STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
910 State Office Building
Portland, Oregon 97201

OPEN-FILE REPORT O-86-7

THE STATE OF SCIENTIFIC INFORMATION RELATING TO THE BIOLOGY AND ECOLOGY OF THE GORDA RIDGE STUDY AREA, NORTHEAST PACIFIC OCEAN: NEKTON

By James T. Harvey[1] [2] and David L. Stein[1]

Final Report for Contract No. 63-630-8501

Submitted to:

Oregon Department of Geology and Mineral Industries

and the

Living Resources Subgroup, Gorda Ridge Task Force

Released February 1986

[1]College of Oceanography, Oregon State University
Corvallis, Oregon 97331

[2]Oregon State University, Mark O. Hatfield Marine Science Center
Newport, Oregon 97365

NOTICE

This report is based on results of a research program directed by the joint federal-state Gorda Ridge Technical Task Force, managed by the Oregon Department of Geology and Mineral Industries, and funded by the Minerals Management Service, U.S. Department of the Interior, through Cooperative Agreement. Opinions expressed are those of the authors and do not constitute endorsement by the sponsoring agencies or the Task Force.

The Oregon Department of Geology and Mineral Industries is publishing this paper because the subject matter is consistent with the mission of the Department. To facilitate timely distribution of information, camera-ready copy submitted by the authors has not been edited by the staff of the Oregon Department of Geology and Mineral Industries.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Preface

The Gorda Ridge, a region of the northeastern Pacific seafloor located about 370 kilometers east of southern Oregon and northern California, is being explored and carefully mapped. One aim of the prospecting effort currently underway is the discovery of recent or past deep-sea hydrothermal vents and the attendant accumulations of metal-rich sulfide ores. Polymetallic sulfide deposits of significant size may be discovered, and these may eventually be commercially exploited. The Gorda Ridge Task Force and ad hoc group is concerned with, among other things, evaluating the environmental and economic consequences of offshore mining activities. This group identified the assessment of scientific information relevant to biological processes in the region of the Gorda Ridge as a high-priority research area. To that end, in February 1985, the state of Oregon's Department of Geology and Mineral Industries contracted with Oregon State University (DOGMAI Contract #63-630-8501) for the production of this report.

In brief this report presents the results of a thorough search of the scientific literature aimed at identifying and assembling the results of biological and ecological studies carried out in, or clearly relevant to the region of the Gorda Ridge Study Area (bounded by 40^0 to 46^0 N latitude and 130^0 W longitude to the continental shelf break). This region of seafloor included the Gorda Ridge, President Jackson Seamount Chain, and basins of Blanco Fracture Zone.

The search of the scientific literature leading to this report was conducted using computer-assisted data retrieval systems, personal contacts with active researchers, and standard bibliographic references. The series of reports is divided into four parts: I. Plankton, II. Benthos, III. Seabirds, and IV. Nekton.

This volume contains a review of the literature concerned with the nekton of the Gorda Ridge Lease Area. It has been divided into four sections dealing with I. Shrimps, II. Cephalopods, III. Fishes, and IV. Marine mammals. Within each section, biological processes (abundance and distribution, reproduction, growth, migration, food habits, and commercial exploitation) are summarized for each species for which there is information. This format is somewhat repetitive, but allows the reader the ability to find specific information on a species of interest without reading the whole document.

I. SHRIMPS

A. Studies Within the Gorda Ridge Lease Area

The majority of studies dealing with pelagic shrimps in the Gorda Ridge Lease Area (GRLA) (Fig.1) have been done by W.G. Pearcy, C.A. Forss, R.A. Wasmer, and E.E. Krygier at Oregon State University (OSU). Collections of shrimps from midwater and bottom trawls have been used to describe the distribution and ecology of these nektonic animals. The majority were made off central Oregon between 70 and 130 km offshore between 1961 and 1976. Only for a few of the more abundant species are there data on abundance, reproduction, growth, migrations, or feeding habits. The following discussion will outline current knowledge regarding shrimp within the GRLA. Species omitted from discussion of individual processes indicates lack of data concerning that species.

Pandalus jordani is included below, but it occurs usually only on the shelf. A few processes for which we have data on this species occur in the GRLA, and these are included below. Other information is relevant only to collections made on the shelf and has not been included.

1. Distribution and abundance

Family Penaeidae
Bentheogennema borealis

Only 14 specimens were captured in 335 midwater trawls 120 km off Newport (Pearcy et al. 1977). Most were caught below 500 m depth. There were an estimated 0.0062 individuals in a m^2 column of water from 0 to 2,400 m during cruises from 1972 to 1976, 129 km off Newport, and comprised only 0.15 % of the shrimp in this water column (Krygier and Pearcy 1981).

Bentheogennema burkenroadi

B. burkenroadi species ranges from lat. 34° to 52° N and east of 142°W long. usually above 1000 m (Krygier and Wasmer 1975). From 335 samples collected 120 km off Newport, OR., Pearcy et al. (1977) estimated peak abundance occurred at 700 to 750 m depth where there were 0.1 to 0.15 individuals per $10^3 m^3$. Distribution is lower mesopelagic, although it may move upwards at night. Krygier and Pearcy (1981) caught 0.0729 individuals in a $1 m^2$ water column from 0 to 2,400 m depth, 129 km off Newport. This species represented 1.82 % of the total number of shrimps in the m^2 water column during 1972 through 1976. Number of individuals per $10^3 m^3$ ranged from 0.003 to 0.253.

Gennadas incertus

This species was extremely rare in samples collected from 1972 through 1976, 129 km off Newport, OR (Krygier and Pearcy 1981). Fewer than 0.0001 individuals were estimated in a m^2 water column from 0 to

Figure 1. GORDA RIDGE STUDY AREA shown inside dashed line. (Rectangular blocks encompass about 2.6 million acres).

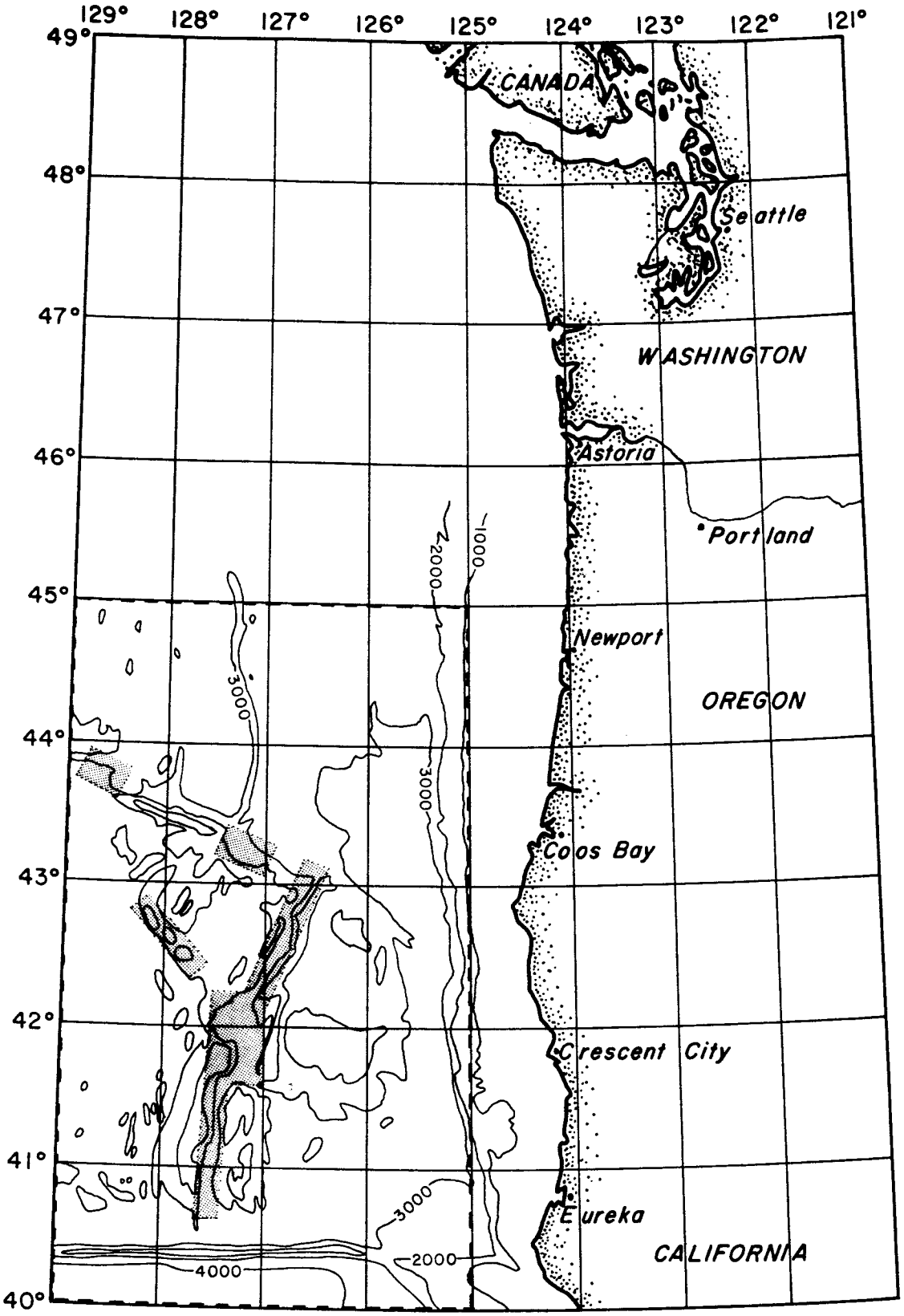

Table 1. List of shrimp species known to occur in the Gorda Ridge Lease Area either from collections or known distributions which overlap the lease area.

Species
Penaeidae
Bentheogennema borealis
Bentheogennema burkenroadi
Gennadas incertus
Gennadas propinquus
Gennadas tinayrei
Hemipenaeus spinidorsalis
Plesiopenaeus armatus
Sergestidae
Sergestes similis
Sergia japonicus
Sergia tenuiremis
Petalidium suspiriosum
Pasiphaeidae
Pasiphaea chaceri
Pasiphaea magna
Pasiphaea pacifica
Pasiphaea tarda
Parapasiphaea cristata
Parapasiphaea sulcatifrons
Oplophoridae
Acanthephyra chacei
Acanthephyra curtirostris
Acanthephyra microphthalma
Acanthephyra quadrispinosa
Meningodora mollis
Notostomus japonicus
Hymenodora acanthitelsonis
Hymenodora frontalis
Hymenodora gracialis
Hymenodora gracilis
Systellaspis braueri
Systellaspis cristata
Systellaspis debilis
Pandalidae
Pandalus jordani
Crangonidae
Crangon abyssorum

2,400 m. These represented <0.01% of the total shrimps caught in the water column.

Gennadas propinquus

Only one specimen was caught in 114 collections of shrimps from 80 km off central Oregon coast between 1961 and 1964 (Pearcy and Forss 1966). Krygier and Pearcy (1981) caught 35 individuals 129 km off Newport, OR from 1972 to 1976. This species was only 0.03% of the total shrimp catch, with 0.0013 in a m^2 water column from 0 to 2400 m. Densities were estimated to be from 0.001 to 0.011 per $10^3 m^3$.

Gennadas tinayrei

This species, like G. propinquus, was rare in collections from 129 km off Newport, OR in 1972 through 1976 (Krygier and Pearcy 1981). There were < 0.0001 individuals in a m^2 water column from the surface down to 2,400 m. This species was < 0.01 % of the total shrimp caught in the water column.

Family Sergestidae
Sergestes similis

In the eastern North Pacific Ocean S. similis occurs from transition waters the Bering Sea (Milne 1968). Greatest concentrations seem to be between 43° and 50° N latitude and 127° and 142° W longitude (Milne 1968). This is the most abundant pelagic shrimp in the northeastern Pacific Ocean (Pearcy and Forss 1969). Number of individuals per $10^3 m^3$ ranged from 3 to 17 (average of 9) for samples taken 72 to 264 km off central Oregon (Pearcy and Forss 1969). It was present in over 80% of collections, and was most common offshore, not often found within 24 km of land. Samples taken 129 km off Newport, OR showed peak night abundance of 4.5 individuals per $10^3 m^3$ at the surface. Day samples were greatest at 400 m where 2.5 individuals per $10^3 m^3$ were present. Krygier and Pearcy (1981) estimated 2.9816 individuals were present under a m^2 water column from 0 to 2,400 m. S. similis comprised over 74% of the shrimp in the water column during cruises from 1972 to 1976 at a station 129 km off Newport, OR. Abundance estimates ranged from 0.002 to 19.1512 individuals per $10^3 m^3$. Greatest concentrations occurred between 200 and 500 m during day and 0 to 200 m at night.

Sergia japonicus

This species was first reported from the northeastern Pacific by Wasmer (1972a). Two specimens were taken in a 50 m^2 pelagic trawl during extensive collections 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981).

Sergia tenuiremus

Pearcy and Forss (1966) reported 6 specimens from 80 km off central Oregon. The number per hour tow ranged from 0.002 to 0.02. Twenty-one specimens were caught 129 km off Newport between 400 and 1000 m depth

(Krygier and Pearcy 1981). This species may be a stray from central Pacific waters, where it occurs in much greater abundance.

Petalidium suspiriosum

Collections of shrimps 80 km off central Oregon between 1961 and 1964 contained 250 individuals (Pearcy and Forss 1966). Greatest catches (3.5 per hour tow) were at night between 0 and 1000 m. Average catch under a meter square water column from the surface to 1000 m was approximately 0.1 per hour tow. Pearcy et al. (1977) found peak numbers at 700 to 900 m where there were 0.1 to 0.23 individuals per $10^3 m^3$. Krygier and Pearcy (1981) estimated 0.1097 individuals in a m^2 water column from 0 to 2400 m. It accounted for 2.74% of total shrimps per m^2 of water column sampled between 1972 and 1976, 129 km off Newport, OR. Densities ranged from 0.002 to 0.275 per $10^3 m^3$, with peak abundance centered at 700 to 1000 m.

Family Pasiphaeidae
Pasiphaea chacei

Twelve individuals were caught in samples collected 80 km off central Oregon, 1961 through 1964 (Pearcy and Forss 1966). Highest catch rate of 0.29 per hour tow was for 32 daytime collections between 0 and 200 m. Estimated abundance was 0.002 to 0.003 individuals per $10^3 m^3$ at 500 to 1000 m depth. Krygier and Pearcy (1981) reported 0.0005 individuals in a m^2 water column from the surface to 2400 m, 129 km off Newport, OR sampled from 1972 to 1976. P. chacei comprised only 0.1% of total shrimp number.

Pasiphaea magna

In 100 tows made 129 km off Newport, OR from 1972 to 1976, only two specimens were collected (Krygier and Pearcy 1981). They did, however, note that high densities of this species had been found in other sampling areas off Oregon.

Pasiphaea pacifica

Twelve specimens were collected 80 km off central Oregon from 1961 to 1964 (Pearcy and Forss 1966). Catches ranged from 0.05 to 0.1 per hour tow. Between 500 and 1000 m there were an estimated 0.005 per $10^3 m^3$. Only five individuals were caught in 100 tows made 129 km off Newport, OR during 1972 through 1976 (Krygier and Pearcy 1981). Estimated number in a m^2 water column extending from the surface to 2400 m was less than 0.0001, although P. pacifica have been found in high densities at other locations off Oregon.

Pasiphaea tarda

Twenty individuals were collected in 100 midwater tows 129 km off Newport, OR from 1972 through 1976 (Krygier and Pearcy 1981). Estimated number was 0.0011 in a m^2 water column from 0 to 2400 m; 0.3% of the total shrimp catch.

Parapasiphaea cristata

Only two individuals were collected in 114 tows made 80 km off the central Oregon coast from 1961 through 1964 (Pearcy and Forss 1966). Ten were caught in 100 trawls made 129 km off Newport, OR from 1972 to 1976 (Krygier and Pearcy 1981). Estimated number in a m^2 water column extending from the surface to 2400 m was 0.0008, 0.02% of the total catch.

Parapasiphaea sulcatifrons

Six specimens were caught in 114 tows taken 80 km off central Oregon from 1961 to 1964 (Pearcy and Forss 1966). Fourteen were caught by Krygier and Pearcy (1981) during sampling 129 km off Newport, OR from 1972 to 1976. Estimated number was 0.0030 in a m^2 water column down to 2400 m, 0.07% of the total catch of shrimps.

Family Oplophoridae
Acanthephyra chacei

Krygier and Forss (1981) originally described this species. It is known from 44°22' to 45°57'N lat., 125°33' and 138°30' W long., although a single specimen was caught near the southern tip of the Alaska peninsula. A. chacei is bathypelagic between 1500 and 2400 m. A total of 39 specimens are known from the northeastern Pacific.

Acanthephyra curtirostris

Only six specimens of this species were collected in 114 tows from 1961 through 1964 (Pearcy and Forss 1966). Catch was 0.07 to 0.08 individuals per hour tow. Forty-five were caught in 335 samples taken 120 km off Newport between 1971 and 1973 (Pearcy et al. 1977), the majority below 400 m. Krygier and Pearcy (1981) captured 84 in 100 tows 129 km off Newport, OR from 1972 to 1976. There were 0.0185 individuals in a m^2 water column from 0 to 2400 m, 0.46% of total shrimps captured. Estimated density was 0.002 to 0.091 per $10^3 m^3$.

Acanthephyra quadrispinosa

Distributed across the Pacific, usually between 30° and 45° N lat., one was reported off Vancouver Island (Butler 1980; Wasmer 1972). Recently, Krygier and Pearcy (1981) reported a single female from 400 to 500 m 129 km off Newport, OR.

Meningodora mollis

Rare off Oregon, M. mollis is known in the area from a single specimen from 1000 m off Oregon (Forss 1966). and two additional animals in tows made 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981).

Notostomus japonicus

Krygier and Pearcy (1981) caught 50 individuals 129 km off Newport, OR between 1972 and 1976. They estimated 0.0019 in a m^2 water column extending from the surface to 2400 m, 0.05% of the estimated total catch of shrimp. Abundance estimates ranged from 0.001 to 0.017 individuals per $10^3 m^3$.

Hymenodora acanthitelsonis

Fifteen specimens were caught in 100 midwater tows 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981). This species is considered rare. Only captured in the beam trawl, H. acanthitelsonis may be epibenthic.

Hymenodora frontalis

Distributed from the Bering Sea south to Monterey Bay, California, H. frontalis occurs between 590 and 3200 m (Rathbun 1904). Pearcy and Forss (1966) reported catches of 0.07 to 10.5 animals per hour tow, 80 km off central Oregon between 1961 and 1964. Maximum catches were at night between 0 and 1000m depth. H. frontalis was abundant from 700 to 1000 m, (0.5 to 0.68 individuals per $10^3 m^3$) at a station 120 km off Newport, OR between 1971 and 1973 (Pearcy et al. 1977). It was the second most abundant shrimp collected 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981). They estimated 0.4133 animals in a m^2 water column from 0 to 2400 m, 10.31% of the total shrimps. Density estimates ranged from 0.003 to 1.101 per $10^3 m^3$.

Hymenodora gracialis

In the eastern North Pacific H. gracialis occurs from the Gulf of California north to the Bering Sea (Rathbun 1904). Wasmer (1972) reported specimens between 33° and 54° N lat. Krygier and Pearcy (1981) caught 267 specimens in 100 tows 129 km off Newport, OR between 1972 and 1976. They estimated 0.0652 in a m^2 water column from 0 to 2400 m, 1.63% of the shrimps inhabiting the water column. Density estimates ranged from 0.005 to 0.122 per $10^3 m^3$.

Hymenodora gracilis

Cosmopolitan in all oceans, H. gracilis can be caught off Oregon between 0 and 1000 m (Forss 1966). Pearcy and Forss (1966) used a non-closing midwater trawl to catch 107 specimens 80 km off central Oregon between 1961 and 1964. Catches averaged 0.58 to 1.5 individuals per hour tow. Densities were between 0.003 and 0.005 per $10^3 m^3$. Krygier and Pearcy (1981) reported 0.2833 individuals in a m^2 water column from the surface to 2400 m 129 km off Newport between 1972 and 1976. In the water column, it was third most abundant, comprising 7.07% of the shrimp in the water column. Densities ranged from 0.002 to 0.589 individuals per $10^3 m^3$.

Systellaspis braueri

Forss (1966) first reported this species from off Oregon. He reported it to be frequently in collections. Pearcy and Forss (1966) collected 44 specimens 80 km off central Oregon between 1961 and 1964. In 26 collections between 0 and 1000 m S. braueri averaged 0.39 per hour tow. Pearcy et al. (1977) working 120 km off Newport, OR caught 44 between 400 and 1000 m. Samples collected 129 km off Newport, OR between 1972 and 1976 contained 198 individuals. Estimated number was 0.0417 in a m^2 water column from 0 to 2400 m (Krygier and Pearcy 1981). This was the seventh most abundant shrimp in the water column (1.04% of total). Density estimates ranged from 0.003 to 0.086 individuals per $10^3 m^3$.

Systellaspis cristata

In the northeastern Pacific this species ranges from Vancouver Island, British Columbia south to Gulf of Panama (Butler 1980). Krygier and Pearcy (1981) reported only 6 specimens from 100 tows taken 129 km off Newport, OR between 1972 and 1976. They estimated 0.0007 animals in a m^2 water column extending from the surface to 2400 m.

Systellaspis debilis

This species is most abundant in the Atlantic Ocean, although a few specimens have been caught near Hawaii. (Wasmer 1972). This species is rare in the GRLA; Krygier and Pearcy (1981) caught only one animal (the first collected in the northeastern Pacific) in 100 tows 129 km off Newport.

Family Pandalidae
Pandalus jordani

P. jordani occur from Unalaska Island, AK south to San Nicholas Island, CA (Butler 1980). Highest catches of this species off Oregon occur within 25 km of land, although two individuals have been caught 45 and 65 km off Newport, OR (Pearcy 1970).

Family Crangonidae
Crangon abyssorum

This species occurs from the Bering Sea south to Cortes Bank, CA. Krygier and Pearcy (1981) caught 48 individuals in 100 tows made 129 km off Newport, OR between 1972 and 1976. Forty-seven of these were taken in beam trawls.

2. Reproduction

Reproductive biology of most shrimps is poorly known. Except for commercially important species, shrimps are rarely caught in great numbers, and the vast majority of species occur far offshore. Although at least 28 species of shrimp reside in the GRLA there has been very little work other than studies by C.A. Forss, E.E. Krygier, W.G. Pearcy, and R.A. Wasmer at Oregon State University. A synopsis of

available information follows. Lengths are given as carapace length (C.L.).

Family Penaeidae
Bentheogennema borealis

Collections from 129 km off Newport, OR between 1972 and 1976 indicated sex ratio was nearly 1:1 (Krygier and Pearcy 1981).

Bentheogennema burkenroadi

Females collected 120 km off central Oregon coast between 1972 and 1973 appear to reach sexual maturity at size of 12 mm, males at 11 mm (Krygier and Wasmer 1975). Judging from the condition of the testis and ovary, spawning season lasts 4 to 6 months, with a 6 to 8 month rest period. Spawning begins in late November; 50% of the animals are spawned out by February (Krygier and Wasmer 1975). Sex ratio was 1:1. Krygier and Pearcy (1981) reported a sex ratio of 1.1:1, females to males, for shrimp caught 129 km off Newport between 1972 and 1976. The largest female was 19 mm, and the largest male was 17 mm. The smallest individual was 5 mm.

Family Sergestidae
Sergestes similis

Pearcy and Forss (1966) reported the results of 358 Issac-Kidd midwater trawl (IKMT) collections 24 to 264 km off Newport and Coos Bay, OR. Female S. similis apparently mature at 11 mm. Part of the population spawned throughout the year, although there was a reduction in spawning during the summer. Twenty-four percent of the catch consisted of adults. Sex ratio was 1:1. Larvae and mastigopus stage shrimp occurred in winter and spring. Krygier and Pearcy (1981) suggested S. similis lives just over one year, and that a few may live to 1.5 to 2 years. Lengths ranged from 3 to 17 mm.

