NOAA Technical Memorandum NMFS

AUGUST 1997

PLANKTON SAMPLING DURING THE WHALE HABITAT AND PREY STUDY 10 JULY - 4 AUGUST 1996

Wesley A. Armstrong
Susan E. Smith

NOAA-TM-NMFS-SWFSC-242

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

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Plankton Sampling During the Whale Habitat and Prey Study 10 July - 4 August 1996

Wesley A. Armstrong and Susan E. Smith

ABSTRACT

Two large area surveys and one small area survey composed of 68 plankton sampling stations were completed in the Southern California Channel islands during the 1996 Whale Habitat and Prey Study. *Euphausia pacifica*, *Nematocelis difficilis*, and *Thysanoessa spinifera* were the dominant euphausiids captured during the large area surveys. *Euphausia pacifica*, *Nyctiphanes simplex*, and *T. spinifera* were the dominant euphausiid species captured during the small area survey. Calanoid copepods were the most common non-euphausiid taxa captured during both survey types. *Euphausia pacifica* was most commonly distributed adjacent to and offshore of the 200 m depth contour , and *T. spinifera* was most commonly distributed adjacent to and offshore of the 200 m depth contour. Length frequency data indicated the majority of euphausiids captured were adult sized except for *T. spinifera* individuals which were predominantly late juveniles and developing preadults. Fecal samples collected during the survey indicated *E. pacifica* and *T. spinifera* were targeted by blue, fin, and humpback whales in the study area.

INTRODUCTION

The Southwest Fisheries Science Center Whale Habitat and Prey Study (WHAPS) was organized to determine why euphausiids concentrate in particular areas around the Southern California Channel Islands and how they are used by blue (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliea*) and other rorqual whales. Accordingly, a net sampling program was developed to identify plankton species and determine distribution of euphausiids within the study area. The large area survey was aimed at determining general distribution of euphausiid species and other plankton, while the small area survey was aimed at identifying specific acoustic targets associated with feeding whales or in the vicinity of whale sightings. Species composition, and abundance estimates of euphausiids were used to determine association with whale foraging patterns, water mass boundaries, spatial patterns of primary productivity, and bathymetry (see Fiedler et al., in prep). Plankton tows were used in conjunction with acoustic survey methods (Hewitt and Demer 1993) to verify size frequency and species composition of plankton sampled in the study area. A preliminary analysis of plankton species composition, estimated abundance of major taxa captured, and distribution and length frequency of dominant euphausiids sampled during the 1996 WHAPS is presented in this report.

METHODS AND MATERIALS

The principal study area was bounded by the parallels of 33°N and 35°N, and the meridians 119°W and 121.5 °W. Large area surveys A and B were undertaken (11 July 1996 to 16 July 1996 and 29 July 1996 to 2 August 1996) along a predetermined grid of stations 42.6 km apart in a 185 km by 139 km region of the Southern California Channel

Islands (Figures 1a and 1b). A small area survey, designed as a series of gridlines bisecting the shelf break 2.8 km apart, was conducted from 17 July to 29 July 1996 with one additional tow 3 August 1996 (Figure 2). During the small area survey most of the sampling effort was focused along the 200 m depth contour around San Miguel Island where euphausiid concentrations were common. A series of plankton sampling net tows were designed to target and sample acoustically detected scatterers presumed to be euphausiids and other planktonic crustaceans or fish. Net tows were taken on every occasion in which feeding whales were sighted.

Large Area Surveys

There were 23 Isaacs-Kidd Midwater Trawl (IKMT) deployments during survey A and 15 IKMT deployments during survey B (Figures 1a and 1b). Standardized oblique tows lasted from 10 to 46 minutes and averaged 24.8 minutes. The standard IKMT tow was from 200-250 m to the surface whether or not acoustic targets were detected at the station, or 10-25 m above bottom to the surface in shallower waters. Trawl retrieval rate was 20 m per minute. Actual tow depths ranged from 75 m to 246 m and averaged 173.7 m (Table 1). Tow speeds generally ranged from 1.5 to 2.5 knots and wire angle was maintained between 35° and 55° off the vertical.

A standard 2 m IKMT depressor frame fitted with 505 μm mesh plankton net and a 16.5 cm diameter PVC codend was deployed at each station. Trawl flow volumes were measured using a calibrated General Oceanics model 2030R flow meter mounted on the depressor frame inside of the net mouth opening. Flow volumes were calculated by multiplying flowmeter counts by 2.94 m^2 (surface area of opening) and by 0.0277 (m per count of the flowmeter). Tow depths were obtained in real-time from a Keller PSI 300DS pressure transducer mounted at the end of a conducting electromechanical cable. The transducer's location was approximately 1 m above the roof of the net. The depth and the rate of return of the net to the surface were monitored on a digital readout. Mean values and minimum-maximum ranges of tow duration, volume of water filtered per tow, maximum depth of tow and bottom depths are listed in Table 1.

Small Area Survey

There were 30 stations sampled with a Multiple Opening Closing Net and Environmental Sampling System (MOCNESS) (Wiebe et al., 1985) during the small area survey (Table 2). All tows were directed at acoustic targets. Station tow duration averaged 48.5 minutes and ranged from 11 to 91 minutes. Plankton sampling locations (Figure 2) were selected based upon the presence of acoustic scattering layers identified during the large area surveys and/or consistently observed during small area survey transects across the 200 m depth contour. MOCNESS station numbers (mocxy) incorporated MOCNESS station number (x) and contiguous plankton net tow number (y). Tows were generally made from shallow to deep water. Near the shelfbreak, tows were made parallel to the dropoff.

The MOCNESS was equipped to deploy eight nets. The four odd-numbered nets were not coupled with codends and were used as drogues to position the even-numbered

sampling nets joined with codends inside a targeted acoustic layer. Generally four net samples were collected at each station using 1 m^2 opening nets fitted with 505 μm mesh and 16.5 cm diameter PVC codends attached. Ordinarily the fishing nets were towed horizontally through target layers but occasionally the nets were towed obliquely through a range of depths if the target was thick or was migrating toward the surface. Most (80 %) samples were collected during daylight hours concurrent with whale sightings. Nets were opened and closed sequentially by commands from a deck unit on the surface. The MOCNESS data stream consisted of temperature, depth, conductivity, frame angle, flow counts, net number, and net response, and was transmitted to a deck unit interfaced with a laptop computer. Raw data were processed into statistical summary tables at the completion of each tow, and archived.

Selected Stations

Six of the 30 plankton sampling stations (moc6a029, moc10a033, moc12a035, moc18a041, moc22a045, moc28a051) summarized in Table 2 were selected to illustrate trends in species composition, distribution, abundance, and vertical stratification of euphausiids and other major taxa in areas where strong acoustic scattering layers correlated with high densities of rorqual whales. Data collected describing species composition, distribution, abundance, and vertical stratification of taxa sampled during the remaining 24 stations were summarized, and archived.

Examination of Plankton Samples

All IKMT and MOCNESS net samples were examined within two hours of completed net tows. Catches from each MOCNESS net were treated as discrete sample sets. Euphausiids were identified to species (with the exception of larval forms) wherever possible. Subsamples of euphausiids were examined to determine sex and stage of maturity. Adult females were identified by the presence of ripening or ripe eggs in the ovaries or by the presence of spermatophores attached to the thelycum. Adult males were identified by the presence of fully developed secondary sexual characteristics (e.g., presence of external or internal spermatophores, fully developed petasma and modified antennal appendages). Naupliar stages, calyptopes and most early furcilia, were all categorized as "larval euphausiids." Remaining planktonic taxa were placed in general taxonomic groupings (Table 3).

Wet biomass of plankton samples was measured as total volume of water displaced by the sample as described in Kramer et al. (1972). Abundance of euphausiids and other species were estimated as a percentage volume of total wet biomass of the sample. The volumetric proportion of the total sample for each species of euphausiid and other planktonic taxa was estimated visually from the total sample or from a representative subsample. This value was then reconverted to a volumetric value (percent of sample multiplied by total wet biomass of the sample). Estimates of relative abundance were standardized by taking the volumetric value and dividing by flow volume per 1000 m^3 and expressed as volume density (ml) per 1000 m^3, and by calculating species volume per 1000 m^3 and dividing the result by flow volume m^3/retrieval depth m and expressed as area density (ml) per m^2.

Length frequency data were collected for euphausiids during large area survey B and throughout the small area survey. Total length (TL) of euphausiids was measured from the tip of the rostrum to tip of the telson. In samples with greater than 100 individuals, TL measurements were taken from a subsample. Individuals with TL less than 6 mm were not included in the length frequency analysis; these were generally larval forms of the species, according to Brinton and Wyllie (1976). After processing, each sample was preserved in 10% buffered formalin.

Comparison of sampling gear

Since two types of net systems were used during the surveys, a test was conducted on catches made at the same position and approximately the same time (plankton sampling stations moc029a52 and IKMT station 53) to determine if there were sampling differences between the two gear types. The IKMT was deployed immediately following the MOCNESS tow. Each was deployed to a depth of 75 m, and brought to the surface at 20 m per minute. Both sampling gears captured mostly *T. spinifera* so this species was used for comparison. Total length data were collected and length distributions of the two tows were compared using the Kolmogorov-Smirnov (K-S) goodness of fit test. The null hypothesis was MOCNESS and IKMT sample from the same distribution of vulnerable size classes, and the alternative hypothesis was they do not sample from the same distribution of vulnerable size classes.

Whale fecal samples

Blue (n=13), fin (n=3) and humpback (n=1) whale fecal samples were collected as a means of determining locally consumed prey. Dipnets were used to collect samples. Subsamples were filtered to facilitate the dissection of mandibles from euphausiid exoskeleton remains. Species specific anatomical characters of mandibles (Kieckhefer 1992) were used to determine euphausiid species identification in the categories: *Euphausia pacifica*, *T. spinifera*, *N. simplex*, and other species. Preliminary examination of fecal samples was made during the cruise. Samples were labeled and preserved in 10% buffered formalin.

RESULTS

Large Area Surveys

All euphausiids and other planktonic taxa comprising greater than 1% of the estimated volume of the catch were listed by station in Table 4 and summarized in Table 5. The dominant euphausiid species captured during large area surveys were *E. pacifica* and *N. difficilis* caught at 76.3% and 68.4% of the stations respectively. *Thysanoessa spinifera* was caught at 31.6% of the stations. Calanoid copepods were the most commonly caught non-euphausiid taxa, occurring in 76.3% of the samples. Ctenophores and diatom/radiolarians were also common, caught during 50% and 36.8 % of the samples, respectively.

