	CEABYSSAL	57.48325	136.9763	Day	16:35	30	1.31	135.5	-	-	2,000+	16.1	31.6
20026	14-Aug	CEABYSSAL	57.46895	136.9403	Day	17:42	30	1.80	40.6	-	-	2,000+	16.1	31.6

Table 2.—(cont.)

Haul number	2005 Date	Station code	Start latitude (dec-deg)	Start longitude (dec-deg)	Event	Start time	Haul time (min)	Trawl speed (m/s)	Ambient light (W/m^2)	Secchi depth (m)	CTD depth (m)	Bottom depth (m)	Temp (ºC) (3-m)	Salinity PSU (3-m)
20027	14-Aug	CEABYSSAL	57.49552	136.9659	Day	18:41	30	1.36	36.8	9	200	2,000+	16.1	31.5
20028	14-Aug	CEABYSSAL	57.47328	136.9206	Night	22:12	30	1.72	0.0	-	-	2,000+	16.0	31.6
20029	14-Aug	CEABYSSAL	57.49820	136.9462	Night	23:39	30	1.52	0.0	-	-	2,000+	16.1	31.5
20030	15-Aug	CEABYSSAL	57.48027	136.9084	Night	01:12	30	1.47	0.0	-	200	2,000+	16.1	31.5
20031	15-Aug	CESLOPE	57.57498	136.6508	Day	15:15	30	1.57	516.8	8.5	200	814	16.4	31.5
20032	15-Aug	CESLOPE	57.58532	136.6466	Day	16:44	30	1.70	216.5	-	-	788	15.6	31.5
20033	15-Aug	CESLOPE	57.55167	136.6450	Night	22:13	30	1.52	0.0	-	200	738	15.0	31.5
20034	15-Aug	CESLOPE	57.56513	136.6283	Night	23:47	30	1.65	0.0	-	200	727	16.1	31.5
20035	16-Aug	CESLOPE	57.57898	136.6252	Night	01:44	30	1.47	0.0	-	200	665	16.1	31.5
20036	16-Aug	CESHELF	57.62865	136.4392	Day	14:48	30	1.44	705.0	7.5	120	139	15.7	31.5
20037	16-Aug	CESHELF	57.64107	136.4494	Day	16:05	30	1.67	573.0	-	-	138	15.9	31.5
20038	16-Aug	CESHELF	57.63267	136.4306	Day	17:20	20	1.59	416.2	-	-	135	15.7	31.5
20039	16-Aug	CESHELF	57.63753	136.4311	Day	18:20	30	1.85	257.8	6.5	120	132	15.7	31.5
20040	16-Aug	CESHELF	57.63522	136.4200	Night	22:10	30	1.65	0.0	-	-	133	15.5	31.6
20041	16-Aug	CESHELF	57.64668	136.4301	Night	23:36	31	1.39	0.0	-	-	131	15.6	31.6
20042	17-Aug	CESHELF	57.63632	136.4103	Night	00:46	30	1.62	0.0	-	115	130	15.5	31.6
20043	17-Aug	CSGULLY	58.03548	136.8743	Day	15:03	30	1.31	251.2	4.5	220	392	13.0	30.6
20044	17-Aug	CSGULLY	58.02177	136.8629	Day	16:28	30	1.67	263.3	-	-	390	13.8	30.9
20045	17-Aug	CSGULLY	58.03202	136.8780	Day	17:34	30	1.39	108.7	-	-	397	13.6	30.7
20046	17-Aug	CSGULLY	58.01965	136.8706	Day	18:42	30	1.70	35.5	4.5	200	394	13.8	30.9
20047	17-Aug	CSGULLY	58.02372	136.8813	Night	22:18	30	1.59	0.0	-	200	398	15.7	31.5
20048	18-Aug	CSGULLY	58.03038	136.8940	Night	00:08	30	1.29	0.0	-	-	408	15.5	31.4
20049	18-Aug	LSTRAIT	57.84737	136.4397	Day	16:25	30	1.57	91.2	-	70	119	14.3	31.4
20050	18-Aug	LSTRAIT	57.84973	136.4391	Day	17:56	30	1.72	74.5	6.5	200	169	14.6	31.3
20051	18-Aug	LSTRAIT	57.87475	136.4150	Day	19:05	30	1.70	49.9	-	-	228	14.4	31.3
20052	18-Aug	LSTRAIT	57.85455	136.4370	Night	22:32	30	2.13	0.0	-	90	184	14.6	31.5
20053	19-Aug	LSTRAIT	57.88205	136.4093	Night	01:07	30	1.75	0.0	-	210	227	14.4	31.5
20054	19-Aug	CSSHALLOW	58.14068	136.7029	Day	15:12	30	1.75	139.0	5	60	102	13.6	31.0
20055	19-Aug	CSDEEP	58.10240	136.6120	Day	17:19	30	2.08	410.9	6	160	259	14.8	31.4
20056	19-Aug	CSDEEP	58.10852	136.6187	Night	22:12	30	1.41	0.0	-	210	262	12.7	31.3
20057	20-Aug	CSSHALLOW	58.13435	136.6901	Night	00:06	30	1.52	0.0	-	115	78	13.3	30.9

Table 3.—Catch data at stations sampled during rope trawl operations in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. Overall percentage frequency of occurrence is based on all 56 day and night hauls at all localities. Catch data do not include 109 Pandelid shrimp caught at the Cape Edward transect.