Sergia tenuiremis

Based on 21 individuals from 129 km off Newport, OR between 1972 and 1976, Krygier and Pearcy (1981) found the ratio of males to females was equal. The largest animal was 28.5 mm.

Petalidium suspiriosum

Krygier and Pearcy (1981) found sex ratio of this species was 1.5 females to 1.0 males. Between 400 and 1000 m the sex ratio was unity, although in water below 1000 m, females were most numerous. Females grow to 9 to 13 mm, while males only reach 10 mm.

Family Pasiphaeidae
Pasiphaea chacei

Females bearing eggs were 19.9 to 24.0 mm, with an average fecundity of 67 eggs (43 to 96) (Krygier and Pearcy (1981). Egg diameter was 1552 to 2224 microns; 10.1 percent of the volume of the shrimp was eggs.

Pasiphaea pacifica

Ovigerous females (17.5 to 23.3 mm) carried 12 to 66 medium-sized eggs most of the year (Krygier and Pearcy 1981). Egg diameter was 1550 to 2120 microns. There is some evidence that spawning may occur twice within a season for some females.

Pasiphaea tarda

This species may segregate by size. Adults occur deepest (Krygier and Pearcy 1981). One female (49.6 mm C.L.) bearing 153 eggs was caught in July, 129 km off Newport, OR.

Family Oplophoridae
Acanthephyra chacei

Two ovigerous females (32.6 and 36.7 mm) were captured in March and August (Krygier and Forss 1981). This species appears to become sexually mature at 25 mm.

Acanthephyra curtirostris

Females outnumber males (1.4:1.0). Three females (21.2 through 26.7) with eggs were caught in April and September (Krygier and Pearcy 1981). Fecundity ranged from 1367 to 3010, mean 2188. Eggs were 796 to 983 microns in diameter. Eggs made up 40.6% of the body volume of females.

Notostomus japonicus

The sex ratio of animals caught 129 km off Newport, OR between 1972 and 1976 was about unity (Krygier and Pearcy 1981). Two ovigerous females captured in June and December were 39.0 and 41.0 mm, with up to 1230 eggs of 1.0 to 1.3 mm diameter. Approximately 10% of the body volume of females was made up of eggs.

Hymenodora acanthitelsonis

One 20.6 mm ovigerous female was caught in October 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981). The 18 eggs ranged in diameter from 2790 to 3488 microns.

Hymenodora frontalis

The sex of specimens less than 8 mm was not indentifiable (Krygier and Pearcy 1981). Females 10.5 to 14.0 mm with eggs were found throughout the year. Fecundity ranged from 1 to 18, with an average of 14. Egg diameters were 2380 to 2968 microns, and composed 57.2% of the total volume of the shrimp.

Hymenodora gracialis

Sex of this species becomes recognizable at 8 mm C.L. (Krygier and Pearcy 1981). Above 2400 m females are more abundant than males (4.1:1);

large males may be mostly below 2400 m. Most mature animals probably reside in deep water. Only 8 ovigerous females (12.8 to 19.1 mm C.L.) were collected in June, July, and September during tows 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981). Fecundity ranged from 4 to 14, with egg diameters of 1963 to 2453 microns. The proportion of the total volume made up of eggs was 15.4%.

Hymenodora gracilis

Females generally outnumbered males at all depths sampled 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981). At 8 mm C.L. this species becomes sexually recognizable. Females bearing eggs (8.7 to 10.4 mm) occur only at depths greater than 1000 m, and only during May, June, and July. Fecundity ranged from 4 to 7, with an average of 7. Eggs, 2286 to 2857 microns in diameter, made up 43.9% of the total shrimp volume.

Systellaspis braueri

Above 1000 m immature animals predominate, while adults are common below this depth (Krygier and Pearcy 1981). Individuals become sexually recognizable at 13 mm, and the smallest caught was 4 mm. Females were more common than males (2.4:1) in tows conducted 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981). Ovigerous females (30.0 to 35.5 mm C.L.) were caught in January, February, March, May, July, and September, suggesting a prolonged reproductive period. Fecundity ranged from 28 to 82, with an average of 49. Eggs were 3029 to 4278 microns in diameter, and represented 27.5% of the volume of the shrimp.

Systellaspis cristata

Only one ovigerous female was captured (Krygier and Pearcy 1981). This 19.8 mm female, captured in May, carried 13 eggs ranging from 2500 to 3670 microns in diameter. The eggs were 15.7% of the volume of the shrimp.

3. Growth

For most species of nektonic shrimp there is a paucity of data regarding growth. For many species maximum size of individuals is known. The following information is summarized from Krygier and Pearcy (1981) who conducted 100 tows 129 km off Newport, OR between 1972 and 1976. Where other sources of information are used the citation is included.

Family Penaeidae
Bentheogennema borealis

Postlarvae are about 5 mm, the largest female captured was 19 mm, and largest male 17 mm.

Bentheogennema burkenroadi

It takes 3 to 5 months for growth through the egg and larval stages (Krygier and Wasmer 1975). Approximately another year is required to reach maturity at 11 to 12 mm, and another 5 to 6 months are needed before spawning. Therefore generation time is about 2 years. The largest female captured was 20 mm, and the largest male was 17 mm. Krygier and Pearcy (1981) reported the largest female captured was 19 mm, while the largest male was 17 mm. The smallest individual captured was only 5 mm.

Family Sergestidae
Sergestes similis

Larvae are 1 to 2 mm, and juveniles about 3 mm (one month of age). One year olds are about 11 mm (Pearcy and Forss (1969). Average growth rate is about 0.8 mm C.L. per month for S. similis caught 24 to 264 km off Oregon between 1961 and 1967. Animals 12 to 17 mm are probably older than one year, but are rare. The largest individuals caught by Krygier and Pearcy (1981) were 17 mm.

Sergia tenuiremis

The largest specimens of this species were 28.5 mm C.L. for both males and females. The smallest caught was 13 mm.

Petalidium suspiriosum

Males normally do not exceed 10 mm, while females reach 9 to 13 mm, suggesting that females either grow more rapidly or live longer than males.

Family Pasiphaeidae
Pasiphaea chacei

The largest female captured was 24 mm, the largest male 17 mm. The smallest animal was 8 mm.

Pasiphaea tarda

The largest females caught off Oregon were 52 mm, males reached 56 mm. The smallest individual was 5 mm.

Parapasiphaea cristata

The largest females were 28.5 to 29.0 mm. No recognizable males were found. The smallest individual was 7 mm.

Parapasiphaea sulcatifrons

The largest males and females caught were 24 mm, while the smallest were 5 mm.

Family Oplophoridae
Acanthephyra chacei

The largest female found in the GRLA was 36.7 mm, the largest male 37.0 mm (Krygier and Forss (1981). The smallest animal was 6.0 mm.

Acanthephyra curtirostris

Males and females reached a maximum of 27 mm, and the smallest 6 mm.

Notostomus japonicus

The largest female caught was 41 mm, the largest male 39.8 mm, and the smallest about 6 mm.

Hymenodora acanthitelsonis

The largest female caught was 20.6 mm, the largest male was 19.3 mm, and the juveniles were 7 to 7 mm.

Hymenodora frontalis

The largest female was 14 mm and the largest male was 16 mm. Generally there were fewer females in the smaller size class (8 to 9 mm), which may be a result of a faster growth rate for females in the smaller sizes. The smallest individual captured was 3.3 mm.

Hymenodora gracialis

The largest female caught in the GRLA was 18 mm, the largest male was 20 mm. The smallest animal was about 4 mm.

Hymenodora gracilis

Males appear to reach a larger size than females, which may be the result of a greater growth rate. The largest female caught was 12 mm, while the largest male was 14 mm. Most females were less than or equal to 10 mm, while the males were predominately in the 11 to 14 mm size class. The smallest individual was 3 mm.

Systellaspis braueri

This species was one of the largest Caridea captured 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981). The largest female caught was 34 mm, the largest male 36 mm, and the smallest individual 4 mm.

Systellaspis cristata

The largest female captured was 20 mm, the largest male 17 mm, and the smallest an 8 mm juvenile, in samples taken from 129 km off Newport, OR between 1972 and 1976 (Krygier and Pearcy 1981).

Family Cragonidae
Crangon abyssorum

The largest specimen of this species from benthic trawls taken 129 km off Newport, OR between 1972 and 1976 was 13 mm, while the smallest was 3 mm (Krygier and Pearcy 1981).

4. Migrations

Data on vertical migrations have been collected primarily in the northern region of the GRLA, and principally by Pearcy and Forss (1966), Pearcy et al. (1977), and Krygier and Pearcy (1981). The existence of vertical migrations has been suggested based on the differences in night and day catches at discrete depth intervals. Generally diel vertical migrations mean the shrimps are in the upper 200 m during the night where they prey upon plankton, and are below 200 m during the day, where they may school and rest.

Family Penaeidae
Bentheogennema borealis

Evidence from tows made night and day 120 and 129 km off the central Oregon coast has shown that this species is not a vertical migrator (Pearcy et al. 1977; Krygier and Pearcy 1981). It generally occurs between 100 and 1000 m, with highest densities at 600 to 1000 m (Krygier and Pearcy 1981).

Bentheogennema burkenroadi

Although B. burkenroadi occurs from the surface down to 1000 m, a small part of the population makes diel vertical migrations (Krygier and Wasmer 1975). During day the majority of the population is below 500 m, while at night it is usually below 100 m. Individuals migrating above 500 m at night included both sexes, although adults appeared to migrate into shallower water than juveniles (Krygier and Wasmer 1975). There may be upward movement of shrimp from below 1000 m. Pearcy et al. (1977) found the majority was distributed between 400 and 1000 m during the day, and from 100 to 1000 m at night. They concluded this species was a vertical migrator. Krygier and Pearcy (1981) found a population maximum between 700 and 800 m during the day, and between 600 and 700 m at night.

Gennadas propinquus

G. propinquus occurs between 50 and 700 m. Differences in day and night catches suggested it makes diel vertical migrations (Krygier and Pearcy 1981).

Gennadas tinayrei

This species appears to have a limited depth distribution (400 to 500 m), and does not make vertical migrations (Krygier and Pearcy 1981).

Family Sergestidae
Sergestes similis

This most abundant shrimp is a strong vertical migrator. Pearcy and Forss (1966) always caught greater numbers in the upper 150 m at night than during the day, while between 150 and 500 m daytime catches were greater than nighttime. These animals are found between 0 and 1000 m throughout the day, but the peaks of abundance occur at 0 to 100 m during night and 400 to 500 m during the day (Krygier and Pearcy 1981). Seventy-five percent of the population was between 200 and 400 m during the day, while most occur above 100 m at night.

Sergia tenuiremis

This species is mesopelagic (Pearcy and Forss 1966), generally found between 400 and 1000 m. Juveniles may exhibit a more pronounced vertical migration than adults (Krygier and Pearcy 1981).

Petalidium suspiriosum

P. suspiriosum is commonly distributed between 200 and 1000 m, and apparently does not vertically migrate (Pearcy and Forss 1966). Pearcy et al. (1977) found peak abundance at 500 m. During winter this peak was shallower than in summer. The population maximum occurred between 600 and 1000 m at a station 129 km off Newport, OR. There was no evidence for diel vertical migration (Krygier and Pearcy 1981).

Family Pasiphaeidae
Pasiphaea chacei

Pearcy and Forss (1966) provided some evidence for diel vertical migration in this species. Although Krygier and Pearcy (1981) caught few individuals, they concluded there was a diurnal vertical migration.

Pasiphaea pacifica

Pearcy and Forss (1966) reported some evidence for vertical migration for this species.

Pasiphaea tarda

P. tarda, a non-migratory species, occurred between 200 and 2000 m at 129 km off Newport, OR (Krygier and Pearcy 1981).

Parapasiphaea cristata

This species was only caught below 1250 m, and probably does not migrate vertically (Krygier and Pearcy 1981).

Parapasiphaea sulcatifrons

Occurring between 500 and 1250 m, P. sulcatifrons does not exhibit vertical migrations (Krygier and Pearcy 1981).

Family Oplophoridae
Acanthephyra chacei

This species is distributed from 1500 to 3900 m, and is probably not a vertical migrator (Krygier and Forss 1981; Krygier and Pearcy 1981).

Acanthephyra curtirostris

There is no evidence that this species, which occurs between 300 and 1000 m, performs a diel vertical migration (Pearcy et al. 1977; Krygier and Pearcy 1981).

Notostomus japonicus

This upper mesopelagic species is caught between 200 and 850 m, and shows no signs of vertical migration (Krygier and Pearcy 1981).

Hymenodora acanthitelsonis

This species apparently lives between 2400 m and the bottom. There is no evidence for vertical migration (Krygier and Pearcy 1981).

Hymenodora frontalis

H. frontalis occurs primarily below 500 m, and does not migrate vertically (Pearcy et al.1977; Krygier and Pearcy 1981). Krygier and Pearcy (1981) reported abundance between 600 and 1250 m, although it was caught occasionally at 100 m.

Hymenodora gracialis

This species is bathypelagic, with 75% of the catch (and the population maximum) between 2000 and 2400 m (Krygier and Pearcy 1981). There is no evidence for vertical migration.

Hymenodora gracilis

H. gracilis occurs from 600 to 2400 m, although the population maximum is probably from 1500-2400 m (Krygier and Pearcy 1981). There is no evidence for vertical migration.

Systellaspis braueri

This species probably does not migrate vertically; it occurs between 500 and 2000 m (Krygier and Pearcy 1981).

Systellaspis cristata

Rarely found in the GRLA, S. cristata occurs between 200 and 700 m (Krygier and Pearcy 1981). There are insufficient samples to determine if vertical migration exists.

Family Crangonidae
Crangon abyssorum

This species is primarily benthic, although it has been caught in midwater trawls at 1250 to 1500 m (Krygier and Pearcy 1981). C. abyssorum may swim above the bottom to feed, but does not make diel vertical migrations.

5. Food habits

Very few studies exist on food habits of pelagic shrimps. Knowledge of feeding habits of shrimps collected in the GRLA are summarized below. Omission of species indicates lack of information.

Family Pasiphaeidae
Pasiphaea pacifica

Renfro and Pearcy (1966) described feeding habits of two species of shrimp caught 28 to 83 km off the coast of Oregon. Twenty-five P. pacifica, gathered between 1962 and 1964, consumed mostly crustaceans. Based on eye structure, the predominant prey were Euphausia pacifica, copepods, and chaetognaths.

Family Sergestidae
Sergestes similis

The diet of S. similis consists mainly of small crustaceans, calanoid copepods, and euphausiids (Renfro and Pearcy 1966). Eighty percent of the shrimp examined had empty stomachs.

Family Pandalidae
Pandalus jordani

Although only two of 1043 specimens collected in midwater trawls off central Oregon were from the GRLA (the rest were from shelf waters), the feeding habits may be relevant. Pearcy (1970) reported P. jordani stomach contents contained primarily euphausiids, copepods, fish scales, chetognath jaws, and shrimps.

6. Commercial exploitation

There is currently no commercial harvesting of shrimps in the GRLA. Distance from shore and reduced densities compared to shrimps on the shelf make harvest of pelagic shrimps commercially unprofitable.

B. Relevant Studies Outside the Gorda Ridge Lease Area

1. Distribution and abundance

There have been few studies outside the GRLA to augment population size data for shrimps in the region. These are Wasmer (1972), and some work done by Omori and Gluck (1979) on larvae to the south.

Family Penaeidae
Hemipenaeus spinidorsalis

Only two specimens have been collected in the vicinity of the GRLA. They were caught in a beam trawl 3° west of the GRLA in June 1970 (Wasmer 1972). This species was previously known from Central America and the Galapagos Islands. Although this record suggests its occurrence in the GRLA, it would undoubtedly be extremely rare.

Plesiopenaeus armatus

A single specimen of this species was captured in a beam trawl in June 1970, 3° west of the GRLA (Wasmer 1972). Previously P. armatus was known from the South Atlantic, North Pacific, and Indian Oceans. Although not known from the GRLA, occurrence there is possible but probably rare.

Family Sergestidae
Sergestes similis

Larvae generally occurred between the surface and 100 m off southern California (Omori and Gluck 1979). Three of thirteen stations were located just south of the GRLA, the others were below 35° N. At the three northernmost stations south larvae ranged in abundance from 1 to 60 individuals under a m^2 column of water extending from the surface to 100 m.

2. Reproduction

Very little work outside the GRLA reduces deficiencies in knowledge of reproductive biology of shrimps in the area.

Family Sergestidae
Sergestes similis

Omori and Gluck (1979) found peak spawning in late December to early April. Spawning activity was greatest when the vertical stratum of optimum temperature for the larvae was thickest. Spawning was regulated by cold temperatures associated with upwelling in May through August.

3. Migrations

Family Sergestidae
Sergestes similis

Larvae and postlarvae exhibit restricted diel vertical migrations, and gradually increase their range of movements with increasing size. Larger individuals live at increasingly greater depths (Omori and Gluck 1979).

4. Food habits

Osterberg et al. (1964) and Judkins and Fleminger (1972) studied food habits of shrimps. However, many of their samples were from the Columbia River mouth area. No additional studies were found which would contribute to this discussion.

Family Sergestidae
Sergestes similis

S. similis, from samples near the Columbia River mouth, ate copepods, euphausiids, prawns, and fish scales. Judkins and Fleminger (1972) studied the feeding habits of 270 individuals collected between 31° and 53° N. Prey included euphausiids, ostracods, amphipods, chaetognaths, and fish scales, but the most abundant and diverse of the groups eaten was adult calanoid copepods. The principal genera were Metridia, Calanus, Pleuromamma, Rhincalanus, Euchaeta, Eucalanus, Scolecithricella, and Candacia. Copepods occurred in 80% of the sampled guts, euphausiids in 40%, fish scales in 20%, and chaetognaths in 15%.

Family Pasiphaeidae
Pasiphaea pacifica

Osterberg et al. (1964) reported P. pacifica in the vicinity of the Columbia River mouth ate euphausiids and cephalopods.

5. Commercial exploitation

Although the pink shrimp, Pandalus jordani, is harvested in great numbers off the Oregon and Washington coasts (Pearcy 1972), its fishery is confined to shelf waters. There are no additional commercial harvests of shrimps in other areas surrounding the GRLA.

C. Gaps In The Data

Virtually all aspects of the ecology of shrimps in the region of the GRLA need study. For some species there are fairly recent and reliable estimates of population densities, although seasonal and yearly variations are unknown. Most species occurring in the area have probably been recorded, so only the extremely rare species remain to be described. Much of the area is below 3000 m depth, although most studies

in the GRLA have been conducted above 2000 m. Little is known of the deep water fauna.

There are some data concerning reproduction and vertical placement and migrations of shrimps in the GRLA, but most of these studies were in the northern sector and did not involve all species. Knowledge of growth and feeding habits is lacking for most species.

In consideration of the potential development of this area and the possible effects on shrimp species, the most critical data needs are for better estimates of the abundance and distribution of the important species in the immediate vicinity of exploration sites. Any assessment of the impacts of development will need initial estimates of population size and distribution. Secondarily, much more information is needed on aspects of shrimp biology (reproduction, growth, and feeding habits) possibly affected by mining.

II. CEPHALOPODS

A. Studies Within the Gorda Ridge Lease Area

Cephalopods are less well known than other nekton. They are particularly difficult to study because they cannot be observed easily and are excellent net avoiders. In addition, they have excellent eyesight and are relatively intelligent. For these reasons, and because few net samples have been obtained in the GRLA, most aspects of cephalopod biology from this region are poorly known. W.G. Pearcy and his student K. Jefferts from Oregon State University have provided the bulk of information dealing with these organisms in the GRLA. the species known to inhabit the GRLA or presumed to occur there, are listed in Table 2.

1. Distribution and abundance

There have been very few quantitative studies of the cephalopods in the GRLA. The majority of work consists of simple surveys of species present in the region. Pearcy (1965) and Jefferts (1983) have made a few abundance estimates.

Family Sepiolidae
Rossia pacifica

This species is distributed around the Pacific rim from Japan through the Bering Sea and down to Baja California (Roper et al. 1984). Jefferts (1983) reported only seven individuals from 1491 tows made in the California Current region which includes the GRLA. All were collected inshore of the California Current.

Family Enoploteuthidae
Abraliopsis felis

This species is reported from 27° to 43° N and out to 147° W at 26° N (McGowan and Okutani 1968). Recently, Jefferts (1983) reported this species to 43° N, and out to 172° W in the North Pacific. Pearcy et al. (1977) caught 26 specimens in 335 samples from a station 120 km off Newport, OR between 1971 and 1973; they were mostly larvae and juveniles. In the California Current region, which includes the GRLA, Jefferts (1983) caught 1530 individuals in 1491 tows. A. felis made up 6.9% of the cephalopods captured in this region. Pearcy (1965) reported catches of 0.7, 0.1, and 0.1 Abraliopsis sp. per hour tow in tows from 0 to 200 m, 0 to 500 m, and 0 to 1000 m, respectively. These tows were made 80 km off Newport, OR between 1961 and 1963. Between 0 and 200 m there were no Abraliopsis caught in 9 tows conducted during daylight hours, but 0.7 per hour were collected in 63 tows at night. From 0 to 500 m the catches were 0.2 and 0.1 for day and night tows, respectively.

Table 2. List of cephalopod species which are known to exist in the GRLA, or are presumed to inhabit the area because their distributions overlap the region.

Species
Family Sepiolidae
Rossia pacifica
Family Enoploteuthidae
Abraliopsis felis
Pyroteuthis addolux
Family Octopoteuthidae
Octopoteuthis deletron
Family Onychoteuthidae
Onychoteuthis borealijaponicus
Moroteuthis robusta
Family Gonatidae
Gonatus berryi
Gonatus californiensis
Gonatus modokai
Gonatus onyx
Gonatus oregonensis
Gonatus pyros
Gonatus sp. A
Gonatus sp. B
Gonatus sp. C
Gonatus ursabrunae
Gonatopsis borealis
Berryteuthis anonychus
Berryteuthis magister
Family Architeuthidae
Architeuthis sp.
Family Histioteuthidae
Histioteuthis dofleini
Histioteuthis heteropsis
Family Bathyteuthidae
Bathyteuthis abyssicola
Bathyteuthis berryi
Family Ommastrephidae
Ommastrephes bartramii

Family Chiroteuthidae
Chiroteuthis calyx
Valbyteuthis oligobessa

Family Mastigoteuthidae
? *Mastigoteuthis dentata*

Family Cranchiidae
Cranchia scabra
Leachia dislocata
Heliocranchia pfefferi
Taonius pavo
Galiteuthis phyllura

Family Bolitaenidae
Japetella heathi

Family Octopodidae
Octopus sp.

Family Vampyroteuthidae
Vampyroteuthis infernalis

Pyroteuthis addolux

Young (1972) considered this species oceanic and rare along the continental shelf. Jefferts (1983) described distribution of this species as occurring between 20° and 40° N, and 130° and 170° W. She considered it to be a major component of North Pacific Central Waters. Although Jefferts did not report any specimens from GRLA, otter trawls near the area have captured this species (Stein, unpubl. data), so it is included.

Family Octopoteuthidae
Octopoteuthis deletron

This species may range from Oregon to Peru (Young 1972). Jefferts (1983) found individuals as far north as 48° N, and west to 146° W. In the California Current region, which includes the GRLA, she reported 324 specimens (1.5% of total cephalopods) from 1491 tows. Pearcy (1965) reported catches of 0.0, 0.04 , and 0.02 individuals per hour tow at depth intervals of 0 to 200 m, 0 to 500 m, and 0 to 1000 m, respectively. In midwater tows made 40 to 264 km off the Oregon coast, this species comprised approximately 2% of the cephalopods caught (Pearcy 1965). Between 1971 and 1973 Pearcy et al. (1977) caught 26 individuals in 335 samples from 120 km off Newport,.

Family Onychoteuthidae
Onychoteuthis borealijaponicus

This species occurs throughout the North Pacific. Along the west coast of North America it occurs between 29° N and 50° N (Jefferts 1983). Jefferts reported 140 (0.6% of total cephalopods) specimens in the California Current region. Pearcy (1965) found this species was less than 2% of the cephalopods caught in midwater trawls from 40 to 264 km off Oregon. The abundance of O. borealijaponicus this species is undoubtedly underestimated because it can easily avoid nets (Young 1972).