The largest catches of *E. pacifica* and *N. difficilis* were generally distributed near or deeper than the 200 m depth contour (Figures 3a and 3b), whereas the largest catches

of *T. spinifera* were most frequently distributed over shelf waters less than 200 m deep (Figure 3c). The two largest catches of *T. spinifera* were taken at IKMT stations 53 and 62 northwest of San Miguel and north of San Nicolas islands.

Total lengths of 279 *E. pacifica* and 152 *T. spinifera*, listed in Table 6, were measured from randomly selected specimens taken during large area sampling. Total lengths ranged from 9.0 to 24.9 mm and 9.0 to 26.9 mm respectively (Figure 4a). The calculated mean total lengths were 16.9 mm and 16.8 mm for the two species. Total lengths from 152 randomly selected *N. difficilis* specimens ranged from 13.0 mm to 26.9 mm and the mean value for this species was 19.4 mm. Adult body size of *E. pacifica* is 11-22 mm TL; *N. simplex* is 8-12 mm TL; and *N. difficilis* is 16-25 mm TL. T*hysanoessa spinifera* has an extended juvenile phase and matures at a relatively large size, with males beginning to mature at 16 mm TL and females at around 21 mm TL with a maximum size of about 30 mm TL (Brinton and Wyllie 1976; Smith and Adams 1988). The distribution of sizes indicated the majority of measured *E. pacifica, N. difficilis* and *N. simplex* specimens were adults, whereas most measured specimens of *T. spinifera* were late juveniles or developing preadults.

Small Area Survey

The dominant euphausiid species captured during the 30 small area survey stations were *T. spinifera* captured during 70% of the stations, and *E. pacifica* captured during 63% of the stations (Table 7). The largest catches of *E. pacifica* were taken at stations located north and west of San Miguel, as well as, north or south of Santa Rosa islands and generally distributed parallel to the 200 m depth contour or in deeper water adjacent and offshore of the 200 m contour (Figure 5a). The largest catches of *T. spinifera* were taken at stations located northwest of San Miguel and north of Santa Rosa and San Nicolas islands and generally distributed inshore of the 200 m depth contour (Figure 5b). Calanoid copepods were the most commonly captured non-euphausiid taxa.

Table 8 and 9 summarize species composition, average bottom depth, average sampling or net depth, and estimated abundance of specimens collected at the six small area survey stations. These stations were selected for analysis because tows were located in areas where whales were present. Since MOCNESS tows targeted layers detected with the EK-500, we assumed the catch represented the vertical stratification of the dominant organisms in the water strata sampled. *Euphausia pacifica* was captured most frequently at the selected stations with deeper bottom depths (mean value 223 m) and taken at greater average net sample depths (mean value 128 m) than *T. spinifera*, which was collected at an average bottom depth of 187 m and average net sample depth of 109 m, respectively. Larval and juvenile euphausiids, copepods, and diatoms/radiolarians were captured most frequently in shallow net sample depths throughout the study area.

Length frequencies of euphausiids measured during the small area survey are listed in Table 10 and summarized in Figure 4b. There were a total of 1584 and 1238 randomly selected *E. pacifica* and *T. spinifera* specimens measured. Total lengths of *E. pacifica* ranged from 7.0 mm to 22.9 mm and from 6.0 mm to 30.5 mm for *T. spinifera*.

Calculated mean TL for each species were 15.7 mm and 17.5 mm, respectively. This indicated the majority of measured *E. pacifica* specimens were adults and the majority of *T. spinifera* specimens measured were juveniles, developing males/females, and mature males. Total lengths from 233 randomly selected *N. simplex* were measured. Specimen TL ranged from 6.0 mm to 16.9mm and the mean TL value for this species was 11.5 mm indicating the majority of measured specimens were adults.

The results of the comparison between samples collected by MOCNESS and IKMT at the same station suggested species composition was similar for both types of gear, but a K-S test on the length frequency from each station was significant ($p = 0.0291$). Therefore, the null hypothesis that these two gears sampled from the same distribution of vulnerable size classes was rejected. Plotted data from the test illustrate empirical length distribution data for *T. spinifera* captured with MOCNESS was skewed toward TL <15 mm (Figure 6).

Preliminary analysis of euphausiid mandibles extracted from whale fecal material indicated *E. pacifica* and *T. spinifera* were the dominant prey remains in scat samples.

DISCUSSION

In the current study, results of net sampling from large and small area surveys werer used with acoustic sampling to describe the taxonomic composition, horizontal distribution, and relative abundance of euphausiids and other major categories of planktonic fauna sampled. Both IKMT and MOCNESS gear designs were effective at capturing euphausiids, but a K-S test indicated the two gear types did not sample from the same distribution of vulnerable size classes. Qualitative descriptions of zooplankton samples can be influenced by natural variables determined by oceanography, environment, and the ecology of the organisms being sampled and/or by artificial variables imposed by how data are analyzed, samples are aliquoted, counted, and what methods are used to collect samples (Brinton 1962). In addition, net avoidance behavior of mobile zooplankton such as euphausiids may affect the ability to make accurate abundance estimates (Clutter and Anroku 1968). Therefore, abundance estimates made during the survey are probably most useful as a distribution index.

There were differences in length frequencies detected within *E. pacifica* and *T. spinifera* when the large area and small area surveys were compared. The mean TL of *E. pacifica* specimens was greater during the large area survey, and conversely the mean TL for *T. spinifera* specimens was larger during the small area survey. These differences may reflect real demographic differences for each species. Brinton (1962) reported daytime adult populations of *E. pacifica* were most common in the upper 280 m of the water column in the eastern north Pacific, and *T. spinifera* commonly form extensive near shore surface shoals, in which mature adults are a significant component, during July to September along the California coast north of San Francisco south to the Channel Islands.

Estimates of mean TL may have been confounded by ontogenetic differences in euphausiid habitat distributions (small area survey stations were more inshore oriented)

and/or possible bias caused by euphausiid patchiness. In addition, the more random structure of the large area sampling scheme compared to the targeted nature of the small area survey may have caused bias in the study.

Smaller individuals may have been better represented in the large area survey because we sampled there randomly and did not target aggregations as we did during the small area survey. It is possible that the swarms or aggregations we targeted in the small area survey were more likely to be made up of larger, adult individuals. Differences could also be due to the patchy distribution of length frequency classes. Euphausiids tend to segregate by size within individual patches, apparently to facilitate swimming efficiency (Nicol 1984, Smith and Adams 1988).

Net selectivity may have played a role in the size distribution of the catch. Comparisons between *T. spinifera* length frequency data collected during the large area and small area surveys indicated the MOCNESS collected specimens with a higher mean TL, collected samples from a wider range of size classes than the IKMT, and caught the largest specimens during the survey (Tables 6 and 9). However, a K-S test performed on TL data from specimens of *T. spinifera* sampled by MOCNESS and IKMT during stations 52 and 53 suggested, if one used these two sampling systems, the opposite happens. Specimens caught with MOCNESS had empirical frequency values of TL that were skewed toward smaller specimens (< 15 mm) when compared to empirical frequency values of TL of *T. spinifera* captured by the IKMT (Figure 6). The fact that *T. spinifera* captured by MOCNESS during the small area survey were larger on average, and the system sampled larger specimens than the IKMT is contrary to what one would expect based on the results of the K-S test. It is possible that the results of the trawl comparison done at stations 52 and 53 may have been influenced by small-scale patchiness in size classes sampled.

Whale fecal sample analysis indicated *E. pacifica* and *T. spinifera* were the dominant euphausiid prey species of blue, fin and humpback whales. Collection and analysis of fecal material from actively feeding whales should be considered a high priority in future studies. Feeding habits data from fecal analysis may provide more precise assessment of the species and size distribution of euphausiids targeted by whales in the various oceanographic and bathymetric habitats of the study area.

Feeding rorqual whales were most frequently observed at stations where acoustic back-scatter and plankton catches indicated the greatest concentrations of euphausiids[1]. In areas where feeding whales were congregated, it was highly probable plankton net sampling and preliminary analysis of whale fecal material accurately reflected dominant euphausiid species composition and distribution. Accordingly, it was likely aggregations of feeding blue, fin, and other rorqual whales, were targeting aggregations of *E. pacifica* when foraging parallel and offshore to the 200 m depth contour surrounding San Miquel,

[1] Fiedler, P., S. Reilly, R. Hewitt, D. Demer, V. Philbrick, S. Smith, W. Armstrong, D. Croll, B. Tershy, and B. Mate 1997. Blue Whale Habitat and Prey in the Channel islands. Submitted to Deep Sea Research 5/28/97.

Santa Rosa, and San Nicolas islands, *T. spinifera* when foraging inside the 200 m depth contour around the islands, and both species when they traversed between these habitats.

ACKNOWLEDGEMENTS

Special thanks to Demitry Abramenkoff and Dave Griffith for assisting with deployment of sampling gear and processing of plankton samples. We gratefully acknowledge the time and effort contributed by Barbara C. Armstrong, David Demer, Roger Hewitt, and George Watters during the writing of this report and thank them for providing input, insightful comments, and suggesting editorial changes.

