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ICHTHYOPLANKTON, PARALARVAL CEPHALOPOD, AND STATION DATA FOR OBLIQUE (BONGO) PLANKTON TOWS FROM THE OREGON, CALIFORNIA, AND WASHINGTON LINE-TRANSECT EXPEDITION (ORCAWALE) IN 2001

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National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

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ABSTRACT

This report provides ichthyoplankton and paralarval/juvenile cephalopod data from oblique (Bongo) net tows, and associated station and tow data collected during the Oregon, California, and Washington Line-Transect Expedition (ORCAWALE) survey in 2001. This survey was the second comprehensive survey of marine mammals and ecosystem measurements fully encompassing the Exclusive Economic Zone (EEZ) and adjacent international waters out to 300 nautical miles (nmi) along the West Coast of the contiguous United States. In total, 71 Bongo net tow samples were collected between 31 July and 7 December in 2001 aboard the National Oceanographic and Atmospheric Administration (NOAA) research vessels *David Starr Jordan* and *McArthur*, during which the two ships surveyed the area extending from the Canada/Washington border south to the California/Mexico border, and westward to about 130° W. The data are presented in a series of six tables; the background, methodology, and information necessary for interpretation of the data are presented in the accompanying text.

INTRODUCTION

Under the 1994 amendments to the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) are required to produce Stock Assessment Reports (SARs) for all stocks of marine mammals within the waters of the United States Exclusive Economic Zone (U.S. EEZ), to review new information every year for strategic stocks and every three years for non-strategic stocks, and to update the stock assessment reports when significant new information becomes available (Barlow 1997; Barlow et al. 1995, 1997, 1998; Carretta et al. 2001, 2002, 2004, 2005, 2006; Forney et al. 1999, 2000). The Protected Resources Division (PRD, formerly the Marine Mammal Division) of the Southwest Fisheries Science Center (SWFSC, La Jolla, California), along with the National Marine Mammal Laboratory (NMML, Seattle, Washington) produce the SARs guided by the MMPA and the Endangered Species Act. Individually, and sometimes jointly, the two laboratories conduct research on the marine mammals, seabirds, and sea turtles of the eastern Pacific Ocean, primarily in the EEZ and the greater Eastern Tropical Pacific (ETP). Their research is designed to aid in the management and conservation of these protected species. Often the PRD participates in projects directed toward individual species, taxa, or other geographic areas.

The first marine mammal stock assessment was compiled from published sources, with additional unpublished data included where it contributed to the assessment (Barlow et al. 1995). The first major revision of the NMFS marine mammal stock assessment reports for the eastern Pacific region occurred in 1996. SWFSC and the Office of Protected Resources planned and executed a survey where transects were mapped in a grid to uniformly encompass the whole area. To date, it was the largest and most comprehensive marine mammal survey completed along the U.S. West coast; preliminary results were reported by Barlow (1997). The survey included waters within 300 nmi off California, surveyed previously in 1991 (Hill and Barlow 1992), and added the waters off Oregon and Washington. This survey was named ORCAWALE for Oregon, California and Washington Line-Transect *Experiment* (Von Saunder and Barlow 1999). Prior to this survey, in the waters off Oregon and Washington, cetacean abundances were estimated only for the most abundant species, and only by aerial surveys within 100 nmi from the coast (Green et al. 1992, 1993). Zooplankton samples were not collected on this first ORCAWALE survey. The oceanographic ecosystem studies from this cruise are being analyzed and will be reported in Klimaszewski et al. *in prep*.

In 2001, in continuation of the work begun on the first ORCAWALE survey, and in an effort to increase the understanding of the ecosystems involved, PRD conducted another marine mammal survey of this area. The primary objective of the second ORCAWALE survey (Oregon, California, and

Washington Line-Transect *Expedition*), was to estimate the absolute abundance of marine mammal populations, and to better understand their distributions along the west coast of the United States, out to a distance of approximately 300 nmi. (Figure 1[1]). The secondary goals were to collect other biological and physical oceanographic data to characterize the environment. Two research vessels were used for this survey: the NOAA ships *David Starr Jordan* (*Jordan*) and *McArthur*. The *Jordan* conducted research from 30 July to 10 November, but mechanical breakdowns limited the number of effective sea days, and the *McArthur* completed the last three weeks of the survey, from 15 November to 8 December 2001 (Figure 2). Approximately the same area and time period were surveyed in the 1996 survey.

The marine mammal survey component of ORCAWALE 2001 was conducted according to line-transect methods (Buckland et al. 1993) that have been used consistently by SWFSC for estimating abundance of cetaceans (Kinzey et al. 2001). Other cetacean research (Appler et al. 2004) included recording cetacean vocalizations using a towed array during daylight hours on the *Jordan*, and opportunistic deployment of Navy surplus sonobuoys by both vessels. Photographs for identification of marine mammals were taken opportunistically, as were skin sample biopsies for genetic analyses to aid in defining stocks. Notes were taken on marine mammal activities for behavioral studies. Estimates of cetacean abundance from this survey were made by Barlow (2003).

Oceanographic ecosystem studies and sampling techniques were published by Philbrick et al. (2003). In addition to cetacean data from line-transect methods, seabird and pinniped observations were conducted concurrently. Thermosalinographs ran continuously, measuring the temperature and salinity of the surface water. A conductivity-temperature-depth (CTD) cast with a rosette of Niskin bottles was collected each morning before sunrise. From the seawater samples primary productivity, chlorophyll *a*, salinity calibration, and nutrient samples were collected. Expendable bathythermograph (XBT) drops were made daily at 0900, 1200, and 1500, and after sunset local ship time, just prior to the zooplankton net tow. Surface chlorophyll samples were taken after each XBT drop to measure chlorophyll *a* and temperature. Additional salinity samples were taken on the fourth CTD cast to verify the CTD and thermosalinograph conductivity cells. Potential cetacean prey abundance was estimated by acoustic sampling with an EK500 echosounder on the *Jordan*, and an EQ50 echosounder on the *McArthur*; these operated continuously, at the discretion of the Commanding Officer.

Fish were collected by trolling while underway or by hook-and-line while stationary. An Acoustic Doppler Current Profiler (ADCP) also ran continuously on the *Jordan* and was logged to a data acquisition system. A chronological record of oceanographic and net tow stations was kept by the ship (Electronic Marine Operations Log) with dates and times in GMT. The *Jordan* provided a digital copy of this log and the cruise weather log at the completion of the cruise.

This report provides ichthyoplankton and paralarval cephalopod data collected on the 2001 ORCAWALE survey. Zooplankton samples were processed and primary ichthyoplankton identifications were completed on a contract through PRD. Analysis of cephalopods and further ichthyoplankton identifications were done by SWFSC FRD Ichthyoplankton Ecology and Systematics Laboratory personnel. PRD processed and analyzed the hydrographic and other biological samples. All available net tow records for the ORCAWALE 2001 survey were verified and edited to produce this data report. The data are presented in a series of six tables. This is the first data report on the paralarval cephalopod and ichthyoplankton collected during an ORCAWALE survey, and makes the data available to all investigators. California waters have been surveyed for ichthyoplankton since 1951 by the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program (For example see Watson et al. 2005).

[1] Map redrawn from: Appler, J. and J. Barlow. 2002. Cruise report for the Oregon, California, and Washington Line-Transect Expedition 2001 OR.CA.WA.L.E.

Starting in the early 1980s, the Northwest and Alaska Fisheries Center (NWAFC, subsequently split into two science centers, Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC)), in cooperation with the Soviet Union (USSR/USA cruises, 1980–1987), sampled ichthyoplankton along the coasts of Washington, Oregon, and northern California (Doyle 1995, Doyle et al. 2002; Matarese et al. 2003). Paralarval cephalopod identifications from CalCOFI samples were done in the mid-1950's (Okutani and McGowan 1969), and resumed in 1997 to develop a fishery independent index of trends in market squid (*Loligo opalescens*) population abundance.

SAMPLING AREA AND PATTERN

A total of 71 Bongo net tows were made on the ORCAWALE survey in 2001, employing two research vessels: *Jordan* sampled stations 1–54 and *McArthur* sampled stations 55–71 (Figure 3). Distributions of perpendicular distance were not significantly different between the two vessels used on this survey, so data from the two ships were pooled (Barlow 1997). The survey was conducted in six legs, five legs on the *Jordan* and one on the *McArthur*:

Jordan Leg 1	30 July–17 August	San Diego, California–Newport, Oregon
Jordan Leg 2	30 August–16 September	Portland, Oregon–Eureka, California
Jordan Leg 3	19 September–04 October	Eureka, California–San Diego, California
Jordan Leg 4	08–27 October	San Diego, California–Astoria, Oregon
Jordan Leg 5	01–10 November	Astoria, Oregon–San Diego, California
McArthur Leg 6	15 November–08 December	San Francisco, California–San Diego, California

The principal study area was the U.S. West Coast EEZ and international waters out to a distance of approximately 300 nautical miles from the coasts of Washington, Oregon, and California. The ships followed a grid of predetermined tracklines (Figure 1) to uniformly cover this area. Actual tracklines surveyed are shown in Figure 2.