			Transect or locality						
Common name	Genus species	Life history	Icy Point transect	Cape Edward transect	Cross Sound transect	Lisianski Strait	Icy Strait	Total catch	Overall frequency (%) of occurrence
Pink salmon	*Oncorhynchus gorbuscha*	Juvenile	308	28	20	47	6	409	34
		Adult	3	5	15	12	0	34	32
Chum salmon	*Oncorhynchus keta*	Juvenile	14	57	27	27	0	125	43
		Adult	0	0	2	0	0	2	4
Sockeye salmon	*Oncorhynchus nerka*	Juvenile	1	4	12	1	0	18	16
		Immature	1	2	0	0	0	3	5
Coho salmon	*Oncorhynchus kisutch*	Juvenile	1	7	17	5	0	30	25
		Adult	0	10	9	0	1	20	18
Chinook salmon	*Oncorhynchus tshawytscha*	Juvenile	2	2	0	0	1	5	9
		Immature	0	5	1	1	0	7	7
Rockfish	*Sebastes* spp.	Juvenile	10	0	0	1	0	11	7
Sablefish	*Anoplopoma fimbria*	Juvenile	67	0	2	1	0	70	21
Steelhead	*Oncorhynchus mykiss*	Adult	1	0	0	0	0	1	2
Capelin	*Mallotus villosus*	Imm.-Adult	203	0	6	0	0	209	9
Crested sculpin	*Blepsias bilobus*	Imm.-Adult	0	0	0	0	1	1	2
Eulachon	*Thaleichthys pacificus*	Imm.-Adult	44	0	26	17	0	87	13
Prowfish	*Zaprora silenus*	Juv.-Imm.	0	2	0	1	0	3	5
Poacher	*Agonidae*	Juvenile	0	0	1	0	0	1	2
Walleye pollock	*Theragra chalcogramma*	Juvenile	9	0	0	6	0	18	11
		Adult	3	0	0	0	0	15	5
Black rockfish	*Sebastes melanops*	Adult	0	2	0	1	0	3	5
Arrowtooth flounder	*Atheresthes stomias*	Adult	1	0	0	0	0	1	2
Salmon shark	*Lamna ditropis*	Immature	0	1	0	0	0	1	2
Pomfret	*Brama japonica*	Adult	197	7	0	0	0	204	27
Pacific saury	*Cololabis saira*	Adult	0	4	0	0	0	4	4
Pacific sardine	*Sardinops sagax*	Adult	6	21	55	5	0	87	29
Blue shark	*Prionace glauca*	Adult	2	4	0	0	0	6	9
Ragfish	*Icosteus aenigmaticus*	Juvenile	3	2	0	0	0	5	9
Pacific hake	*Merluccius productus*	Adult	0	0	162	1	0	163	5
Lanternfish	Myctophidae	Juv.-Adult	2,292	2,139	4	0	0	4,435	25
Pacific herring	*Clupea pallasi*	Juvenile	0	0	7	28,747	0	28,754	11
		Imm.-Adult	499	89	81	1,753	0	2,422	21
Market squid	*Loligo opalescens*	Imm.-Adult	0	0	0	1	0	1	2
Squid <100mm	*Gonatidae*	Juv.-Imm.	44	121	1,334	3	0	1,502	36
Squid >100<~300mm	Unidentified	Juv.-Imm.	12	0	62	0	0	74	14
Humboldt squid	*Dosidicus gigas*	Imm.-Adult	0	29	0	0	0	29	9
Total			3,723	2,542	1,843	30,630	9	38,747	

Table 4.—Fork length (minimum, maximum, mean and standard deviation, SD, of fork length) and life history stage of a portion of the fish and squid sampled in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. Life history stage abbreviations are: Juve. = juvenile in first year at sea and Imm. = immature. Measurements for squid are in mantle length.