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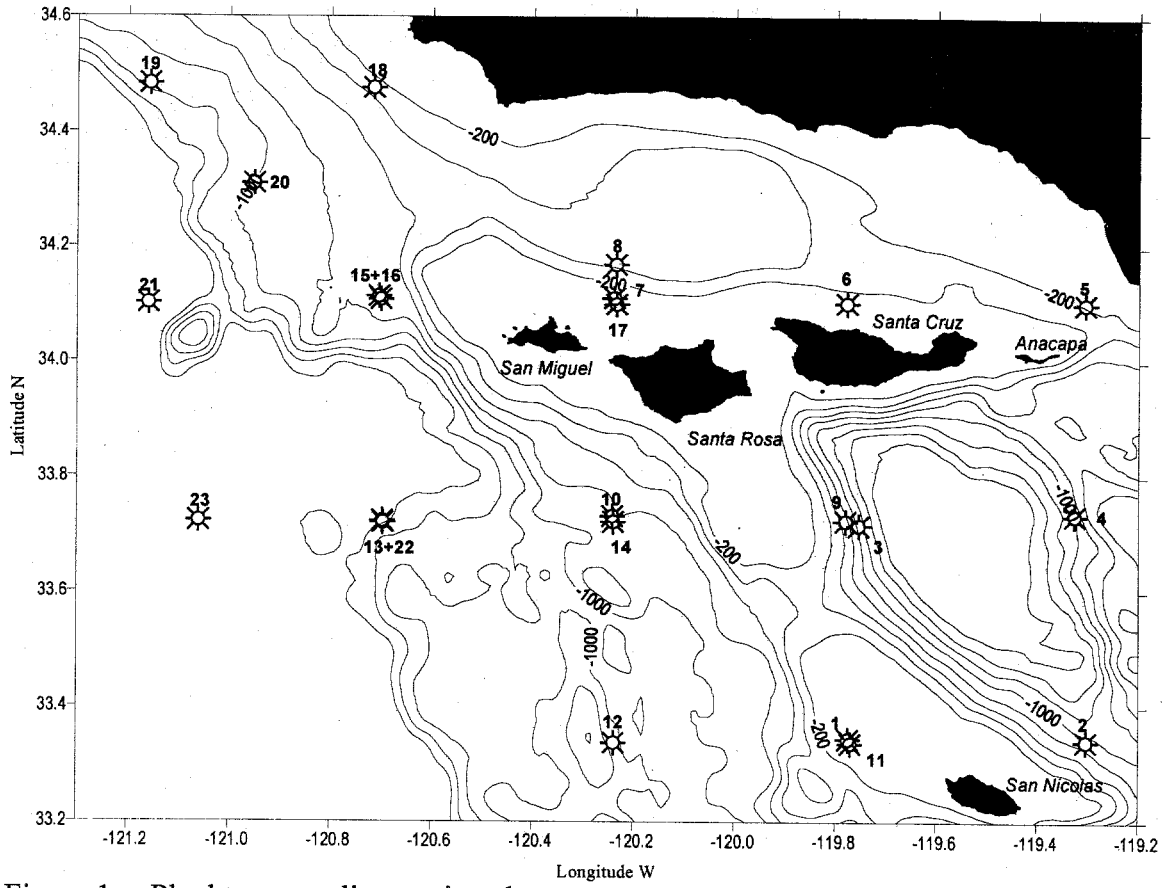

Figure 1a. Plankton sampling stations large area survey A.

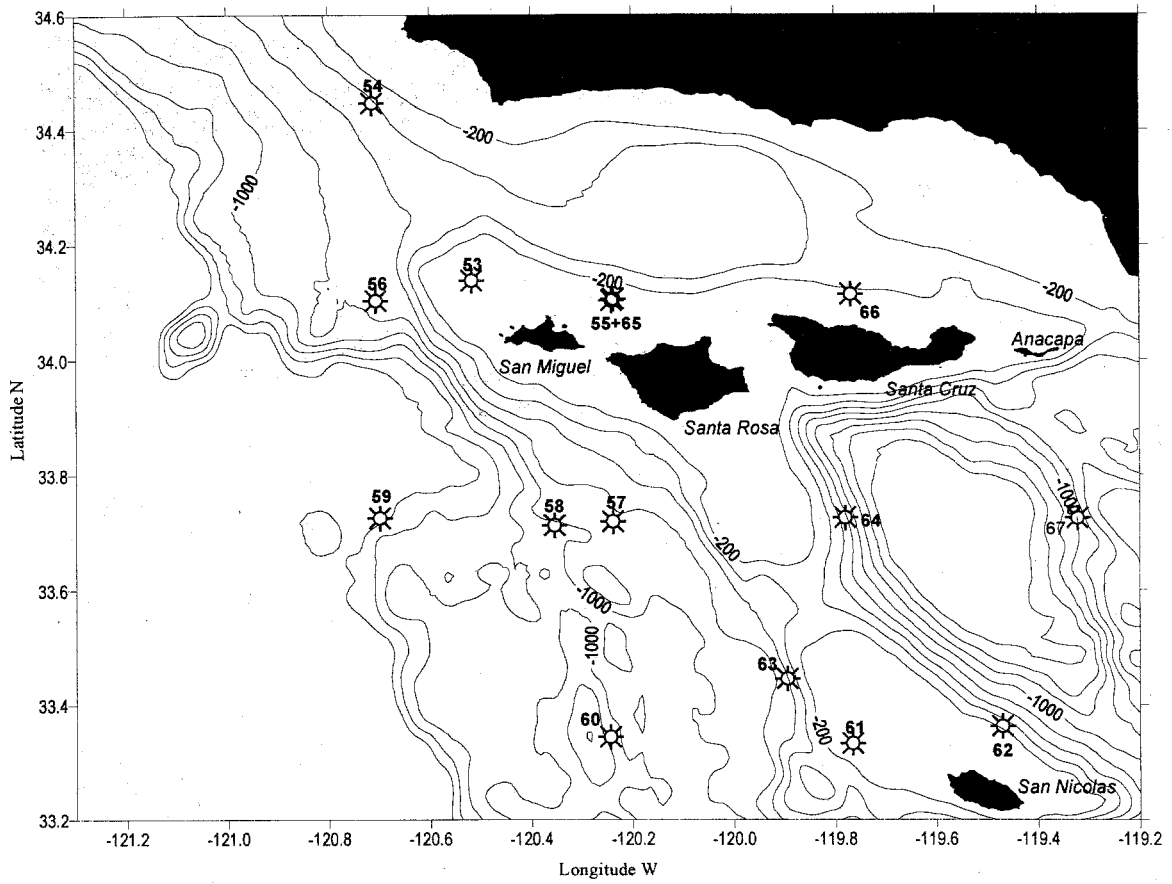

Figure 1b. Plankton sampling stations large area survey B.

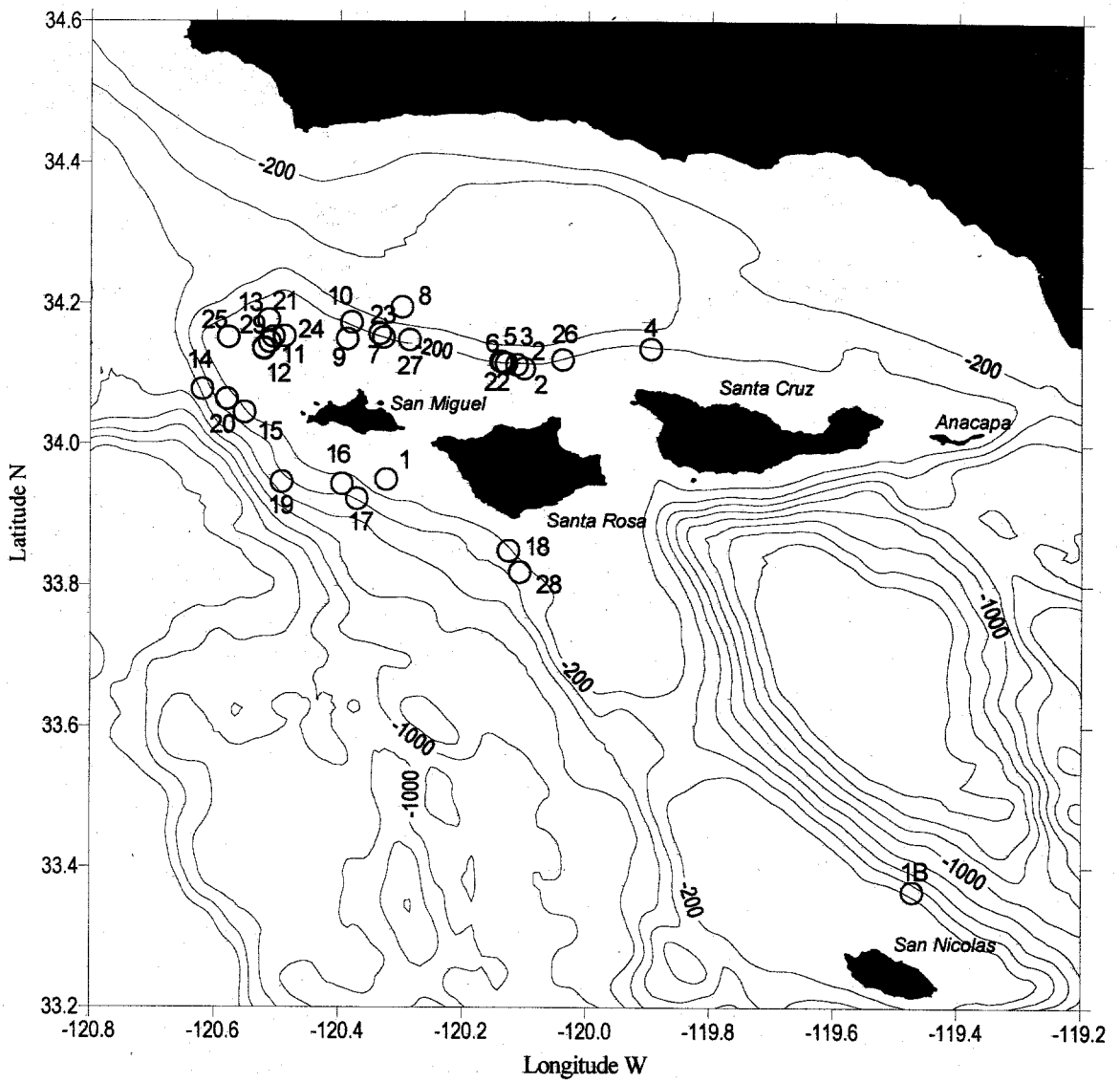

Figure 2. Small area survey MOCNESS stations.