Moroteuthis robusta

M. robusta occurs in neritic waters of the North Pacific rim from Japan to southern California (Jefferts 1983). Although rarely caught in nets because of its large size and swiftness, (none were reported by Pearcy (1965) or Jefferts (1983) for the GRLA), they are captured occasionally in commercial hauls off the Oregon coast (Van Hyning and Magill 1964).

Family Gonatidae
Gonatus berryi

This species occurs from southern California north to the Bering Sea (Jefferts 1983). G. berryi represented 0.05% of cephalopods caught in the California current region (Jefferts 1983). Larval and juvenile abundance in the GRLA ranges from <0.05 to < 0.15 individuals per $10^3 m^3$ (Kubodera and Jefferts 1984).

Gonatus californiensis

Found from southern California north to 44° N (Jefferts 1983), only six specimens were reported from the California Current region (Jefferts 1983). Pearcy (1965) did not collect this species off the Oregon coast. Kubodera and Jefferts (1984) reported the abundance of juveniles in the GRLA to be 0.01 to 0.15 individuals per m^3.

Gonatus modokai

This species is distributed across the subarctic Pacific, although only 13 specimens were collected in the GRLA (Jefferts 1983). Pearcy (1965) did not find this species off the Oregon coast between 1961 and 1963. Kubodera and Jefferts (1984) found larvae did not occur in the GRLA, but juveniles numbered < 0.05 to <0.15 per $10^3 m^3$.

Gonatus onyx

G. onyx occurs from off southern California to the Bering Sea (Jefferts 1983). It is the most abundant cephalopod in the California Current region, with 12,979 individuals (59.6% of total) collected in 1491 tows (Jefferts 1983). Pearcy (1965) reported G. fabricii as the most common cephalopod off Oregon. Young (1972), however, suggested most of these were probably G. onyx. Pearcy reported from 0.1 to 0.5 G. fabricii per hour tow, comprising 38% of the cephalopods caught. Pearcy et al. (1977) caught 118 specimens in 335 samples taken 120 km off Newport, OR. In the GRLA, larvae are fewer than 0.30 per $10^3 m^3$, but juveniles may be as abundant as >0.50 per $10^3 m^3$ (Kubodera and Jefferts 1984).

Gonatus oregonesis

Just recently been described (Jefferts, in press), between 0.01 and 0.15 individuals per m^3 occur in the GRLA (Kubodera and Jefferts 1984).

Gonatus pyros

This species has been found as far north as 57° N, and as far south as southern California (Jefferts 1983). It was the fifth most abundant cephalopod (945 individuals, 4.3% of total) in 1491 tows from the California Current region (Jefferts 1983). Pearcy (1965), however, did not report this species off the Oregon coast between 1961 and 1963. Pearcy et al. (1977) reported 23 specimens in 335 samples taken 120 km off Newport, OR. Larval abundance has been reported as < 0.05 to >0.50 individuals per $10^3 m^3$; juveniles as <0.05 to < 0.30 individuals per $10^3 m^3$ (Kubodera and Jefferts 1984).

Gonatus sp. A

This undescribed species occurs in the GRLA and in the Alaska Current as far east as 176° W (Jefferts 1983). Two specimens were reported from the GRLA by Jefferts (1984). Kubodera and Jefferts (1984) reported densities of larvae between ≤ 0.15 and >0.50 individuals per $10^3 m^3$; the post-larvae numbered ≤ 0.15 per $10^3 m^3$.

Gonatus sp.C

Kubodera (1978) first collected this species in the western North Pacific and southern Bering Sea, and it has been subsequently reported along the North Pacific rim to central California (Jefferts 1983). Forty-one specimens have been collected in the California Current system, a few from the GRLA. Pearcy (1965) did not report this species off the coast of Oregon.

Gonatus sp. E

Five specimens of this previously undescribed species were all caught within the GRLA (Jefferts 1983).

Gonatus ursabrunae

Only recently described (Jefferts, in press), abundance of this species in the GRLA has been reported as 0.01 and 0.05 individuals per m^3 (Kubodera and Jefferts 1984).

Gonatopsis borealis

This species occurs in the eastern North Pacific from southern California to the Bering Sea, and south to Japan (Jefferts 1983). It comprised 3% of the total catch of cephalopods off the coast of Oregon between 1961 and 1963. It was the fifth most abundant species (Pearcy 1965). Pearcy et al. (1977) caught only 10 specimens in 335 samples taken 120 km off Newport, OR. Jefferts (1983) reported 451 individuals (2.0% of total) from the California Current region, many from the GRLA. Larval and juvenile abundance in the GRLA range from ≤ 0.05 to >0.50 per $10^3 m^3$ and <0.05 to <0.30 per $10^3 m^3$, respectively (Kubodera and Jefferts 1984).

Berryteuthis anonychus

Occurs from southern California north to the Gulf of Alaska, and east to the Bering Sea (Jefferts 1983). Ninety-four specimens were collected in 1491 tows in the California Current region. Pearcy (1965) listed this species from the Oregon coast, but did not give the number caught. Larvae, less than 10 mm, may number between <0.05 and <0.15 individuals per $10^3 m^3$, while post-larvae (>10 mm) range between <0.05 and <0.30 individuals per $10^3 m^3$ (Kubodera and Jefferts 1984).

Berryteuthis magister

B. magister is distributed off Japan, through the Aleutians and south to Oregon (Jefferts 1983). Eighteen specimens were collected in the California Current region, some from the GRLA. Although larvae were not caught in the GRLA, juveniles numbered <0.30 per $10^3 m^3$ at one station (Kubodera and Jefferts 1984).

Family Architeuthidae
Architeuthis sp.

Although not known from there, the range of this species includes the GRLA (Roper et al. 1984). Architeuthis is very large and very rarely seen. Distributional information has been obtained mostly from strandings, sightings at sea, and examination of predator stomachs. It is likely a single species, A. japonica, and occurs throughout the North Pacific (F.G. Hochberg, pers. comm.).

Family Histioteuthidae
Histioteuthis dofleini

This species is cosmopolitan in all oceans (Jefferts 1983). In the North Pacific it is usually confined to the waters of the California Current system. Thirty-five specimens were collected in the California Current region during 1491 tows (Jefferts 1983).

Family Histioteuthidae
Histioteuthis heteropsis

This species occurs from northern Baja California to northern Oregon (Jefferts 1983). Nineteen individuals were caught in 1491 tows taken in the California Current system.

Family Bathyteuthidae
Bathyteuthis abyssicola

A single specimen was collected in the GRLA on 3 June 1969 (Jefferts 1983). The species is known from the North Pacific, Antarctic, north and central Atlantic, and Gulf of Panama.

Bathyteuthis berryi

A single specimen of this species was collected in the GRLA on 29 July 1965 (Jefferts 1983), representing a range extension from the previously described distribution off southern California (Young 1972).

Family Ommastrephidae
Ommastrephes bartramii

In the North Pacific this species is common from 25° to 45° N (Jefferts 1983). A single individual was captured at the eastern edge of the GRLA on 24 August 1965.

Family Chiroteuthidae
Chiroteuthis calyx

This was the third most abundant cephalopod (9% of total) in the California Current region, and is common throughout the eastern North Pacific (Jefferts 1983). Pearcy (1965) found 0.5, 0.1, and 0.1 individuals per hour of tow at 0 to 200 m, 0 to 500 m, and 0 to 1000 m respectively off Oregon. C. calyx was the third most abundant species (8%) of total catch between 1961 and 1963. Pearcy et al. (1977) found

this to be the most abundant cephalopod (N=246) in 335 samples taken 120 km off the coast of Newport, OR.

Valbyteuthis oligobessa

Described from samples taken off southern California (Young 1972). Jefferts (1983) recently collected three specimens off Oregon in the GRLA.

Family Mastigoteuthidae
?Mastigoteuthis dentata

Previously known only from off the Galapagos Islands and Gulf of Panama (Clarke 1966). However, three individuals from off Oregon in the GRLA, have extended its known range (Jefferts 1983).

Family Cranchiidae
Cranchia scabra

This species is found circumglobally, principally between 36° N and 38° S, (Jefferts 1983). Pearcy (1965) reported the presence of this species off the Oregon coast, where it was approximately 1% of the total catch of cephalopods. Three specimens were collected in the California Current region during 1491 tows (Jefferts 1983).

Leachia dislocata

This species is distributed between 30° and 55° N, and as far east as 130° W (Jefferts 1983). Jefferts (1983) reported 85 specimens (0.4% of total) from the California Current region.

Heliocranchia pfefferi

Not reported from the GRLA by either Pearcy (1965) or Jefferts (1983), recent otter trawls in the vicinity captured a specimen (Stein, unpubl. data). This species is generally found in the tropical Pacific, south of the region of interest.

Taonius pavo

This species occurs throughout the North Pacific and is apparently rare in central waters (Jefferts 1983). Pearcy (1965) found an average of 0.01, 0.14, and 0.06 per hour tow at depth intervals of 0 to 200 m, 0 to 500 m, and 0 to 1000 m, respectively, from 40 to 264 km off Oregon between 1961 and 1963. Pearcy et al. (1977) reported this to be the fourth most abundant (N=104) cephalopod in catches 120 km off Newport, OR between 1971 and 1973. T. pavo was the sixth most abundant cephalopod being about 3% of the total catch. Jefferts (1983) also ranked this squid as the sixth most abundant cephalopod (N=774) in the California Current region, which includes the GRLA.

Galiteuthis phyllura

This species appears to be distributed across the North Pacific (Jefferts 1983). Pearcy (1965) reported none in 72 tows from 0 to 200 mm 0.04 individuals per hour tow in 23 tows from 0 to 500 m, and 0.06 per hour tow in 24 tows from 0 to 1000 m. In samples taken 40 to 264 km off Oregon this species was approximately 2% of the total catch of cephalopods. Jefferts (1983) reported 419 (1.9% of total) from tows in the California Current region. It was the eighth most common cephalopod.

Family Bolitaenidae
Japetella heathi

Found throughout the eastern North Pacific (Jefferts 1983), Pearcy (1965) reported J. heathi accounted for over 3% of the total catch making it the fourth most abundant cephalopod off Oregon. Number per hour tow ranged from 0.03 to 0.21. It was was the second most abundant cephalopod (N=170) in 335 samples taken 120 km off Newport, OR (Pearcy et al. 1977). In the California Current region J. heathi was second most common, comprising 9.2% of the cephalopods (Jefferts 1983).

Family Octopodidae
Octopus sp.

Species of Octopus are difficult to identify. Many specimens from midwater trawls are immature and cannot be identified. Octopods comprised about 2% of cephalopods off Oregon (Pearcy 1965). Pearcy et al. (1977) collected 38 specimens in 335 samples from 120 km off Newport, OR. Octopus occur along the entire North Pacific rim. Many of the specimens examined by (Jefferts 1983) were juveniles.

Family Vampyroteuthidae
Vampyroteuthis infernalis

In the eastern Pacific, this species occurs from southern California to Oregon (Jefferts 1983). It represented less than one percent of the total cephalopod catch off Oregon (Pearcy 1965). Jefferts (1983) reported 76 individuals caught in the California current region.

2. Reproduction

Information on cephalopod reproduction of is lacking throughout the world, especially in the eastern North Pacific. Most studies in this region simply describe species composition and distribution. Summaries of catches of early life stages of gonatids from the North Pacific have provided some data on reproduction of this important family (Kubodera and Jefferts 1984a). The summaries below include data from within GRLA and outside it.

Family Enoploteuthidae
Abraliopsis felis

Small A. felis ([30 mm dorsal mantel length (DML)) were most abundant in summer off Oregon (Pearcy 1965). During the rest of the year larger animals were present, suggesting seasonal breeding.

Family Gonatidae
Gonatus berryi

In samples from the eastern North Pacific larvae were present from May to November, and juveniles from May to January (Kubodera and Jefferts 1984). Peak larval abundance was in June and August, and of post-larvae in November.

Gonatus californiensis

Larvae were present in the GRLA in March, May and September, and post-larvae in March (Kubodera and Jefferts 1984).

Gonatus modokai

Larvae were present from late June through mid-August, and post-larvae and juveniles were caught from March through September (Kubodera and Jefferts 1984).

Gonatus onyx

Pearcy (1965) assumed that breeding was not seasonal in this species (reported as G. fabricii), because size distributions for summer and non-summer periods were similar. Larvae are taken almost year round, although post-larvae and juveniles may be more abundant later in the year (Kubodera and Jefferts 1984). Abundance falls off sharply in September, and does not increase until April.

Gonatus oregonensis

Larvae were only present in the eastern North Pacific in December, while post-larvae were caught in February, June, July, and August (Kubodera and Jefferts 1984).

Gonatus pyros

Larvae were infrequently caught, and were present in February, June, July, and September (Kubodera and Jefferts 1984). Post-larvae were caught throughout the year, but peaked in abundance in late spring to late summer. Juveniles were also present throughout the year, but peak abundances were in August and November.

Gonatus sp. A

Larvae were present in catches from February through August; post-larvae were abundant from June through September (Kubodera and Jefferts

1984), suggesting spring hatching and growth to the post-larval stage during early to mid-summer.

Gonatus ursabrunae

Larvae and post-larvae were collected from late June to early August (Kubodera and Jefferts 1984).

Gonatopsis borealis

Larvae and post-larvae were collected year round. Juveniles appeared to be most abundant in mid to late summer, with a possible second peak in late winter (Kubodera and Jefferts 1984). Therefore, the species appears to have a prolonged hatching period.

Berryteuthis anonychus

In the eastern North Pacific there appear to be two abundance peaks, one from July through September, and a second from February through April (Kubodera and Jefferts 1984). Post-larvae are somewhat more frequent than larvae in August and September.

Berryteuthis magister

Larvae were more abundant in early summer, post-larvae and juveniles in late summer (Kubodera and Jefferts 1984).

3. Growth

There are no data on growth rates of cephalopods in the GRLA. There are data on size (dorsal mantle lengths), but these can not be used to estimate growth without data on time of hatching and age at collection.

4. Migrations

Very little is known about vertical or horizontal migrations of cephalopods, especially in the GRLA. Some net collections by Pearcy (1965) and Pearcy et al. (1977) provide data for a limited number of species.

Family Enoploteuthidae
Abraliopsis felis

Pearcy (1965) found greater numbers at the surface at night than during the day, and concluded this species probably has a daily vertical migration. Pearcy et al. (1977) supported this conclusion; most specimens occurred at 300 to 500 m during the day, but most were above 200 m at night.

Family Octopoteuthidae
Octopoteuthis deletron

Most specimens were collected above 200 m both day and night, providing no evidence for diel vertical migration in this species (Pearcy et al. 1977).

Family Gonatidae
Gonatus onyx

Highest catches of this species occurred at night in tows to 200 m; daytime tows had the largest catches in tows to 500 m (Pearcy et al. 1977), suggesting diel vertical migration into the upper 200 m at night. One hundred twenty km off Oregon, most animals were above 200 m at night while daytime samples had the greatest number of individuals between 300 and 500 m (Pearcy et al. 1977).

Gonatus pyros

There was some evidence of diel vertical migration from 335 samples taken 120 km off Newport, OR (Pearcy et al. 1977). The majority of captures were above 300 m at night, and between 300 to 500 m during the day.

Gonatopsis borealis

Pearcy et al. (1977) collected three specimens at night above 300 m, but during the day all captures were between 200 and 500 m, suggesting diel vertical migration in this species.

Family Chiroteuthidae
Chiroteuthis calyx

Pearcy et al. (1977) found part of the population of this species moved below 200 m during the day, although some remained between 0 and 100 m.

Family Cranchiidae
Taonius pavo

T. pavo is mesopelagic between 200 and 1000 m (Pearcy 1965). Pearcy et al. (1977), found a slight increase in abundance in the upper 200 m during the night. The majority were below 200 m.

Galiteuthis phyllura

This species only occurred below 200 m, and does not appear to migrate vertically (Pearcy 1965).

Family Bolitaenidae
Japetella heathi

Pearcy (1965) considered this to be a mesopelagic species, infrequently occurring in the upper 200 m. Pearcy et al. (1977),

however, found a few animals above 100 m. Some evidence suggested that during the day some individuals move below 400 m.

Family Octopodidae
Octopus sp.

Samples from 120 km off Newport show no signs of diel vertical migration (Pearcy et al. 1977). Individuals were present between 0 and 600 m throughout the day.

5. Food habits

Food habits of cephalopods are especially difficult to study because prey is minced by the beak and radula before being swallowed. There has been absolutely no work on the feeding habits of cephalopods in the GRLA and much of the North Pacific. The market squid, Loligo opalescens, which has not been caught in the GRLA, is the only squid species for which there is some information on prey.

6. Commercial exploitation

There presently is no commercial harvesting of cephalopods in the GRLA (Laevastu and Fiscus 1978). Although there appears to be ample biomass of cephalopods, there is no fishery. Loligo opalescens is harvested in California and Oregon, but all the catches come from nearshore spawning grounds, none from off the continental shelf. The Japanese harvest squids in the North Pacific, using drift nets and jigs, but their activities do not extend as far south as the GRLA.

B. Relevant Studies Outside the Gorda Ridge Lease Area.

1. Distribution and abundance

Family Enoploteuthidae
Abraliopsis felis

Larval Abraliopsis were 0 to 120 individuals per $10^3 m^3$ between 35° and 40° N (Okutani and McGowan 1969). Larval abundance in 1954 between April and December gradually increased until June and July, then decreased with the approach of autumn. Larvae were most abundant in May through August (Okutani and McGowan 1969).

Family Gonatidae
Gonatus berryi

Kubodera and Jefferts (1984) found <0.05 to <0.15 individuals per 10^3m^3 in the region north of the GRLA. Length were from <10 mm DML to >20 mm.

Gonatus modokai

Individuals 10 to 20 mm dorsal mantle length (DML) were 0.05 to 0.15 per 10^3m^3 to the north of the GRLA (Kubodera and Jefferts 1984).

Gonatus onyx

G. onyx was more abundant to the north of the GRLA (<0.05 to >0.50 per 10^3m^3) than to the south (<0.05 to <0.30 per 10^3m^3), both in density and number of samples containing this species (Kubodera and Jefferts 1984). None <10 mm DML were found south of the region.

Gonatus pyros

Kubodera and Jefferts (1984) reported no catches of this species to the south of the GRLA. To the north, individuals >10 mm DML ranged in abundance from <0.05 to >0.50 per 10^3m^3. None <10 mm DML were found in the area to the north.

Gonatus sp. A

To the north of the GRLA, individuals <10 mm DML were from <0.05 to <0.30 per 10^3m^3. Animals 10 to 18 mm DML reached <0.15 per 10^3m^3 (Kubodera and Jefferts 1984).

Gonatopsis borealis

G. borealis occurred often to the north of the GRLA, and relatively rarely to the south. In both regions, it numbered between <0.05 and <0.30 per 10^3m^3.

Berryteuthis anonychus

This species did not occur south of the GRLA. To the north, abundance was <0.05 to 0.15 per 10^3m^3 (Kubodera and Jefferts 1984).

Berryteuthis magister

B. magister occurs both north and south (more often to the north) of the GRLA in abundances from <0.05 to 0.30 per 10^3m^3 (Kubodera and Jefferts 1984).

Family Ommastrephidae
Ommastrephes bartramii

An experimental fishery to the north of the GRLA has produced estimates of the O. bartramii population based on catch per unit effort

(CPUE) data (Robinson and Jamieson 1984). Drift gill nets fished between July and August 1983, caught 51.9 to 646.3 kg squid per km of net, or 6.65 to 86.17 kg/km/hr. This species composed 56.8% of the squid catch in the gill nets, with a mean CPUE of 339.2 kg squid/km and 39.68 kg squid/km/hr.

Family Cranchiidae
Heliocranchia pfefferi

Larvae of this species were captured at only one station south of the GRLA (Okutani and McGowan 1969).

2. Reproduction

Family Onychoteuthidae
Onychoteuthis borealijaponicus

Mercer and Bucy (1983) examined 272 males and 183 females collected north of the GRLA. Sperm packets were developing in males during late July, although other signs of sexual maturation were not evident in late August and early September. Sexual maturity occurred at 250 to 280 mm DML. Spawning may occur in early to mid-winter and hatching in mid to late-winter. Maturity of NE Pacific O. borealijaponicus occurs approximately one to two months later than off the coast of Japan.

Family Cranchiidae
Heliocranchia pfefferi

The few data concerning larval abundance south of the GRLA seem to indicate spawning in spring and summer (Okutani and McGowan 1969).

3. Growth

O. borealijaponicus is the only species for which there are growth data (Mercer and Bucy 1983). Nothing which would supplement the meager data collected within the region is known regarding the growth of cephalopods outside the GRLA.

Family Onychoteuthidae
Onychoteuthis borealijaponicus

Mercer and Bucy (1983) reported growth of one size group in mean DML from 92 mm in mid-May to 176 mm in late-August, representing a growth rate of approximately 2 cm DML per month. This corresponds well with data derived from squids in the northwestern Pacific (Mercer and Bucy 1983).

4. Migrations

Lack of adequate samples allows few conclusions regarding vertical or horizontal migrations.

Family Onychoteuthidae
Onychoteuthis borelijaponicus

Mercer and Bucy (1983) suggested that this species may migrate north past Washington to spawn.

5. Food habits

Family Ommastrephidae
Ommastrephes bartramii

Twelve specimens were examined for feeding habits. These squids fed on their own species (66%), other squid and some fishes (17%), and 17% had empty stomachs (Robinson and Jamieson 1984).

6. Commercial exploitation

Loligo opalescens is the only species of squid taken in sizable numbers commercially. Catches have fluctuated from 25.8 to 1904.1 X 10^3 kg/yr in California (Dewees and Price 1982). Since 1982 a fishery for this species has developed off Oregon. Landings have been 51,363, 135,000, 430,454, and 795,454 kg/year, 1982 to date (R. Starr, Oregon Department Fish and Wildlife, pers. comm.). L. opalescens, however, does not appear to live in the GRLA, but over the continental shelf. Dosidicus gigas has become the target of a fishery in southern California and Mexico, but its range does not extend north into the GRLA (Dewees and Price 1982).

There have been few successful ventures into full commercial harvesting of species occurring in the GRLA. Some recent experimental fisheries have been tried north of the GRLA off Washington and British Columbia (Bernard 1981, Mercer and Bucy 1983, Robison and Jamieson 1984, Sloan 1984). Interest in developing cephalopod fisheries in this area is keen, although a fishery has not begun.

Family Onychoteuthidae
Onychoteuthis borealijaponicus

Experimental jigging off the coast of Washington between May and September 1981 caught 1259 O. borealijaponicus in 107.6 hrs fishing (Mercer and Bucy 1983). Onychoteuthis borealijaponicus was only encountered on four nights off Vancouver Island during July and August 1983 (Sloan 1984). Catches ranged from 1.5 to 6.2 kg, with a corresponding effort of 99 and 210 man and machine hours per station.

Family Ommastrephidae
Ommastrephes bartramii

In the offshore waters of the eastern North Pacific O. bartramii has received the most attention regarding fishery development. Only two were caught in 107.6 hrs of squid jigging off Washington in 1981 (Mercer and

Bucy 1983). The species was much more abundant off Vancouver Island, where catches ranged from 516 to 22905 kg in gill nets, and 0 to 95 kg in jigs (Sloan 1984). Catch per unit effort for gill nets ranged from 2.6 to 86.7 kg/km/hr; for jigging, CPUE ranged from 0 to 10.75 kg squid/hr. Drift nets fished for this species off Vancouver Island between July and August 1983 and caught 130 to 3214 kg per day (Robinson and Jamieson 1984). CPUE estimates were 6.65 to 86.17 kg squid/km/hr.

C. Gaps In The Data

Cephalopods, more than any other nektonic group, are poorly known. Their excellent eye sight and high swimming speeds make them difficult to capture in nets. Much of what we know in the GRLA comes from small midwater trawls samples, which primarily catch small adults or larvae. Effective capture of large, fast swimming adults, requires a large net fished at greater speeds through the entire water column. This is both costly and time consuming.