Common name	Genus species or family	Life history	Number measured	Min length (mm)	Max length (mm)	Mean length (mm)	SD length (mm)
		Target species					
Pink salmon	*Oncorhynchus gorbuscha*	Juvenile	212	115	194	145.8	14.1
Chum salmon	*Oncorhynchus keta*	Juvenile	125	125	205	175.6	13.7
Sockeye salmon	*Oncorhynchus nerka*	Juvenile	18	112	180	163.2	15.2
Coho salmon	*Oncorhynchus kisutch*	Juvenile	30	203	303	245.7	25.2
Chinook salmon	*Oncorhynchus tshawytscha*	Juvenile	5	218	349	263.2	49.9
Sablefish	*Anoplopoma fimbria*	Juvenile	68	99	210	181.3	16.6
Rockfish.	*Sebastes* spp.	Juvenile	10	32	56	47.4	7.8
		Forage species					
Pacific herring	*Clupea pallasi*	Juvenile	92	63	92	76.0	5.4
Pacific herring	*Clupea pallasi*	Imm.-Adult	421	116	269	173.9	34.7
Capelin	*Mallotus villosus*	Imm.-Adult	166	87	125	102.2	6.2
Crested sculpin	*Blepsias bilobus*	Imm.-Adult	1	138	138	138.0	-
Eulachon	*Thaleichthys pacificus*	Imm.-Adult	87	126	198	173.4	14.4
Prowfish	*Zaprora silenus*	Juve.-Imm.	3	80	191	130.3	56.2
Poacher (Agonidae)	*Agonidae*	Juvenile	1	38	38	38.0	-
Walleye pollock	*Theragra chalcogramma*	Juvenile	12	55	82	64.4	8.0
Pacific saury	*Cololabis saira*	Immature	4	175	196	187.0	9.0
Pacific sardine	*Sardinops sagax*	Adult	87	209	289	253.6	18.7
Ragfish	*Icosteus aenigmaticus*	Juvenile	5	53	167	133.6	45.9
Market squid	*Loligo opalescens*	Imm.-Adult	1	55	55	55.0	-
Squid (<100 mm ML)	*Gonatidae*	Juvenile	105	19	90	38.4	10.9
Squid (100-~300 mm ML)	*Gonatidae*	Imm.-Adult	78	109	330	249.3	47.3
		Predator species					
Walleye pollock	*Theragra chalcogramma*	Adult	6	222	357	269. 7	51.5
Black rockfish	*Sebastes melanops*	Adult	3	184	475	324.3	145.8
Arrowtooth flounder	*Atheresthes stomias*	Adult	1	301	301	301.0	-
Blue shark	*Prionace glauca*	Adult	6	1020	1700	1331.0	256.0
Pacific hake	*Merluccius productus*	Adult	42	440	588	483.7	29.5
Pomfret	*Brama japonica*	Adult	153	310	428	341.7	16.1
Pink salmon	*Oncorhynchus gorbuscha*	Adult	35	427	559	497.8	27.6
Sockeye salmon (1 Ocean)	*Oncorhynchus nerka*	Immature	3	429	610	543.0	99.2
Coho salmon	*Oncorhynchus kisutch*	Adult	21	460	738	634.5	70.5
Chinook salmon	*Oncorhynchus tshawytscha*	Immature	7	403	855	548.1	148.6
Chum salmon	*Oncorhynchus keta*	Adult	2	658	699	678.5	29.0
Steelhead	*Oncorhynchus mykiss*	Adult	1	825	825	825.0	-
Salmon shark	*Lamna ditropis*	Adult	1	1130	1130	1130.0	-
Humboldt squid	*Dosidicus gigas*	Adult	29	299	615	520.8	62.2

Table 5.— Average biomass per haul (CPUE: g/haul) of fish, squid, and jellyfish (gelatinous species) at day and night periods along the Icy Point transect in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005.

Common name	Life history or size	Icy Point shelf hauls (4 day, 3 night) CPUE Day	Icy Point shelf hauls (4 day, 3 night) CPUE Night	Icy Point slope hauls (4 day, 3 night) CPUE Day	Icy Point slope hauls (4 day, 3 night) CPUE Night	Icy Point abyssal hauls (4 day, 3 night) CPUE Day	Icy Point abyssal hauls (4 day, 3 night) CPUE Night
Target species							
Pink salmon	Juvenile	13.5	2,757.3	0.0	0.0	0.0	0.0
Chum salmon	Juvenile	15.8	188.3	0.0	0.0	0.0	0.0
Sockeye salmon	Juvenile	0.0	9.0	0.0	0.0	0.0	0.0
Coho salmon	Juvenile	33.5	0.0	0.0	0.0	0.0	0.0
Chinook salmon	Juvenile	0.0	227.3	0.0	0.0	0.0	0.0
Sablefish	Juvenile	72.5	504.3	455.3	0.0	0.0	0.0
Rockfish	Juvenile	0.0	0.0	2.3	0.0	0.3	0.0
Forage species							
Eulachon	Adult	0.0	577.0	0.0	0.0	0.0	0.0
Myctophidae	Juvenile-Adult	0.0	0.0	0.0	33.3	0.0	1,898.3
Pacific herring	Adult	0.0	8,902.0	0.0	0.0	0.0	0.0
Pacific sardine	Adult	53.5	332.0	0.0	0.0	0.0	0.0
Ragfish	Juvenile	0.0	0.0	0.0	1.7	13.0	0.0
Walleye pollock	Juvenile	0.3	5.0	0.0	0.0	0.0	0.0
Capelin	Adult	0.0	419.7	0.0	0.0	0.0	0.0
Squid	<100 mm ML	0.0	4.0	0.0	12.3	0.0	1.3
Squid	100-300 mm ML	0.0	0.0	0.0	668.7	0.0	601.3
Predator species							
Pomfret	Adult	0.0	0.0	1,987.0	2,600.7	5,075.0	32,866.7
Pink salmon	Adult	0.0	454.0	0.0	0.0	0.0	812.7
Sockeye salmon	Immature	0.0	0.0	0.0	290.0	0.0	0.0
Steelhead	Adult	0.0	0.0	1,425.0	0.0	0.0	0.0
Walleye pollock	Adult	0.0	1.0	0.0	0.0	0.0	0.0
Arrowtooth flounder	Adult	0.0	72.0	0.0	0.0	0.0	0.0
Blue shark	Adult	0.0	0.0	12,045.0	0.0	0.0	0.0
Gelatinous species							
Jellies (clear)		8,500.0	1,766.7	150,500.0	178,666.7	132,250.0	300,000.0
Jellies (red)		6,750.0	100.0	5,250.0	9,333.3	6,625.0	20,000.0
Jellies (yellow)		0.0	0.0	0.0	9000.0	0.0	0.0

Table 6.—Average catch per unit effort (CPUE: g/haul) of fish, squid, and jellyfish (gelatinous species) at day and night periods along the Cape Edward transect in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. No juvenile rockfish or sablefish target species were caught along this transect.