ZOOPLANKTON SAMPLING GEAR AND METHODS

The Bongo net tow on ORCAWALE 2001 was a double oblique haul towed from a depth of ~200 m (300 meters of wire out, or, to 15 m from the bottom in shallow areas) designed to filter a constant amount of water per depth interval (~2 m^3/m of depth) over the vertical range of most ichthyoplankters. The Bongo frame (McGowan and Brown 1966; Smith and Richardson 1977) consists of a pair of circular frames connected to a central axle. The axle is free to rotate so that the mouth openings are vertical during the tow. The standard CalCOFI Bongo net used has 71 cm diameter frames and net material constructed of 0.505 mm nylon mesh. Each net consists of a cylindrical section ~146 cm long, a truncated conical section ~161 cm long, and a detachable cod end. The samples were taken from the starboard net. A General Oceanics flowmeter is suspended across the center of the starboard net; meter readings were taken at the beginning and end of each plankton tow. Hauls were made following standard CalCOFI protocol at a ship speed of 1.5–2.0 knots, and were initiated by clamping the net to the towing cable above a 34 kg weight suspended below the surface. The net was lowered to depth by paying the wire out at 50 m/minute (35 m of depth/minute). After fishing at depth for 30 seconds, the net was retrieved at 20 m/minute (14 m of depth/minute). The angle of stray was recorded every 30 seconds and maintained at 45° (± 3°) by adjusting ship speed and course. After reaching the surface, the nets were washed down and the samples preserved in 5% formalin buffered with sodium borate. Samples were returned to the plankton sorting laboratory at the SWFSC at the end of the cruise. The Bongo sample was taken a minimum of 1 full hour after sunset each night. The tow took approximately 30 minutes to complete. Detailed descriptions of gear and methods are given by Kramer et al. (1972) and Smith and Richardson

(1977); Ohman and Smith (1995) provided summaries of historical CalCOFI zooplankton methods and calibration factors for the Bongo as well as other gear types.

LABORATORY PROCEDURES

The ichthyoplankton and cephalopods were removed from the invertebrate portion of each sample and bottled separately in 3% sodium borate buffered formalin. In addition to cephalopods, and fish eggs and larvae, some samples contained juvenile, and occasionally adult, stages of fishes; these were removed and bottled separately in 3% formalin. The volume of water filtered by the net was computed from the flowmeter readings. A “standard haul factor” is used for oblique Bongo net tows to calculate the total number of individuals of a taxon under a unit surface area (Kramer et al. 1972; Smith and Richardson 1977; Moser et al. 1993). A requirement for this is the entire depth distribution of the taxon must be encompassed during the tow. We determined a zooplankton displacement volume for each Bongo net sample (methods described in Staff, SPFI 1953 and Kramer et al. 1972). Samples containing > 25 ml of plankton were fractioned, usually to ~50% of their original volume. Aliquot percentages for fractioned samples are listed in Table 1 under the "Percent Sorted" column. The sorting process included the removal of all cephalopods and ichthyoplankton from the samples.

A standard haul factor (SHF) was calculated for each Bongo net tow to make them comparable and to allow estimation of areal abundance. The SHF is calculated by the formula:

$$SHF = \frac{10\ D}{V}$$

where D = depth of haul = cosine of the average angle of stray of the towing cable multiplied by cable length (m)

V = total volume of water (m^3) strained during the haul

$$V = R \cdot a \cdot p$$

where R = total number of revolutions of the current meter during the haul

a = area (m^2) of the mouth of the net

p = length of the column of water needed to produce one revolution of the current meter

Tow depth, volume of water strained, and standard haul factor are listed in Table 1 for each tow taken during ORCAWALE 2001. Detailed descriptions of factors involved in calculating these values are presented in Ahlstrom (1948), Kramer et al. (1972), and Smith and Richardson (1977).

IDENTIFICATION

Early ontogenetic stages of fishes and cephalopods are inherently difficult to identify and this is further complicated by the large number and diversity of species which contribute to the plankton of the California Current region. Most ichthyoplankton identifications were accomplished by establishing

ontogenetic series on the basis of morphology, meristics, and pigmentation, and then linking these series through overlapping features to known metamorphic, juvenile, or adult stages (Powles and Markle 1984). Our ability to identify fish larvae in the California Current region improved greatly during 1988–1995 as a result of an intensive research project aimed at producing a taxonomic monograph on the ontogenetic stages of fishes of this region (Moser 1996). Additional regional identification manuals were used as well; see Matarese et al. (1989). Except for damaged specimens, most fish larvae in the 2001 survey could be identified to species. A total of 65 larval fish categories (including disintegrated) was identified in the Bongo net tows: 53 to species, 9 to genus, and 2 to family. Body lengths of Pacific sardine, northern anchovy, and Pacific hake larvae were measured to the nearest 0.5 mm. Identifications were done primarily on contract by Barbara S. MacCall, with help from SWFSC FRD Ichthyoplankton Ecology and Systematics Laboratory personnel: D. A. Ambrose, W. Watson, and the senior author of this report. Cephalopod paralarvae[2] were identified using Young (1972) and Sweeney et al. (1992). In total, 18 cephalopod taxa were identified: 12 to species, 4 to genus, 1 to family, and 1 to order. Identifications were done by W. Watson and the senior author.

With few exceptions, taxonomic categories above species represent small specimens which were damaged and partly disintegrated during capture. The following taxonomic categories in Table 6 require special explanation:

Cephalopods

Berryteuthis spp. – a small paralarva that could not be identified below the level of genus.

Gonatidae – immature young paralarvae that could not be identified with any certainty below the family level.

Gonatus spp. – small paralarvae that could not be identified below the level of genus.

Japetella spp. – a small individual that could not be identified below the level of genus.

Octopus spp. – small and damaged specimens that could not be identified below the level of genus.

Teuthida – a damaged specimen that could not be identified with any certainty below the ordinal level

Fish

Cyclothone spp. – small or damaged larvae lacking diagnostic characters.

[2] "Paralarva" is a termed coined by Young and Harman (1988) to describe the early developmental stage of cephalopods from hatching to subadult; it includes both morphological and ecological components. The morphological distinction between paralarval and juvenile stages has been defined for some families but not for all; we made no attempt to distinguish between these stages.

Diaphus spp. – *Diaphus theta* is the dominant *Diaphus* species in the survey area and most, if not all, of the larvae from the California Current region are this species; the generic category is used because a small proportion of the *Diaphus* larvae captured at the outer margin of the survey pattern may represent other species whose larvae are identical to those of *D. theta*.

Disintegrated fish larvae – one larva that could not be identified because of its poor condition; disintegrated larvae are routinely separated from the "unidentified" category to monitor the general condition of the ichthyoplankton samples.

Microstoma spp. – larvae of a distinct but undescribed microstomatid species.

Nannobrachium spp. – Zahuranec (2000) moved the subgroup of *Lampanyctus* characterized by small or absent pectoral fins in adults to the genus *Nannobrachium*; two *Nannobrachium* species, *N. ritteri* (formerly *L. ritteri*) and *N. regale* (formerly *L. regalis*), occur commonly in the present ORCAWALE survey pattern (at least three other species occur in the area, but are relatively uncommon); larval *N. ritteri* and *N. regale* > ~ 5 mm have been identified in oblique tow samples since 1954 (see Moser 1996).

Parophrys vetulus – see comment for Pleuronectidae.

Pleuronectidae – a damaged larva unidentifiable below family level due to poor condition; Sakamoto (1984) changed pleuronectid generic designations for species in the California Current Region as follows: 1) *Glyptocephalus zachirus* was changed to *Errex zachirus*; 2) *Isopsetta isolepis, Lepidopsetta bilineata,* and *Parophrys vetulus* were transferred into *Pleuronectes* and 3) *Lyopsetta exilis* was changed to *Eopsetta exilis*; although these changes were incorporated in the lists of Robins et al. (1991) and Eschmeyer (1998) we follow Nelson (1994) in retaining the older nomenclature because Sakamoto's (1984) changes were based on a phenetic study; also, the older names are used in the major identification guides to fishes of our region (Miller and Lea 1972, Eschmeyer et al. 1983, Matarese et al. 1989, and Moser 1996).

Sebastolobus spp. – larvae of this genus < 10 mm in length are not identifiable to species; larvae > 10 mm are identified as *S. alascanus* or *S. altivelis.*

Vinciguerria lucetia – V. lucetia, an eastern tropical Pacific species, is common in the southern part of the ORCAWALE region whereas the central water mass species *V. poweriae* is encountered rarely, usually only at the most seaward ORCAWALE stations; a small percentage of *V. poweriae* larvae may have been included in the *V. lucetia* category because of the difficulty in separating early larvae which often are virtually identical.