For some species a little information is available regarding their distribution and abundance. For most species, however, there are only records of occurrence and very little else. Because larvae are more easily captured, there is some data on reproduction (e.g. spawning times). For the rest of the parameters discussed here, however, virtually nothing is known.

The most important data required for the GRLA is that of abundance and distribution of cephalopods in the water column over the ridge. These data are needed to assess whatever potential affects exploration may have on the populations. Subsequent studies should then examine the reproduction, growth, movements, and feeding habits of these species.

III. FISHES

A. Studies Within The Gorda Ridge Lease Area.

The lease area begins approximately 40 to 75 km offshore. The distance from shore has limited the number of studies of fishes in the region and the great depth of the water has imposed difficulties in sampling the water column. Sampling demersal and epibenthic fishes is especially difficult. Many regional studies have begun or ended in the area and it has therefore been peripheral to most. California Cooperative Oceanic Fisheries Investigations (CalCOFI) has provided a wealth of information on ichthyoplankton in California, but these studies stopped at the California-Oregon border. Studies by S.L. Richardson and colleagues at Oregon State University have provided much of the information on larvae off the coast of Oregon. Many of the studies dealing with adult fishes in this region have been carried out by William G. Pearcy, David L. Stein, their colleagues, and students at Oregon State University. Although a great deal is known about the environment and fauna on the continental shelf, the waters at great depths and distance from shore are rarely investigated. There are few published accounts of the fish fauna inhabiting the abyssal areas of the Pacific Ocean (Pearcy et al. 1982). Therefore, the fishes within the Gorda Ridge lease area and surrounding waters are comparatively poorly known.

1. Distribution and abundance

There have been few systematic collections of fishes in this area. Therefore, abundance estimates for the various fish species occurring in the lease area are limited. Most population studies concern deep water species caught in midwater trawls, or commercially important albacore which are caught trolling. The following discussion includes only those species for which information exists on population abundance or density within the lease area. For fish species which occur in Table 3, but are not included in the discussion, there are no data on density or population size. Distributional data are from Eschmeyer et al. (1983), unless stated otherwise.

Family Petromyzontidae
Lampetra tridentata

This species ranges from Japan and the Bering Sea south to central Baja.

Family Chimaeridae
Hydrolagus colliei

This species is found from southeast Alaska to Baja and northern Gulf of California. It is common between British Columbia and northern California, and has been recovered from 913 m depth.

Table 3. List of species and common names of fishes which are known or expected to occur in the GRLA. Species are listed if they have been collected or observed in the lease area, or if their known distribution overlaps the region. The families and species are listed in the order as given by Nelson (1984). Common names are taken from Robins et al. (1980), Hart (1973), and Miller and Lea (1972). Species which occur in the lease area only as larvae, the adults occurring on the shelf, are marked with an asterisk (*).

Species	Common Name
Petromyzontidae	
Lampetra tridentata	Pacific lamprey
Chimaeridae	
Hydrolagus colliei	spotted ratfish
Hexanchidae	
Hexanchus griseus	sixgill shark
Notorhynchus maculatus	sevengill shark
Lamnidae	
Alopias vulpinus	thresher shark
Carcharodon carcharias	white shark
Cetorhinus maximus	basking shark
Isurus oxyrinchus	shortfin mako
Scyliorhinidae	
Apristurus brunneus	brown cat shark
Carcharinidae	
Galeorhinus zyopterus	soupfin shark
Prionace glauca	blue shark
Squalidae	
Somniosus pacificus	Pacific sleeper shark
Squalus acanthias	spiny dogfish
Rajidae	
Bathraja abyssicola	deepsea skate
Bathyraja spinosissima	
Bathyraja kincaidi	sandpaper skate
Bathyraja trachura	roughtail skate
Raja binoculata	big skate
Raja inornata	California skate
Raja rhina	longnose skate
Raja stellulata	starry skate

Notacanthidae	
Notacanthus chemnitzii	
Polyacanthonotus challengeri	
Nemichthyidae	
Avocettina infans	
Nemichthys larseni	
Nemichthys scolopaceus	slender snipe eel
Cyematidae	
Cyema atrum	
Serrivomeridae	
Serrivomer ?sector	
Saccopharyngidae	
Saccopharynx sp.	
Engraulidae	
Engraulis mordax*	northern anchovy
Argentinidae	
Nansenia candida	*bluethroat argentine
Argentina sialis	*Pacific argentine
Bathylagidae	
Bathylagus berycoides	
Bathylagus milleri	*stout blacksmelt
Bathylagus ochotensis	*eared blacksmelt
Bathylagus pacificus	*slender blacksmelt
Bathylagus wesethi	
Bathylagus stilbius	California smoothtongue
Opisthoproctidae	
Bathylychnops exilis	
Dolichopteryx longipes	brownsnout spookfish
Macropinna microstoma	barreleye
Alepocephalidae	
Alepocephalus tenebrosus	California slickhead
Bellocia alvifrons	
Bathylaco nigricans	
Conocara salmoneum	
Leptochilichthys agassizi	
Nemabathyroctes bifurcata	
Searsiidae	
Holtbrynia sp.	
Maulisia sp.	
Mirorictus taningi	
Pellisolus sp.	
Sagamichthys abei	

Salmonidae	
Oncorhynchus gorbuscha	pink salmon
Oncorhynchus keta	chum salmon
Oncorhynchus kisutch	coho salmon
Oncorhynchus nerka	sockeye salmon
Oncorhynchus tshawytscha	chinook salmon
Salmo gairdneri	rainbow trout
Gonostomatidae	
Cyclothone acclinidens	benttooth bristlemouth
Cyclothone alba	
Cyclothone atraria	
Cyclothone microdon	veiled anglemouth
Cyclothone pallida	
Cyclothone pseudopallida	
Cyclothone signata	
Danaphos oculatus	bigeye lightfish
Gonostoma atlanticum	
Sternoptychidae	
Argyropelecus affinis	slender hatchetfish
Argyropelecus hemigymnus	spurred hatchetfish
Argyropelecus sladeni	silvery hatchetfish
Argyropelecus lychnus	silver hatchetfish
Sternoptyx diaphana	
S. obscura	
Chauliodontidae	
Chauliodus macouni	Pacific viperfish
Astronesthidae	
Borostomias panamensis	
Rhadinesthes ?decimus	
Melanostomiidae	
Bathophilus flemingi	highfin dragonfish
Eustomias sp. A	
Leptostomias gladiator?	
Melanostomais biseriatus	
Opostomias mitsuii	
Photonectes margarita	
Tactostoma macropus	longfin dragonfish
Malacosteidae	
Aristostomias scintillans	
Idiacanthidae	
Idiacanthus antrostomus	
Scopelarchidae	
Benthalbella dentata	northern pearleye
Benthalbella linguidens	

Notosudidae	
Scopelosaurus harryi	scaly paperbone
Synodontidae	
Bathysaurus mollis	
Paralepididae	
Lestidium ringens	slender barracudina
Notolepis rissoi	
Paralepis atlantica	duckbill barracudina
Anotopteridae	
Anotopterus pharao	daggertooth
Alepisauridae	
Alepisaurus ferox	longnose lancetfish
Neoscopelidae	
Scopelengys tristis	
Myctophidae	
Ceratoscopelus townsendi	
Diaphus ?fulgens	
Diaphus micropunctatus	
Diaphus rafinesquii form R-1	
Diaphus rafinesquii form R-2	
Diaphus theta	California headlightfish
Dorsadena yaquinae	
Electrona risso	
Lampadena urophaos	
Lampanyctus fernae	
Lampanyctus jordani	
Lampanyctus regalis	pinpoint lampfish
Lampanyctus ritteri	broadfin lampfish
Lamannyctus sp. B	
Notoscopelus resplendens	patchwork lampfish
Parvilux ingens	
Protomyctophum crockeri	flashlightfish
Protomyctophum thompsoni	
Stenobrachius leucopsarus	northern lampfish
Stenobrachius nannochir	
Symbolophorus californiensis	California lanternfish
Taaningichthys bathyphilum	
Taaningichthys paurolychnus	
Tarletonbeania crenularis	blue lanternfish
Tarletonbeania taylori	
Trophorturus mexicanus	
Moridae	
Antimora microlepis	finescale codling
Melanonidae	
Melanonus zugmayeri	

Merlucciidae	
Merluccius productus	Pacific hake
Macrouridae	
Albatrossia pectoralis	pectoral rattail
Coryphaenoides acrolepis	roughscale rattail
Coryphaenoides armatus	
Coryphaenoides cinereus	
Coryphaenoides filifer	filamented rattail
Coryphaenoides leptolepis	
Coryphaenoides yaquinae	
Nezumia stelgidolepis	California rattail
Ophidiidae	
Bassozetus sp. A	
Dicrolene filamentosa	
Spectrunculus grandis	
Aphyonidae	
Barathronus pacificus	
Sciadonus pedicellaris	
Ceratiidae	
Ceratias holbolli	
Cryptopsaras couesi	warted seadevil
Oneirodidae	
Bertella idiomorpha	
Chaenophryne longiceps	
Chaenophryne melanorhabdus	
Dolopichthys longicornis	
Leptacanthichthys gracilispinis	
Oneirodes bulbosus	
Oneirodes thompsoni	
Exocoetidae	
Cypselurus californicus	California flyingfish
Scomberesocidae	
Cololabis saira	Pacific saury
Lampridae	
Lampris guttatus	opah
Trachipteridae	
Trachipterus altivelis	king-of-the-salmon
Anoplogastridae	
Anoplogaster cornuta	
Melamphaidae	
Melamphaes lugubris	highsnout melamphid
Melamphaes parvus	
Poromitra crassiceps	crested melamphid

Scopeloberyx nycterinus	
Scopelogadus mizolepis	twospine mizolepis
Rondeletiidae	
Rondeletia loricata	
Cetomimidae	
?*Cetomimus* sp.	
Cetostomus sp.	
Ditropichthys storeri	
Gyrinomimus sp.	
Scorpaenidae	
*Sebastes aleutianus**	rougheye rockfish
*Sebastes alutus**	Pacific ocean perch
*Sebastes babcocki**	redbanded rockfish
*Sebastes crameri**	darkblotched rockfish
*Sebastes diploproa**	splitnose rockfish
*Sebastes flavidus**	yellowtail rockfish
*Sebastes helvomaculatus**	rosethorn rockfish
*Sebastes ruberrimus**	yelloweye rockfish
*Sebastes saxicola**	stripetail rockfish
Sebastolobus alascanus	shortspine thornyhead
Sebastolobus altivelis	longspine thornyhead
Anoplopomatidae	
Anoplopoma fimbria	sablefish
Cottidae	
Zesticelus profundorum	flabby sculpin
Psychrolutidae	
Psychrolutes phrictus	
Agonidae	
Bathyagonus nigripinnis	blackfin poacher
Cyclopteridae (Liparidae)	
Acantholiparis caecus	
Acantholiparis opercularis	
Careproctus cypselurus	
Careproctus filamentosus	
Careproctus gilberti	
Careproctus longifilis	
Careproctus melanurus	blacktail snailfish
Careproctus microstomus	
Careproctus oregonensis	
Careproctus ovigerum	abyssal snailfish
Elassodiscus cypselurus	
Nectoliparis pelagicus	tadpole snailfish
Odontoliparis ferox	
Osteodiscus cascadiae	
Paraliparis cephalus	
Paraliparis dactylosus	

Paraliparis deani	prickly snailfish
Paraliparis latifrons	
Paraliparis megalopus	
Paraliparis melanobranchus	
Paraliparis mento	
Paraliparis paucidens	
Paraliparis pectoralis	
Paraliparis rosaceus	
Paraliparis ulochir	
Paraliparis attenuatus	
Paraliparis barbulifer	
Rhinoliparis attenuatus	
Percichthyidae	
Howella brodiei	
Apogonidae	
Rhectogramma sherborni	
Carangidae	
Seriola dorsalis	yellowtail
Trachurus symmetricus	jack mackerel
Bramidae	
Brama japonica	Pacific pomfret
Taractes asper	rough pomfret
Caristiidae	
Caristius macropus	
Scorpididae	
Medialuna californiensis	half-moon
Pentacerotidae	
Pentaceros richardsoni	pelagic armorhead
Zoarcidae	
Bothrocara brunneum	twoline eelpout
Bothrocara molle	soft eelpout
Bothrocara pusillum	
Bothrocara remigerum	
Derepodichthys alepidotus	
Embryx crotalinus	flatcheek eelpout
Lycenchelys camchatica	
Lycenchelys jordani	shortjaw eelpout
Lycenchelys sp. A	
Cycenchelys sp. B	
Lycenchelys sp. C	
Lycenchelys sp. D	
Lycenchelys sp. E	
Lycodapus dermatinus	
Lycodapus endemoscotus	
Lycodapus fierasfer	blackmouth eelpout
Lycodapus mandibularis	pallid eelpout

Lycodapus pachysoma	
Lycodes brevipes	shortfin eelpout
Lycodes diapterus	black eelpout
Lycodes sp. A	
Lycodopsis pacifica	blackbelly eelpout
Lyconema barbatum	bearded eelpout
Maynea bulbiceps	
Melanostigma pammelas	midwater eelpout
Taranetzella lycoderma	
Zaproridae	
Zaprora silenus	
Chiasmodontidae	
Dysalotus oligoscolus	
Kali ?normani	
Icosteidae	
Icosteus aenigmaticus	ragfish
Trichiuridae	
Aphanopus carbo	black scabbardfish
Benthodesmus elongatus	
Scombridae	
Thunnus alalunga	albacore
Luvaridae	
Luvarus imperialis	
Stromateidae	
Icichthys lockingtoni	medusafish
Peprilus simillimus	Pacific pompano
Tetragonurus cuvieri	smalleye squaretail
Bothidae	
*Citharichthys sordidus**	Pacific sanddab
*Citharichthys stigmaeus**	speckled sanddab
Pleuronectidae	
*Atheresthes stomias**	arrowtooth flounder
Embassichthys bathybius	deepsea sole
*Glyptocephalus zachirus**	rex sole
*Hippoglossus stenolepis**	Pacific halibut
*Lyopsetta exilis**	slender sole
*Microstomus pacificus**	Dover sole
*Parophrys vetulus**	English sole
Molidae	
Mola mola	ocean sunfish

Family Hexanchidae
Hexanchus griseus

The sixgill shark is found in all temperate waters of the world, and in the north Pacific ranges from the Aleutian Islands to northern Baja.

Notorhynchus maculatus

The sevengill shark is most commonly found off central California, but ranges from northern British Columbia to Gulf of California.

Family Lamnidae
Alopias vulpinus

This species is found worldwide in warm seas, and in the North Pacific is found from British Columbia to Chile. Adults are usually offshore and epipelagic, while the young are found nearshore and in bays.

Carcharodon carcharias

The white shark is found from Gulf of Alaska to Gulf of California, and appears to associate with islands with seals and sea lions.

Cetorhinus maximus

The range of this species extends from Aleutian Islands and Gulf of Alaska to Gulf of California and Chile. Generally coastal and epipelagic.

Isurus oxyrinchus

Range extends from Oregon to Gulf of California, although it is thought to be rare north of southern California. Found nearshore and in the epipelagic zone.

Family Scyliorhinidae
Apristurus brunneus

The brown cat shark is found from southeast Alaska to northern Baja, and in deep water to 1189 m.

Family Carcharinidae
Galeorhinus zyopterus

The soupfin shark is generally known from northern British Columbia to central Baja, Peru and Chile. It may inhabit offshore waters to a depth of 411 m.

Prionace glauca

In the North Pacific this species is known from Gulf of Alaska to Chile. Blue sharks can be found mostly offshore and near the surface.

Family Squalidae
Somniosus pacificus

This species has been caught as deep as 2000 m, and is found from Japan and the Bering Sea to Baja.

Squalus acanthias

The spiny dogfish is distributed from Alaska to central Baja, and is thought to be mostly coastal.

Family Rajidae
Bathyraja abyssicola

This rare deepwater skate is known from Bering Sea to northern Baja (Hart 1973), and has been found to depths of 7904 m.

Bathyraja spinosissima

The white skate is found from Oregon to Costa Rica, and inhabits water to a depth of 2000 m (Miller and Lea 1972).

Bathyraja kincaidi

This species has a distribution from Alaska to southern California, and is usually associated with the bottom depths of 1372 m.

Bathyraja trachura

The black skate is found from the Bering Sea to northern Baja. This species is associated with the bottom and has been found as deep as 2000 m.

Raja binoculata

The known distribution of this species is from the Bering Sea and southeast Alaska to central Baja, in water to depths of 110 m.

Raja inornata

This species is found from Straits of Juan de Fuca to central Baja, and as deep as 671 m.

Raja rhina

The longnose skate can be found from southeast Alaska to central Baja, and to depths of 622 m.

Raja stellulata

This species is known from the Bering Sea to northern Baja, and to depths of 732 m.

Family Notacanthidae
Polyacanthonotus challengeri

This species is known from Japan, Bering Sea, and British Columbia (Hart 1972), but is presumed to occur farther south than these records indicate.

Family Nemichthyidae
Avocettina infans

This species has been recorded from British Columbia to Gulf of Panama, and to depths of 600 m (Hart 1972).

Nemichthys scolopaceus

The slender snipe eel is found from Central America to Alaska and Japan, and has been recorded as deep as 2000 m (Miller and Lea 1972, Hart 1973).

Family Cyematidae
Cyema atrum

This species most likely can be found between Oregon and Panama to depths of 610 m.

Family Engraulidae
Engraulis mordax

The northern anchovy is found from Queen Charlotte Island to the tip of Baja. This species is usually found nearshore and near the surface, although it has been caught at 219 m.

This species inhabits the lease area only as larvae. Adults spawn in shelf waters and the larvae are advected offshore, first appearing in the area around June. Abundances range from less than one per $10^3 m^3$ to greater than 100 per $10^3 m^3$ (Richardson 1973). Larvae are largely confined to surface waters. In April-May 1983, an estimated 21 individuals per $10^3 m^3$ occurred at one station (Clark and Kendall 1985).

Family Argentinidae
Nansenia candida

This species is known from Queen Charlotte Islands to California, and to a depth of 825 m (Hart 1973).

Argentina sialis

This species has an offshore distribution from Oregon to southern Baja and Gulf of California, in depths to 274 m.

Family Bathylagidae
Bathylagus milleri

In the North Pacific this species ranges from Japan and Bering Sea to northern Baja, and is found to a depth of over 1000 m (Miller and Lea 1972).

During eight cruises for midwater fishes between 1969 and 1973, B. milleri was caught on two (Pearcy 1977). Abundance was 0.2 to 1.7 fish per $10^5 m^3$ in daytime tows of the upper 500m. Pearcy (1964) reported catching 17 individuals of this species in 47 tows between 0 and 1000 m at a station 93 km west of Newport. Collections 100 to 158 km west of Newport revealed peak abundance of 10 to 18 individuals per $10^5 m^3$ during the day at 650 m (Willis and Pearcy 1982). Peak abundance at night occurred at 500 m where there were 2 to 12 per $10^5 m^3$.

Bathylagus ochotensis

Miller and Lea (1972) reported the distribution of this species to be from Bering Sea and Sea of Okhotsk to northern Baja, and to a depth of 1000 m.

Pearcy (1964) reported the results of deepwater tows off Newport and Coos Bay, Oregon from 15 to 165 miles offshore. Two stations (15 and 25 miles) were outside the lease area. Thirty-two B. ochotensis were caught in 22 of 75 hauls. B. ochotensis larvae are a major component of the ichthyoplankton in the lease area. Abundance ranged from 8 to 67 individuals per $10m^2$ in April through May 1980, and 6 to 63 individuals per $10m^2$ in May through June 1981 (Kendall and Clark 1982; Clark 1984). Seven to 128 larvae per $10m^2$ were estimated to occur in the waters of the lease area during April-May 1983 (Clark and Kendall 1985).

Bathylagus pacificus

This species has been found to depths of over 1000 m, and from Bering Sea and Kuril-Kamchatka Trench to southern California (Miller and Lea 1972).

B. pacificus averaged 0.3 to 4.3 individuals per $10^5 m^3$ in daytime IKMT net tows in the upper 500m (Pearcy 1977). Pearcy (1964) caught 63 specimens of this species in 47 midwater tows between 0 and 1000 m at a station 93 km from Newport. Peak densities of 40 and 48 animals per $10^5 m^3$ occurred at 650 m night and day hours, respectively (Willis and Pearcy 1982). These samples, from a large pelagic trawl towed in an area 100 to 158 km off Newport, revealed average densities ranging from 0 to 6 individuals per $10^5 m^3$ at 500 m to 23 to 28 animals per $10^5 m^3$ at 650 m.

Bathylagus wesethi

This species is known from Oregon to central Baja, and to a depth of over 1000 m (Miller and Lea 1972).

Bathylagus stilbius

This species has a distribution in the North Pacific from Colombia, South America to Bering Sea and Sea of Okhotsk, and is found to a depth of 800 m (Miller and Lea 1972).

Family Opisthoproctidae
Macropinna microstoma

The barreleye is found from Bering Sea to Baja, and to a depth of 890 m. Willis and Pearcy (1982) reported average densities of 2 to 3 M. microstoma per $10^5 m^3$ from trawls 100 to 158 km off Newport. Most individuals were caught at 500 m, but a few were deeper.

Family Alepocephalidae
Alepocephalus tenebrosus

This species occurs from Bering Sea to at least California, and to a depth of 1524 m.

Family Searsiidae
Sagamichthys abei

This species is found from British Columbia to California.

Family Salmonidae
Oncorhynchus gorbuscha

The pink salmon is distributed from Japan through the Arctic Ocean south to northern California, occasionally appearing as far south as La Jolla.

Oncorhynchus keta

The chum salmon is known to occur from Japan through Arctic Alaska and south to San Diego, California.

Oncorhynchus kisutch

The coho salmon is distributed from Korea and Japan through arctic Alaska to Baja.

Oncorhynchus nerka

This species occurs from northern Japan through Bering Sea and to southern California.

Oncorhynchus tshawytscha

The king salmon is found from Japan to the Bering Sea and down to San Diego.

Salmo gairdneri

Steelhead are found in the sea from Japan and Bering Sea to central California.

Family Gonostomatidae
Cyclothone acclinidens

C. acclinidens is found in the eastern Pacific from Peru-Chile trench to Oregon, and to a depth of over 1000 m (Miller and Lea 1972). This species was caught in large pelagic trawls 100 to 158 km off Newport (Willis and Pearcy 1982). Average maximum densities were 13 and 3 individuals per $10^5 m^3$ at 800 m during night and day, respectively. A maximum density of 17 animals per $10^5 m$ occurred at 800 m during daytime.

Cyclothone atraria

Daytime trawls within the upper 500 m of the water column captured this species during six of the eight cruises within the lease area (Pearcy 1977). C. atraria numbered between 0.3 and 14.9 individuals per $10^5 m^3$ when present. One hundred to 158 km off Newport, average densities of 1 to 4 individuals per $10^5 m^3$ for daytime tows, and 1 to 12 individuals per $10^5 m^3$ for nighttime tows occurred (Willis and Pearcy 1982). Maximum density for this species was 18 individuals per $10^5 m^3$ at night at 800 m.

Cyclothone microdon

This species is found from Japan through the Bering Sea to California, and to a depth of 5300 m (Hart 1973). Pearcy (1964) reported on 47 midwater trawls 50 nm offshore from Newport which caught 273 of this species between 0 and 1000 m. These specimens were probably misidentified and were most likely C. atraria.

Cyclothone pseudopallida

Average densities of this species from a large pelagic trawl fished 100 to 158 km off Newport were 2 to 4 individuals per $10^5 m^3$ at a depth of 500 m for night and day hours, respectively. The number of animals of this species fell off rapidly below 500 m.

Cyclothone signata

Forty-seven midwater trawls between 0 and 1000 m caught 376 individuals (Pearcy 1964). Average densities of 3.5 and 9 individuals per $10^5 m^3$ occurred at 500 m depth for night and daytime samples, respectively. Up to 16.5 individuals per $10^5 m^3$ occurred at 500 m during the day (Willis and Pearcy 1982).

Danaphos oculatus

In the eastern Pacific this species ranges from Oregon to Gulf of Panama, and is found to a depth of 400 m (Miller and Lea 1972).