Common name	Life history or size	Cape Edward shelf hauls (4 day, 3 night) CPUE Day	Cape Edward shelf hauls (4 day, 3 night) CPUE Night	Cape Edward slope hauls (2 day, 3 night) CPUE Day	Cape Edward slope hauls (2 day, 3 night) CPUE Night	Cape Edward abyssal hauls (4 day, 3 night) CPUE Day	Cape Edward abyssal hauls (4 day, 3 night) CPUE Night
Target species							
Pink salmon	Juvenile	250.8	70.0	0.0	0.0	0.0	0.0
Chum salmon	Juvenile	414.8	166.7	647.0	59.3	0.0	0.0
Sockeye salmon	Juvenile	41.0	14.0	0.0	0.0	0.0	0.0
Coho salmon	Juvenile	118.6	316.0	0.0	0.0	0.0	0.0
Chinook salmon	Juvenile	0.0	120.0	0.0	0.0	0.0	0.0
Forage species							
Myctophidae	Juvenile-Adult	0.0	0.0	0.0	1,200.7	0.0	218.3
Pacific herring	Adult	0.0	1,783.3	0.0	0.0	0.0	0.0
Pacific sardine	Adult	0.0	736.0	0.0	134.0	392.5	0.0
Pacific saury	Adult	0.0	0.0	0.0	0.0	26.0	0.0
Prowfish	Immature	8.2	0.0	0.0	0.0	0.0	0.0
Ragfish	Juvenile	0.0	16.7	0.0	0.0	10.0	0.0
Squid	<100 mm ML	6.6	0.0	0.5	402.7	0.0	38.0
Predator species							
Pomfret	Adult	0.0	0.0	0.0	1,322.0	0.0	1,178.7
Pink salmon	Adult	934.4	534.0	0.0	500.0	0.0	676.7
Sockeye salmon	Immature	0.0	1,534.0	0.0	0.0	0.0	0.0
Chinook salmon	Immature	0.0	5,312.7	0.0	0.0	0.0	0.0
Coho salmon	Adult	5,467.2	4,046.7	0.0	2,120.0	0.0	0.0
Black rockfish	Adult	0.0	0.0	0.0	1,316.0	0.0	0.0
Salmon shark	Adult	0.0	0.0	0.0	0.0	4,512.5	0.0
Blue shark	Adult	0.0	11,229.3	0.0	0.0	1,457.3	2,197.0
Humboldt squid	>300 mm ML	0.0	0.0	0.0	33,939.3	0.0	12,798.0
Gelatinous species							
Jellies (clear)		61,284.2	24,500.0	38,500.0	26,666.7	5,1500.0	118,333.3
Jellies (red)		5,245.9	1,333.3	2,500.0	1,666.7	8,750.0	4,000.0
Jellies (yellow)		0.0	0.0	1,500.0	2,333.3	0.0	0.0

Table 7.—Rope trawl catch per standard haul (CPUE) of fish and squid at diel periods along the Icy Point transect in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. Life history stage abbreviations are: j = juvenile in first year at sea, im = immature, one-ocean year or older, and a = adult size. Unknown squid were categorized by mantle length (ML) size.

	Icy Point shelf stations (4 day, 3 night)				Icy Point slope stations (4 day, 3 night)				Icy Point abyssal stations (4 day, 3 night)			
	CPUE		FO (%)		CPUE		FO (%)		CPUE		FO (%)	
Species	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Target species												
Pink salmon (j)	0.5	102.0	25.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chum salmon (j)	0.3	4.3	25.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sockeye salmon (j)	0.0	0.3	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coho salmon (j)	0.3	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chinook salmon (j)	0.0	0.7	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sablefish (j)	1.5	8.3	50.0	100.0	9.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Rockfish (j)	0.0	0.0	0.0	0.0	2.3	0.0	50.0	0.0	0.3	0.0	25.0	0.0
Forage species												
Lanternfish	0.0	0.0	0.0	0.0	0.0	13.3	0.0	100.0	0.0	1126.0	0.0	100.0
Capelin	0.0	67.7	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eulachon	0.0	14.7	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific herring	0.0	166.3	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific sardine	0.3	1.7	25.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Walleye pollock (j)	0.3	2.7	25.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Squid (<100 ML)	0.0	1.0	0.0	66.7	0.0	12.3	0.0	100.0	0.0	2.0	0.0	66.7
Squid (100-300 ML)	0.0	0.0	0.0	0.0	0.0	2.0	0.0	66.7	0.0	3.0	0.0	66.7
Predator species												
Pink salmon (a)	0.0	0.3	0.0	33.3	0.0	0.0	0.0	0.0	0.0	1.0	0.0	66.7
Steelhead (a)	0.0	0.0	0.0	0.0	0.3	0.0	25.0	0.0	0.0	0.0	0.0	0.0
Sockeye salmon (im)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	33.3	0.0	0.0	0.0	0.0
Pomfret (a)	0.0	0.0	0.0	0.0	3.0	3.3	50.0	100.0	7.5	72.5	75.0	100.0
Arrowtooth flounder	0.0	0.3	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Walleye pollock (a)	0.0	1.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue shark	0.0	0.0	0.0	0.0	0.5	0.0	25.0	0.0	0.0	0.0	0.0	0.0