SPECIES SUMMARY

The most abundant paralarval cephalopod collected in Bongo net tows on the 2001 ORCAWALE survey, the enoploteuthid squid *Abraliopsis felis*, was also highest in frequency of occurrence, with 42.3% of the total paralarvae and 28.2% positive tows (Tables 2 and 3), respectively. It was collected throughout the whole cruise track. The 2nd most abundant species, the chiroteuthid squid *Chiroteuthis calyx*, was only one-quarter as abundant as the most abundant species (10.4% of the total paralarvae), and ranked 2nd in occurrence, with 11.3% positive tows. It occurred south of Cape Mendocino, except for one station (10) off Oregon. The 3rd most abundant taxa was the gonatid squid genus *Gonatus* spp. with 9.2% of the total paralarvae, and tied for 5th with 5.6% positive tows. *Gonatus* spp. was collected from Coos Bay, Oregon, south to Santa Cruz; the family Gonatidae was collected further south to San Diego, while *G. onyx* was collected north of Pt. Reyes and *G. pyros* occurred south of Monterey. The genus *Octopus* spp., collected

off Point Arena and south, was 4th in abundance and tied for 3rd in occurrence, with 7.8% of the total paralarvae and 7.0% positive stations. The 5th most abundant paralarvae was the onychoteuthid squid *Onychoteuthis borealijaponica*, with 5.6% of the total paralarvae; it tied for 7th in occurrence with four other species (4.2% positive tows). *O. borealijaponica* was collected south of Point Conception. The next five most abundant taxa were the family Gonatidae (4.9% of the total paralarvae), *Leachia dislocata* (4.4%), *Gonatus onyx* (3.8%), *Gonatus pyros* (2.5%), and *Pterygioteuthis gemmata* (2.2%). These taxa occurred tied for 5th, tied for 3rd, and the last three were tied for 7th in occurrence with two other species. The ten most abundant taxa comprised three-quarters of the total paralarvae collected (75.3%), with eight additional taxa (24.7%) completing the compliment of paralarvae in the ORCAWALE 2001 survey.

Of the five most abundant fish larvae collected in Bongo net tows on the 2001 ORCAWALE survey, northern lampfish (*Stenobrachius leucopsarus*) ranked first in abundance, with 18.0% of the total larvae, and 6th in occurrence, with 21.1% positive tows (Tables 4 and 5). The most southern occurrence of northern lampfish was off Point Arena. The 2nd most abundant species, northern anchovy (*Engraulis mordax*) accounted for 10.0% of the total larvae, tied for 13th in occurrence (10.0% of the samples), and was collected south of Point Reyes. Pacific sanddab (*Citharichthys sordidus*) ranked 3rd with 8.1% of the larvae and 2nd in occurrence (28.2% of the stations). The rockfish genus *Sebastes* ranked 4th in abundance with 7.6% of the total larvae and 4th in frequency of occurrence with 25.5% positive tows. Tying with *Sebastes* in abundance (7.6% of the total larvae), speckled sanddab *Citharichthys stigmaeus* ranked 5th in occurrence (22.5% positive tows). *C. sordidus*, *Sebastes* spp. and *C. stigmaeus* were collected throughout the whole cruise track. The next five most abundant taxa were Panama lightfish *Vinciguerria lucetia* (6.0% of total larvae), snubnose blacksmelt *Bathylagus wesethi* (4.8%), California flashlightfish *Protomyctophum crockeri* (4.5%), longfin dragonfish *Tactostoma macropus* (4.4%) and blue lanternfish *Tarletonbeania crenularis* (3.7%). These species ranked tied for 11th, 10th, 1st, tied for 18th with two other species, and 3rd in frequency of occurrence, respectively. The ten most abundant larval fish taxa comprised 51.3% of all the larvae collected in Bongo net tows on the ORCAWALE survey in 2001. The remaining 48.7% was distributed among 55 other categories (including the disintegrated category). Of the ten most abundant taxa, six are midwater species, three are coastal demersal taxa, and one is a coastal pelagic species.

EXPLANATION OF TABLES

Table 1. Data are listed sequentially by the Bongo net tow number. This table lists for each Bongo net tow the pertinent station and tow data, the volume of water filtered, the standard haul factor, the plankton volume, the percentage of sample sorted, the total number of fish eggs and larvae, and the total number of paralarval cephalopods during the 2001 ORCAWALE survey. Data are listed in the order of station occupancy, shown on the station chart (Figure 3). Ship codes are JD, *Jordan* or M4, *McArthur*. Plankton displacement volumes were determined after removal of large organisms (those with individual displacement volumes > 5 ml) and expressed as ml per 1000 m^3 of water filtered. Time is listed as Pacific Standard Time (PST) at the start of each tow in 24-hour designation. The values for total fish eggs and larvae, and paralarval cephalopods are raw counts (unadjusted for percent of sample sorted or standard haul factor). The listings for station latitude and longitude in this table may differ from values given for stations in Philbrick et al. (2003) and Appler et al. (2004) data reports, reflecting the difference in position of the net tow versus other types of sampling. Dates given here and in Figure 3 for the beginning and end of each cruise are based on PST at the first and last Bongo net tow station of the cruise and do not include transit time from port to the first station and to port after the last station. Thus, our cruise dates may differ slightly from those in Philbrick et al. (2003) and Appler et al. (2004) reports which are based on GMT and include transit time to the first station and from the last station.

Table 2. Pooled occurrences of all paralarval cephalopods taxa taken in Bongo net tows on ORCAWALE survey cruises in 2001, listed in rank order.

Table 3. Pooled counts of all paralarval cephalopods taxa taken in Bongo net tows on ORCAWALE survey cruises in 2001, listed in rank order. Numbers are adjusted for percent sorted and standard haul factors.

Table 4. Pooled occurrences of all larval fish taxa taken in Bongo net tows on ORCAWALE survey cruises in 2001, listed in rank order.

Table 5. Pooled counts of all larval fish taxa taken in Bongo net tows on ORCAWALE survey cruises in 2001, listed in rank order. Numbers are adjusted for percent sorted and standard haul factors.

Table 6. Numbers of paralarval cephalopods and fish larvae for each taxon, listed by tow number and calendar month of the Bongo net tow. Counts are adjusted for percentage of sample sorted and standard haul factor. Taxa are listed in phylogenetic sequence (Eschmeyer 1998, Voss et al. 1998); genera are listed alphabetically.

Table 7. Summary of oceanographic and ecosystem samples collected during the 2001 ORCAWALE survey aboard the NOAA ships *Jordan* and *McArthur*. The totals for each type of sample collected for each Leg of the survey are listed. From Philbrick et al. (2003).

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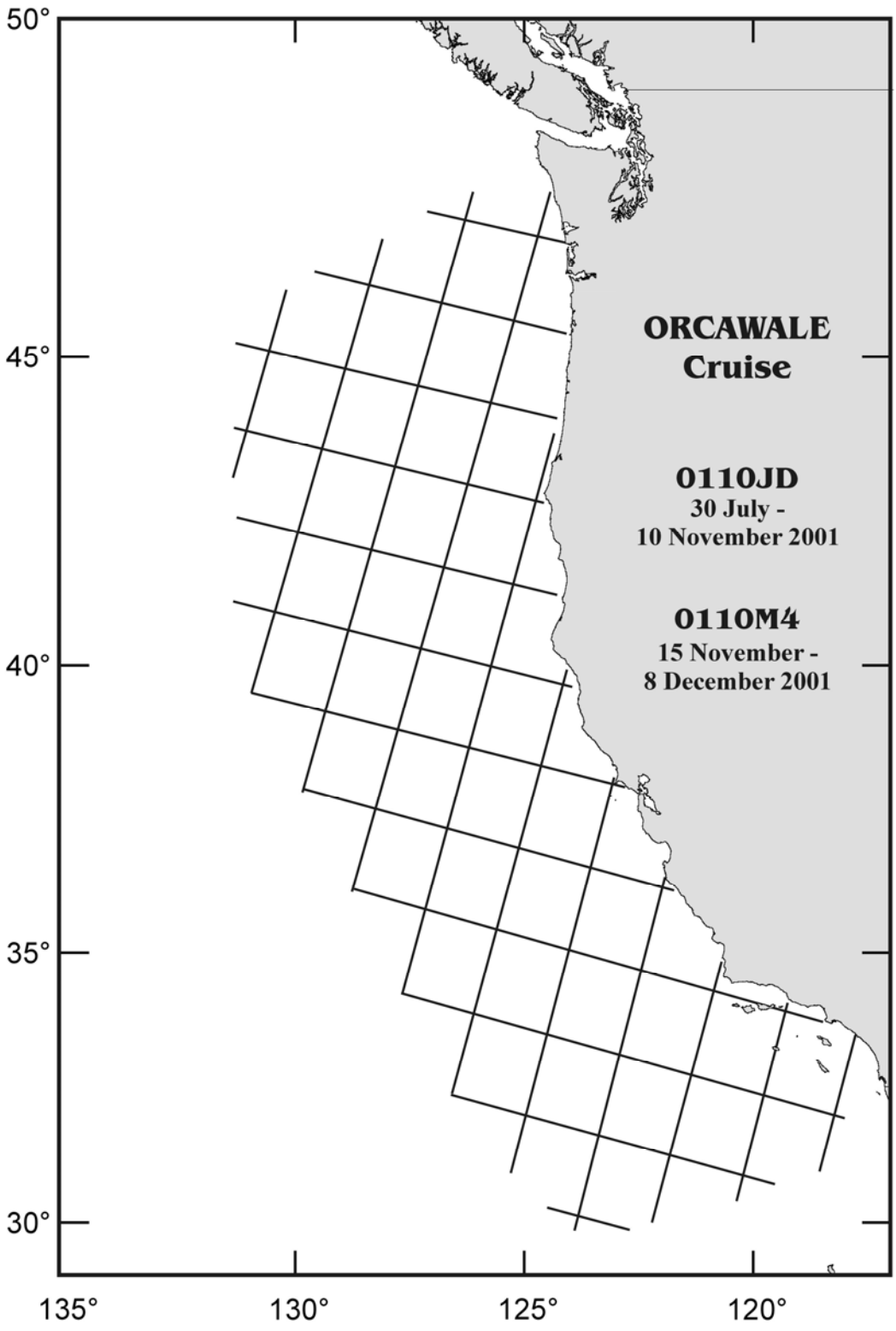