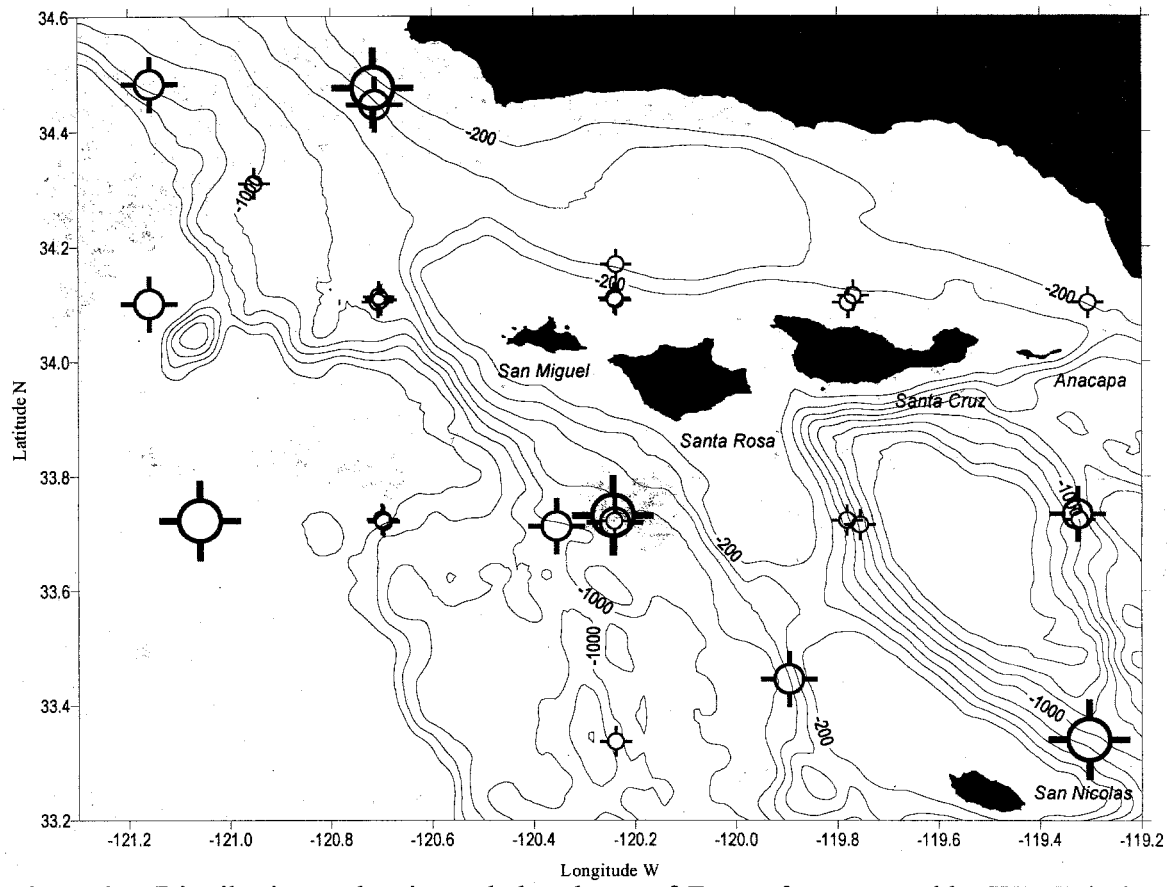

Figure 3a. Distribution and estimated abundance of *E. pacifica* captured by IKMT during large area surveys A and B. Symbols indicate stations where *E. pacifica* were caught. The relative abundance (sample volume per 1000 m^3) is depicted by the diameter of the circle. The three circle sizes represent (smallest to largest) abundance values ranging from 0.1 - 24.9, 25 - 49.9, to > 50 ml per 1000 m^3. Note the largest samples were collected at stations offshore of the 200 m contour.

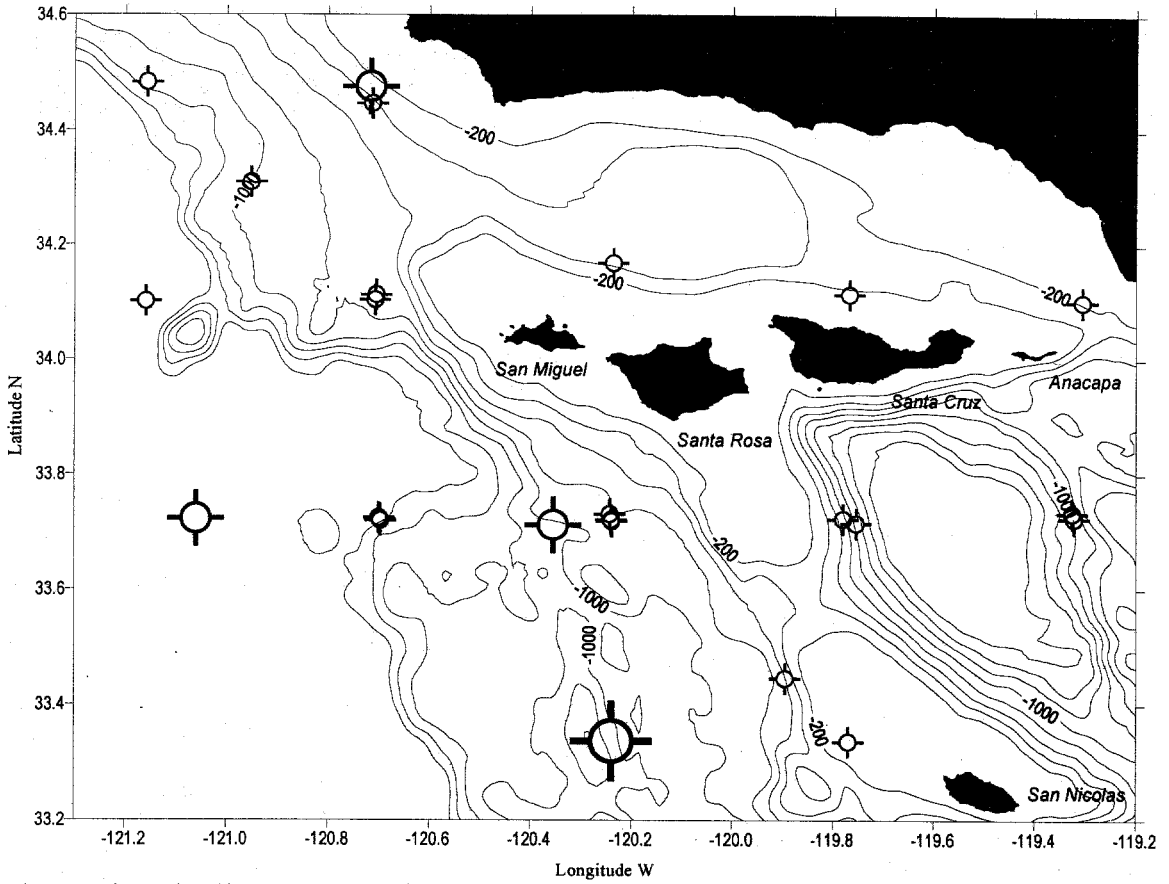

Figure 3b. Distribution and estimated abundance of *N. difficilis* captured by IKMT during large area surveys A and B. Symbols indicate stations where *N. difficilis* were caught. The relative abundance (sample volume per 1000 m^3) is depicted by the diameter of the circle. The three circle sizes represent (smallest to largest) abundance values ranging from 0.1 - 24.9, 25 - 49.9, to > 50 ml per 1000 m^3. Note the largest samples were collected at stations offshore of the 200 m contour.

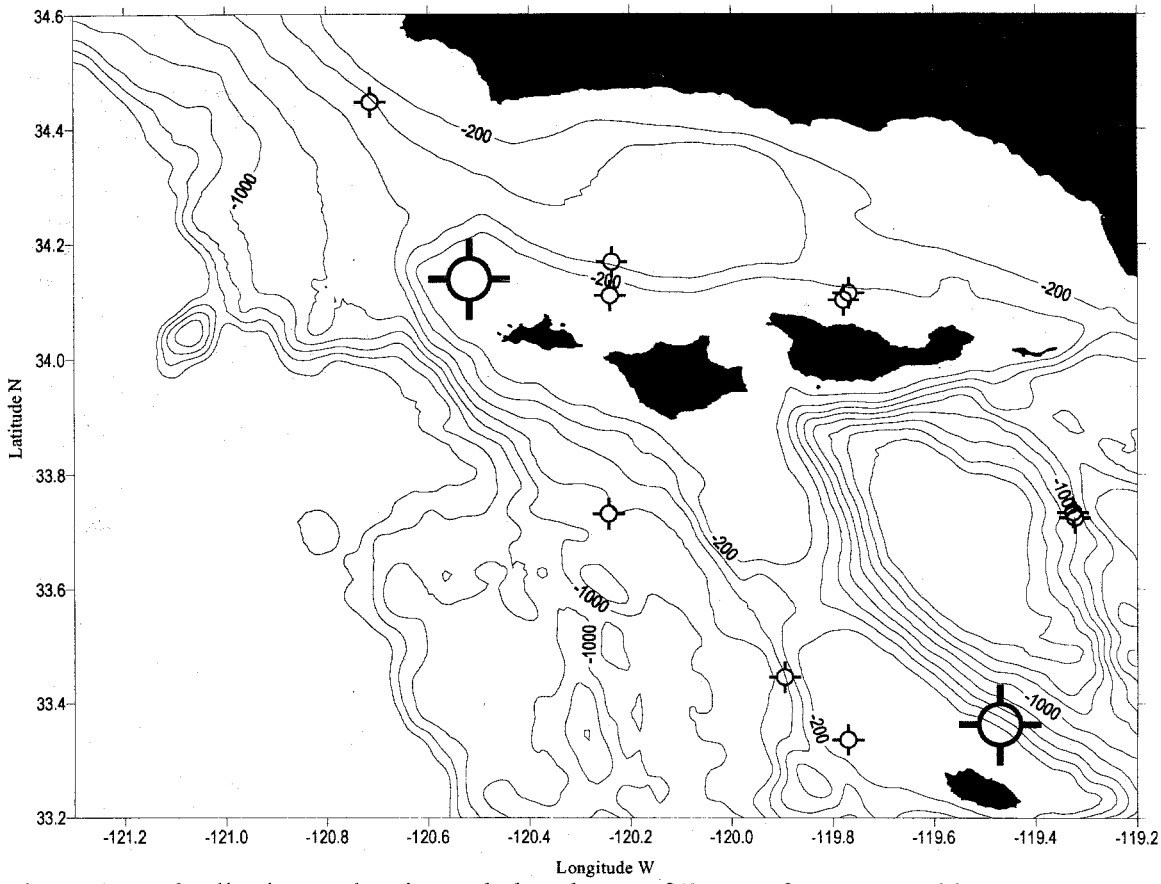

Figure 3c. Distribution and estimated abundance of *T. spinifera* captured by IKMT during large area surveys A and B. Symbols indicate stations where *T. spinifera* were caught. The relative abundance (sample volume per 1000 m^3) is depicted by the diameter of the circle. The three circle sizes represent (smallest to largest) abundance values ranging from 0.1 - 24.9, 25 - 49.9, to > 50 ml per 1000 m^3. Note the largest samples were collected at stations inshore of the 200 m contour.

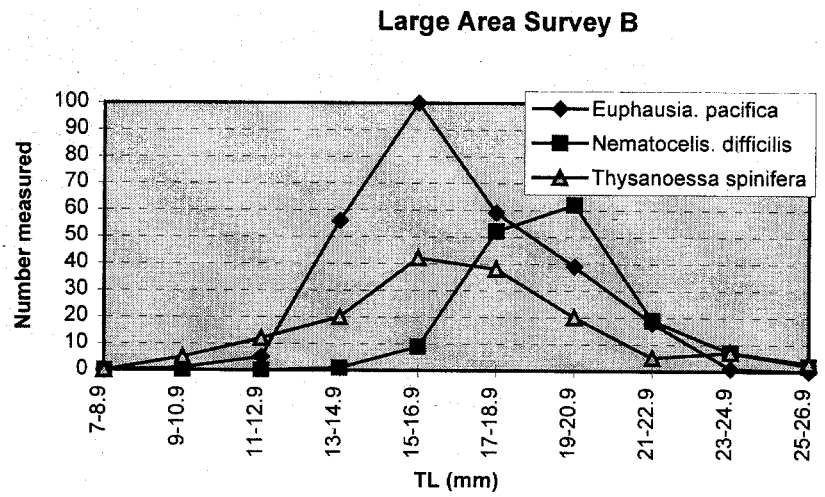

Figure 4a. Length frequency of dominant euphausiid species captured during large area survey B.