Table 8.—Rope trawl catch per standard haul (CPUE) of fish and squid at diel periods along the Cape Edward transect in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. No juvenile rockfish or sablefish target species were caught along this transect. Life history stage abbreviations are: j = juvenile in first year at sea, im = immature, one-ocean year or older, and a = adult size. Unknown squid were categorized by mantle length (ML) size.

	Cape Edward shelf stations (4 day, 3 night)				Cape Edward slope stations (2 day, 3 night)				Cape Edward abyssal stations (4 day, 3 night)			
	CPUE		FO (%)		CPUE		FO (%)		CPUE		FO (%)	
Species	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Target species												
Pink salmon (j)	5.9	1.7	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chum salmon (j)	6.3	2.7	75.0	100.0	10.5	1.0	100.0	66.7	0.0	0.0	0.0	0.0
Sockeye salmon (j)	0.8	0.3	50.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coho salmon (j)	0.5	1.7	25.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chinook salmon (j)	0.0	0.7	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Forage species												
Lanternfish	0.0	0. 0	0.0	0.0	0.0	542.0	0.0	100.0	0.0	171.0	0.0	100.0
Pacific herring	0.0	29.7	0.0	100.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific sardine	0.0	3.7	0.0	100.0	0.0	0.7	0.0	66.7	0.0	0.0	50.0	0.0
Pacific saury	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	50.0	0.0
Ragfish	0.0	0.3	0.0	33.3	0.0	0.0	0.0	0.0	0.3	0.0	25.0	0.0
Squid (<100 mm ML)	0.3	0.0	25.0	0.0	0.5	30.7	50.0	100.0	0.0	9.0	0.0	66.7
Prowfish	0.6	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predator species												
Pink salmon (a)	0.6	0.3	50.0	33.3	0.0	0.3	0.0	33.3	0.0	0.3	0.0	33.3
Coho salmon (a)	1.3	1.0	50.0	66.7	0.0	0.7	0.0	33.3	0.0	0.0	0.0	0.0
Chinook salmon (im)	0.0	1.7	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sockeye salmon (im)	0.0	0.7	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pomfret (a)	0.0	0.0	0.0	0.0	0.0	1.0	0.0	66.7	0.0	1.3	0.0	100.0
Humboldt squid	0.0	0.0	0.0	0.0	0.0	7.0	0.0	66.7	0.0	2.7	0.0	100.0
Black rockfish	0.0	0.0	0.0	0.0	0.0	0.7	0.0	33.3	0.0	0.0	0.0	0.0
Blue shark	0.0	0.7	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	25.0	33.3
Salmon shark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	25.0	0.0

Table 9.—Frequency of occurrence (%) and average weight (g) of principal diet items from stomachs of potential predators of target fish species collected at stations sampled in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. The "Other" prey category includes unidentifiable matter and rare occurrences of kelp, unknown gelatinous material, and copepods.

Predator species	*n*	Life history	General prey item category							
			Fish	Euphausiids	Cephalopods	Crab	Salps	Amphipods	Other	Empty
Frequency of occurrence (%) of principal prey items										
Pomfret	53	Adult	26	34	49	28	6	21	9	21
Pacific hake	37	Adult	16	65	22	0	0	0	5	27
Pink salmon	35	Adult	31	51	3	26	0	20	3	14
Coho salmon	21	Adult	81	33	5	24	5	0	0	5
Humboldt squid	10	Adult	30	60	80	10	20	0	30	0
Pacific sardine	10	Adult	0	60	0	0	0	30	20	0
Chinook salmon	8	Immature	50	50	25	50	0	0	0	0
Sockeye salmon	3	Immature	0	100	0	0	0	0	0	0
Chum salmon	2	Adult	0	50	50	0	100	0	0	0
Black rockfish	2	Adult	100	100	0	50	0	50	0	0
Walleye pollock	1	Adult	100	0	0	0	0	0	0	0
Steelhead	1	Adult	100	0	0	0	0	0	100	0
Prey weight ($\bar{x}$) of principal prey items										
Pomfret	53	Adult	0.3	2.0	1.9	0.3	0.1	0.1	0.1	0.0
Pacific hake	37	Adult	0.6	5.8	2.6	0.0	0.0	0.0	0.1	0.0
Pink salmon	35	Adult	2.9	1.4	0.0	0.6	0.0	0.2	0.0	0.0
Coho salmon	21	Adult	77.7	1.1	0.1	5.5	0.5	0.0	0.0	0.0
Humboldt squid	10	Adult	2.6	135.2	9.6	0.4	0.9	0.0	49.0	0.0
Pacific sardine	10	Adult	0.0	0.6	0.0	0.0	0.0	0.4	0.2	0.0
Chinook salmon	8	Immature	5.2	2.2	0.3	0.8	0.0	0.0	0.0	0.0
Sockeye salmon	3	Immature	0.0	6.8	0.0	0.0	0.0	0.0	0.0	0.0
Chum salmon	2	Adult	0.0	0.4	2.8	0.0	8.8	0.0	0.0	0.0
Black rockfish	2	Adult	15.1	5.0	0.0	15.8	0.0	0.2	0.0	0.0
Walleye pollock	1	Adult	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Steelhead	1	Adult	156.6	0.0	0.0	0.0	0.0	0.0	17.4	0.0