Family Sternoptychidae
Argyropelecus affinis

The slender hatchetfish is found from Oregon to California, and to a depth of 650 m (Miller and Lea 1972).

Argyropelecus hemigymnus

In the eastern Pacific this species is known from Oregon to California, and to 800 m depth (Miller and Lea 1972).

Argyropelecus sladeni

In the eastern Pacific this species is found from British Columbia to southern Baja, and to a depth of 650 m (Miller and Lea 1972).

Argyropelecus lychnus

In the eastern Pacific the silver hatchetfish is known from British Columbis to South America, and to a depth of 4066 m (Hart 1973).

Family Chauliodontidae
Chauliodus macouni

This species is distributed from Gulf of Alaska to central Baja, and can be found to a depth of 1500 m. Pearcy (1964) reported 210 specimens from 47 tows 80 km offshore from Newport. Peak densities of 0.15 individuals per $10^3 m^3$ occurred near 400 m at a station 120 km off Newport (Pearcy et al. 1977). Between 500 and 1000 m depth densities of C. macouni averaged 12 to 17 individuals per $10^5 m^3$ at 500 m, and steadily declined with depth for both day and night samples (Willis and Pearcy 1982).

Family Melanostomiidae
Bathophilus flemingi

This species has been reported from British Columbia to Baja.

Tactostoma macropus

The longfin dragon fish is known to occupy the waters from Gulf of Alaska to southern California, and to a depth of 600 m (Miller and Lea 1972).

T. macropus was the fourth most abundant mesopelagic fish species off Oregon (Pearcy 1964). Pearcy and Laurs (1966) reported 36.9 individuals per $10^3 m^2$ within the upper 150 m 80 km offshore from Newport; there were 8.7 individuals per $10^3 m^2$ between 150 and 500 m depth. There were 1.3 to 35.9 individuals per $10^5 m^3$ during eight cruises within the lease area (Pearcy 1977). Analysis of 335 IKMT tows 120 km off Newport showed 0.5 individuals per 1000 m^3 near the surface at night (Pearcy et al. 1977). During the day, peak abundance was at 500 m (0.24 individuals per $10^3 m^3$). T. macropus occurred in densities as high as 24 individuals per $105 m^3$ at 500 m 100 to 158 km off Newport. Night tows

consistently showed densities of 0.5 to 1 individual per $10^5 m^3$ from 500 to 1000 m, whereas day tows averaged 17 individuals per $10^5 m^3$ at 500 m.

Family Malacosteidae
Aristostomias scintillans

This species is known from southern British Columbia to central Baja. A. scintillans was only collected on one of eight cruises in the lease area between 1969 and 1973 (Pearcy 1977). Average abundance was 0.2 individuals per $10^5 m^3$.

Family Idiacanthidae
Idiacanthus antrostomus

This species occurs from California to the eastern tropical Pacific.

Family Scopelarchidae
Benthalbella dentata

The northern pearleye is found in the North Pacific from Gulf of Alaska to Baja, and to a depth of 1000 m. Nineteen B. dentata were collected in 104 midwater trawls 80 km east of Newport (Pearcy 1964). Average density of 0 to 2 individuals per $10^5 m^3$ occurred between 0 and 1000 m at a location 100 to 158 km off Newport (Willis and Pearcy 1982). It was not abundant at 650 m during the day (4.3 individuals per $10^5 m^3$).

Notosudidae
Scopelosaurus harryi

In the North Pacific this species is found from Japan, British Columbia and southern California, and to a depth of 800 m.

Family Paralepididae
Lestidium ringens

This species is distributed from British Columbia to central Baja.

Notolepis rissoi

This species is known from British Columbia to Mexico, and to a depth of 2200 m (Hart 1973).

Family Anotopteridae
Anotopterus pharao

The daggertooth is found from Japan and Bering Sea to California (Miller and Lea 1972).

Family Alepisauridae
Alepisaurus ferox

In the eastern Pacific this species is found from Unalaska Island, Alaska to Chile (Miller and Lea 1972).

Family Neoscopelidae
Scopelengys trisits

This species is known from California to Chile.

Family Myctophidae
Ceratoscopelus townsendi

This species is found from southern British Columbia to southern California, and to a depth of 400 m (Hart 1973). It is rare in British Columbia.

Diaphus theta

In the North Pacific this species is distributed from Japan and Gulf of Alaska to northern Baja, and is found below 900 m (Miller and Lea 1972).

In eight cruises for midwater fishes in the lease area (Pearcy 1977), D. theta averaged 8.2 to 78.1 individuals per $10^5 m^3$ in the upper 500 m. In 152 samples taken 80 km off Newport, OR from 1962 to 1964, an average of 1.05 individual D. theta per m^2 occurring in the water column from 0 to 1000 m (Pearcy and Laurs 1966). There were 113.2 individuals per 1000 m^2 from 0 to 150 m, and 99.8 individuals per 1000 m^2 from 150 to 500 m depth. In 335 IKMT samples from 120 km off Newport, D. theta reached maximum densities of 0.39 and 0.33 individuals per 1000 m^3 at the surface during night and at 300 to 400 m during the daylight, respectively (Pearcy et al. 1977).

Clark (1984) found between 14 and 485 D. theta larvae per $10m^2$. In April through May 1983, there were 14 to 946 larvae per $10m^2$ (Clark and Kendall 1985).

Lampanyctus regalis

In the eastern North Pacific this species is known from Gulf of Alaska to Mexico, to depths of 1375 m (Hart 1973).

Between 1961 and 1962, 104 midwater trawls collected 44 individuals 80 km off Newport (Pearcy 1964). All were collected above 1000 m. Lampanyctus regalis was collected on four of the eight cruises in the lease area between 1969 and 1973. Abundances were 0.3 to 2.8 individuals per $10^5 m^3$ in the upper 500 m 80 km off Newport, OR (Pearcy 1977). Willis and Pearcy (1982) reported average densities of 1 to 8 individuals per $10^5 m^3$ during the day (maximum at 650 m), and 2 to 3 individuals per $10^5 m^3$ during the night. Maximum density was 9 individuals per $10^5 m^3$ at 500 m and during the day.

Lampanyctus ritteri

This species is found from British Columbia to Mexico. L. ritteri was caught in 35 of the 75 tows off Newport and Coos Bay in 1961 and 1962 (Pearcy 1964). One hundred and three individuals were caught during these tows. L. ritteri was caught on all eight cruises between 1969 and

1973, and averaged 0.7 to 12.1 individuals per $10^5 m^3$ (Pearcy 1977). In 335 IKMT tows 120 km east of Newport, L. ritteri densities were 0.9 individuals per $10^3 m^3$ at the surface at night and at 500 m during the daytime (Pearcy et al. 1977).

Notoscopelus resplendens

This species is found from British Columbia to southern California (Hart 1973).

Protomyctophum crockeri

The flashlightfish is known from Oregon to southern California, and to a depth of 550 m (Miller and Lea 1972). Present in four of eight cruises off Newport, P. crockeri averaged 0.4 to 1.4 individuals per $10^5 m^3$ (Pearcy 1977). Thirty-seven individuals were collected in 18 of 75 tows off Newport and Coos Bay (Pearcy 1964). Ichthyoplankton surveys collected 6 and 20 larvae per $10m^2$ at stations within the lease area between (Bates 1984).

Protomyctophum thompsoni

This species is distributed from Gulf of Alaska to Baja, and may inhabit depths of 1370 m (Hart 1973). P. thompsoni was collected on all eight cruises for midwater fishes between 1969 and 1973 (Pearcy 1977). It was relatively abundant compared to other species; it averaged 1.7 to 21.5 individuals per $10^5 m^3$. An IKMT 120 km off Newport collected P. thompsoni at densities of about 0.15 and 0.8 individuals per 1000 m^3 at 200 to 400 m during the day (Pearcy et al. 1977).

Stenobrachius leucopsarus

The northern lampfish is found from Japan and Bering Sea to northern Baja. This is the most numerous mesopelagic fish in the lease area; it is approximately 45% of the total catch, and is present in 80% of the tows (Pearcy 1964). Eighty km off Newport, abundances have reached 232.6 individuals per $10^3 m^2$ (0 to 150 m), and 103.2 individuals per $10^3 m^2$ (150 to 500 m) (Pearcy and Laurs 1966). S.leucopsarus was caught during eight cruises off Oregon, and averaged 8.1 to 161.0 individuals per $10^5 m^3$ (Pearcy 1977). Pearcy et al. (1977) towed an IKMT between 0 and 1000 m and caught densities of 0 to 0.34 animals per 1000 m^3. Greatest densities were for animals longer than 30 mm standard length (SL), between 400 to 600 m during the day and near the surface at night. A large pelagic trawl fished 100 to 158 km off Newport caught 1 to 28 individuals per $10^5 m^3$ during the day and 1 to 15 individuals per $10^5 m^3$ at night (Willis and Pearcy 1982). Highest densities occurred at 500 m, where there were up to 36 individuals per $10^5 m^3$.

Larval surveys in the lease area have shown S. leucopsarus is one of the most numerous components of the ichthyoplankton. Concentrations as high as 89.95 individuals per $10^3 m^3$ have been reported (Richardson 1973). Kendall and Clark (1982) calculated an abundance of 8 to 387 individuals per $10m^2$ in April through May 1980. Clark (1984) found from 15 to 1311 individuals per $10m^2$. Seven to 669 larvae per $10m^2$ were

present at the stations occupied during a cruise from April to May 1983 (Clark and Kendall 1983). Thirty of 32 stations contained this species.

Stenobrachius nannochir

Pearcy (1964) reported 41 S. nannochir from 104 midwater trawls 50 nm off Newport. It was only collected on one cruise of eight off Oregon between 1969 and 1973 (Pearcy 1977) In 1971, an average of 1.3 individuals were collected per 10^5m^3. Two to 8 individuals per 10^5m^3 occurred during the day 100 to 158 km off Newport (Willis and Pearcy 1982). Night tows contained 0 to 4 individuals per 10^5m^3. Highest densities occurred at 650 m.

Symbolophorus californiensis

This is an uncommon species off Oregon. It has been recorded off Japan and Alaska to central Baja, and to depths of 1560 m (Hart 1973). Four were collected in four of 75 tows off Oregon within the lease area (Pearcy 1964).

Tarletonbeania crenularis

This lanternfish is found from British Columbia to central Baja, and to a depth of 900 m (Miller and Lea 1972). The blue lanternfish are abundant off Oregon. Pearcy (1964) found it was approximately 10% of the catch, making it the third most abundant midwater species. Eighty km off Newport, abundances were 190.4 individuals per 10^3m^2 between 0 and 150 m, and 35.7 individuals per 10^3m^2 at 150 to 500 m (Pearcy and Laurs 1966). T. crenularis was collected on all eight cruises off Oregon between 1969 and 1973 (Pearcy 1977). During this time it averaged 2.3 to 103.7 individuals per 10^5m^3. Midwater trawls taken 120 km off Newport collected 0.15 animals per 1000 m^3 near the surface at night and 0.1 individuals per 1000 m^3 between 200 and 400 m during the day (Pearcy et al. 1977). An additional concentration (0.2 to 0.5 individuals per 1000 m^3) occurred at 600 to 800 m throughout the day.

Egg and larvae surveys off northern California and Oregon showed T. crenularis to be a significant component of the plankton during certain years. Richardson (1973) found up to 10.92 individuals per 10^3m^3, and Bates (1984) reported 6 to 35 larvae per $10m^2$. Seven to 77 larvae per $10m^2$ were estimated for April-May 1983 (Clark and Kendall 1985).

Family Moridae
Antimora microlepis

This species has a range which includes Bering Sea and Japan to Chile, and has been caught at depths of 2896 m (Miller and Lea 1972; Eschmeyer et al. 1983). Within the lease area A. microlepis composes from zero to three percent of the total number of benthic fish fauna (Pearcy et al. 1982).

Family Melanonidae
Melanonus zugmayeri

This species is known from a few specimens collected off British Columbia and California.

Family Macrouridae
Coryphaenoides acrolepis

The roughscale rattail is found from Japan and Alaska to Guadalupe Island, and to a depth of 2000 m (Miller and Lea 1972). This species was caught at only one of the seven stations within the lease area, and represented one percent of the catch at that location (Pearcy et al. 1982). Stein (1980) gives averages of 8.9 to 18.8 juveniles per $10^6 m^3$ for IKMT and COBB midwater trawls in hauls at 500 to 600 m.

Coryphaenoides armatus

This species is found throughout the world's oceans except the Arctic, and to a depth of 4000 m (Iwamoto and Stein 1974). This species was the most abundant deep-sea benthic fish in the lease area (Pearcy et al. 1982), but only mud bottoms have been sampled. The seven sampling stations within the lease area all contained this species. Abundances ranged from 0.6 to 3.7 individuals per $10^3 m^2$. C. armatus may comprise 42 to 73 percent of the total number of fishes caught (Pearcy et al. 1982).

Coryphaenoides filifer

This species can be found from Bering Sea to southern California and to a depth of 2904 m (Iwamoto and Stein 1974). This species probably represents the second most abundant benthic fish in the lease area (Pearcy et al. 1982). C. filifer was caught at all seven stations within the lease area, and it numbered between 0.4 to 1.6 individuals per $10^3 m^2$ (Pearcy et al. 1982). Stein (1985) found substantial populations of the species in midwater off northern California.

Coryphaenoides leptolepis

C. leptolepis represented between 2 and 9% of the number of benthic fishes in the area, and was the third most abundant (Pearcy et al. 1982). There were 0.1 to 0.4 individuals per $10^3 m^2$ in the lease area.

Nezumia stelgidolepis

This species is known from off Vancouver Isalnd to Panama, and to a depth of 600 m (Iwamoto and Stein 1974).

Family Exocoetidae
Cypselurus californicus

This species ranges from Oregon to southern Baja, and is generally found near the surface.

Family Scomberesocidae
Cololabis saira

The Pacific saury is distributed from Japan and Gulf of Alaska to Mexico. It generally is found in schools near the surface. C. saira is abundant in the lease area as neustonic larvae. Kendall and Clark (1982) reported 16 to 383 individuals per 10^3m^3. Clark (1984) found 12 to 65 larvae per 10^3m^3 in the neuston in May through June 1981. In October through November 1981, 12 to 123 larvae per 10^3m^3 occurred in neuston tows (Bates 1984). Clark and Kendall (1985) estimated 16 to 518 larvae per 10^3m^3 in collections made during April-May 1983.

Family Lampridae
Lampris guttatus

This species is found from Japan and Gulf of Alaska to Gulf of California.

Family Trachipteridae
Trachipterus altivelis

The king-of-the-salmon can be found from Alaska to Chile, and to depths of at least 500 m. Larval T.altivelis were more abundant in neuston tows than in bongo nets. In neuston tows, between May and June 1981, 11 to 101 larvae per 10^3m^3 were collected at various stations (Clark 1984). Ten to 296 larvae per 10^3m^3 were collected in neuston nets and 6 to 45 larvae per $10m^2$ in bongo nets in October and November 1981 (Bates 1984).

Family Melamphaidae
Melamphaes lugubris

This species is known from Bering Sea to Baja, and has been found to depths of 1500 m (Hart 1093). This species is not very abundant compared to other mesopelagic fishes caught by Willis and Pearcy (1982) 100 to 158 km off Newport. Average densities were 0 to 2.5 individuals per 10^5m^3, with a maximum density of 7 individuals per 10^5m^3 recorded at 650 m during the day.

Poromitra crassiceps

This species is known to occur from Gulf of Alaska to Chile, and down to 2000 m (Miller and Lea 1972). Twenty-five specimens of P. crassiceps were collected in 104 midwater tows, 80 km off Newport (Pearcy 1964). Caught on only one of eight cruises in the lease area, its density was 1.7 individuals per 10^5m^3 (Pearcy 1977). Willis and Pearcy (1982) reported average densities of 4 and 8 individuals per 10^5m^3 for 800 m during day and night, respectively. Maximum number of individuals was 13 per 10^5m^3 at night at 800 m.

Family Scorpaenidae
Sebastes sp.

Adult rockfishes, common on the shelf and slope, are rare in the lease area. Larvae are quite abundant in the lease area. Richardson et al. (1980) conducted a four-year survey of fish larvae off Oregon. Most samples were taken within 40 km of shore, and rockfish were not identified to species.

The number of rockfish larvae present under 10 m^2 of sea surface in the study area ranged from 0 to 199.12. Generally, Sebastes larvae were more abundant beyond the shelf than over it (Richardson et al. 1980). Kendall and Clark (1982) caught 16 to 606 larvae per $103m^3$ during April and May 1980. Clark (1984) in a similar study caught 6 to 29 larvae per $10m^2$ in bongo net tows during October and November 1981. Bates (1984) caught larvae in bongo nets (7 to 41 individuals per $10m^2$) and neuston nets (12 larvae per 10^3m^3 at one station). Clark and Kendall (1985) calculated that there were 7 to 22 larvae per 10^3m^3 in the lease area at bongo net stations during April and May 1983. Neuston nets samples from the same stations raised the estimates to 25 to 209 per 10^3m^3.

Anoplopoma fimbria

Sablefish occur from Japan and Bering Sea to central Baja, with the adults found at depths as great as 1829 m. Larvae of this commercially valuable species were collected using neuston nets. Kendall and Clark found 13 to 572 larvae per 10^3m^3 in April and May 1980, but A. fimbria occurred at only one station (11 larva per 10^3m^3) during surveys in May and June 1981 (Clark 1984). Neuston tows in April-May 1983 collected 15 to 61 larvae per 10^3m^3 (Clark and Kendall 1985).

Family Cottidae
Zesticelus profundorum

This species is found from Bering Sea to northern Baja, and to depths of 2580 m.

Family Psychrolutidae
Psychrolutes phrictus

This species is distributed from Bering Sea to San Diego, and to depths of 2800 m.

Family Agonidae
Bathyagonus nigripinnis

This species is found from the Commander Islands to northern California, and to a depth of 1247 m.

Family Cyclopteridae
Acantholiparis opercularis

A. opercularis was collected at six of the seven stations sampled in the lease area between 1963 and 1976 (Pearcy et al. 1982). It

represented between zero and two percent of the total number of fishes caught.

Paraliparis latifrons

P. latifrons occurred at four of the seven stations within the lease area sampled by Pearcy et al. (1982). This species was zero to one percent of the total number of fishes in the area.

Family Scombridae
Thunnus alalunga

T. alalunga is highly migratory. There are no direct estimates of the population size in the lease area. Because of the commercial fishery, however, there are records of catch-per-unit effort (CPUE) data which give relative estimates of numbers of albacore in the region. Clemens and Craig (1965) reported that albacore were generally caught in the lease area from July through October, with catches usually between 0 and 50 tons per one degree square. September 1969 and 1970 had catches of 500 to 1000 tons in that area.

Laurs and Lynn (1974) described the distribution and availability of albacore during the 1971 through 1974 fishing seasons. Albacore catches were greatest approximately 230 km offshore where there were 5 to 100 fish caught per 150 line-hours during May through July 1972. In 1973 catches ranged from less than 5 to 100 to 200 fish per 150 line-hours, with the greatest catches occurring at 41^{o} N, 130^{o} W.

Family Stromateidae
Icichthys lockingtoni

The medusafish usually occur in the lease area as larvae, which have been collected with bongo and neuston nets by the NMFS. Kendall and Clark (1982) reported neuston tows in April and May which caught 16 to 59 larvae per 10^3m^3. Clark (1984) reported 10 to 179 larvae per 10^3m^3 in neuston nets and 4 to 35 individuals per $10m^2$ using bongo nets. Bates (1984) caught 12 to 195 larvae per 10^3m^3 in neuston tows in May and June 1981. In April and May 1983, estimated abundances were 16 to 285 individuals per 10^3m^3 (Clark and Kendall 1985).

Family Bothidae
Citharichthys sordidus

Bongo net tows in October and November 1981 caught 4 to 13 larvae per $10m^2$ (Bates 1984), although only nine of thirty-three stations within the lease area had such larvae.

Family Pleuronectidae
Eopsetta jordani

This species, like many of the other flatfishes, occurs in the lease area only as larvae. No petrale sole were collected in 123 bongo net tows, and only one animal was caught in 336 IKMT tows (Pearcy et al. 1977).

Glyptocephalus zachirus

Rex sole adults do not occur in the lease area, but larvae are advected into the region by surface currents. Pearcy et al. (1977) caught rex sole in bongo and IKMT net tows at various locations in the lease area. The average number in bongo nets varied from 0.32 to 2.27 per 10 m^2 for stations 93 and 46 km off Newport, respectively. The number caught in the IKMT ranged from 0 to 0.75 individuals per tow, for stations 46 to 306 km off Newport, Coos Bay, and Brookings.

Lyopsetta exilis

A single Bongo net tow caught 15 larvae per $10m^2$ in April and May 1980 (Kendall and Clark 1982). Larvae were as abundant as 30 per $10m^2$ in May and June 1981, although larvae only occurred at three stations in the lease area (Clark 1984).

Microstomus pacificus

This species is not found in the lease area as adults, but larvae are advected there. Pearcy et al. (1977) ,using bongo nets, found an average of 0.16 larvae per 10 m^2 at 46 km increasing to an average of 1.75 per 10 m^2 at 111 km. IKMT catches were between 0.05 and 0.83 individuals per tow. Bates (1984) reported that only one neuston tow contained M. pacificus larvae: estimated abundance was 16 larvae per $10m^2$. Clark and Kendall (1985) estimated that 8 per $10m^2$ were present at only one station out of thirty-three in the lease area during April and May 1983.

2. Reproduction

Little data exists on the reproductive biology of fishes in this region. The few available studies are restricted to deep-dwelling species, and those of commercial importance.

Family Alepocephalidae
Bathylaco nigricans

A single mature male of 180 mm SL was collected within the lease area 96 km west of the Oregon coast (Stein 1978).

Family Melanostomiidae
Tactostoma macropus

Fecundity in this species ranges from 24,00 to 66,000 eggs/female, and females mature at approximately 305 mm (Fisher 1979). Spawning seems to occur in the summer months (July through September 1976), based upon oocyte development and larval abundance. Metamorphosis occurs between 45 and 55 mm (Fisher 1979). Spawning probably occurs far offshore, although 24 females in various stages of maturity were found within 80 km of shore.

Family Paralepididae
Paralepis atlantica

A single specimen of this species was collected in July 1977, 65 km west of Newport. The female contained ripening eggs up to 0.16 mm in diameter (Howe et al. 1980).

Family Myctophidae
Stenobrachius leucopsarus

Smoker and Pearcy (1970) described the reproduction and growth of this species off Oregon. Individuals were collected up to 720 km from shore; there was no effort to relate reproductive state to distance offshore. Therefore this discussion will include some samples which were collected outside the lease area, although the majority of specimens were obtained within the region of interest.

S. leucopsarus appears to mature sexually at a length of about 65 mm SL, which corresponds to an age of 4 years (Smoker and Pearcy 1970). The gonads begin to mature in October and spawning occurs between October and March.

Occurrence of larvae off Oregon between July and August (Richardson 1973) suggests the spawning season is longer than that reported by Smoker and Pearcy (1970). Larvae were not collected in October, showing that S. leucopsarus does not spawn throughout the year. Estimates of abundance of larvae primarily from the lease area were between 0 and 89.95 individuals per $10^3 m^3$ (Richardson 1973). Larvae were taken more frequently in nets fished at 200 m than in shallower tows.

Tarletonbeania crenularis

T. crenularis larvae were collected from May through October 1969, indicating spawning occurred for at least this period (Richardson 1973).

Family Macrouridae
Coryphaenoides acrolepis

Stein and Pearcy (1982) described the reproductive biology of macrourid fishes off the coast of Oregon. Many of the samples were from within the lease area, although some were to the west (in deeper water) and north. Since their samples were not treated separately in the publications, discussions of their findings will incorporate some results from outside the lease area.

Females mature at approximately 460 mm TL, with fecundity between 22,657 and 118,612 eggs (Stein and Pearcy 1982). Ripe females were captured in April and September while ripe and spent females were caught in October. These data suggest semi-annual spawning. Ripe eggs were generally 2.0 mm in diameter. Juveniles appear to become benthic at about 80 mm TL, after an ontogenetic migration. Stein (1980) described the increase in body size with increasing depth of this species off Oregon. Postlarvae were captured at 500 m, while juveniles were caught at 650 m and deeper.