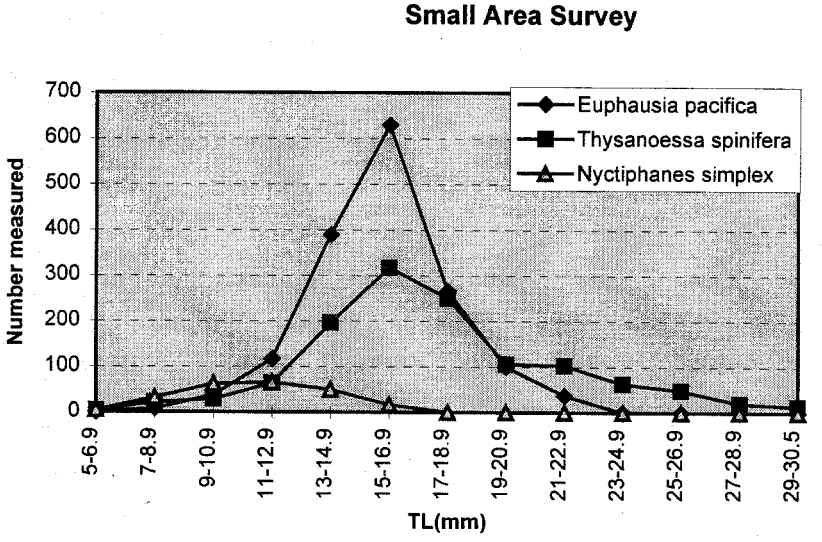

Figure 4b. Length frequency of dominant euphausiid species captured during small area survey.

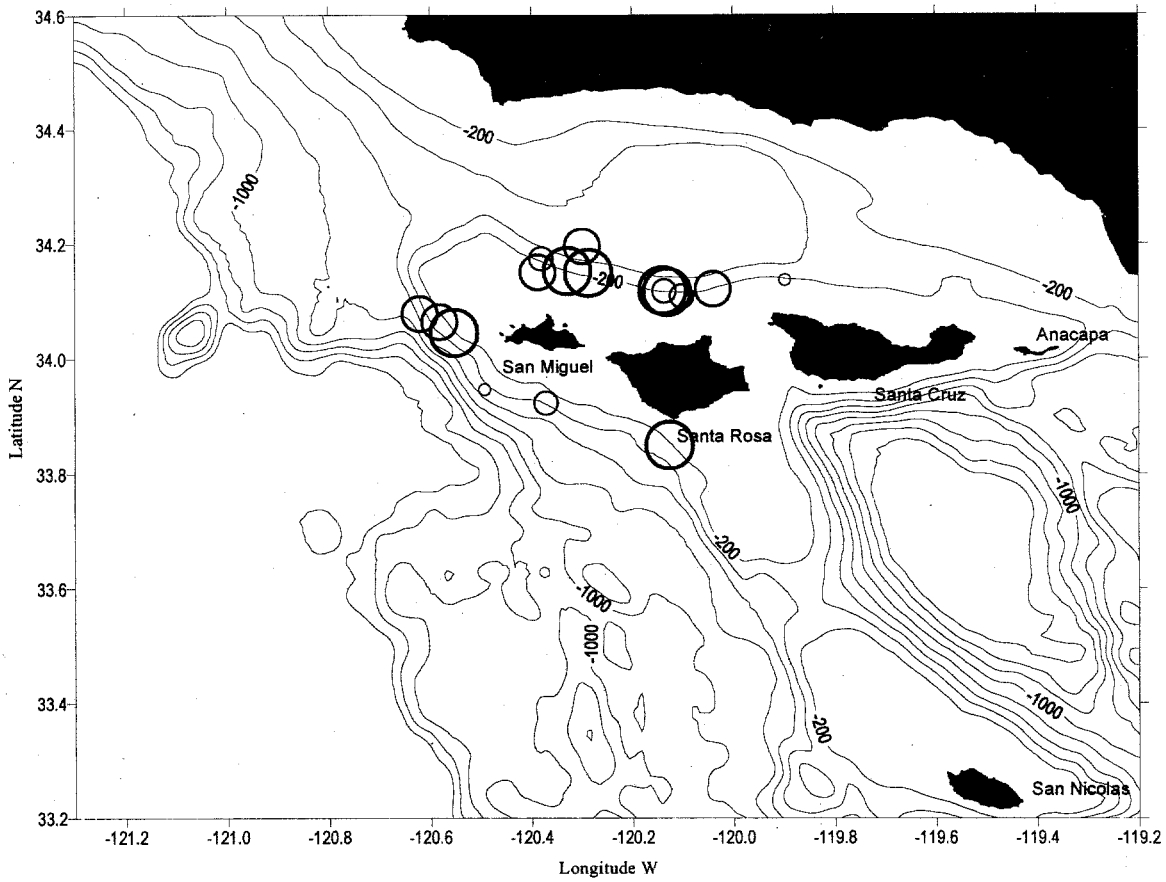

Figure 5a. Distribution and estimated abundance of *E. pacifica* captured by MOCNESS during small area survey. Circles indicate stations where *E. pacifica* was caught. The relative abundance (sample volume per 1000 m^3)is depicted by the diameter the circle. The four circle sizes represent (smallest to largest) abundance values ranging from 0.1 - 249.9, 250 - 499.9, 500 - 1000, to >1000 ml per 1000 m^3. Note the largest samples were collected adjacent and offshore of the 200 m contour.

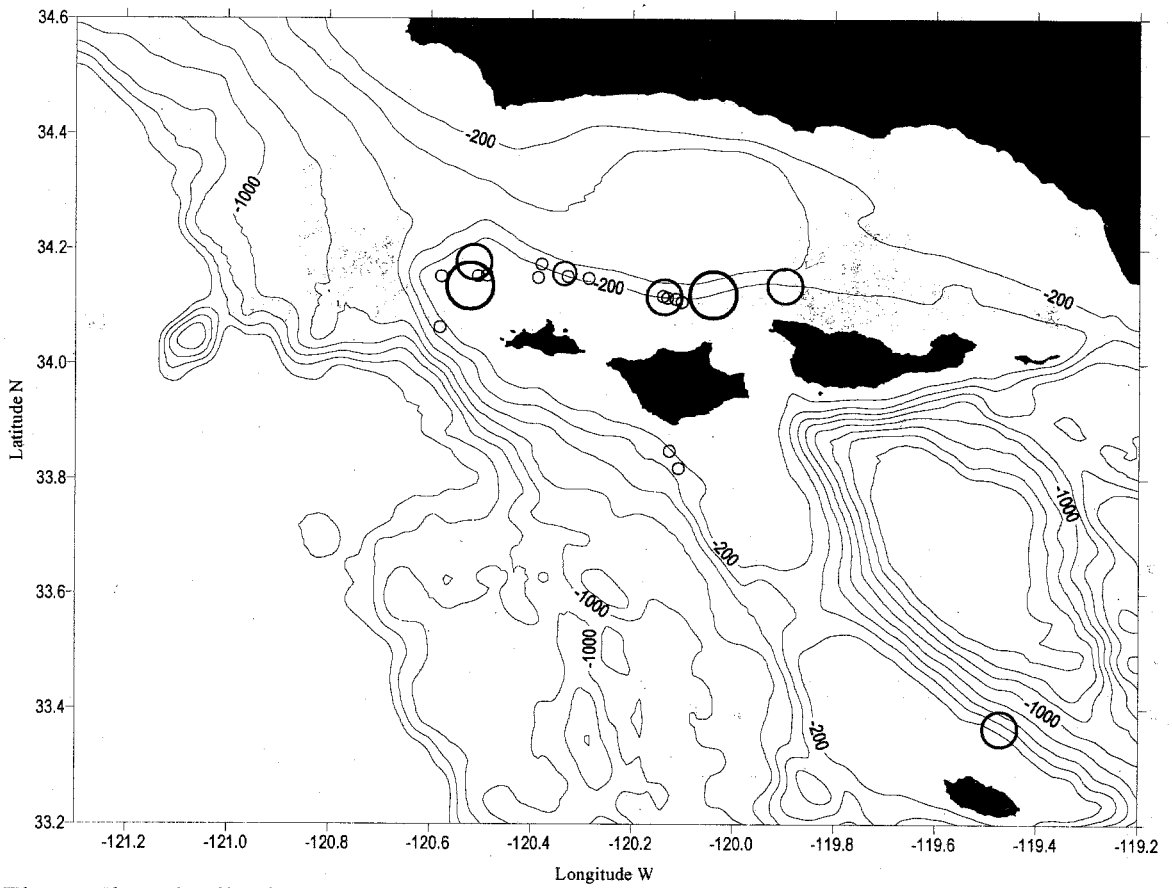

Figure 5b. Distribution and estimated abundance of *T. spinifera* captured by MOCNESS during small area survey. Circles indicate stations where *T. spinifera* was caught. The relative abundance (sample volume per 1000 m^3)is depicted by the diameter the circle. The four circle sizes represent (smallest to largest) abundance values ranging from 0.1 - 249.9, 250 - 499.9, 500 - 1000, to >1000 ml per 1000 m^3. Note the largest samples were collected adjacent and inshore of the 200 m contour.