Table 10.—Percent frequency of occurrence of fish prey items and their average weight (g) from stomachs of potential predators of target fish species collected at stations in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. Asterisk denotes target species prey items.

		Fish prey item category									
Predator species	*n*	Juvenile salmon*	Juvenile sablefish*	Juvenile rockfish*	Capelin	Pacific herring	Pacific sardines	Lanternfish	Pacific sandlance	Unknown larvae	Unknown fish
		Frequency of occurrence (%) of fish prey items									
Pomfret	53	0	0	8	0	0	0	6	0	11	4
Pacific hake	37	0	0	0	0	0	0	3	0	0	14
Pink salmon	35	0	0	0	3	3	0	3	0	3	20
Coho salmon	21	24	14	0	5	10	24	5	5	0	38
Humboldt squid	10	0	0	0	0	0	0	20	0	0	10
Pacific sardine	10	0	0	0	0	0	0	0	0	0	0
Chinook salmon	8	0	0	0	0	0	0	0	0	13	38
Black rockfish	2	0	0	0	0	0	0	50	0	0	50
Walleye pollock	1	0	0	0	0	0	0	0	0	0	100
Steelhead	1	0	0	0	0	0	0	0	0	0	100
		Weight ($\bar{x}$) of fish prey items									
Pomfret	53	0.0	0.0	0.2	0.0	0.0	0.0	1.3	0.0	0.4	0.1
Pacific hake	37	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.3
Pink salmon	35	0.0	0.0	0.0	0.1	1.4	0.0	0.0	0.0	0.2	2.0
Coho salmon	21	15.2	18.8	0.0	0.0	13.7	45.2	11.7	11.7	0.0	23.1
Humboldt squid	10	0.0	0.0	0.0	0.0	0.0	0.0	79.6	0.0	0.0	37.4
Pacific sardine	10	0	0	0	0	0	0	0	0	0	0.0
Chinook salmon	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	14.0
Black rockfish	2	0.0	0.0	0.0	0.0	0.0	0.0	21.0	0.0	0.0	15.0
Walleye pollock	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Steelhead	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	156.6

Table 11.—Release and recovery information for adipose-fin-clipped salmon sampled in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. All fish lacked the adipose fin, indicating the presence of a coded-wire tag (CWT); however, none of the coho salmon contained an actual CWT, suggesting these fish originated from Washington State where all hatchery production of salmonids must be adipose clipped but not necessarily CWTed. Agency acronym definitions are: NSRAA = Northern Southeast Regional Aquaculture Association and ODFW = Oregon Department of Fish and Wildlife.

		Release information						Recovery information					
Haul #	Fish #	Tag code	Agency	Brood year	Date	Locality	Size (g)	Date	Station	Size (g)	Fork length (mm)	Days since release	Marine migration (km)
						Chinook salmon							
20022	63	09:40/34	ODFW	2003	03/12/05	Imnaha River, Oregon (L. Glass hatchery)	18.4	08/13/05	IPSHELF	196.8	251	154	1,800
20040	04	04:10/39	NSRAA	2003	05/17/05	Bear Cove, Alaska (Medvejie hatchery)	77.6	08/16/05	CESHELF	184.0	251	91	80
						Coho salmon							
20040	03	No tag	-	-	-	-	-	08/16/05	CESHELF	140.6	222	-	-
20044	03	No tag	-	-	-	-	-	08/17/05	CSGULLY	355.4	299	-	-
20046	12	No tag	-	-	-	-	-	08/17/05	CSGULLY	243.1	271	-	-

Table 12.—Information associated with blue and salmon sharks externally tagged in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005.

2005 Date	Haul number	Station	Fork length (cm)	Estimated weight (kg)	Sex	Tag number
			Blue shark			
12 August	20012	IPSLOPE	170	30.70	♀	05 -01021
12 August	20012	IPSLOPE	143	17.71	♀	05 -01025
14 August	20025	CEABYSS	102	5.83	♀	05- 01011
14 August	20028	CEABYSS	104	6.59	♀	05- 01016
16 August	20041	CESHELF	138	15.98	♀	05- 01010
17 August	20042	CESHELF	[3]139	17.69	♀	05- 01013
17 August	Hook & line	CESHELF	[4]130	13.26	♀	05- 01007
			Salmon shark			
14 August	20027	CEABYSS	113	18.05	♀	05- 01020

[3]Length estimated from the average of five prior trawl-caught blue sharks.