Coryphaenoides armatus

No ripe females of this species were reported by Stein and Pearcy (1982), although ripening eggs were seen in animals greater than 700 mm TL. Fecundity ranged from 2,585,374 to 2,711,398 eggs/female, but these are estimates of maturing eggs and it's possible that not all would reach maturity. Stein (1985) reported a ripe C. armatus female from just south of the study area. This individual, 960 mm TL, had an estimated 6.2×10^6 ripe eggs. Female C.armatus apparently do not mature until 740 mm TL. Juveniles of this species become benthic at 80 mm TL.

Coryphaenoides filifer

Female C. filifer were ripe in January, June, July, and August (Stein and Pearcy 1982).. Spent females were collected in February and June, and therefore may spawn semi-annually. Females become mature at a length of about 500 mm. Fecundity ranged from 9034 to 51,110 eggs/female, and is related to length. Eggs were considered ripe when they reached a diameter of 2.0 mm.

Coryphaenoides leptolepis

No females of this species were collected with eggs riper than stage II (0.21 to 0.90 mm in diameter, firmly bound to ovarian tissue, immature) (Stein and Pearcy 1982). Juveniles become benthic at 50 mm TL.

Family Scorpaenidae
Sebastolobus alascanus

Pearcy (1962) reported collections and observations of large floating egg masses off Oregon. Eggs from within the lease area were subsequently identified as those of Sebastolobus sp. Occurrence of egg masses provided evidence that spawning occurs between March and May. One egg mass, analyzed in the laboratory, had eggs 1.2 to 1.4 mm in diameter, and contained well developed embryos one day after collection. Hatching occurred approximately 10 days after collection; the prolarvae were 2.6 mm long. Within 10 days after hatching, the mouth was open and the eyes were fully pigmented. Observation did not continue beyond that time.

Sebastolobus altivelis

Eggs of this genus were collected as described in the section above on S. alascanus. In addition, a ripe 28.5 cm female was collected 41 m off the Oregon coast and contained eggs of 1.2 to 1.3 mm (Pearcy 1962). Spawning most likely occurs between March and May.

Family Psychrolutidae
Psychrolutes phrictus

Males may be segregated from females, perhaps inhabiting rocky areas (Stein and Bond 1978). Juveniles may exist pelagically until approximately 30 mm when they become benthic (Matarese and Stein 1980).

Family Cyclopteridae

Acantholiparis opercularis

Stein (1980) examined 61 specimens and found the number of ripe eggs per female was from one to six; mean of 3.2. Only females larger than 65 mm contained greater than 4 ripe eggs. Females become mature at 51 mm SL, with ripe females generally occurring from February through November. Spawning probably occurs throughout the year.

Careproctus filamentosus

Stein (1980) was able to examine only one female of this species, 180 mm SL, collected in February. The largest eggs were 0.70 mm, and obviously immature. No conclusions regarding reproduction in this species can be inferred.

Careproctus longifilis

Three females collected in February, March, and November measured 146, 162, and 162 mm respectively (Stein 1980). Eggs reached 7.09 mm in diameter, and 16 in number. The size distribution of ovarian eggs suggested this species may have prolonged or continuous spawning.

Careproctus melanurus

Twenty-six individuals (15 females, 11 males) were examined from the area, with maximum fecundity of 534 eggs (Stein 1980). Maximum egg size was 4.63 mm, and length at maturity for females appeared to be 200 to 220 mm. Spawning may be seasonal, because females with eggs over 4.0 mm were only caught in April and June. Males with the largest testes were collected in June and September.

Careproctus microstomus

Stein (1980) examined three females collected in February, March, and October. One female contained 19 eggs, and the largest eggs measured over 7 mm. This species may spawn continuously.

Careproctus oregonensis

Two females examined by Stein (1980) contained up to 10 eggs per female; the largest eggs were approximately 5 mm in diameter. The various sizes found in the ripe females would suggest this species may have prolonged or continuous spawning.

Careproctus ovigerum

Only one specimen, a 431 mm female, was examined from the lease area (Stein 1980). This animal contained 756 ripe eggs, ranging in size from 6.93 to 7.75 mm. Size distribution of eggs within the ovaries would seem to suggest well-separated spawning periods.

Osteodiscus cascadiae

Stein (1980) examined 130 O. cascadiae. Females matured by approximately 65 mm SL; maximum fecundity was 7 eggs (mean of 4.05). The largest eggs were 5.29 mm in diameter. Spawning occurs all year, and the eggs are probably laid in small aggregations or perhaps singly.

Paraliparis cephalus

Twelve specimens of this species were examined (Stein 1980). No females contained mature eggs; maximum egg size was 0.86 mm. One male collected in January was 82 mm and had well-developed testes as if ready to spawn.

Paraliparis latifrons

Maximum fecundity for 38 individuals collected during four months of the year was 8 eggs with a mean of 3.7 (Stein 1980). Maximum egg diameter was 4.47 mm. Females appeared to mature at 61 mm SL. Spawning most likely occurs throughout the year.

Paraliparis megalopus

There were a maximum of 32 ripe eggs (greater than 3.62 mm) in one female (Stein 1980). The largest egg collected from three females was 4.31 mm. Spawning may be prolonged or continuous. Males collected in October were apparently ripe.

Paraliparis mento

One male and one female collected in January were examined (Stein 1980). The female contained 101 eggs up to 2.50 mm in diameter. The 95 mm male appeared to be ripe. This species may be a periodic spawner.

Paraliparis rosaceus

Five females collected in January and March had a maximum fecundity of 1,277 eggs (Stein 1980). The largest egg was 3.65 mm, and one female of 350 mm SL, appeared ready to spawn. This species appears to be a periodic spawner.

3. Growth

As with many aspects of deep-sea fish biology, very little known regarding growth of most oceanic species which inhabit the lease area. The majority of work available to date has been the result of projects by Oregon State University investigators on midwater species.

Family Melanostomiidae
Tactostoma macropus

Fisher (1979) studied growth of this species within the lease area. Growth curves for 11 year-classes show similar trends, indicating

similar growth in different years. Fish were generally 65 to 75 mm SL at the their first January of life, 95 to 125 mm at one year, 150 to 175 mm at two years, 195 to 215 mm after three years of life. Fisher (1982) found that females grow larger than males. Fish grew 30 to 40 mm between the ages of two and three years.

Family Myctophidae
Stenobrachius leucopsarus

Smoker and Pearcy (1970) calculated growth in this species by examining mean length of successive year-classes, mean lengths of fish aged by otoliths, and length of fish back calculated from diameters of otolith annuli. Year-class analysis revealed the following linear growth from age two through four: Length(mm) = 20.78 + 1.59X(months since January of first year), r=0.98. Based on otolith aging, the formula for growth was given as: $Lx = 84.96 - 79.32e^{-0.34x}$, where Lx = length at age x, and x = age in years. Otolith annuli indicated maximum age is 7 to 8 years. The growth rates given for back calculations of age-group lengths based upon annuli on the otoliths are similar to the above.

Family Macrouridae
Coryphaenoides acrolepis

Females reach a maximum of 860 mm TL, males 750 mm (Stein and Pearcy 1982). The length-weight relationships for males and females are given as log weight(g) = 3.39 log TL - 6.14 and log weight = 3.32 log TL - 6.00, respectively. Smaller fish occurred at the extremes of the depth range, with the largest animals present at 1600 m. The deeper animals may have slower growth or differential mortality rates.

Coryphaenoides armatus

Females reach 976 mm TL,but males only grow to 690 mm TL (Stein and Pearcy 1982). The length-weight relationship was given for males as log wt = 3.02 log TL - 5.50 and for females as log wt = 3.48 log TL - 6.25 (Stein and Pearcy 1982). After 800 mm TL is attained animals gain weight much more rapidly than length. Total length increases with depth to 4000 m and then may decrease. The deeper-dwelling animals may have slower growth or higher mortality at intermediate sizes.

Coryphaenoides filifer

Females reach greater lengths than males (860 mm TL vs. 690 mm TL). The weight-length relationship of the sexes is similar: $wt = 2.2 \times 10^{-6} TL^{3.04}$, $R^2 = 0.97$ (Stein and Pearcy 1982). Average length of fish was relatively constant throughout the depth range.

Coryphaenoides leptolepis

The maximum lengths attained by the males and females appear to be similar (Stein and Pearcy 1982). The length-weight relationships were similar: log wt = 3.23 log TL - 5.92 for males, and log wt = 3.29 log TL - 6.06 for females.

Family Cyclopteridae
Acantholiparis opercularis

The length-weight relationship for 61 specimens was: Weight(grams) = $8.05 \times 10^{-7} SL^{3.45}$ (Stein 1980).

Careproctus melanurus

The length-weight relationship for 26 specimens was: Weight(grams) = $8.160 \times 10^{-6} SL(mm)^{3.10}$ (Stein 1980).

Osteodiscus cascadiae

The length-weight relationship for 130 specimens was: Weight(grams) = $5.268 SL(mm)^{3.00}$ (Stein 1980).

Paraliparis latifrons

The length-weight relationship for 28 specimens was: Weight(grams) = $5.19 \times 10^{-6} SL(mm)^{2.99}$ (Stein 1980).

Family Pleuronectidae
Glyptocephalus zachirus

As mentioned above, G. zachirus occurs in the lease area only as larvae; adults are found on the shelf. Pearcy et al. (1977) reported on the growth of larvae in the lease area, with a few samples included from outside the region. All larvae collected in March through May were stage I (symmetrical, left eye has not migrated) but by February of the next year all were stage IV (left eye on right side). The larvae probably settle to the bottom after one year, although some may remain pelagic for over a year.

Microstomus pacificus

This species only occurs in the lease area as larvae. Larval growth in the study area during the one year of pelagic existence is summarized by Pearcy et al. (1977). During the first year larvae grow to approximately 20 to 30 mm SL, after which they settle. Larger (greater than 50 mm) larvae appear to represent a residual population which did not find suitable conditions for metamorphosis, and may remain in the plankton until suitable conditions are present. These larger larvae do not appear to grow much at all. Their fate is unknown in regions such as the study area where the bottom is below the species depth range.

Family Scombridae
Thunnus alalunga

Albacore occurring within the GRLA are juveniles of 2-4 years old (Bell, 1962; Otsu and Uchida, 1963). Lengths range from 55-87 cm, but most are 65-80 cm (Laurs and Lynn, 1977). They are generally smaller than fish caught further south. Because albacore are migratory and occur seasonally for only a short time within the GRLA, growth rates within the area are unknown. However, growth of one fish tagged within the GRLA

and recovered elsewhere is known (Otsu, 1960). This fish, tagged and released at 42°20'N, 127°33'W, was recaptured 287 days later, 6768 km away. It grew 7.2 cm during its freedom. Another fish (Clemens, 1961) released outside the GRLA and recovered within it at 40°59'N, 124°59'W, traveled 1003 km in 83 days, but apparently "shrank" 4.8 cm.

4. Migration

What is known of the vertical or horizontal movements of fishes in the lease area has been generally inferred from catch data. Vertical migration of mesopelagic fishes has been well studied by Dr. W.G. Pearcy and colleagues at Oregon State University. Most studies are based on discrete collections of fishes by midwater nets to predict vertical movements. For larger species, movements have been monitored by analyzing tag returns, or following individual fish. There is little if any data on movements of the majority of fish in the lease area. The following summarizes studies of migrations of fish species within the area. Failure to mention a particular species means there are no data regarding that particular species.

Family Bathylagidae
Bathylagus milleri

Pearcy et al. (1977) presented evidence that this species did not migrate vertically in the lease area. Alternatively, Willis and Pearcy (1982) found significantly more individuals at 500 m at night, and at 650 m by day. There was no difference in abundance throughout the day at 800 m. Therefore, it appears this species, especially smaller individuals, moves from around 650 m to 500 m and above at night.

Bathylagus ochotensis

B. ochotensis may migrate vertically in the lease area. The majority of individuals caught during the night were in the upper 50 m, but by day most fish were caught at 500 to 700 m (Pearcy et al. 1977).

Bathylagus pacificus

This species does not appear to undergo diel vertical migrations in this area. Pearcy et al. (1977) caught few fish above 400 m either day or night. The largest catches 100 to 158 km west of Newport were at 650 m for both day and night samples (Willis and Pearcy 1982). Smaller fish (50 to 70 mm SL) may seek deeper water, and as they grow move into shallower depths from which they migrate upward during the night.

Family Opisthoproctidae
Macropinna microstoma

This species is most common at 500 m both day and night, and does not appear to engage in diel vertical migrations (Willis and Pearcy 1982).

Family Chauliodontidae
Chauliodus macouni

This species is not known to make diel vertical migrations off Oregon. Results of 335 IKMT samples 120 km off Newport indicated the population was centered at 400 to 500 m throughout the day (Pearcy et al. 1977). C. macouni was most abundant at 500 m day and night in samples taken 11 to 158 km off Oregon (Willis and Pearcy 1982). Individuals may migrate into shallower water at night.

Family Gonostomatidae
Cyclothone acclinidens

Trawls taken 100 to 158 km west of Newport caught the majority of this species at 800 m (Willis and Pearcy 1982). Much greater catches occurred at night at this depth, which may suggest they move deeper during the day.

Cyclothone atraria

Pearcy et al. (1977) found was no evidence for vertical migration in this species off Oregon. Willis and Pearcy (1982) found more C. atraria at 650 and 800 m during the day and night, respectively. This species may therefore move into deeper water during the day.

Cyclothone pseudopallida

Willis and Pearcy (1982) provided evidence for diel movements of this species into the upper 500 m at night. Generally, most catches were greatest at 500 m both day and night.

Cyclothone signata

This species was most abundant at 500 m both day and night 100 to 158 km off Newport (Willis and Pearcy 1982). There was, however, some evidence for a migration above 500 m at night.

Family Sternoptychidae
Arygropelecus sladeni

Pearcy et al. (1977) found individuals scattered between 100 and 1000 m 120 km off the coast of Oregon. There was no evidence for diel vertical migration.

Family Melanostomiidae
Tactostoma macropus

Midwater tows 80 km off the central Oregon coast provided indirect evidence of diel vertical migrations. At night 36.9 individuals per $10^3 m^2$ were captured in the upper 150 m, whereas no animals were caught at these depths during the day (Pearcy and Laurs 1966). Daytime tows at 150 to 500 m, caught 26.2 individuals per $10^3 m^2$. T. macropus was the predominant fish caught in the scattering layer at 96 to 144 m depth from 2048 to 2351 hrs (Pearcy and Mescecar 1970). From 0200 to 0535 hrs

it occurred at 10 to 50 m. During the daytime the scattering layer descended, and T. macropus concentrated at 175 to 400 m from 1610 to 2100 hrs.

Pearcy et al. (1977) estimated abundances at various depths from 335 night and daytime trawls 120 km off Newport. They concluded T. macropus migrates from a population centered at 500 m in the day to the upper 200 m at night. Willis and Pearcy (1982) observed that smaller fish (< 240 mm SL) are probably the majority of the vertical migrators into the upper 500 m.

Family Scopelarchidae
Benthalbella dentata

All indiviuals captured 120 km off Oregon occurred below 200 m, and probably do not migrate vertically (Pearcy et al. 1977). This species was most abundant between 500 and 650 m at stations 100 to 158 km off Newport. Catches were unrelated to time of day, implying no vertical migration (Willis and Pearcy 1982).

Family Paralepididae
Lestidium ringens

This species may make diel vertical migrations. Numerous individuals are present in the upper 100 m at night, but none are caught in the upper 150 m during the day (Pearcy et al. 1977). However, it is probably a good net avoider.

Family Myctophidae
Diaphus theta

Midwater tows 80 km off central Oregon provide evidence for vertical migrations of D. theta. At night, abundances were 128.2 and 24.8 individuals per $10^3 m^2$ in the upper 150 m and from 150 to 500 m, respectively (Pearcy and Laurs 1966). Compared to day when abundance was only 15.0 individuals per $10^3 m^2$ in the upper 150 m and 124.6 per $10^3 m^2$ at 150 to 500 m. These data suggest a 500 m migration daily. The results of 335 IKMT samples taken 120 km off Newport showed peak abundance of this species from 200 to 600 m during the day (Pearcy et al. 1977). At night peak abundance is from the surface to 200 m, with a small group at 350 m. This deeper group probably does not migrate.

Lampanyctus regalis

Most abundant at 650 m both night and day, L. regalis may move upward at night (Willis and Pearcy 1982). Pearcy et al. (1977) found a few individuals near the surface at night, but most occurred between 200 and 700 m.

Lampanyctus ritteri

L. ritteri appears to migrate from a daytime depth of 400 to 600 m to the upper 200 m at night (Pearcy et al. 1977). Very few individuals occur below 600 m.

Protomyctophum thompsoni

This species does not appear to migrate vertically off Oregon. Pearcy et al. (1977) reported concentrations of this species between 200 and 400 m both day and night.

Stenobrachius leucopsarus

Pearcy and Laurs (1966) sampled the mesopelagic fishes 50 nm off the central Oregon coast, and found significant increases in abundance of this species in the upper 150 m at night. Daytime catches were greatest at 150 to 500 m, indicating a migration to the surface at night. Pearcy and Mesecar (1970) reported the results of tows through the DSL off central Oregon. S. leucopsarus was distributed mainly at 10 to 45 m from 2048 to 2351 hrs., whereas it was mostly at 175 to 410 m from 1024 to 2100 hrs. Pearcy et al. (1977) analyzed 335 midwater trawls taken 120 km off Newport and found daytime depths were 200 to 600 m, but peak nighttime abundance was above 100 m. There was a second peak at 420 m of non-migrators.

The many studies of this species have shown that they migrate from 300 to 600 m to 0 to 50 m at night (Willis and Pearcy 1982).

Stenobrachius nannochir

All S. nannochir collected 120 km off Oregon were below 400 m (Pearcy et al. 1977). It does not appear this species makes diel vertical migrations in the upper mesopelagic zone.

Symbolophorus californiense

S. californiense abundance changes from 200 to 600 m during the day to 0 to 400 m at night (Pearcy et al. 1977), suggesting diurnal vertical migrations.

Tarletonbeania crenularis

Pearcy and Laurs (1966) demonstrated vertical migrations of this species from up to 500 m to the surface. Peak catches (197.4 individuals per $10^3 m^2$) occurred at night above 150 m, and the greatest daytime catches were at 150 to 500 m (43.0 individuals per $10^3 m^2$). Few T. crenularis occurred below 500 m. Pearcy et al. (1977) found this species to be slightly less abundant than some other myctophids. Highest density of animals occurred in the upper 100 m in day tows, but at night fish occurred between 200 and 600 m, with a second peak at 700 m.

Family Macrouridae
Coryphaenoides acrolepis

Adult C. acrolepis are considered epibenthic. They are not thought to engage in vertical or horizontal migrations. There is, however, evidence for ontogenetic migration. Stein (1980) provided data from samples collected in the lease area. The smallest animals were collected

in the upper 200 m, postlarvae from 500 m, and juveniles were from 650 to 800 m. Only individuals greater than 13 mm head length were caught below 800 m.

Family Melamphaidae
Melamphaes lugubris

Peak of abundance of M. lugubris occurs at 650 m for animals caught 100 to 158 km off Newport (Willis and Pearcy 1982). There are appears to be a limited vertical migration from 650 to near 500 m during the night.

Poromitra crassiceps

Pearcy et al. (1977) found P. crassiceps only below 400 m, and there was no evidence of diel vertical migration. Willis and Pearcy (1982) caught more at night than by day when fishing at 800 m; they thought this species was moving daily between deeper depths. Few individuals were collected at 500 m.

Family Scombridae
Thunnus alalunga

Albacore are highly migratory. They only occur in the GRLA in summer, when a portion of the stock, migrating from the western Pacific off Japan and reaching western North America at about 38°N, migrate northward to Canadian and sometimes to Alaskan waters (Laurs 1979, in Kethen 1980). In this migration, they pass through the GRLA. Distribution of albacore is determined by oceanographic conditions (Alverson 1961, Johnson 1962, Lane 1965, Owen 1968, Pearcy 1973, Laurs and Lynn 1977, Laurs, Fielder, and Montgomery 1984). Hydrographic fronts appear particularly important (Laurs et al. 1984). Temperature may be the primary determinant of albacore distribution. Fish generally occur in waters between 16° and 19°C (Clemens 1961, Laevastu and Hela 1970). Because the predominant summer upwelling off Oregon results in a belt of cold water immediately offshore (Alverson 1961), albacore are usually distributed well offshore in warmer waters (Pearcy 1973; Owen 1968; Lane 1965). Thus, albacore occur regularly in the GRLA, but their location, abundance, and routes are highly variable.

This highly migratory species is seasonally abundant in the offshore waters of Oregon and California. Individuals tagged off the coast of southern California from June through August migrate northward along the California coast arriving in the waters off Oregon in July through November (Clemens 1961). Only one tagged albacore from southern California was been caught in the lease area (Clemens 1961). This was probably because few animals were tagged when the northern fishery became active, and the fish seemed to be located farther out to sea, away from the main fishing grounds. The tagging data would indicate a general northward movement of fish from off the Baja and southern California coasts to northern California, Oregon, and Washington.

5. Food habits

As with other aspects of fish biology in this area, most of the feeding studies have been carried out by W.G. Pearcy, and his colleagues and students. Most of the species listed in Table 3 are rare and therefore few individuals have been collected. The feeding habits of the main constituents of the mesopelagic and demersal habitat have been examined, as well as some of the epi-pelagic fishes such as albacore. The following is a summary of studies regarding feeding habits of fishes collected within the Gorda Ridge lease area. The species accounts are listed in the order of Table 3. Omissions mean no information is available on this subject for those species.

Family Melanostomiidae
Tactostoma macropus

Osterberg et al. (1964) examined 52 specimens of this species from off Oregon (there was no mention where the samples were taken). Food was primarily euphausiids and sergestid shrimp. Lanternfish, however, represented approximately half of the total volume of prey consumed. Fisher (1980) examined 530 individuals, most taken approximately 85 km west of Newport. Juveniles ate principally euphausiids (mostly Euphausia pacifica), and a few copepods. As the fish grew larger, euphausiids still predominated, but fish and shrimp (Sergestes similis) were eaten more frequently. The largest fish ate other fishes (Stenobrachius leucopsarus, Diaphus theta, and Sebastes sp.) and less often euphausiids and S. similis. Larger fish either consumed fewer prey or had faster digestion rates than smaller fish of this species.

Family Myctophidae
Diaphus theta

Tyler and Pearcy (1975) examined 129 specimens caught 80 to 120 km off Newport. Forty-five percent of the stomachs contained euphausiids (primarily Euphausia pacifica), 51.2% had copepods (mostly Calanus sp. and Metridia lucens), and 10.1% contained amphipods (generally Parathemisto pacifica). The remainder of the prey were pteropods, ostracods, polychaetes, chaetognaths, and salps.

Stenobrachius leucopsarus

S. leucopsarus were collected 84 to 120 km west of Newport from 1963 to 1965. Of 366 stomachs containing food, euphausiids were in 50.6%, copepods in 55.2%, and amphipods in 7.7% (Tyler and Pearcy 1975). D. theta consumed mostly the euphausiid, E. pacifica, copepods, Calanus sp., and Metridia lucens, and the amphipod, Parathemisto pacifica. The remainder of the diet included eggs, pteropods, ostracods, polychaetes, chaetognaths, salps, fish, and diatoms.

Based on samples from 120 km west of Newport, Pearcy et al. (1979) compared feeding habits of migrating (0 to 100 m) and non-migratory (300 to 700 m) S. leucopsarus. Shallower fish ate primarily the euphausiid Euphausia pacifica, amphipod Parathemisto pacifica, copepods Metridia pacifica, Pareuchaeta spp., Calanus cristatus, Calanus plumchrus,

Heterorhabdus spp., and Eucalanus bungii, in that order. Deeper individuals ate (in rank order) the following: C. plumchrus, Paraeuchaeta spp., euphausiids, ostracods, E. bungii, Metridiidae, E. pacifica, Calanus sp., Heterorhabdus spp., and fish scales.