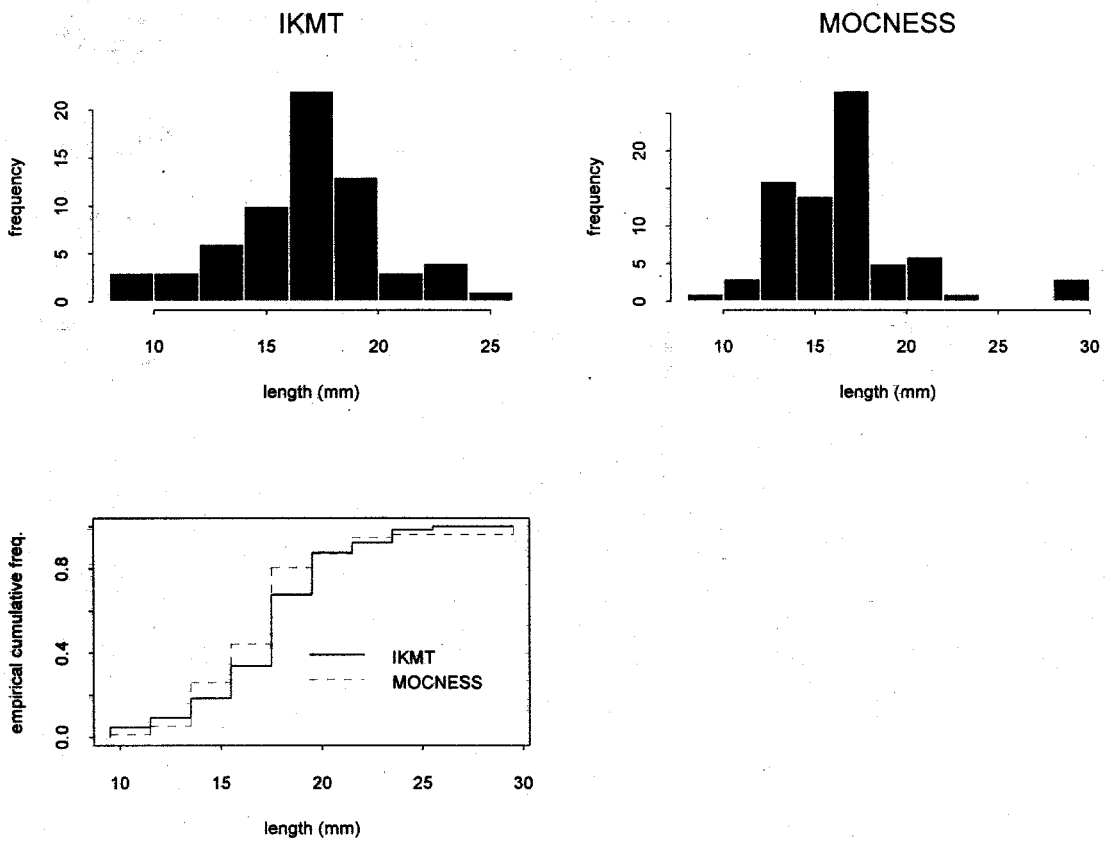

Figure 6. Results of Kolmogorov-Smirnov test.

Table 1. IKMT tow summary large area surveys A and B.

Station Number	Latitude North	Longitude West	Date (GMT)	Start Time (GMT)	End Time (GMT)	Volume filtered ml^3	Tow Depth (m)	Bottom Depth (m)
1	33.343	119.775	071196	1612	1624	1837.2	81	100
2	33.340	119.303	071196	2026	2100	6008.8	200	854
3	33.715	119.755	071296	0205	0243	7106.8	200	854
4	33.734	119.326	071396	1239	1308	3929.6	200	810
5	34.102	119.306	071296	1716	1757	8464.7	206	1070
6	34.101	119.779	071296	2243	2301	2397.9	180	182
7	34.109	120.240	071396	0220	0235	2126.4	112	117
8	34.168	120.237	071396	1230	1255	3169.3	87	103
9	33.723	119.781	071396	1909	1949	6037	202	490
10	33.731	118.090	071396	2318	2344	3076.8	197	670
11	33.336	119.770	071496	0421	0442	4176.8	89	102
12	33.337	120.239	071496	1236	1256	2163	203	930
13	33.720	120.696	071496	1718	1747	4292.4	200	1610
14	33.721	120.241	071496	2056	2120	2811.5	200	925
15	34.107	120.701	071596	0150	0212	2118.3	220	731
16	34.112	120.705	071596	1225	1250	3056.9	202	730
17	34.098	120.236	071596	1624	1637	1832.6	84	96
18	34.476	120.717	071596	2058	2131	4368.1	200	291
19	34.483	121.158	071696	0101	0121	2266.2	200	1160
20	34.309	120.952	071696	1226	1251	2362	201	1005
21	34.101	121.160	071696	1827	1850	2947.8	201	2221
22	33.722	120.698	071696	2303	2328	3506.1	200	1619
23	33.723	121.060	071796	0344	0407	2254.4	246	3150
53	34.138	120.518	073096	0527	0542	1931.5	75	100
54	34.446	120.713	073096	1253	1339	7642.7	209	430
55	34.106	120.237	073096	1720	1730	1293.9	80	99
56	34.103	120.707	073096	2103	2126	2698.5	200	730
57	33.718	120.240	073096	0136	0209	3902.3	206	932
58	33.712	120.355	073196	1243	1315	4966.1	206	1154
59	33.725	120.700	073196	1555	1622	3967.7	205	1625
60	33.344	120.245	073196	2059	2117	2604.4	200	760
61	33.333	119.766	073196	0028	0043	2213.0	78	93
62	33.363	119.470	073196	0345	0405	3128.3	150	250
63	33.446	119.895	080196	1231	1300	3834.0	215	695
64	33.725	119.780	080196	1919	1943	3182.0	203	770
65	34.103	120.241	080296	1234	1247	1791.3	75	94
66	34.114	119.768	080296	1602	1631	3914.6	179	183
67	33.724	119.322	080296	0029	0056	3475.4	210	935

IKMT Tow Summary	Duration (minutes)	Volume filtered ml^3	Tow Depth (m)	Bottom Depth (m)
Mean	24.8	3496.2	173.7	754.5
Minimum	10	1294	75	93
Maximum	46	8465	246	3150
N	38	38	38	38

Table 2. MOCNESS tow summary small area survey.

Station Number	Latitude North	Longitude West	Date (GMT)	Time Start (GMT)	Time End (GMT)	Duration (minutes)
moc01a024	33.950	120.324	071796	1944	2020	36
moc02a025	34.108	120.102	071896	1522	1607	45
moc03a026	34.113	120.114	071896	2009	2101	52
moc04a027	34.136	119.898	071996	0315	0411	56
moc05a028	34.118	120.140	071996	1702	1748	46
moc06a029	34.115	120.131	071996	2330	0044	74
moc07a030	34.152	120.328	072096	1950	2050	60
moc08a031	34.195	120.299	072096	2243	2351	68
moc09a032	34.150	120.387	072196	1504	1556	52
moc10a033	34.173	120.380	072196	1647	1741	54
moc11a034	34.152	120.506	072196	2353	0026	33
moc12a035	34.135	120.521	072296	0450	0545	55
moc13a036	34.145	120.512	072296	0712	0723	11
moc14a037	34.077	120.620	072396	1822	1925	63
moc15a038	34.045	120.553	072496	0416	0513	57
moc16a039	33.943	120.395	072496	2003	2046	43
moc17a040	33.922	120.371	072596	0019	0104	45
moc18a041	33.849	120.127	072596	0316	0345	29
moc19a042	33.946	120.493	072596	1534	1615	41
moc20a043	34.063	120.581	072696	0041	0120	39
moc21a044	34.177	120.513	072696	0314	0345	31
moc22a045	34.116	120.137	072696	1958	2027	29
moc23a046	34.157	120.335	072796	0032	0157	85
moc24a047	34.153	120.488	072796	1741	1834	53
moc25a048	34.152	120.578	072896	0034	0136	62
moc26a049	34.120	120.040	072896	1703	1749	46
moc27a050	34.148	120.287	072896	2117	2152	35
moc28a051	33.818	120.108	072996	2233	2324	51
moc29a052	34.137	120.522	073096	0412	0425	13
moc1b068	33.366	119.472	080396	1922	2053	91

Table 3. List of non-euphausiid major taxonomic groupings.

Taxonomic Groupings
Larval Fish
Adult Fish
Heteropods
Pteropods
Other Pelagic mollusk
Decapods
Scyphozoan medusae
Hydrozoan medusae
Ctenophores
Amphipods
Copepods
Chaetognaths
Polychaetes
Diatoms/Radiolarians
Eggs
Ostracods
Barnacle cypris
Unidentified Squid
Siphonophores
Salps
Cladocerans
Larvaceans
Echinoderm larva

Table 4. IKMT catch summary large area surveys A and B.

Station Number	Taxon	Species Vol. (ml) per ($1000m^3$)	ml/m^2
1	Larval/Juvenile Euphausiids	14.5	1.2
1	Chaetognaths	14.5	1.2
1	Copepods	33.5	2.7
1	Diatoms/Radiolarians	39.1	3.2
2	*Euphausia pacifica*	127.3	25.5
3	*Euphausia pacifica*	48.3	9.7
3	Larval/Juvenile Euphausiids	13.8	2.8
3	*Nematocelis difficilis*	4.1	0.8
3	*Stylocheiron sp.*	1.4	0.3
3	Copepods	38.6	7.7
4	*Euphausia pacifica*	65	13
4	Larval/Juvenile Euphausiids	0.9	0.2
4	*Nematocelis difficilis*	2.8	0.6
4	*Stylocheiron sp.*	0.9	0.2
4	*Thysanoessa spinifera*	0.9	0.2
5	*Euphausia pacifica*	18.9	3.9
5	Larval/Juvenile Euphausiids	9.5	1.9
5	*Nematocelis difficilis*	1.9	0.4
5	Copepods	81.4	16.8
6	*Euphausia pacifica*	4.4	0.8
6	Larval/Juvenile Euphausiids	3.1	0.6
6	*Nyctiphanes simplex*	0.6	0.1
6	*Thysanoessa spinifera*	5	0.9
6	Copepods	43.8	7.9
7	*Euphausia pacifica*	2.7	0.3
7	Larval/Juvenile Euphausiids	1.4	0.2
7	*Thysanoessa spinifera*	2.7	0.3
7	Scyphozoa medusae	2.7	0.3
7	Copepods	6.3	0.7
7	Ctenophores	10.1	1.1
8	*Euphausia pacifica*	32.8	2.9
8	*Nematocelis difficilis*	4.1	0.4
8	*Thysanoessa spinifera*	2.5	0.2
8	Copepods	32.8	2.9
9	*Euphausia pacifica*	27.8	5.6
9	*Nematocelis difficilis*	23.9	4.8
9	Copepods	14.9	3
9	Chaetognaths	19.9	4
10	*Euphausia pacifica*	80.6	16.3
10	*Nematocelis difficilis*	3	0.6
10	*Thysanoessa spinifera*	1	0.2
11	Larval/Juvenile Euphausiids	1.4	0.1
11	*Nematocelis difficilis*	0.5	0
11	*Nyctiphanes simplex*	13.8	1.2

Table 4. IKMT catch summary large area surveys A and B.