[4]Additional blue shark captured with hook and line.

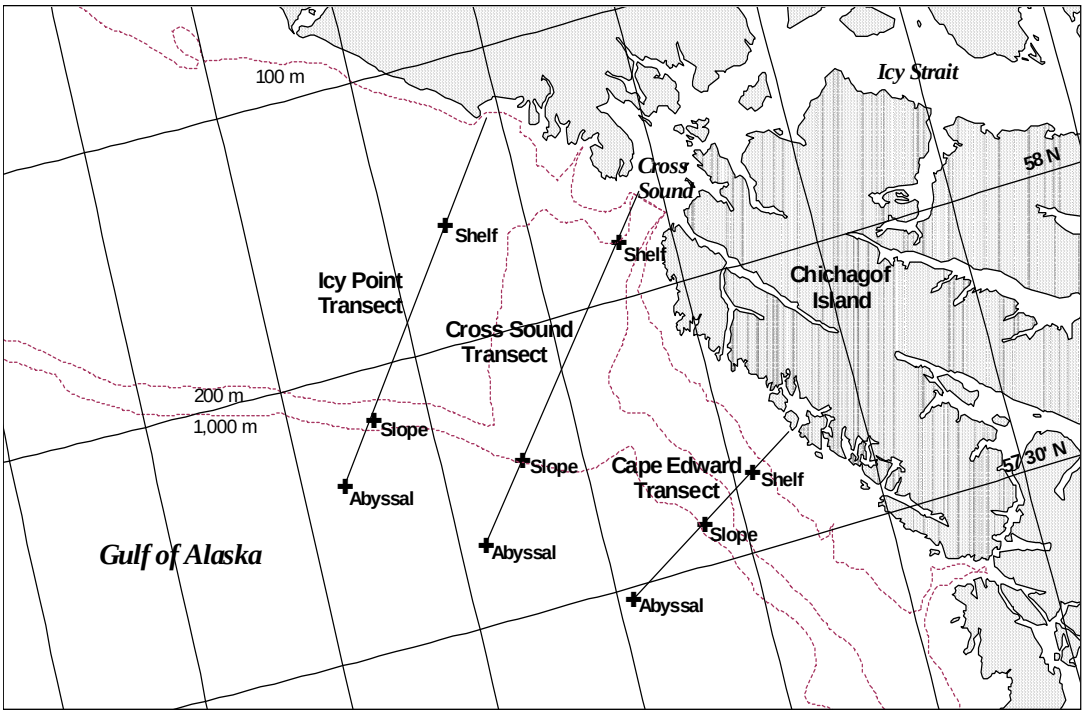

Figure 1.—Experimental sampling design in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005.