Figure 1. Nominal tracklines for the ORCAWALE 2001 survey.

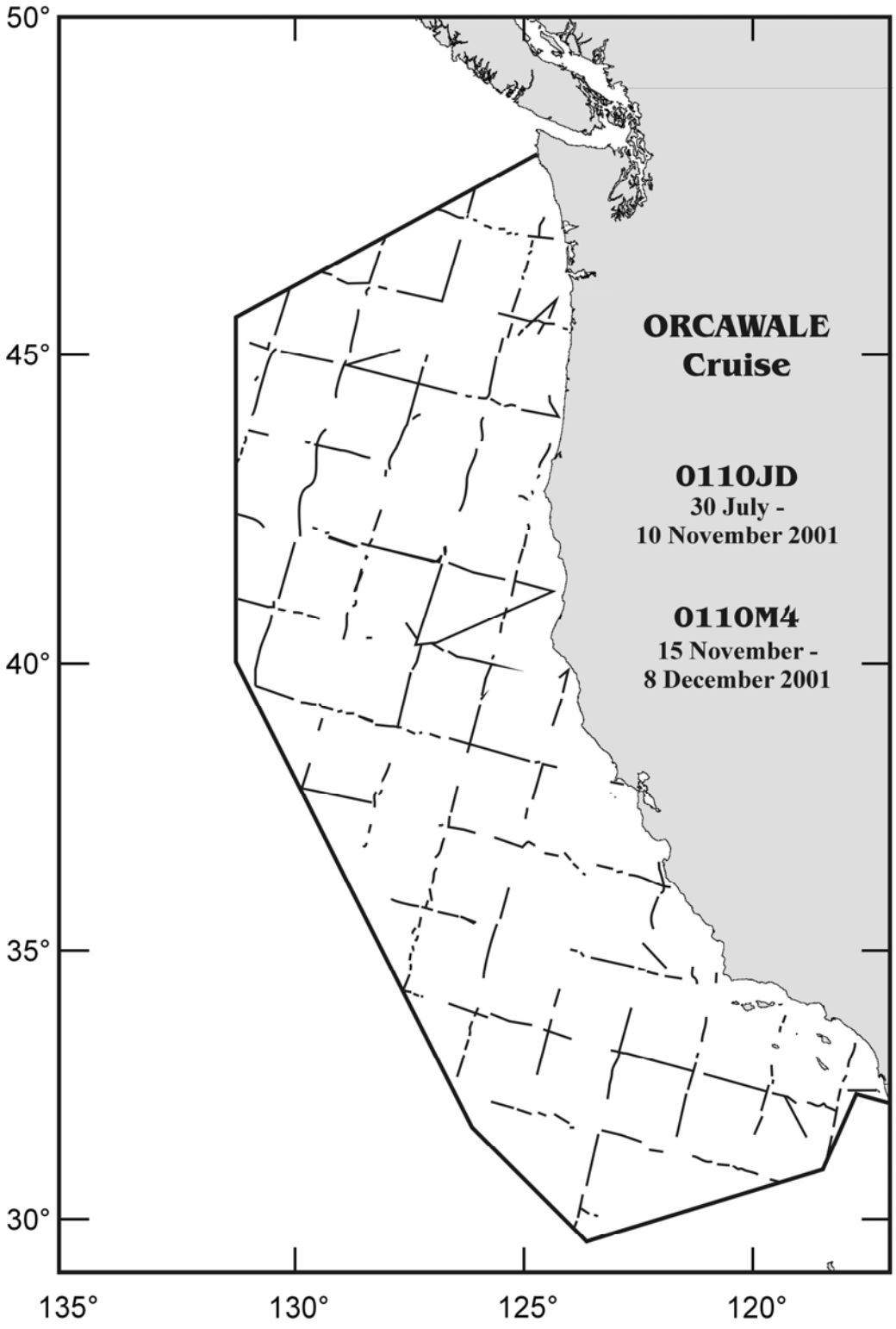

Figure 2. Actual tracklines during ORCAWALE 2001 survey

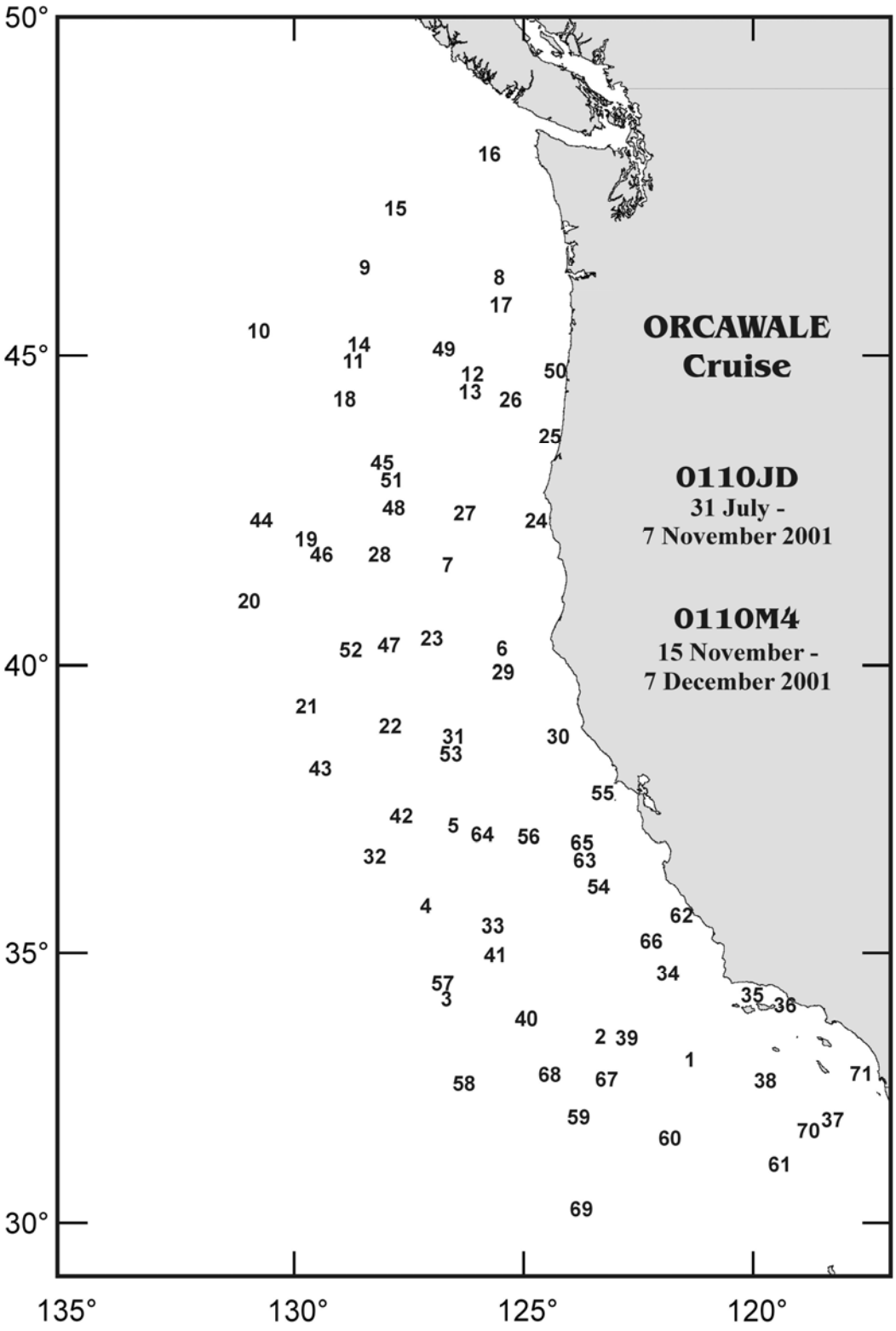

Figure 3. Bongo net tow stations for the ORCAWALE 2001 survey.