Tarletonbeania crenularis

Tyler and Pearcy (1975) examined 153 specimens of this species caught 84 to 120 km west of Newport. Forty-eight percent had eaten euphausiids (Euphausia pacifica), 28.8% copepods (predominately Metridia lucens), 6.5% amphipods (primarily Parathemisto pacifica), and 5.9% pteropods (Limacina helicina). The rest of the diet was ostracods and chaetognaths.

Family Macrouridae
Coryphaenoides acrolepis

Of 216 C. acrolepis collected 120 to 270 km off central Oregon, 95% had everted guts, 2% were empty, and only 3% (6 individuals) contained food in their stomachs (Pearcy and Ambler 1974). The prey consisted of cephalopods (Gonatus fabricii, Cranchiidae, and Vampyroteuthis infernalis), amphipods, decapods (Crangon abyssorum and Chionectes tanneri), and fishes.

Coryphaenoides armatus

A total of 1044 C. armatus were collected from 1961 to 1972 at various locations 120 to 270 km off the central Oregon coast (Pearcy and Ambler 1974). Seventy-three percent of these animals had everted stomachs, 0.2% had stomachs which were empty, and 27% had stomachs containing food. Eighty-four different food items were identified. The most important were Crangon abyssorum, Strothygura sp., copepods, amphipods, cephalopods, holothuroids, and fishes. Of minor importance were shrimp, mysids, euphausiids, pelecypods, and echiuroids. As the fish grew, pelagic prey (such as fishes and cephalopods) became a larger portion of the diet.

Coryphaenoides filifer

Pearcy and Ambler (1974) examined stomachs of 837 individuals caught primarily 120 to 270 km off the central Oregon coast. Ninety-two percent of those caught had everted guts, while 1% had empty stomachs, and 7% had identifiable prey. C. filifer ate primarily crustaceans (mysids, shrimp, amphipods, and Crangon abyssorum), holothuroids, polychaetes, cephalopods, and fishes. The remainder of the diet was copepods, euphausiids, ophiuroids, and pelecypods. C. filifer consumed 40 different types of prey.

Coryphaenoides leptolepis

A study of stomach contents of 160 C. leptolepis caught primarily 120 to 270 km off the central Oregon coast determined that 49% had everted guts, 0.6% were empty, and 50% contained prey (Pearcy and Ambler 1974). This species ate Crangon abyssorum, copepods, amphipods,

Storthyngura sp., mysids, polychaetes, and ophiuroids. A small portion of the diet was made up of euphausiids, shrimp, and fishes. The largest fish (500 to 599 mm) preyed on pelagic organisms, while the smaller fish ate benthic animals.

Albatrossia pectoralis

Five of the 22 specimens of A. pectoralis caught 120 to 270 km off the central Oregon coast contained food in their stomachs (Pearcy and Ambler 1974). Prey consisted of cephalopods (Cranchiidae and Japatella sp.), ophiuroids (Ophiocten pacificum, Ophiacantha sp. and Scotoplanes sp.) and fishes.

Family Psychrolutidae
Psychrolutes phrictus

Stein and Bond (1978) reported the feeding habits of 25 specimens, at least six of which were caught in the GRLA. The most frequently consumed prey were sea pens (Stylatula sp., Balticina ? sp., Funiculina sp.) crabs (Chionoecetes sp.), and snails (Buccinium sp.). Other prey items included Sebastolobus alascanus, Sebastes sp., octopod beaks, ophiuroids, a plastic bag, rocks, hermit crabs (Pagurus sp., Parapagurus sp.), anemone, sea cucumber, and crinoids.

Family Scombridae
Thunnus alalunga

Albacore occurring within the GRLA have been studied by Laurs (in litt. to R. Brodeur, 3 June 1982), Pearcy (1973), Iversen (1961) and Pinkas, Oliphant, and Iverson (1971). The last two did not separate the results from within the GRLA and outside it, but their results are included here because their findings can be taken as typical albacore feeding habits within GRLA.

Laurs (in litt., op. cit.) found that albacore in the GRLA ate primarily crustaceans (73.2% by volume), but Pearcy (1973) found that fish "within 130 miles of shore had been feeding largely on fishes..." but offshore, "squids and sometimes euphausiids were more important...". Stomach contents of three groups of albacore actually collected within the GRLA on three separate occasions during the summer contained cephalopods (80.2%) and crustaceans (46.6% and 79.4%). Most of the crustaceans were Sergestes similis. Total number of taxa eaten was 34 and included a wide variety of invertebrates and fishes.

Iverson (1971) studied feeding of albacore throughout the northeast Pacific and found significant differences between albacore from different areas and between albacore from the same area. Larger fish generally had eaten relatively more food than smaller fish, but less per pound of body weight. Stomach contents included representatives of 32 fish families and 11 orders of invertebrates. Sauries (Cololabis saira) were the most common fish eaten by albacore from temperate waters. Off Oregon and Washington (43-47°N, 125-127°W) albacore ate mostly fish (79.3%) (Pinkas et al., 1971). Anchovies were 57.1% and sauries 19.7% of total food volume. Importance of food items varied by year;

cephalopods were not commonly eaten in 1968, but were important in 1969. In 1968, 28 spp. of prey were identified, but in 1969, there were only 11.

Albacore appear to feed throughout the day, with a gradual increase in feeding with time of day (Pearcy et al. 1974).

6. Commmercial exploitation

The majority of the fish species occurring in the lease area are not commercially valuable or are too difficult and expensive to harvest. Salmon, which are known to inhabit the oceanic region of the North Pacific, is harvested by North Americans along the coast or in their native rivers. The only commercial fishery which occurs in the lease area is for albacore. Because albacore is a prized food fish, many studies have been made of its abundance, distribution, and natural history. Unfortunately, few of these investigations have taken place in the GRLA.

Family Scombridae
Thunnus alalunga

Albacore are heavily fished within the study area when they are present. Keene (1974) reviewed the tactics and behavior of Oregon albacore fishermen in 1968-1970. Some of his data were obtained from within the GRLA and the rest from north of the area. The fishery usually starts in late June or early July, and ends in September. Catches fluctuate greatly from year to year. For instance, between 1946 and 1977, the lowest (total state) catch occurred in 1954 (469,440 lbs) and the highest in 1968 (37,751,816 lbs) (Oregon Dept. Fish and Wildlife 1977). In 1979, landings were 8,819,541 lbs, but in 1978, they were 18,397,673 lbs (Oregon Dept. Fish and Wildlife 1982). At ports south of Newport (south of 44°N) landings were 600,915 lbs in 1977, 2,572,805 lbs in 1978, and 366,748 lbs in 1979 (Kay Brown, Oregon Dept. Fish and Wildlife, in litt. to D. Stein, 6 May 1980).

Some areas within the GRLA include high albacore catches, but these vary between and within years. For instance, in 1981, the periods from 1 to 15 July had average daily jigboat catches greater than 200 fish in the one-degree squares 42-43°N, 126-127°W and 43-44°N, 127-128°W. In the next two weeks (July 16-31) catches in the same squares fell to 51-100 fish per day, and in the period from August 1-15, no fish were caught in the area (Majors, et al. 1982).

Although albacore have been caught off California since the early 1900's, the fishery for albacore along the Oregon and Washington coasts did not begin until 1937 (Johnson 1962). The fishery in the Pacific Northwest is generally conducted by troll and live-bait boats, and begins in mid-July and runs through October or November. Approximately 40% of the catch occurs in August (Johnson 1962), although yearly fluctuations occur due to changes in fishing effort, sea surface temperature, and availability of fish. Albacore seem to prefer water of 14.4° to 16.1°C (Alverson 1961), but may be susceptible to different

types of gear depending on the availability of the different prey species (Pearcy 1973).

From 1937 to 1972 catches fluctuated from below 1 million pounds (1952 to 1955) to above 37 million pounds (1968) (Meehan and Hreha 1969a; Hreha 1974). The majority of the catch from 1961-1967 was from waters between 30° and 48° N and east of 128° (Meehan and Hreha 1969b). Catch statistics for 1961 to 1967 were summarized for one degree squares in the lease area from 1961 to 1967 (Meehan and Hreha 1969b). Catches range from 0 to the maximum of 4.2 million pounds for a one degree square off Coos Bay (August 1966). A similar analysis for albacore landings in California (fish caught within the lease area) from 1951 to 1961 showed peak catches occurring in August and September, and generally 1 to 50 tons caught per one-degree square (Clemens and Craig 1965).

Thus, although the GRLA is a productive area for the albacore fishery, prediction of abundances and areas of high catch is not presently possible.

B. Relevant Studies Outside The Gorda Ridge Lease Area.

1. Distribution and abundance

Family Engraulidae
Engraulis mordax

Anchovy populations were estimated south of the GRLA by the California Cooperative Sardine Research group (CalCSR). The following figures are provided to give a representation of their findings. Larvae were found to number 0.05 to 7.99 larvae per station in 1951, and 1 to 20 per station in 1952. Richardson (1973) reported this species numbered between 1 and greater than100 individuals per $10^3 m^3$ from 31 July through 12 August north of the GRLA.

Family Gonostomatidae
Cyclothone pallida

Two individuals were caught between 2088 and 2850 m in a single tow of 10 midwater tows taken south of the GRLA (Stein 1985).

Family Sternoptychidae
Argyropelecus hemigymnus

Stein (1985) caught 19 specimens in four midwater tows taken south of the GRLA. Two were caught in tows at discrete depths ranging from 2090 to 2525 m.

Family Idiacanthidae
Idiacanthus antrostomus

Two individuals were caught in two oblique tows taken south of the GRLA (Stein 1985) between 0 and 2315 m.

Family Synodontidae
Bathysaurus mollis

Stein (1985) reported abundance from 0.005 to 0.01 individuals per $10^3 m^2$ south of the GRLA. Biomass estimates ranged from 1.2 to 6.9 g $10^{-3} m^2$.

Family Myctophidae
Parvilux ingens

Stein (1985) reported 9 specimens from 4 of 9 midwater trawls taken south of the GRLA. Three were caught at discrete depths ranging from 2090 to 2350 m.

Taaningichthys paurolychnus

Eleven specimens were caught in four of ten tows made south of the GRLA (Stein 1985). Six of the individuals were caught at discrete depths ranging from 2090 to 2350 m.

Family Merlucciidae
Merluccius productus

CalCSR (1952) found 0.05 to 7.99 larvae of this species per station south of the GRLA in 1951. Ahlstrom (1965) reported 1 to 100 larvae per station south of the GRLA in 1954.

Family Macrouridae
Coryphaenoides armatus

Stein (1985) collected C. armatus south of the GRLA; abundance ranged from 0.01 to 0.05 individuals per $10^3 m^2$. Estimates of biomass were 24.6 g $10^{-3} m^2$.

Coryphaenoides yaquinae

Estimated abundances of C. yaquinae south of the GRLA were between 0.02 and 0.07 individuals per $10^3 m^2$ (Stein 1985). Biomass estimates were 10.4 to 24.1 g $10^{-3} m^2$.

Family Cetomimidae
?Cetomimus sp.

Three specimens were caught in two of ten midwater trawls made south of the GRLA (Stein 1985) between 2088 and 3000 m depth.

Cetostomus sp.

Nine specimens were collected by Stein (1985) in two midwater tows out of a total of ten made south of the GRLA.

Ditropichthys storeri

Only one individual of this species was caught in ten midwater tows made south of the GRLA (Stein 1985).

Gyrinomimus sp.

Stein (1985) reported four specimens from two midwater tows out of a total of 10 made south of the GRLA.

Family Melamphaidae
Melamphaes parvus

Six specimens were caught in three of ten midwater trawls south of the GRLA (Stein 1985). Three individuals were caught in discrete samples at depths ranging from 2090 to 2525 m.

Scopeloberyx nycterinus

Stein (1985) caught 67 individuals in ten midwater tows made south of the GRLA between depths of 2088 to 3020 m. All tows made in the area contained this species.

Family Alepocephalidae
Bellocia alvifrons

Two individuals were caught in a single midwater tow (of 10) made south of the GRLA (Stein 1985). They were taken between 2850 and 3020 m depth.

Bathylaco nigricans

Stein (1985) caught 11 individuals in 4 of 10 tows made south of the GRLA. In discrete samples this species was found between 2090 and 2525 m depth.

Family Opisthoproctidae
Bathylychnops exilis

A single specimen was collected in 10 midwater tows made south of the GRLA (Stein 1985).

Family Anotopteridae
Anotopterus pharao

Nine specimens were caught in two of ten tows made south of the GRLA (Stein 1985). Oblique tows were made from the surface down to 2525 m.

Family Cyemidae
Cyema atrum

Stein (1985) caught 44 individuals in 5 of ten tows made south of the GRLA. Forty specimens came from one tow from the surface down to 2315 m.

Family Chiasmodontidae
Dysalotus oligoscolus

Four specimens were collected in three of 10 midwater tows made south of the GRLA (Stein 1985). Two were collected between 2090 and 2525 m.

Family Serrivomeridae
Serrivomer ?sector

A single specimen was taken in ten tows made south of the GRLA (Stein 1985).

Family Saccopharyngidae
Saccopharynx sp.

One individual was caught in ten tows made south of the GRLA at a depth between 0 and 3000 m (Stein 1985).

Family Melanonidae
Melanonus zugmayeri

A single specimen was collected in an oblique tow between 0 and 2315 m south of the GRLA (Stein 1985). Only one of ten tows made in the area contained this species.

Family Oneirodidae
Leptacanthichthys gracilispinus

One individual was caught in an oblique (0 top 2088 m) tow out of ten made south of the GRLA (Stein 1985).

Family Scopelosauridae
Scopelosaurus harryi

One individual was collected from a series of ten midwater tows made south of the GRLA (Stein 1985) between 0 and 2088 m.

Family Apogonidae
Rhectogramma sherborni

Stein (1985) caught 54 specimens on a single tow, in a series of ten, made south of the GRLA. The catch was made between 2088 and 2850 m.

Family Searsiidae
Sagamichthys adei

A single individual was caught between 2088 and 2850 m in a midwater trawl south of the GRLA (Stein 1985). Only one of ten tows in the area contained this species.

Family Nemichthyidae
Nemichthys scolopaceus

Two specimens were collected in one tow made between 0 and 2315 m south of the GRLA (Stein 1985). Ten tows were made in the area, and only one contained this species.

Family Paralepididae
Lestidium ringens

Only one individual was collected in ten tows made south of the GRLA (Stein 1985). The oblique tow which captured this animal was between 0 and 2315 m.

Family Carangidae
Trachurus symmetricus

Samples from south of the GRLA have contained between 0.05 and 7.99 individuals per station in 1951 (CalCSR 1952). In 1958 there were 1 to 1000 larvae per station (Ahlstrom 1965).

Family Scorpididae
Medialuna californiensis

Three specimens were caught north of the GRLA in gill nets less than 10 m below the surface (Nagtegaal and Farlinger 1980).

2. Reproduction

Family Macrouridae
Coryphaenoides armatus

Six females, all greater than 740 mm TL, caught south of the GRLA, contained ripe or ripening eggs (Stein 1985). The individual with the ripest eggs (0.82 mm diameter) was 960 mm TL and contained an estimated 6.2×10^6 eggs. Based on this information and past samples, Stein (1985) concluded sexual maturity may not occur until the animals are very large, that reproduction may not be synchronous within the population, and females may spawn only once and then die. Additionally, they may not form spawning aggregations, but spawn at widely spaced locations and at different times, and the spawning females may be a small portion of the total population.

3. Growth

Family Scombridae
Thunnus alalunga

Most data available on the growth of albacore applicable to GRLA fish come from off California. Clemens (1961) found that "52 cm (fish) would...(reach) 65 cm in one year; 65 cm would grow to 76 cm, 76 cm fish to 85...". No difference exists in length-weight relationship between male and female fish. The relationship was Weight = 4.936×10^{-8} $Length^{2.99}$. The von Bertalanffy growth equation for California fish was $L_t = 1356\ (1-e^{-0.17(t+1.87)})$, where L_t = length at time t.

4. Migrations

Family Zoarcidae
Lycodapus mandibularis

This species is thought to exhibit a diel vertical migration in Monterey Canyon, California (Anderson 1978). Although these samples were taken nearshore, the depths of the canyon are similar to those in the GRLA. Daytime concentrations occurred at depths of 500 to 600 m, and were shallower at night. Postlarvae are found throughout the depth range of the adults, while larvae are generally closer to the bottom (Peden and Anderson 1979).

5. Food habits

Family Synodontidae
Bathysaurus mollis

Only one of six specimens of this species collected south of the GRLA contained some prey, a moderately large fish, possibly a macrourid (Stein 1985).

Family Macrouridae
Coryphaenoides armatus

Ten specimens of this species were sampled for food habits south of the GRLA (Stein 1985). They fed principally on nektonic animals such as fishes and cephalopods. In addition, they consumed decapods, cirripeds, amphipods, and polychaetes. Two animals had eaten Bathysaurus mollis. Much of the food (cephalopods and barnacles) must have come from shallower waters, but was probably eaten as carrion.

Coryphaenoides yaquinae

Based on samples taken south of the GRLA, this species consumed principally benthic invertebrates (Stein 1985). Diet consisted mostly of polychaetes and amphipods, but also included isopods, amphipods, copepods, decapods, cirripeds, cephalopods, gastropods, ophiuroids,

holothuroids, echiuroids, spunculids, and fish. Larger individuals (greater than 500 mm TL) ate other fishes, including Bathysaurus mollis.

C. Gaps In The Data.

Of all the nekton the fishes have received the greatest amount of study. W.G. Pearcy and colleagues at OSU have made extensive studies of the fishes, primarily in the northern section of the GRLA. These data include estimates of densities, vertical migrations, feeding habits, reproduction, and growth. The majority of the work has centered on the most abundant fish species in the mesopelagic zone offshore.

Perhaps the greatest gap in the data concerning fishes in the GRLA, is adequate estimates of the abundance of fishes over the ridge. Effects of development will most likely affect those animals residing in the immediate vicinity of the ridge. Although it can be assumed that results of studies to the north are applicable to the Gorda Ridge, many more studies need to be done in the region of possible development. Specifically, more detailed studies of vertical migrations, communities, and natural history of GRLA organisms are required.

Finally, processes addressed above all need to be studied further. Work to date has provides some data on biology of some of a few deep-water fishes, but almost all are in need of study. We know practically nothing of most deep-water species in terms of their reproduction, growth, feeding habits or movements. We do not even know what species of fishes actually occur on Gorda Ridge, let alone nektonic invertebrates. A systematic, intensive collecting program in the water over the Gorda Ridge would provide answers to many of these questions.

IV. MARINE MAMMALS

A. Studies Within The Gorda Ridge Lease Area

There have been few studies of marine mammals in the lease area. Many marine mammal species whose known distribution includes the lease area (Table 4) are present for short periods of time, either for feeding or during migration. Many cetacean species (whales, dolphins, and porpoises) use the area around the shelf break for feeding, but these animals are difficult to observe and few efforts have been made to study them. Most pinniped species (seals, sea lions, and walrus) occupy the waters near shore and do not venture off the shelf. The following is a summary of the data regarding various biological processes that involve the marine mammals within the lease area.

1. Distribution and abundance

Only two studies have attempted specifically to assess the distribution and abundance of marine mammals in the lease area (Dohl et al. 1981, 1982, Fiscus and Niggol 1965). Neither adequately estimated populations.

Family Balaenopteridae
Balaenoptera musculus

Blue whales are relatively rare; an estimated 1,600 individuals reside in the North Pacific (National Marine Fisheries Service 1984). Three blue whales were seen on 19 March 1959 approximately 50 miles west of Cascade Head, OR (145°06'N, 125°11'W) as reported by Fiscus and Niggol (1965). Although Dohl et al. (1981) saw no blue whales within the lease area, blue whales must occur off Oregon during May and June and again in August through October during their annual migration (Rice 1974). There are no current estimates of number of blue whales which move through the lease area.

Balaenoptera physalus

There are about 17,000 fin whales in the North Pacific (National Marine Fisheries Service 1984). Although in their seasonal movements from Baja California to the Bering Sea (Rice 1974) they would undoubtedly occur in the lease area, there are no known published sightings of this species in this area. Tomilin (1957) reported March to be the primary whaling season for fin whales off the coasts of California, Oregon, and Washington.

Balaenoptera borealis

Past estimates for the population of sei whales in the North Pacific were 9,000 individuals (Brownell et al. 1978) Recently, estimates reached 30,000 animals on the western side of the Pacific (National Marine Fisheries Service 1984). Sei whales are considered to be an

Table 4. List of marine mammal species with distributions which are known to overlap with the Gorda Ridge lease area according to Leatherwood et al. (1982).

Species	Common Name
Order Cetacea	
Family Balaenidae	
Eubalaena glacialis	right whale
Family Balaenopteridae	
Balaenoptera musculus	blue whale
Balaenoptera physalus	fin whale
Balaenoptera borealis	sei whale
Balaenoptera acutorostrata	minke whale
Megaptera novaeangliae	humpback whale
Family Physeteridae	
Physeter macrocephalus	sperm whale
Kogia breviceps	pygmy sperm whale
Family Ziphiidae	
Berardius bairdii	Baird's beaked whale
Ziphius cavirostris	Cuvier's beaked whale
Mesoplodon carlhubbsi	Hubb's beaked whale
Mesoplodon stejnegeri	Stejneger's beaked whale
Mesoplodon densirostris	Blainville's beaked whale
Family Delphinidae	
Orcinus orca	killer whale
Pseudorca crassidens	false killer whale
Globicephala macrorhynchus	short-finned pilot whale
Grampus griseus	Risso's dolphin
Stenella coeruleoalba	striped dolphin
Delphinus delphis	common dolphin
Lagenorhynchus obliquidens	Pacific white-sided dolphin
Lissodelphis borealis	northern right-whale dolphin
Family Phocenidae	
Phocoenoides dalli	Dall's porpoise
Phocoena phocoena	harbor porpoise
Order Pinnipedia	
Family Otariidae	
Eumetopias jubatus	northern sea lion
Zalophus californianus	California sea lion
Callorhinus ursinus	northern fur seal

Family Phocidae	
Phoca vitulina vitulina	harbor seal
Mirounga angustirostris	northern elephant seal

offshore species (Dohl et al. 1981), however this species has not been observed in the lease area.

Balaenoptera acutorostrata

The minke whale has only recently become the target of whaling nations, and therefore there are no population estimates for the North Pacific. There are no known reports of this species in the lease area.

Megaptera novaeangliae

Approximately 1,000 humpbacks occur in the North Pacific (National Marine Fisheries Service 1984). Humpbacks have been caught off the Washington coast from April through October, the majority in June through August. There are no known records of this species in the lease area.

Family Physeteridae
Physeter macrocephalus

An estimated 472,000 sperm whales reside in the North Pacific (National Marine Fisheries Service 1984). Eastern Pacific (east of 150°W) sperm whales are one of three North Pacific stocks recognized (Best 1975). Sperm whales were observed on four occasions during 1958 and 1959 cruises within the lease area (Fiscus and Niggol 1965). One sperm whale was recorded in the lease area during aerial surveys in 1980 (Dohl et al. 1981).

Kogia breviceps

There have been no published observations or estimates of numbers of pygmy sperm whales in the lease area.

Family Ziphiidae

The beaked whale family consists of species which are confined to the deeper regions of the oceans. For this reason we assume some beaked whale species inhabit the lease area, but because of their low numbers they are rarely encountered. There are no published records of beaked whales in the lease area, nor are there any estimates of abundance in the Pacific.

Family Delphinidae
Orcinus orca

Killer whales are found throughout the Pacific Ocean but are more abundant within 800 km of shore (Mitchell 1975). There were an estimated 249 killer whales in the waters adjacent to British Columbia and Washington in 1973 (National Marine Fisheries Service 1974), there are no current estimates for the population in the North Pacific or the lease area. Eighteen individuals were seen in the lease area during two pelagic surveys in 1959 (Fiscus and Niggol 1965).

Pseudorca crassidens

The false killer whale is difficult to identify from a ship or an aircraft and therefore is rarely identified at sea. This species has not been recorded in the lease area and there are no estimates of its numbers.