Station Number	Taxon	Species Vol. (ml) per (1000m^3)	ml/m^2
11	*Stylocheiron sp.*	1.4	0.1
11	*Thysanoessa spinifera*	0.5	0
11	Chaetognaths	4.6	0.4
11	Diatoms/Radiolarians	9.2	0.8
11	Copepods	11.5	1
12	*Euphausia pacifica*	6.5	1.3
12	Larval/Juvenile Euphausiids	9.7	2
12	*Nematocelis difficilis*	58.3	11.8
12	Ctenophores	56.6	11.5
13	*Euphausia pacifica*	44.7	8.9
13	*Nematocelis difficilis*	4.2	0.8
13	Diatoms/Radiolarians	34.9	7
13	Ctenophores	41.9	8.4
14	*Euphausia pacifica*	0.9	0.2
14	Larval/Juvenile Euphausiids	0.9	0.2
14	*Nematocelis difficilis*	17.1	3.4
14	Copepods	12.8	2.6
14	Diatoms/Radiolarians	48.7	9.7
15	*Euphausia pacifica*	23	5.1
15	Copepods	15.4	3.4
15	Diatoms/Radiolarians	25.6	5.6
15	Ctenophores	51.2	11.3
16	*Euphausia pacifica*	19.4	3.9
16	*Nematocelis difficilis*	21.6	4.4
16	Diatoms/Radiolarians	15.1	3.1
16	Ctenophores	32.4	6.5
17	Larval/Juvenile Euphausiids	2.4	0.5
17	Ctenophores	11.9	2.4
17	Copepods	95.2	19.2
18	*Euphausia pacifica*	109.2	21.8
18	*Nematocelis difficilis*	48.5	9.7
18	Ctenophores	63.1	12.6
19	*Euphausia pacifica*	58.2	11.6
19	*Nematocelis difficilis*	23.3	4.7
19	*Stylocheiron sp.*	1.2	0.2
19	Ctenophores	21	4.2
20	*Euphausia pacifica*	17.3	3.5
20	*Nematocelis difficilis*	12	2.4
20	Ctenophores	33.2	6.7
20	Hydrozoan medusae	51.8	10.4
21	*Euphausia pacifica*	50.5	10.2
21	Larval/Juvenile Euphausiids	5.3	1.1
21	*Nematocelis difficilis*	17.3	3.5
21	Diatoms/Radiolarians	13.3	2.7
21	Copepods	16	3.2

Table 4. IKMT catch summary large area surveys A and B.

Station Number	Taxon	Species vol. (ml) per ($1000m^3$)	ml/m^2
21	Ctenophores	16	3.2
22	*Euphausia pacifica*	17.2	3.4
22	Larval/Juvenile Euphausiids	6.6	1.3
22	*Nematocelis difficilis*	2.7	0.5
22	*Stylocheiron sp.*	1.3	0.3
22	Copepods	15.9	3.2
22	Diatoms/Radiolarians	26.5	5.3
22	Ctenophores	53.1	10.6
23	*Euphausia pacifica*	86.5	21.3
23	Larval/Juvenile Euphausiids	17.3	4.3
23	*Nematocelis difficilis*	43.2	10.6
23	Ctenophores	34.6	8.5
23	Diatoms/Radiolarians	72.1	17.7
53	*Thysanoessa spinifera*	264.8	10.3
53	Larval/Juvenile Euphausiid	0.03	0.001
54	*Euphausia pacifica*	25.4	0.7
54	*Thysanoessa spinifera*	4.4	0.1
54	*Nematocelis difficilis*	12.1	0.3
54	Ctenophores	48.5	1.3
55	*Euphausia pacifica*	0.02	0.001
55	Larval/Juvenile Euphausiid	77.9	4.8
55	Copepods	113.5	7
56	*Euphausia pacifica*	12.5	0.9
56	*Nematocelis difficilis*	2.1	0.2
56	Copepods	9.3	0.7
56	Diatoms/Radiolarians	14	1
57	*Euphausia pacifica*	47.7	2.5
57	*Nematocelis difficilis*	3.9	0.2
57	Larval/Juvenile Euphausiid	0.01	0.001
57	Ctenophores	61.9	3.3
58	*Euphausia pacifica*	27.1	1.1
58	*Nematocelis difficilis*	27.1	1.1
58	Larval/Juvenile Euphausiid	10.9	0.5
58	Ctenophores	11.9	0.5
58	Copepods	11.9	0.5
58	Diatoms/Radiolarians	15.2	0.6
59	*Euphausia pacifica*	2.5	0.1
59	*Nematocelis difficilis*	16.5	0.9
59	*Stylocheiron sp.*	0.01	0.001
59	*Euphausia gibboides*	1.3	0.1
59	Ctenophores	16.5	0.9
59	Diatoms/Radiolarians	63.4	3.3
60	*Stylocheiron sp.*	0.7	0.1

Table 4. IKMT catch summary large area surveys A and B.

Station Number	Taxon	Species vol. (ml) per ($1000m^3$)	ml/m^2
60	*Euphausia hemmigibba*	0.007	0.001
60	*Euphausia hemmigibba/gibboides*	0.007	0.001
60	Ctenophores	49.6	3.8
61	Scyphozoa medusae	163.1	5.8
62	*Thysanoessa spinifera*	621.9	29.8
63	*Euphausia pacifica*	36.5	2
63	*Thysanoessa spinifera*	13.7	0.8
63	*Nematocelis difficilis*	13.7	0.8
63	*Euphausia hemmigibba/gibboides*	0.009	0.001
64	Larval/Juvenile Euphausiid	4.9	0.3
64	Ctenophores	12.3	0.8
64	Copepods	12.3	0.8
64	Diatoms/Radiolarians	17.2	1.1
65	Larval/Juvenile Euphausiid	12.5	0.5
65	Copepods	159	6.7
66	*Euphausia pacifica*	0.01	0.0005
66	*Thysanoessa spinifera*	0.01	0.0005
66	*Nematocelis difficilis*	7.3	0.3
66	Scyphozoa medusae	31.4	1.4
66	Copepods	47.1	2.2
67	*Euphausia pacifica*	18	1.1
67	*Thysanoessa spinifera*	0.006	0.0004
67	*Nematocelis difficilis*	0.6	0.04
67	*Stylocheiron sp.*	0.01	0.0004
67	Larval/Juvenile Euphausiid	0.01	0.0004
67	*Euphausia hemmigibba/gibboides*	0.01	0.0004
67	Ctenophores	11.6	0.7
67	Diatoms/Radiolarians	17.4	1.1

Table 5. Summary of species composition and abundance for large area surveys A and B.

Taxon	N	Frequency (%) of stations	Estimated Abundance Mean (ml) per 1000 m^3	Estimated Abundance Mean ml/m^2
Euphausia gibboides	1	2.6	1.3	0.1
Euphausia hemmigibba	2	5.3	0.007	0.001
Euphausia hemmigibba/gibboides	3	7.9	0.007	0.0005
Euphausia pacifica	29	76.3	34.9	6.1
Larval/Juvenile Euphausiid	20	52.6	9.2	1.1
Nematocelis difficilis	26	68.4	14.4	2.4
Nyctiphanes simplex	3	7.9	4.8	0.4
Stylocheiron sp.	8	21.1	0.9	0.1
Thysanoessa spinifera	12	31.6	76.4	3.6
Chaetognaths	3	7.9	13	1.9
Copepods	29	76.3	32.2	5.7
Ctenophores	19	50	35.4	7.3
Diatoms/Radiolarians	14	36.8	31.6	6.1
Hydrozoan medusae	1	2.6	51.8	10.4
Scyphozoa medusae	3	7.9	2.7	0.3

Table 6. Length frequency data for euphausiids measured during the small area survey.

Total Length (mm)	*Euphausia. pacifica*	*Nematocelis. difficilis*	*Thysanoessa spinifera*	*Nyctiphanes simplex*	*Stylocheiron sp.*	*Thysanoessa gregaria*	*Euphausia gibboides*
7-8.9	0	0	0	1	3	0	0
9-10.9	1	0	5	1	1	1	0
11-12.9	5	0	12	2	0	0	0
13-14.9	56	1	20	0	0	0	0
15-16.9	100	9	42	0	0	0	1
17-18.9	59	52	38	0	0	0	0
19-20.9	39	62	20	0	0	0	0
21-22.9	18	19	5	0	0	0	0
23-24.9	1	7	7	0	0	0	0
25-26.9	0	2	3	0	0	0	0
N	***279***	***152***	***152***	***4***	***4***	***1***	***1***
Mean length (mm)	***16.9 mm***	***19.4 mm***	***16.8 mm***	***10.5 mm***	***8. 5 mm***	***10 mm***	***16 mm***

Table 7. Euphausiid catches small area survey.

Station Number	Species	Abundance (volume (ml) per 1000 m^3)
moc01a024	Juvenile Euphausiid	37.1
moc02a025	*Euphausia pacifica*	355.1
moc02a025	*Thysanoessa spinifera*	1.3
moc02a025	*Nyctiphanes simplex*	12.201
moc02a025	Juvenile Euphausiid	0.1
moc03a026	*Euphausia pacifica*	6358.0
moc03a026	*Thysanoessa spinifera*	0.3
moc03a026	*Nyctiphanes simplex*	135.923
moc03a026	Juvenile Euphausiid	3.1
moc04a027	*Euphausia pacifica*	42.1
moc04a027	*Thysanoessa spinifera*	742.1
moc04a027	*Nyctiphanes simplex*	238.351
moc04a027	Juvenile Euphausiid	0.03
moc05a028	*Euphausia pacifica*	2544.5
moc05a028	*Thysanoessa spinifera*	38.0
moc05a028	*Nyctiphanes simplex*	26.085
moc05a028	Juvenile Euphausiid	36.3
moc06a029	*Euphausia pacifica*	3278.7
moc06a029	*Thysanoessa spinifera*	138.2
moc06a029	*Nyctiphanes simplex*	0.345
moc06a029	Juvenile Euphausiid	86.9
moc07a030	*Euphausia pacifica*	2219.5
moc07a030	*Thysanoessa spinifera*	6.6
moc07a030	*Nyctiphanes simplex*	2.959
moc07a030	Juvenile Euphausiid	315.8
moc08a031	*Euphausia pacifica*	532.0
moc08a031	*Nyctiphanes simplex*	0.042
moc08a031	Juvenile Euphausiid	0.1
moc09a032	*Euphausia pacifica*	659.6
moc09a032	*Thysanoessa spinifera*	4.0
moc09a032	*Nyctiphanes simplex*	0.074
moc09a032	Juvenile Euphausiid	146.5
moc10a033	*Euphausia pacifica*	409.1
moc10a033	*Thysanoessa spinifera*	78.7
moc10a033	*Juvenile Euphausiid*	109.1
moc11a034	*Thysanoessa spinifera*	225.7
moc11a034	*Nyctiphanes simplex*	1.200
moc11a034	Juvenile Euphausiid	12.7
moc12a035	*Thysanoessa spinifera*	2666.9
moc12a035	*Nyctiphanes simplex*	23.755
moc12a035	Juvenile Euphausiid	89.6
moc14a037	*Euphausia pacifica*	727.2

Table 7. Summary of small area survey euphausiid catches.