Table 1. Station and Bongo net tow data for ORCAWALE survey in 2001.

ORCAWALE survey 0110

Tow Number	Latitude (N) deg.	min.	Longitude (W) deg.	min.	Ship Code	Tow Date yr.	mo.	day	Time (PST)	Tow Depth (m)	Volume Water Strained	Standard Haul Factor	Plankton Volume	Percent Sorted	Total Fish Larvae	Total Fish Eggs	Total Para-larvae
1	33	02.4	121	25.1	JD	01	07	31	2020	204	317	6.45	208	100.0	6	3	12
2	33	28.2	123	20.8	JD	01	08	01	2020	212	414	5.12	34	100.0	5	7	3
3	34	11.6	126	40.9	JD	01	08	02	2037	219	393	5.56	31	100.0	68	156	0
4	35	50.9	127	07.4	JD	01	08	03	2034	213	414	5.13	65	100.0	9	0	1
5	37	15.2	126	32.2	JD	01	08	04	2035	214	413	5.19	308	50.3	6	4	4
6	40	15.5	125	29.1	JD	01	08	05	2033	209	413	5.05	681	25.9	7	82	2
7	41	41.7	126	40.7	JD	01	08	06	2034	207	415	4.98	183	100.0	7	3	0
8	46	13.0	125	38.0	JD	01	08	12	2033	215	402	5.35	47	100.0	49	2	2
9	46	22.1	128	32.1	JD	01	08	13	2049	210	424	4.95	57	100.0	28	2	2
10	45	24.2	130	47.6	JD	01	08	14	2052	210	412	5.09	241	100.0	20	0	3
11	45	03.5	128	43.8	JD	01	08	15	2049	209	419	4.98	33	100.0	7	0	0
12	44	44.1	126	10.8	JD	01	08	16	2035	209	400	5.21	72	100.0	4	1	0
13	44	32.4	126	14.1	JD	01	08	31	2038	212	402	5.28	55	100.0	2	5	0
14	45	11.1	128	38.5	JD	01	09	01	2017	217	415	5.21	34	100.0	1	0	0
15	47	14.9	127	52.5	JD	01	09	03	2015	211	415	5.10	63	100.0	22	1	3
16	48	03.7	125	54.5	JD	01	09	04	2013	178	470	3.79	349	100.0	172	0	1
17	45	49.0	125	33.9	JD	01	09	06	2000	213	398	5.35	312	53.2	9	2	2
18	44	20.7	128	58.4	JD	01	09	07	2012	213	387	5.50	44	100.0	4	3	0
19	42	04.4	129	44.2	JD	01	09	10	1958	219	382	5.72	24	100.0	5	1	1
20	41	04.7	130	59.0	JD	01	09	11	2000	212	395	5.36	41	100.0	9	5	0
21	39	19.7	129	42.2	JD	01	09	12	2001	210	400	5.25	33	100.0	6	7	2
22	38	58.2	127	55.7	JD	01	09	13	1947	217	386	5.61	236	50.5	3	2	1
23	40	28.6	127	01.3	JD	01	09	14	1947	211	416	5.07	70	100.0	2	5	1
24	42	24.6	124	46.6	JD	01	09	20	1933	213	395	5.39	218	48.8	3	9	0
25	43	47.4	124	19.7	JD	01	09	21	1918	69	144	4.79	132	100.0	5	114	0
26	44	25.3	125	34.7	JD	01	09	22	1925	213	392	5.41	133	100.0	9	5	0
27	42	32.2	126	20.0	JD	01	09	23	1930	216	383	5.63	269	100.0	7	2	1
28	41	51.1	128	11.8	JD	01	09	24	1942	212	402	5.28	122	100.0	1	3	1

Table 1. (cont.) ORCAWALE survey 0110

Tow Number	Latitude (N) deg.	min.	Longitude (W) deg.	min.	Ship Code	Tow Date yr.	mo.	day	Time (PST)	Tow Depth (m)	Volume Water Strained	Standard Haul Factor	Plankton Volume	Percent Sorted	Total Fish Larvae	Total Fish Eggs	Total Para-larvae
29	39	54.7	125	29.0	JD	01	09	25	1918	212	400	5.31	193	100.0	7	5	6
30	38	47.9	124	19.2	JD	01	09	26	1919	209	408	5.13	243	52.5	3	12	0
31	38	40.1	126	32.1	JD	01	09	27	1921	210	424	4.94	229	48.4	10	6	7
32	36	42.4	128	14.1	JD	01	09	28	1930	213	416	5.11	183	100.0	10	7	6
33	35	28.6	125	42.3	JD	01	09	29	1931	213	402	5.30	25	100.0	43	25	1
34	34	35.7	121	55.1	JD	01	09	30	1920	212	412	5.15	611	100.0	18	11	3
35	34	11.0	120	05.5	JD	01	10	01	1850	212	384	5.53	47	100.0	25	93	2
36	34	06.4	119	28.3	JD	01	10	02	1850	154	299	5.16	60	100.0	87	479	0
37	31	54.5	118	20.6	JD	01	10	03	1846	207	409	5.05	51	100.0	23	3	1
38	32	39.1	119	46.8	JD	01	10	09	1848	211	410	5.14	61	100.0	3	2	0
39	33	25.9	122	47.8	JD	01	10	10	1845	211	408	5.18	108	100.0	2	1	3
40	33	47.3	124	55.7	JD	01	10	11	1901	213	420	5.05	57	100.0	6	16	2
41	34	56.9	125	37.3	JD	01	10	12	1858	215	403	5.33	134	100.0	2	2	4
42	37	25.0	127	41.4	JD	01	10	14	1903	201	476	4.21	63	100.0	9	1	3
43	38	15.4	129	27.1	JD	01	10	15	1910	216	415	5.19	43	100.0	1	2	2
44	42	26.7	130	42.9	JD	01	10	18	1858	214	417	5.12	36	100.0	2	15	1
45	43	19.5	128	06.7	JD	01	10	20	1848	208	408	5.10	287	52.1	5	8	0
46	42	06.8	129	32.0	JD	01	10	21	1904	213	419	5.09	55	100.0	0	15	0
47	40	20.3	127	58.1	JD	01	10	22	1848	210	445	4.71	45	100.0	7	0	2
48	42	37.5	127	52.2	JD	01	10	24	1920	191	477	3.99	222	50.9	3	3	4
49	45	08.8	126	47.4	JD	01	10	25	1847	211	415	5.08	277	44.3	3	0	0
50	44	47.1	124	24.2	JD	01	10	26	1825	114	244	4.65	193	100.0	0	0	0
51	43	04.5	127	54.8	JD	01	11	01	1835	209	418	5.00	395	49.6	3	2	3
52	40	16.8	128	46.1	JD	01	11	02	1828	210	424	4.95	28	100.0	7	1	2
53	38	39.5	126	35.2	JD	01	11	03	1834	213	412	5.16	243	42.0	1	0	1
54	36	10.1	123	25.5	JD	01	11	07	1831	216	411	5.27	268	50.9	18	8	0
55	37	50.6	123	19.5	M4	01	11	15	1855	112	307	3.65	114	100.0	18	267	0
56	37	03.5	124	56.1	M4	01	11	16	1828	209	363	5.75	196	100.0	6	3	0
57	34	25.8	126	46.9	M4	01	11	17	1828	211	374	5.63	53	100.0	3	5	2
58	32	36.5	126	17.6	M4	01	11	18	1829	210	342	6.13	67	100.0	4	0	0
59	31	59.0	123	49.5	M4	01	11	19	1829	209	340	6.13	147	100.0	3	14	2

Table 1. (cont.) ORCAWALE survey 0110

Tow Number	Latitude (N) deg.	min.	Longitude (W) deg.	min.	Ship Code	Tow Date yr.	mo.	day	Time (PST)	Tow Depth (m)	Volume Water Strained	Standard Haul Factor	Plankton Volume	Percent Sorted	Total Fish Larvae	Total Fish Eggs	Total Para-larvae
63	36	39.5	123	43.3	M4	01	11	26	1831	210	370	5.66	168	50.5	6	70	1
64	37	06.2	125	55.4	M4	01	11	27	1834	215	345	6.21	342	45.7	19	56	1
65	36	37.8	123	42.6	M4	01	11	28	1855	208	349	5.96	572	50.0	5	10	0
66	35	10.6	122	15.9	M4	01	11	29	1835	179	488	3.67	37	100.0	1	10	1
67	32	40.7	123	13.5	M4	01	11	30	1832	213	526	4.04	48	100.0	51	3	1
68	32	44.9	124	26.8	M4	01	12	01	1829	210	449	4.67	31	100.0	5	3	1
69	30	15.6	123	45.0	M4	01	12	02	1828	202	374	5.40	27	100.0	43	20	3
70	31	43.4	118	48.5	M4	01	12	06	1827	217	386	5.62	21	100.0	11	5	0
71	32	46.7	117	42.1	M4	01	12	07	1831	208	416	4.99	43	100.0	2	43	1
60	31	34.9	121	50.1	M4	01	11	20	1830	213	369	5.76	68	100.0	17	2	0
61	31	06.1	119	27.1	M4	01	11	21	1855	213	373	5.70	35	100.0	29	8	1
62	35	45.5	120	57.6	M4	01	11	23	1833	218	369	5.90	46	100.0	41	317	1

Table 2. Pooled occurrences of paralarval cephalopods taken in Bongo net tows on ORCAWALE survey in 2001.