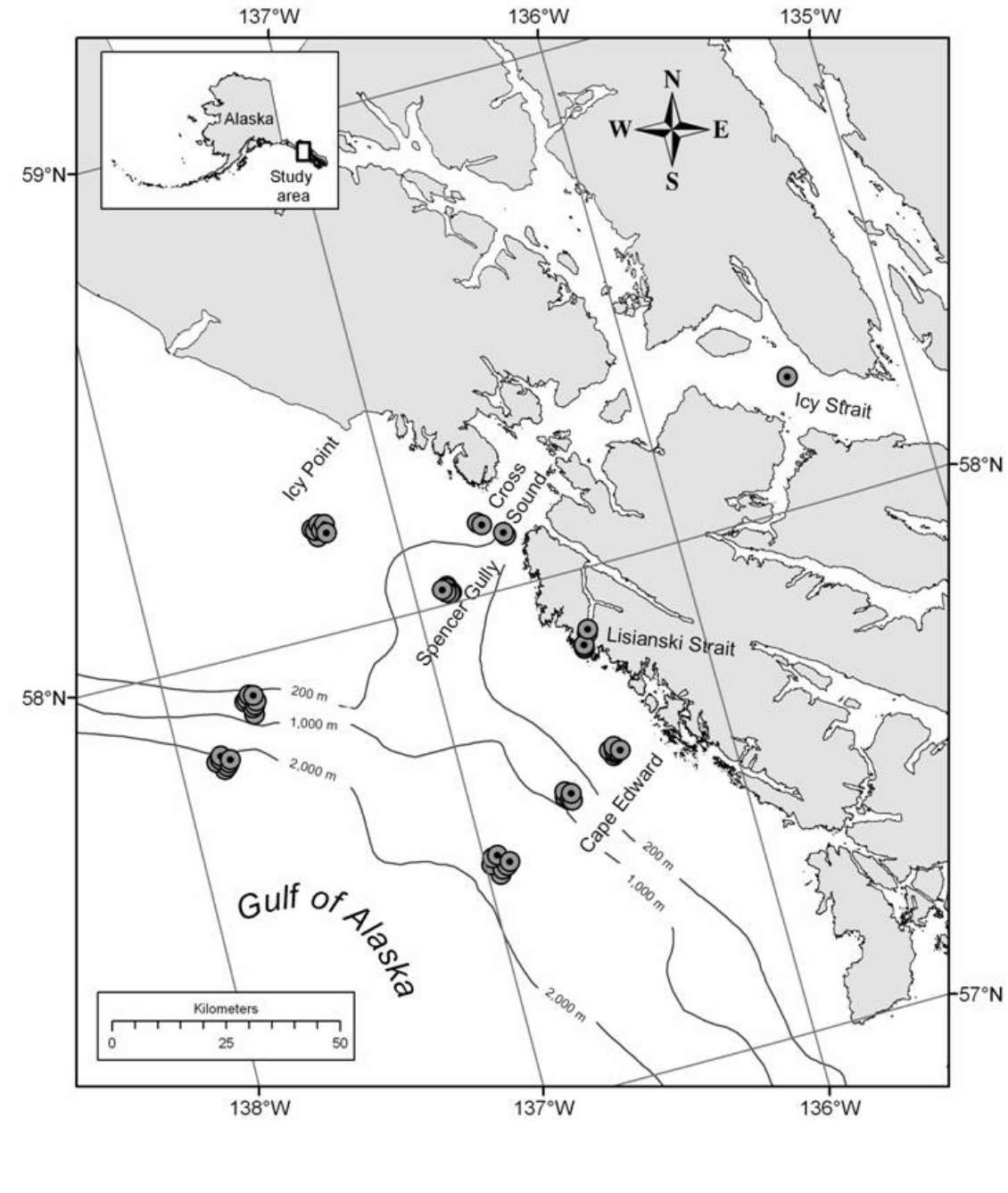

Figure 2.—Start positions of rope trawl hauls fished along the Icy Point, Cape Edward, and Cross Sound transects in the coastal waters of the northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005. Sampling at the original Cross Sound transect was modified to include stations in Lisianski Strait and the Spencer Gully due to weather and time constraints. The test haul locality is shown in Icy Strait.

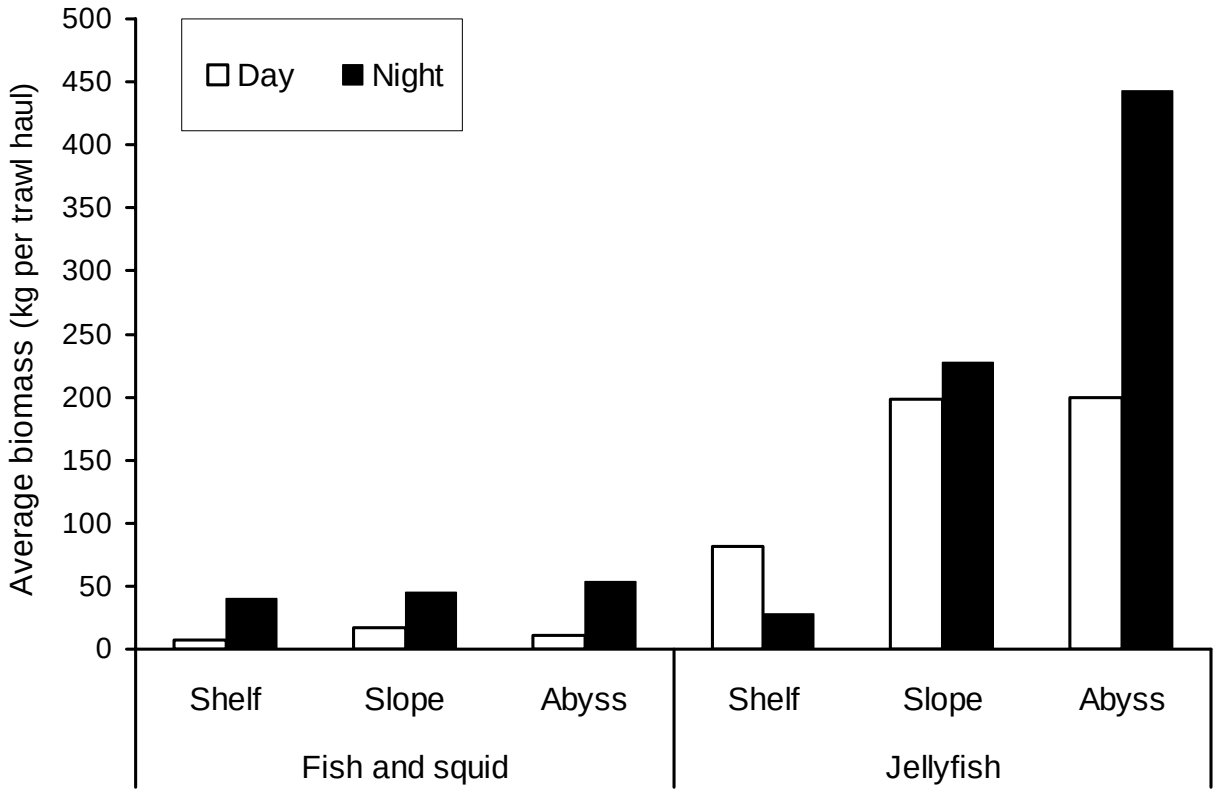

Figure 3.—Average biomass (kg per standard 30-m trawl haul) of fish and squid, and jellies captured at shelf, slope, and abyss stations along the Icy Point and Cape Edward transects in the coastal waters of northeast Pacific Ocean using the R/V *Medeia* from 10 to 20 August 2005.