Station Number	Species	Abundance (volume (ml) per 1000 m^3)
moc14a037	*Nematocelis difficilis*	5.163
moc14a037	*Nyctiphanes simplex*	2.995
moc15a038	*Euphausia pacifica*	1275.3
moc16a039	Juvenile Euphausiid	7.3
moc17a040	*Euphausia pacifica*	355.8
moc17a040	*Nyctiphanes simplex*	0.011
moc17a040	Juvenile Euphausiid	1.1
moc18a041	*Euphausia pacifica*	3178.9
moc18a041	*Thysanoessa spinifera*	0.1
moc18a041	*Nematocelis difficilis*	0.070
moc18a041	*Nyctiphanes simplex*	0.184
moc18a041	Juvenile Euphausiid	73.5
moc19a042	*Euphausia pacifica*	225.0
moc19a042	Juvenile Euphausiid	7.7
moc20a043	*Euphausia pacifica*	699.0
moc20a043	*Thysanoessa spinifera*	4.4
moc20a043	Juvenile Euphausiid	2.5
moc21a044	*Thysanoessa spinifera*	666.9
moc21a044	*Nyctiphanes simplex*	18.299
moc21a044	Juvenile Euphausiid	24.0
moc22a045	*Euphausia pacifica*	359.9
moc22a045	*Thysanoessa spinifera*	622.5
moc22a045	Juvenile Euphausiid	31.8
moc23a046	*Thysanoessa spinifera*	268.8
moc23a046	*Nyctiphanes simplex*	0.042
moc23a046	Juvenile Euphausiid	1.2
moc24a047	*Thysanoessa spinifera*	17.3
moc24a047	*Nyctiphanes simplex*	36.522
moc24a047	Juvenile Euphausiid	21.0
moc25a048	*Thysanoessa spinifera*	31.5
moc25a048	*Nyctiphanes simplex*	1.173
moc25a048	Juvenile Euphausiid	12.1
moc26a049	*Euphausia pacifica*	563.5
moc26a049	*Thysanoessa spinifera*	1188.2
moc26a049	*Nyctiphanes simplex*	68.847
moc26a049	Juvenile Euphausiid	1118.4
moc27a050	*Euphausia pacifica*	3819.6
moc27a050	*Thysanoessa spinifera*	23.9
moc27a050	Juvenile Euphausiid	62.2
moc27a050	Juvenile Euphausiid	0.1
moc28a051	*Euphausia pacifica*	12667.8
moc28a051	*Thysanoessa spinifera*	67.6
moc28a051	Juvenile Euphausiid	103.6
moc01b068	*Thysanoessa spinifera*	642.7
moc01b068	*Nematocelis difficilis*	0.026
moc01b068	Juvenile Euphausiid	11.2

Table 8. Summary of species composition, average bottom depth, average sampling or net depth, and estimated abundance of planktonic species caught at the six small area survey stations selected for analysis.

Station No. moc06a029	**Bottom Depth:** 185 m	**Avg. sample depth (m)**	**Est. Abundance ml/1000 m^3**
Net	**Taxon**		
4	*Euphausia pacifica*	155	3278.5
	Thysanoessa spinifera		138
	Nyctiphanes simplex		0.3
	Copepods		0.3
6	*Euphausia pacifica*	42.9	0.1
	Larval/Juvenile Euphausiid		32.8
	Copepods		262.2
8	*Euphausia pacifica*	25.2	0.1
	Thysanoessa spinifera		0.1
	Larval/Juvenile Euphausiid		54.1
	Larval Fish		0.1
	Decapods		0.1
	Copepods		973.7
	Chaetognaths		0.1
	Diatoms/Radiolarians		43.3
Station No.: moc10a033	**Bottom Depth:** 255 m	**Avg. sample depth (m)**	**Est. Abundance ml/1000 m^3**
Net	**Taxon**		
2	*Euphausia pacifica*	101	408.3
	Thysanoessa spinifera		78.7
4	Adult Fish	232.3	19.3
	Pteropods		0.6
	Decapods		1.3
	Amphipods		5.2
	Copepods		38.7
	Chaetognaths		0.6
	Ostracods		0.6
6	*Euphausia pacifica*	226	0.9
	Adult Fish		5.3
	Decapods		11.6
	Ctenophores		44.5
	Copepods		16
	Chaetognaths		8.9
	Diatoms/Radiolarians		0.9
8	Larval/Juvenile Euphausiid	14.4	109.1
	Decapods		0.1
	Copepods		409
	Chaetognaths		13.6
	Diatoms/Radiolarians		818.1

Table 8. Summary of species composition, average bottom depth, average sampling or net depth, and estimated abundance of planktonic species caught at the six small area survey stations selected for analysis.

Station No.: moc12a035	**Bottom Depth:** 100 m	**Avg. sample depth (m)**	**Est. Abundance ml/1000 m^3**
Net	**Taxon**		
2	*Thysanoessa spinifera*	76.4	147
	Nyctiphanes simplex		1.6
	Larval/Juvenile Euphausiid		1.6
	Copepods		6.3
4	*Thysanoessa spinifera*	40.7	407.9
	Larval/Juvenile Euphausiid		38.4
	Copepods		28.8
6	*Thysanoessa spinifera*	40.6	1114.3
	Larval/Juvenile Euphausiid		49.5
	Copepods		61.9
	Diatoms/Radiolarians		0.1
8	*Thysanoessa spinifera*	2.3	997.9
	Nyctiphanes simplex		22.2
	Larval/Juvenile Euphausiid		0.1
	Copepods		22.2
	Chaetognaths		55.4
	Diatoms/Radiolarians		0.1
Station No.: moc18a041	**Bottom Depth:** 170 m	**Avg. sample depth (m)**	**Est. Abundance ml/1000 m^3**
Net	**Taxon**		
2	*Euphausia pacifica*	129.7	1820.4
	Nyctiphanes simplex		0.2
	Pteropods		0.2
	Copepods		18.4
	Siphonophores		0.2
4	*Euphausia pacifica*	115.6	625.6
	Thysanoessa spinifera		0.1
	Nematocelis difficilis		0.1
	Larval/Juvenile Euphausiid		0.1
	Pteropods		0.1
	Copepods		70.3
6	*Euphausia pacifica*	60.2	721.9
	Thysanoessa spinifera		0.1
	Larval/Juvenile Euphausiid		0.1
	Decapods		0.1
	Copepods		7.4
	Polychaetes		0.1
	Diatoms/Radiolarians		7.4
	Siphonophores		7.4
8	*Euphausia pacifica*	9.7	11.1
	Larval/Juvenile Euphausiid		73.4
	Copepods		133.5
	Diatoms/Radiolarians		4.4

Table 8. Summary of species composition, average bottom depth, average sampling or net depth, and estimated abundance of planktonic species caught at the six small area survey stations selected for analysis

Station No.: moc22a045	**Bottom Depth:** 227 m	**Avg. sample depth (m)**	**Est. Abundance ml/1000 m^3**
Net	**Taxon**		
4	*Euphausia pacifica*	133.5	194.4
	Thysanoessa spinifera		136.1
	Larval/Juvenile Euphausiid		19.4
	Copepods		35
6	*Euphausia pacifica*	131.8	123.7
	Thysanoessa spinifera		247.4
	Larval/Juvenile Euphausiid		12.4
	Copepods		20.6
	Unidentified. Squid		4.1
8	*Euphausia pacifica*	130.1	41.8
	Thysanoessa spinifera		239.1
	Copepods		17.9
Station No.: moc28a051	**Bottom Depth:** 285 m	**Avg. sample depth (m)**	**Est. Abundance ml/1000 m^3**
Net	**Taxon**		
2	*Euphausia pacifica*	251.9	6596
	Amphipods		0.7
	Copepods		0.7
	Chaetognaths		0.7
	Siphonophores		0.7
4	*Euphausia pacifica*	260.8	3263.8
	Thysanoessa spinifera		67.3
	Copepods		0.3
6	*Euphausia pacifica*	249.4	2807.9
	Thysanoessa spinifera		0.3
	Copepods		0.3
8	Larval/Juvenile Euphausiid	20.4	103.6
	Copepods		186.5
	Chaetognaths		33.2

Table 9. Vertical distribution of major planktonic taxa captured at six selected stations during small area survey.

Taxon	Average Bottom Depth (m)	Average Sample Depth (m)	Relative Abundance Average Volume (ml) per $1000m^3$	Number of Nets
Euphausia pacifica	221.1	141.4	1421.0	14
Thysanoessa spinifera	186.9	108.8	255.3	14
Nematocelis difficilis	170.0	115.6	0.1	1
Nyctiphanes simplex	138.8	90.9	6.1	4
Larval/Juvenile Euphausiid	174.9	54.9	38.0	13
Adult Fish	255.0	229.2	12.3	2
Amphipods	270.0	242.1	3.0	2
Chaetognaths	215.0	101.6	14.1	9
Copepods	201.0	111.9	110.0	21
Ctenophores	255.0	226.0	44.5	1
Decapods	224.0	111.6	2.6	5
Diatoms/Radiolarians	190.0	49.9	110.8	8
Larvaceans	285.0	20.4	82.9	1
Larval Fish	185.0	25.2	0.1	1
Ostracods	255.0	232.3	0.6	1
Polychaetes	170.0	60.2	0.1	1
Pteropods	208.3	147.3	2.8	3
Siphonophores	198.3	159.2	0.3	3
Unidentified Squid	227.0	131.8	4.1	1

Table 10. Summary of length frequency data of euphausiids measured during the small scale survey.

Total Length (mm)	*Euphausia pacifica*	*Thysanoessa spinifera*	*Nyctiphanes simplex*	*Nematocelis difficilis*
5-6.9	0	4	5	0
7-8.9	8	22	32	0
9-10.9	38	29	62	0
11-12.9	117	64	66	0
13-14.9	389	196	50	2
15-16.9	629	318	17	7
17-18.9	266	250	0	5
19-20.9	100	106	0	10
21-22.9	37	103	0	1
23-24.9	0	63	0	0
25-26.9	0	48	0	0
27-28.9	0	20	0	0
29-30.5	0	13	0	0
N	***1584***	***1236***	***232***	***25***
Mean Length mm	***15.7***	***17.5***	***11.5***	***18***

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