Rank	Taxon	Occurrences
1	*Abraliopsis felis*	20
2	*Chiroteuthis calyx*	8
3	*Leachia dislocata*	5
3	*Octopus* spp.	5
5	*Gonatus* spp.	4
5	Gonatidae	4
7	*Pterygioteuthis gemmata*	3
7	*Onychoteuthis borealijaponica*	3
7	*Gonatus onyx*	3
7	*Gonatus pyros*	3
7	*Gonatopsis borealis*	3
12	Teuthida	1
12	*Berryteuthis* spp.	1
12	*Histioteuthis heteropsis*	1
12	*Galiteuthis pacifica*	1
12	*Octopoteuthis deletron*	1
12	*Galiteuthis phyllura*	1
12	*Japetella* spp.	1
	Total	68

Table 3. Pooled counts of paralarval cephalopods taken in Bongo net tows on ORCAWALE survey in 2001.

Rank	Taxon	Count
1	*Abraliopsis felis*	308
2	*Chiroteuthis calyx*	76
3	*Gonatus* spp.	67
4	*Octopus* spp.	57
5	*Onychoteuthis borealijaponica*	41
6	Gonatidae	36
7	*Leachia dislocata*	32
8	*Gonatus onyx*	28
9	*Gonatus pyros*	18
10	*Pterygioteuthis gemmata*	16
11	*Gonatopsis borealis*	14
12	*Histioteuthis heteropsis*	6
13	*Japetella* spp.	6
14	*Octopoteuthis deletron*	5
15	*Galiteuthis pacifica*	5
16	Teuthida	5
17	*Galiteuthis phyllura*	5
18	*Berryteuthis* spp.	5
	Total	729

Table 4. Pooled occurrences of fish larvae taken in Bongo net tows on ORCAWALE survey in 2001.

Rank	Taxon	Occurrences
1	*Protomyctophum crockeri*	26
2	*Citharichthys sordidus*	20
3	*Tarletonbeania crenularis*	19
4	*Sebastes* spp.	18
5	*Citharichthys stigmaeus*	16
6	*Stenobrachius leucopsarus*	15
7	*Diaphus* spp.	13
7	*Nannobrachium* spp.	13
9	*Chauliodus macouni*	11
10	*Bathylagus wesethi*	10
11	*Vinciguerria lucetia*	8
11	*Ceratoscopelus townsendi*	8
13	*Engraulis mordax*	7
13	*Diogenichthys atlanticus*	7
15	*Nannobrachium ritteri*	6
15	*Lestidiops ringens*	6
15	*Bathylagus ochotensis*	6
18	*Protomyctophum thompsoni*	5
18	*Tactostoma macropus*	5
18	*Idiacanthus antrostomus*	5
21	*Triphoturus mexicanus*	4
22	*Tetragonurus cuvieri*	3
22	*Symbolophorus californiensis*	3
22	*Trachipterus altivelis*	3
25	*Nannobrachium regale*	2
25	*Sebastolobus* spp.	2
25	*Leuroglossus stilbius*	2
25	*Cyclothone* spp.	2
25	*Melamphaes lugubris*	2
25	*Argentina sialis*	2
25	*Cyclothone signata*	2
25	*Arctozenus risso*	2
25	*Parophrys vetulus*	2
25	*Cyclothone acclinidens*	2
25	*Danaphos oculatus*	2
25	*Sardinops sagax*	2
25	*Microstomus pacificus*	2
38	Pleuronectidae	1
38	*Thalassenchelys coheni*	1
38	*Ichthyococcus irregularis*	1
38	*Argyropelecus hemigymnus*	1
38	*Argyropelecus* spp.	1
38	*Microstoma* spp.	1
38	*Bathylagus milleri*	1
38	*Psettichthys melanostictus*	1
38	*Trachurus symmetricus*	1

Table 4. (cont.)

Rank	Taxon	Occurrences
38	*Sebastes diploproa*	1
38	*Liparis fucensis*	1
38	*Zenion* spp.	1
38	*Scopelogadus bispinosus*	1
38	*Melamphaes parvus*	1
38	*Melamphaes* spp.	1
38	*Cololabis saira*	1
38	Myctophidae	1
38	*Desmodema lorum*	1
38	*Rosenblattichthys volucris*	1
38	*Genyonemus lineatus*	1
38	Disintegrated fish larvae	1
38	*Chiasmodon niger*	1
38	*Leptocephalus giganteus*	1
38	*Rhinogobiops nicholsii*	1
38	*Sebastolobus altivelis*	1
38	*Peprilus simillimus*	1
38	*Scopelarchus analis*	1
38	*Merluccius productus*	1
	Total	291

Table 5. Pooled counts of fish larvae taken in Bongo net tows on ORCAWALE survey in 2002. Counts are adjusted for percent of sample sorted and standard haul factor (see text).

Rank	Taxon	Count
1	*Stenobrachius leucopsarus*	1061
2	*Engraulis mordax*	587
3	*Citharichthys sordidus*	475
4	*Sebastes* spp.	448
5	*Citharichthys stigmaeus*	445
6	*Vinciguerria lucetia*	352
7	*Bathylagus wesethi*	280
8	*Protomyctophum crockeri*	266
9	*Tactostoma macropus*	259
10	*Tarletonbeania crenularis*	215
11	*Ceratoscopelus townsendi*	196
12	*Diogenichthys atlanticus*	115
13	*Diaphus* spp.	96
14	*Triphoturus mexicanus*	95
15	*Chauliodus macouni*	86
16	*Idiacanthus antrostomus*	81
17	*Nannobrachium* spp.	78
18	*Nannobrachium ritteri*	66
19	*Protomyctophum thompsoni*	56
20	*Lestidiops ringens*	50
21	*Microstomus pacificus*	46
22	*Parophrys vetulus*	43
23	*Bathylagus ochotensis*	42
24	*Leuroglossus stilbius*	39
25	*Genyonemus lineatus*	26
26	*Trachipterus altivelis*	25
27	*Argentina sialis*	22
28	*Nannobrachium regale*	20
29	*Symbolophorus californiensis*	18
30	*Tetragonurus cuvieri*	16
31	*Sardinops sagax*	15
31	*Sebastolobus* spp.	15
33	*Cyclothone signata*	14
33	*Bathylagus milleri*	14
33	*Cyclothone* spp.	14
36	*Melamphaes lugubris*	12
36	*Merluccius productus*	12
38	*Danaphos oculatus*	11
38	*Psettichthys melanostictus*	11
38	Disintegrated fish larvae	11
41	*Cyclothone acclinidens*	10
41	*Peprilus simillimus*	10
41	Pleuronectidae	10
41	*Sebastes diploproa*	10
45	*Arctozenus risso*	9
46	*Microstoma* spp.	8

Table 5. (cont.)

Rank	Taxon	Count
47	*Trachurus symmetricus*	6
47	*Argyropelecus hemigymnus*	6
47	Myctophidae	6
47	*Zenion* spp.	6
47	*Sebastolobus altivelis*	6
47	*Melamphaes parvus*	6
47	*Scopelarchus analis*	6
47	*Leptocephalus giganteus*	6
55	*Rosenblattichthys volucris*	5
55	*Liparis fucensis*	5
55	*Desmodema lorum*	5
55	*Melamphaes* spp.	5
55	*Scopelogadus bispinosus*	5
55	*Rhinogobiops nicholsii*	5
55	*Cololabis saira*	5
55	*Ichthyococcus irregularis*	5
55	*Thalassenchelys coheni*	5
55	*Argyropelecus* spp.	5
65	*Chiasmodon niger*	4
	Total	5892

Table 6. Standardized counts of paralarval cephalopods and fish larvae taken in Bongo net tows at stations occupied on ORCAWALE survey in 2001, listed by taxon, tow number, and month. Unoccupied stations are indicated by a dash.

Teuthida

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
44	-	-	-	5.1	-	-

Abraliopsis felis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	32.3	-	-	-	-	-
4	-	5.1	-	-	-	-
5	-	20.6	-	-	-	-
6	-	19.5	-	-	-	-
8	-	10.7	-	-	-	-
9	-	5.0	-	-	-	-
17	-	-	20.1	-	-	-
22	-	-	11.1	-	-	-
23	-	-	5.1	-	-	-
29	-	-	31.9	-	-	-
31	-	-	51.0	-	-	-
32	-	-	5.1	-	-	-
33	-	-	5.3	-	-	-
39	-	-	-	10.4	-	-
40	-	-	-	10.1	-	-
41	-	-	-	10.7	-	-
42	-	-	-	12.6	-	-
47	-	-	-	4.7	-	-
48	-	-	-	31.4	-	-
52	-	-	-	-	5.0	-

Pterygioteuthis gemmata

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
2	-	5.1	-	-	-	-
37	-	-	-	5.1	-	-
69	-	-	-	-	-	5.4

Octopoteuthis deletron

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
41	-	-	-	5.3	-	-

Onychoteuthis borealijaponica

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
2	-	5.1	-	-	-	-
5	-	20.6	-	-	-	-
15	-	-	15.3	-	-	-

Gonatidae

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	12.9	-	-	-	-	-
28	-	-	5.3	-	-	-

Table 6. (cont.)

Gonatidae (cont.)

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
59	-	-	-	-	6.1	-
63	-	-	-	-	11.2	-

***Berryteuthis* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
9	-	5.0	-	-	-	-

Gonatopsis borealis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
32	-	-	5.1	-	-	-
41	-	-	-	5.3	-	-
66	-	-	-	-	3.7	-

***Gonatus* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
19	-	-	5.7	-	-	-
31	-	-	20.4	-	-	-
32	-	-	10.2	-	-	-
51	-	-	-	-	30.2	-

Gonatus onyx

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
6	-	19.5	-	-	-	-
16	-	-	3.8	-	-	-
43	-	-	-	5.2	-	-

Gonatus pyros

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
57	-	-	-	-	5.6	-
59	-	-	-	-	6.1	-
62	-	-	-	-	5.9	-

Histioteuthis heteropsis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	6.5	-	-	-	-	-

Chiroteuthis calyx

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	25.8	-	-	-	-	-
2	-	5.1	-	-	-	-
10	-	15.3	-	-	-	-
21	-	-	10.5	-	-	-
32	-	-	5.1	-	-	-
43	-	-	-	5.2	-	-
52	-	-	-	-	5.0	-
67	-	-	-	-	4.0	-

Table 6. (cont.)

Leachia dislocata

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
47	-	-	-	4.7	-	-
57	-	-	-	-	5.6	-
61	-	-	-	-	5.7	-
68	-	-	-	-	-	4.7
69	-	-	-	-	-	10.8

Galiteuthis pacifica

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
39	-	-	-	5.2	-	-

Galiteuthis phyllura

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
32	-	-	5.1	-	-	-

Japetella spp.

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
27	-	-	5.6	-	-	-

Octopus spp.

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
34	-	-	15.5	-	-	-
35	-	-	-	11.1	-	-
53	-	-	-	-	12.3	-
64	-	-	-	-	13.6	-
71	-	-	-	-	-	5.0

Leptocephalus giganteus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	6.5	-	-	-	-	-

Thalassenchelys coheni

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
47	-	-	-	4.7	-	-

Sardinops sagax

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
5	-	10.3	-	-	-	-
29	-	-	5.3	-	-	-

Engraulis mordax

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	6.5	-	-	-	-	-
26	-	-	16.2	-	-	-
35	-	-	-	22.1	-	-
36	-	-	-	345.7	-	-
55	-	-	-	-	3.7	-
62	-	-	-	-	182.9	-
71	-	-	-	-	-	10.0

Table 6. (cont.)

Argentina sialis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
34	-	-	5.2	-	-	-
35	-	-	-	16.6	-	-

***Microstoma* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
67	-	-	-	-	8.1	-

Bathylagus milleri

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
64	-	-	-	-	13.6	-

Bathylagus ochotensis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
2	-	5.1	-	-	-	-
4	-	5.1	-	-	-	-
12	-	5.2	-	-	-	-
55	-	-	-	-	7.3	-
57	-	-	-	-	5.6	-
64	-	-	-	-	13.6	-

Bathylagus wesethi

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	11.1	-	-	-	-
33	-	-	127.2	-	-	-
40	-	-	-	5.1	-	-
41	-	-	-	5.3	-	-
58	-	-	-	-	6.1	-
60	-	-	-	-	28.8	-
61	-	-	-	-	34.2	-
67	-	-	-	-	20.2	-
69	-	-	-	-	-	32.4
70	-	-	-	-	-	11.2

Leuroglossus stilbius

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
35	-	-	-	33.2	-	-
62	-	-	-	-	5.9	-

***Cyclothone* spp**.

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
32	-	-	10.2	-	-	-
42	-	-	-	4.2	-	-

Cyclothone acclinidens

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
60	-	-	-	-	5.8	-
67	-	-	-	-	4.0	-

Table 6. (cont.)

Cyclothone signata

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
37	-	-	-	10.1	-	-
67	-	-	-	-	4.0	-

***Argyropelecus* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
7	-	5.0	-	-	-	-

Argyropelecus hemigymnus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
59	-	-	-	-	6.1	-

Danaphos oculatus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
33	-	-	5.3	-	-	-
58	-	-	-	-	6.1	-

Ichthyococcus irregularis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
69	-	-	-	-	-	5.4

Vinciguerria lucetia

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	11.1	-	-	-	-
33	-	-	5.3	-	-	-
37	-	-	-	35.4	-	-
60	-	-	-	-	46.1	-
61	-	-	-	-	34.2	-
67	-	-	-	-	97.0	-
69	-	-	-	-	-	113.4
70	-	-	-	-	-	11.2

Chauliodus macouni

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
4	-	5.1	-	-	-	-
5	-	10.3	-	-	-	-
8	-	5.4	-	-	-	-
18	-	-	5.5	-	-	-
19	-	-	5.7	-	-	-
20	-	-	5.4	-	-	-
21	-	-	5.3	-	-	-
24	-	-	11.0	-	-	-
31	-	-	20.4	-	-	-
48	-	-	-	7.8	-	-
68	-	-	-	-	-	4.7

Table 6. (cont.)

Tactostoma macropus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	228.0	-	-	-	-
17	-	-	10.1	-	-	-
29	-	-	5.3	-	-	-
32	-	-	5.1	-	-	-
33	-	-	10.6	-	-	-

Idiacanthus antrostomus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
33	-	-	10.6	-	-	-
61	-	-	-	-	28.5	-
67	-	-	-	-	16.2	-
68	-	-	-	-	-	9.3
69	-	-	-	-	-	16.2

Rosenblattichthys volucris

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
69	-	-	-	-	-	5.4

Scopelarchus analis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
59	-	-	-	-	6.1	-

Arctozenus risso

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
42	-	-	-	4.2	-	-
69	-	-	-	-	-	5.4

Lestidiops ringens

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
39	-	-	-	5.2	-	-
40	-	-	-	10.1	-	-
52	-	-	-	-	5.0	-
53	-	-	-	-	12.3	-
60	-	-	-	-	5.8	-
65	-	-	-	-	11.9	-

Myctophidae

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	5.6	-	-	-	-

Ceratoscopelus townsendi

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	55.6	-	-	-	-
8	-	48.2	-	-	-	-
21	-	-	10.5	-	-	-
33	-	-	31.8	-	-	-
40	-	-	-	10.1	-	-

Table 6. (cont.)

Ceratoscopelus townsendi (cont.)

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
59	-	-	-	-	6.1	-
69	-	-	-	-	-	27.0
70	-	-	-	-	-	5.6

***Diaphus* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	6.5	-	-	-	-	-
3	-	11.1	-	-	-	-
4	-	15.4	-	-	-	-
6	-	19.5	-	-	-	-
7	-	5.0	-	-	-	-
8	-	5.4	-	-	-	-
21	-	-	5.3	-	-	-
23	-	-	5.1	-	-	-
32	-	-	5.1	-	-	-
33	-	-	5.3	-	-	-
37	-	-	-	5.1	-	-
43	-	-	-	5.2	-	-
47	-	-	-	4.7	-	-

***Nannobrachium* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	6.5	-	-	-	-	-
2	-	5.1	-	-	-	-
3	-	5.6	-	-	-	-
4	-	5.1	-	-	-	-
5	-	10.3	-	-	-	-
10	-	5.1	-	-	-	-
12	-	5.2	-	-	-	-
13	-	5.3	-	-	-	-
19	-	-	11.4	-	-	-
20	-	-	5.4	-	-	-
37	-	-	-	5.1	-	-
44	-	-	-	5.1	-	-
69	-	-	-	-	-	5.4

Nannobrachium regale

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
10	-	10.2	-	-	-	-
17	-	-	10.1	-	-	-

Nannobrachium ritteri

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
2	-	5.1	-	-	-	-
33	-	-	10.6	-	-	-
44	-	-	-	5.1	-	-
45	-	-	-	19.6	-	-

Table 6. (cont.)

Nannobrachium ritteri (cont.)

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
47	-	-	-	18.8	-	-
70	-	-	-	-	-	5.6

Stenobrachius leucopsarus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
7	-	5.0	-	-	-	-
8	-	26.8	-	-	-	-
9	-	133.7	-	-	-	-
10	-	71.3	-	-	-	-
11	-	10.0	-	-	-	-
12	-	5.2	-	-	-	-
13	-	5.3	-	-	-	-
14	-	-	5.2	-	-	-
15	-	-	96.9	-	-	-
16	-	-	625.4	-	-	-
17	-	-	40.2	-	-	-
18	-	-	11.0	-	-	-
29	-	-	5.3	-	-	-
30	-	-	9.8	-	-	-
49	-	-	-	11.5	-	-

Triphoturus mexicanus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
2	-	5.1	-	-	-	-
36	-	-	-	5.2	-	-
37	-	-	-	50.5	-	-
61	-	-	-	-	34.2	-

Diogenichthys atlanticus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	11.1	-	-	-	-
60	-	-	-	-	5.8	-
61	-	-	-	-	22.8	-
67	-	-	-	-	48.5	-
68	-	-	-	-	-	4.7
69	-	-	-	-	-	10.8
70	-	-	-	-	-	11.2

Protomyctophum crockeri

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
2	-	5.1	-	-	-	-
3	-	5.6	-	-	-	-
4	-	5.1	-	-	-	-
8	-	5.4	-	-	-	-
10	-	10.2	-	-	-	-
11	-	24.9	-	-	-	-
12	-	5.2	-	-	-	-

Table 6. (cont.)

Protomyctophum crockeri (cont.)

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
18	-	-	5.5	-	-	-
19	-	-	5.7	-	-	-
20	-	-	26.8	-	-	-
21	-	-	5.3	-	-	-
31	-	-	10.2	-	-	-
33	-	-	10.6	-	-	-
38	-	-	-	10.3	-	-
39	-	-	-	5.2	-	-
42	-	-	-	21.1	-	-
45	-	-	-	9.8	-	-
52	-	-	-	-	24.8	-
54	-	-	-	-	20.7	-
56	-	-	-	-	5.8	-
57	-	-	-	-	5.6	-
61	-	-	-	-	11.4	-
67	-	-	-	-	4.0	-
68	-	-	-	-	-	4.7
69	-	-	-	-	-	5.4
70	-	-	-	-	-	11.2

Protomyctophum thompsoni

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
15	-	-	15.3	-	-	-
20	-	-	5.4	-	-	-
26	-	-	16.2	-	-	-
31	-	-	10.2	-	-	-
51	-	-	-	-	10.1	-

Symbolophorus californiensis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
58	-	-	-	-	6.1	-
60	-	-	-	-	5.8	-
70	-	-	-	-	-	5.6

Tarletonbeania crenularis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
5	-	31.0	-	-	-	-
6	-	39.0	-	-	-	-
8	-	5.4	-	-	-	-
10	-	5.1	-	-	-	-
20	-	-	5.4	-	-	-
23	-	-	5.1	-	-	-
26	-	-	5.4	-	-	-
27	-	-	5.6	-	-	-
28	-	-	5.3	-	-	-
29	-	-	10.6	-	-	-
30	-	-	19.5	-	-	-
31	-	-	10.2	-	-	-

Table 6. (cont.)

Tarletonbeania crenularis (cont.)

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
32	-	-	15.3	-	-	-
35	-	-	-	5.5	-	-
42	-	-	-	8.4	-	-
47	-	-	-	4.7	-	-
51	-	-	-	-	10.1	-
52	-	-	-	-	5.0	-
63	-	-	-	-	11.2	-

Desmodema lorum

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
4	-	5.1	-	-	-	-

Trachipterus altivelis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	6.5	-	-	-	-	-
29	-	-	5.3	-	-	-
64	-	-	-	-	13.6	-

Merluccius productus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
62	-	-	-	-	11.8	-

Cololabis saira

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
69	-	-	-	-	-	5.4

***Melamphaes* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
33	-	-	5.3	-	-	-

Melamphaes lugubris

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	6.5	-	-	-	-	-
3	-	5.6	-	-	-	-

Melamphaes parvus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	5.6	-	-	-	-

Scopelogadus bispinosus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
33	-	-	5.3	-	-	-

***Zenion* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	5.6	-	-	-	-

Table 6. (cont.)

***Sebastes* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
6	-	78.0	-	-	-	-
7	-	10.0	-	-	-	-
8	-	160.5	-	-	-	-
9	-	5.0	-	-	-	-
16	-	-	26.5	-	-	-
17	-	-	20.1	-	-	-
22	-	-	22.2	-	-	-
26	-	-	5.4	-	-	-
27	-	-	11.3	-	-	-
29	-	-	5.3	-	-	-
32	-	-	5.1	-	-	-
35	-	-	-	22.1	-	-
36	-	-	-	15.5	-	-
54	-	-	-	-	10.4	-
55	-	-	-	-	21.9	-
56	-	-	-	-	5.8	-
62	-	-	-	-	11.8	-
65	-	-	-	-	11.9	-

Sebastes diploproa

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
34	-	-	10.3	-	-	-

***Sebastolobus* spp.**

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
4	-	5.1	-	-	-	-
7	-	10.0	-	-	-	-

Sebastolobus altivelis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
19	-	-	5.7	-	-	-

Liparis fucensis

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
8	-	5.4	-	-	-	-

Trachurus symmetricus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	5.6	-	-	-	-

Genyonemus lineatus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
36	-	-	-	25.8	-	-

Chiasmodon niger

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
67	-	-	-	-	4.0	-

Table 6. (cont.)

Rhinogobiops nicholsii

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
34	-	-	5.2	-	-	-

Tetragonurus cuvieri

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
37	-	-	-	5.1	-	-
40	-	-	-	5.1	-	-
58	-	-	-	-	6.1	-

Peprilus simillimus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
36	-	-	-	10.3	-	-

Citharichthys sordidus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
17	-	-	10.1	-	-	-
21	-	-	5.3	-	-	-
24	-	-	11.0	-	-	-
27	-	-	22.5	-	-	-
34	-	-	51.5	-	-	-
35	-	-	-	11.1	-	-
36	-	-	-	31.0	-	-
45	-	-	-	19.6	-	-
48	-	-	-	7.8	-	-
49	-	-	-	11.5	-	-
51	-	-	-	-	10.1	-
54	-	-	-	-	113.9	-
55	-	-	-	-	3.7	-
56	-	-	-	-	23.0	-
57	-	-	-	-	5.6	-
62	-	-	-	-	17.7	-
63	-	-	-	-	11.2	-
64	-	-	-	-	54.4	-
65	-	-	-	-	11.9	-
66	-	-	-	-	3.7	-

Citharichthys stigmaeus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
22	-	-	11.1	-	-	-
32	-	-	10.2	-	-	-
34	-	-	20.6	-	-	-
35	-	-	-	27.7	-	-
36	-	-	-	15.5	-	-
37	-	-	-	5.1	-	-
38	-	-	-	5.1	-	-
41	-	-	-	5.3	-	-
48	-	-	-	7.8	-	-
49	-	-	-	11.5	-	-

Table 6. (cont.)

Citharichthys stigmaeus (cont.)

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
54	-	-	-	-	41.4	-
55	-	-	-	-	29.2	-
62	-	-	-	-	11.8	-
63	-	-	-	-	33.6	-
64	-	-	-	-	163.1	-
65	-	-	-	-	23.8	-

Pleuronectidae

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
31	-	-	10.2	-	-	-

Microstomus pacificus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
26	-	-	5.4	-	-	-
31	-	-	40.8	-	-	-

Parophrys vetulus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
25	-	-	24.0	-	-	-
63	-	-	-	-	11.2	-

Psettichthys melanostictus

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
24	-	-	11.0	-	-	-

Disintegrated fish larvae

Tow Number	July	Aug.	Sep.	Oct.	Nov.	Dec.
3	-	11.1	-	-	-	-

Table 7. Summary of oceanographic and ecosystem samples collected during the 2001 ORCAWALE survey aboard the NOAA ships *Jordan* (Legs 1-5) and *McArthur* (Leg 6).

	LEG 1	LEG 2	LEG 3	LEG 4	LEG 5	LEG 6	TOTALS
CTD casts	11	11	10	14	3	17	66
CTD chlorophyll samples	110	110	101	140	30	158	649
Surface chlorophyll samples	47	53	54	63	30	88	335
Primary productivity samples	70	70	63	91	21	117	432
Nutrient samples	121	121	111	155	33	173	714
Salinity samples	47	52	64	62	10	72	307
XBT drops	48	56	51	63	28	92	338
Bongo net tows	12	11	14	13	4	17	71

PHYLOGENETIC INDEX TO TABLE 6

ALPHABETICAL INDEX TO TABLE 6

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W. WATSON, R.L. CHARTER, and S.M. MANION
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385 AMLR 2004/2005 field season report: Objectives, Accomplishments, and Tentative Conclusions.
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(August 2006)