Globicephala macrorhynchus

The short-finned pilot whale is an offshore species which may migrate north in the summer and south in the winter in response to water temperature (Leatherwood et al. 1982). Six individuals were seen in March of 1959 in the lease area (Fiscus and Niggol 1956). There are no current population estimates for the lease area or the North Pacific.

Grampus griseus

Risso's dolphin lives in most tropical and temperate oceans (Rice 1977). Sightings generally occur in central California in the winter and along British Columbia during summer (National Marine Fisheries Service 1977). Fifteen individuals were seen in two groups during March 1959 surveys in the lease area (Fiscus and Niggol 1956). Dohl et al. (1981) found G. griseus quite abundant in the southern part of the lease area during May. The majority of sightings occurred outside the 100 fm contour. There are no estimates for the number of Risso's dolphins in the lease area or the North Pacific. However, Fiscus (unpubl. data) observed 200 in one group off the Washington coast.

Stenella coeruleoalba

The striped dolphin inhabits temperate and tropical waters of all oceans (National Marine Fisheries Service 1977). It has been seen as far north as British Columbia (Scheffer 1953), but is probably rare in the lease area. In fact, no sightings of this species have been reported for the area, although there are an estimated 2.3 million striped dolphins along the coast of North America (National Marine Fisheries Service 1984).

Delphinus delphis

Distributed throughout the world in temperate and tropical seas (Evans 1976), the most northerly sighting in the eastern North Pacific occurred off British Columbia (Giugnet 1954). There are presently no reports of common dolphins in the lease area, although an estimated 900,000 individuals occur along the coast of North America (National Marine Fisheries Service 1984).

Lagenorhynchus obliquidens

The Pacific white-sided dolphin is found from Alaska south to Baja California (Norris and Prescott 1961). There are an estimated 30,000 to 50,000 of this species along the coast of North America (National Marine Fisheries Service 1984). Fiscus and Niggol (1956) counted 27 individuals in the lease area during March and April, 1958 and 1959. Few were seen

inside of the 100 fm contour. L. obliquidens was also observed within the lease area during January and October 1980 (Dohl et al. 1981).

Lissodelphis borealis

Northern right whale dolphins are normally restricted to temperate waters between 30° and 50°N (Leatherwood and Walker 1976). There is one observation by Dohl et al. (1981) within the lease area; there are no other records of this species in this area. Nishiwaki (1972) estimated the population of the North Pacific to be 10,000 individuals.

Family Phocenidae
Phocoenoides dalli

P. dalli may range as far south as central Baja California, although they are rare south of 35°N (Leatherwood et al. 1982). There are 920,000 Dall porpoise in the North Pacific (National Marine fisheries Service 1984), most of which are year round residents north of the Channel Islands off California. Fiscus and Niggol (1965) recorded 21 observations of Dall porpoise in the Gorda Ridge lease area; average group size was 4.5 individuals. Dall porpoise were seen on 14 occasions in the lease area in 1980 (Dohl et al. 1981).

Phocoena phocoena

The harbor porpoise ranges from Alaska to southern California, and is usually a frequent visitor to bays and estuaries (Norris and Prescott 1961). Although it has never been recorded in the lease area, it may range that far offshore on occasion (Daugherty 1966).

Family Otariidae
Callorhinus ursinus

The northern fur seal numbers in excess of 1.3 million individuals in the North Pacific (National Marine Fisheries Service 1984). During winter and spring it is the most abundant pinniped off northern California (Dohl et al. 1981). Forty-three different sightings of fur seals were made during surveys in the lease area during 1980. The majority of sightings were outside the 100 fm contour. Although fur seals may occur as far south as 32°N, the majority spend July through October near their breeding and pupping islands in the Bering Sea and Sea of Okhotsk (Kajimura 1984). The rest of the year the animals are dispersed throughout their range. Therefore, fur seals would be expected in the lease area during November through June. There are no estimates of the number of fur seals inhabiting the lease area during their pelagic phase.

Eumetopias jubatus

Northern sea lions, which are distributed from San Miguel Island, California north to the Bering Sea and Sea of Okhotsk, rarely are seen farther than 37 km from shore (Dohl et al. 1981). They have not been observed in the lease area, but because of their year round presence on northern California and southern Oregon coasts and the possibility of

venturing offshore they are included in this discussion. Approximately 200,000 northern sea lions are found around Alaska, and another 10,000 occur along the west coast of North America (National Marine Fisheries Service 1984).

Family Phocidae
Phoca vitulina

The harbor seal generally occurs near shore and rarely ventures more than 22 km from land (Dohl et al. 1981). Although it has never been reported from the lease area, it's abundance along the coast and infrequent use of offshore areas, suggests harbor seals may infrequently be found in the study area.

Mirounga angustirostris

The northern elephant seal breeds from the Farallon Islands, California south to Isla San Benito, Baja California, and can be found at sea as far north as southeastern Alaska (Rice 1977). A single elephant seal was observed in the lease area on two occasions in 1980 (Dohl et al. 1981). Approximately 100,000 elephant seals live along the coast of North America (National Marine Fisheries Service 1984).

2. Reproduction

Large mysticete whales make a yearly migration from polar feeding areas to tropical and temperate calving and breeding areas. Therefore, although they may be gravid, they do not generally reproduce within the lease area. Odontocetes, on the other hand, have some members which may reproduce in the lease area. Unfortunately, there have been no studies of reproduction of these animals in the lease area.

Pinniped reproduction is tied to land. Seals and sea lions haulout to mate and bear young. Therefore, there is little or no chance that reproduction of pinnipeds occurs in the lease area. The only marine mammals that have been collected in the lease area are fur seals, and information relative to their reproduction is presented below.

Family Otariidae
Callorhinus ursinus

The frequency of pregnancy of fur seals collected off Washington (75-80%) was lower than that of animals collected near the breeding islands (Kajimura et al. 1979). Fur seal pups first arrive along the west coast of North America in mid-December. Fur seals feed while in the lease area but no reproductive behavior is evident.

3. Growth

Marine mammals occupying the lease area generally are migrating and feeding. Amount of growth within the area is unknown. The paucity of

collected material precludes any discussion of growth, however, and there are no published data regarding growth of marine mammals in the lease area.

4. Migrations

Based upon presumed migratory paths, many of the large whales, some of the dolphins, and a few of the pinnipeds may migrate throught the study region. Fiscus and Niggol (1965) and Dohl et al. (1981) have published the only records of animals in the area, but these brief studies provide no data on migration.

5. Feeding habits

No published reports describe the feeding habits of marine mammals in the lease area. The majority of data concerning feeding habits in this area come from stranded animals or animals which were processed on whaling vessels. Specific observations of feeding or collections of animals for feeding studies in the lease area have not been made.

6. Commercial exploitation

There is presently no commercial harvesting of any marine mammal species in the lease area.

B. Relevant Studies Outside The Gorda Ridge Lease Area

The vast majority of studies regarding marine mammals are from outside the Gorda Ridge lease area. Marine mammals of California are relatively well-studied, either through the California Cooperative Oceanic Fisheries Investigations (CalCOFI), Southwest Fisheries Center of the National Marine Fisheries Service (NMFS), investigations of the Center for Coastal Marine Studies, University of California-Santa Cruz, or numerous studies by academic and state institutions scattered along the coast. Alaska and British Columbia marine mammal populations are well studied because of the interest in oil development. National Marine Fisheries Service, the state of Alaska, and the Canadian government have provided funds and scientists for these studies. Unfortunately, along the coasts of Washington and Oregon there are few institutions and little money to study marine mammal populations.

The Gorda Ridge lease area is therefore poorly known. Most information relevant to the local marine mammal populations must therefore be obtained from studies outside the area. The following discussion of processes and the species they affect summarizes such studies. Although these investigations and data are not specific to the lease area, they should still apply to animals there.

1. Distribution and abundance

For cetaceans much of the information regarding population size has been based on whaling records (often catch per unit effort or sighting records) or aerial or shipboard surveys. The estimates are often poor because whales, dolphins, and porpoises spend very little time at the surface and tend to be wary of ships or aircraft. Abundance estimates for smaller cetaceans are very poor or nonexistent; these animals are not commercially important and there have been few attempts to estimate their populations.

Pinnipeds are more easily counted, because they rest and reproduce on shore. Aerial and land counts can provide relatively reasonable estimates for the size of the population. These estimates should take into account the fact that not all of the population is visible during a census; a certain proportion of the animals are still in the water. Recently efforts have been made to deal with this problem and develop "raising factors" for certain species. Estimates of pinnipeds at sea suffer from many of the same problems associated with cetaceans, although pinnipeds remain at the surface for longer periods of time. Therefore, accurate population estimates of marine mammals are rare.

Family Balaenidae
Eubalaena glacialis

The approximately 200 right whales thought to inhabit the North Pacific are distributed from the Bering Sea south to central Baja California. Gilmore (1978) collected eighteen sightings of right whales along the west coast from 1850 to 1967. The low population in the north Pacific and the more northerly center of distribution of this species indicate that very few right whales are expected in the lease area. Fiscus and Niggol (1965) however, reported sighting three individuals 80 miles west of Tillamook Head, OR on 8 April 1959. They also reported three other groups of E. glacialis off Oregon. Very few right whales were taken during whaling in this area. Given this information, no more than a few right whales are likely to be in the lease area at any time.

Family Balaenopteridae
Balaenoptera musculus

In the north Pacific, blue whales are distributed from the Gulf of Alaska to the equator (Rice 1978). Approximately 1,600 individuals make a yearly migration. Some individuals are probably in the lease area during May or June (Rice 1974). Dohl et al. (1981) sighted blue whales sixteen times, a total of 35 individuals, during aerial surveys of central and northern California in 1980. The sighting of three blue whales by Fiscus and Niggol (1965) in the lease area, and the relatively large number of sightings in California, strongly suggest that blue whales occur in the Gorda Ridge lease area during the summer. The number of blue whales frequenting this area is probably very low because the population is small. Most blue whales observed by Dohl et al. (1981) were on the continental slope, although the majority of the species are probably over the slope and farther offshore.

Balaenoptera physalus

In the eastern North Pacific, fin whales occur along the northern California and Oregon coasts during summer (Leatherwood and Reeves 1983). Of the estimated 17,000 individuals in the North Pacific, relatively few have been sighted off northern California and Oregon. Fiscus and Niggol (1965) saw seven animals south of the lease area, and one individual north of the area during 1958 and 1959 surveys. In the waters off central and northern California, Dohl et al. (1981) reported seven sightings (15 animals) during 1980. These observations indicate that, like the blue whale fin whales are relatively rare in the lease area.

Balaenoptera borealis

There are no current estimates of the sei whale population of the eastern North Pacific (National Marine Fisheries Center 1984). Sei whales, like fin whales, occur off northern California and Oregon during the summer. They are somewhat more likely to occur offshore than other baleen whales (Leatherwood and Reeves 1983), and are less likely to be abundant near the shelf break of the lease area. In fact, Dohl et al. (1981) reported only one sighting of sei whales during 1980 in central California; only five individuals were observed in three years of surveys off southern California. Consequently, the number of sei whales in the lease area is likely to be very low.

Balaenoptera acutorostrata

The minke whale is the smallest and most commonly seen baleen whale along the west coast of North America. There are no current estimates of the population size in the eastern North Pacific, although the world population level is thought to be 385,000 to 425,000 (National Marine Fisheries Service 1984). Although this species is one of the most abundant baleen whales, there are few reported sightings near the lease area. Fiscus and Niggol (1965) reported only three separate observations (10 animals). The sightings were generally 80 km offshore and north or south of the lease area. Dohl et al. (1981) separately observed only five minke whales along the continental slope of central and northern California. These results contrasted with studies in the southern California bight, where minkes were the most numerous of the large whales. As with other baleen whales, minke whales are expected to occur in the lease area during summer (National Marine Fisheries Service 1977). Although this species should be the most numerous in the lease area, it may be relatively uncommon. Along Oregon the minke whale is the second most frequent baleen whale to strand (two in the last six years), the most common being the gray whale, Eschtrichtius robustus (Harvey and Mate, unpubl. data).

Megaptera novaeangliae

There are an estimated 1,000 humpback whales in the North Pacific (National Marine Fisheries Service 1984). They occur during the summer along the west coast of North America. This species was taken commercially in this area during April through October of 1913-1915 and

1918-1919 (Tomilin 1957). Because approximately 100 individuals are thought to winter off Mexico, it is possible that many pass through the lease area during their migration (Wolman 1978).

Fiscus and Niggol (1965) observed four groups of humpbacks off Northern California and Washington. Generally the whales were within 32 km of shore, but on one occasion a single animal was seen 93 km offshore. Dohl et al. (1981) sighted humpbacks 37 times (87 individuals). The majority were within the 1000 fm contour. Humpbacks have been observed relatively close to shore off southern Oregon on three occasions (N. Langbehn, pers. comm.). Also, a fisherman reported a humpback whale 56 km offshore of Cape Perpetua in 1981 (Harvey, unpubl. data).

The population of humpbacks moving through the lease area appears to be small. They are easily distinguished from other baleen whales so that there are proportionately more sightings.

Family Physeteridae
Physeter macrocephalus

The 472,000 sperm whales of the North Pacific are widely distributed and generally live offshore of the shelf break (National Marine Fisheries Service 1984). During winter, P. macrocephalus occur south of 40°N, forming breeding congregations off the California continental slope (Leatherwood et al. 1982). During the winter, sperm whales should be present in the lease area. They have been observed over 80 km off Trinidad Head, California, and 65 km off Heceta and Yaquina Heads in March and April 1958 and 1959 (Fiscus and Niggol 1965). Dohl et al. (1981) also reported that most sperm whales are encountered outside the 1,000 fm isobath.

Evidence of the existence of relatively large numbers of sperm whales off Oregon is provided by the recent strandings of a total of 43 sperm whales on three separate occasions (Rice et al., unpubl. manuscript). Forty-one, mostly adult females and juvenile males and females, came ashore in 1979 at Florence. Two months earlier a 17.7 m male stranded south of Winchester Bay, Oregon and a newborn sperm whale washed ashore in northern Oregon three months after the mass stranding. Before 1979, the only sperm whale stranding on record was one in 1961. These would seem to indicate that sperm whales now frequent waters off Oregon and are probably present in the lease area.

Kogia breviceps

The diminutive pygmy sperm whale is rarely seen at sea, and is primarily known from strandings. It apparently occurs in all tropical and temperate oceans of the world (Handley 1966). In the eastern North Pacific, there have been two strandings in Washington (Rice 1978) and a single stranding south of Florence, Oregon in 1980. K. breviceps is believed to spend most of its time in deeper water and probably occurs in the Gorda Ridge lease area. The size of the population in the lease area, however, is probably very small.

Family Ziphiidae
Berardius bairdii

Baird's beaked whale occurs between the Pribilof Islands in the Bering Sea and southern California (Rice 1978). Generally it is confined to waters greater than 1,000 m deep (Leatherwood and Reeves 1983). There are no population estimates for the North Pacific. The species is considered uncommon but not rare. Dohl et al. (1981) documented Baird's beaked whale on four occasions (12 animals). Six of these individuals were seen 48 km off Fort Bragg, California. Wahl (1977) reported six whales 75 km west of Westport, Washington in October 1976. One was seen in Tillamook Bay, Oregon in 1981 (Harvey, unpubl. data). These anecdotal records support the suggestion that the animal is present but not abundant in the northeast Pacific. A few probably occur in the lease area.

Ziphius cavirostris

Cuvier's beaked whale is probably the most abundant Pacific beaked whale (Leatherwood et al. 1982). It occurs from the Bering Sea south to the tip of Baja California. Like most beaked whales, it is a deep water species . Dohl et al. (1981) saw only two in their surveys of California. Forty strandings are recorded from the west coast of north America (Rice 1978). This beaked whale may be the most abundant member of the family as evidenced by Oregon stranding records. Roest et al. (1953) reported a specimen stranded at Oceanlake in 1952. Subsequently one stranded in 1976, two in 1979, and one each in 1980 and 1982 (Harvey and Mate, unpubl. data). Z. cavirostris is difficult to identify at sea, and are not plentiful; thus, records are scarce. The deep water habitat and wide distribution suggest they occur in the lease area, although their abundance unknown.

Mesoplodon spp.

Mesoplodon species are so poorly known and difficult to identify that they have been lumped for the purposes of this discussion. All three species whose ranges include the lease area are extremely rare. All are basically deep water forms and therefore may inhabit the lease area. Dohl et al (1981) observed two Mesoplodon 140 km off central California. Only stranded individuals have been recorded from northern California or Oregon waters. One specimen of M. stejnegeri came ashore at Newport, Oregon.

Family Delphinidae
Orcinus orca

Killer whales occur throughout the Pacific Ocean. They form resident or transient pods. In the Gorda Ridge area Fiscus and Niggol (1965) recorded five pods of whales (a total of 31 individuals). O. orca were observed up to 88 km offshore. Three separate pods were observed off Washington from 1973 through 1976 (Wahl 1977). Wahl noted that one pod was 110 km offshore. Dohl et al. (1981) reported 10 sightings (34 animals). Migration seems to be influenced by food supply. Off Oregon, killer whales have been sighted along the central coast from April

through August during the last three years (Harvey, unpubl. data). Although these are nearshore sightings, animals probably enter the lease area at about the same time of year. National Marine Fisheries Service (1974) estimated there were 249 killer whales in the waters of Washington and British Columbia. Fewer animals are likely to frequent the Oregon coast and the lease area.

Pseudorca crassidens

False killer whales inhabit offshore waters from Washington south to Guerrero, Mexico (Leatherwood et al. 1982). This species has been reported to be uncommon throughout its range (National Marine Fisheries Service 1974) but Fiscus and Niggol (1965) reported two individuals 32 km offshore south of the lease area and suggest that this species is more common off California, Oregon, and Washington than records indicate. The Pacific Northwest is the northern part of its range however, and false killer whales are probably less common here. One animal captured in Puget Sound (Scheffer and Slipp 1948), and a stranding in May 1984 along the Oregon coast (Harvey, unpubl. data) are the only evidences of its existence in these waters.

Globicephala macrorhynchus

No current estimates exist of the population size of this species in the North Pacific (National Marine Fisheries Service 1984). The short-finned pilot whale generally favors offshore waters, but moves inshore in search of food (National Marine Fisheries Service 1974). Individuals were observed south of the lease area five times (Fiscus and Niggol 1965), but generally they are most abundant south of Point Conception, California (Rielly 1978). G. macrorhynchus should be considered uncommon in the Pacific Northwest, and probably occurs rarely in the lease area.

Grampus griseus

Risso's dolphin is distributed from 50°N to the equator and is primarily a warm water species (Leatherwood et al. 1982). It occurs north and inshore during summer when the water is warmer. These cetaceans were observed on two occasions, south of the lease area (in 1958 and 1961) (Fiscus and Niggol 1965). Dohl et al. (1981) found this whale to be the third most abundant cetacean in central and northern California. Most sightings occurred south of Santa Cruz, California, generally outside the 100 fm contour. Wahl (1977) reported four separate sightings of up to 60 individuals 40 to 85 km off Westport, Washington. Stroud (1968) reported a sighting off Neah Bay, Washington. The species is uncommon off Oregon and Washington and is uncommon in the lease area.

Stenella coeruleoalba

The striped dolphin occurs in all temperate and tropical oceans. There may be 2.3 million in the North Pacific (National Marine Fisheries Service 1984). S. coeruleoalba has been reported from Japan, Oregon, Washington, and California (Tomilin 1957). It is difficult to identify from the air; Dohl et al. (1981) reported no sightings during their

aerial surveys. Fiscus and Niggol (1965) also reported no observations from the coasts of Washington and Oregon. The species is occasionally stranded in British Columbia, Washington, or Oregon (Kellogg and Scheffer 1947; Scheffer 1953). The species probably is rare in the lease area.

Delphinus delphis

The common dolphin population may equal 900,000 off the west coast of North America (National Marine Fisheries Service 1984). The most northerly stranding in the eastern Pacific was in British Columbia (Guiguet 1954), but most of the population occurs south of 36°N (Evans 1976). Leatherwood et al. (1972) reported no sightings of live animals in an area north of Santa Cruz, California. Wahl (1977) reported a possible sighting of one to two individuals 72 km northwest of Westport, Washington. This animal should therefore be considered rare in the lease area.

Lagenorhynchus obliquidens

An estimated 30,000 to 50,000 Pacific white-sided dolphins reside off western North America (National Marine Fisheries Service 1984), from Valdez, Alaska to Baja California (Norris and Prescott 1961). This is one of the most abundant cetaceans along the coast, as demonstrated by the large number of sightings. Fiscus and Niggol (1965) reported 135 sightings of groups of from 1 to over 500 individuals. Generally, they occurred between the 100 and 1,000 fm contours. Dohl et al. (1981) considered this to be the most numerous cetacean observed off central and northern California. Pike and MacAskie (1969) summarized the sightings in British Columbia and Washington. The Pacific white-sided dolphin is therefore probably one of the most abundant cetaceans in the lease area, although there are no accurate estimates of the number that occur.

Lissodelphis borealis

Nishiwaki (1972) estimated that there are 10,000 individuals of this species in the North Pacific. Leatherwood and Walker (1976) found actual records only as far north as 50°N, and as far south as San Clemente Island, California (32°N). L. borealis lives primarily offshore, and is rare off northern California, Oregon, and Washington (Leatherwood et al. 1982). No population estimates exist for the lease area. Only six sightings were reported by Fiscus and Niggol (1965), all south of San Francisco, in contrast to Dohl et al. (1981) who found this to be the second most abundant cetacean in central and northern California. Animals reported by these second authors were usually outside the 1,000 fm isobath. In addition, 16 sighting were north of 38°N, but only four were north of 40°N. Individuals were reported however, 85 and 72 km northwest of Westport, Washington (Wahl 1977). This species is found in large schools of up to 2,000 animals, averaging 100 animals per school (Dohl et al. 1981). These observations suggest that L. borealis occurs periodically but irregularly in the lease area in relatively large numbers.

Family Phocenidae
Phocoenoides dalli

There are approximately 840,000 to 2,300,000 Dall's porpoise in the North Pacific, between 28^0 N (Leatherwood and Fielding 1974) and 66^0 N in the Bering Sea (National Marine Mammal Laboratory 1981). Fiscus and Niggol (1965) sighted P. dalli 52 times within two degrees north or south of the lease area. Pike and MacAskie (1969) reported more than 200 sightings off British Columbia; Wahl (1977) saw individuals of this species during 24 of 24 trips out of Westport, Washington. All but one sighting off Washington were farther offshore than 50 km. Dohl et al. (1981) considered this species to be the fifth most abundant off central and northern California. Schools averaged four individuals and generally occurred between the 100 and 1,000 fm contours.

Estimates of the Dall porpoise population of the lease area are not available. This species is probably abundant in the area throughout the year.

Family Otariidae
Callorhinus ursinus

An estimated 1.3 million fur seals reside in the North Pacific (National Marine Fisheries Service 1984). Of these 865,000 breed on the Bering Sea Islands off Alaska, and 4,000 breed and pup along the coast of California. Few other species of pinniped are so pelagic when away from the breeding and pupping grounds. Seasonal migrations of this species through the lease area occur during fall, winter and spring. Dohl et al. (1981) found this to be the most abundant pinniped off central and northern California. It was most abundant in February, when average density along 4,717 km of transects was 0.28 animals/km^2. Most sightings were 40 to 100 km offshore and were evenly distributed. Fur seals were observed on 14 of 47 trips off Washington by Wahl (1977).

C. ursinus is without doubt the most numerous pinniped in the lease area. Seasonal occurrence is from March through May off British Columbia (Pike and MacAskie 1969). Estimates of fur seal abundance in the lease area are unavailable. Using the fur seal density given by Dohl et al. (1981), in the 260,000 km^2 lease area there may be as many as 72,800 fur seals.

Eumetopias jubatus

The North Pacific population of northern sea lions is considered to be 230,000 to 240,000 individuals (Marine Fisheries Service 1984). Ten thousand are on the coasts of British Columbia, Washington, Oregon, and California. Individuals spend most of their time near shore. All sightings of this species by Dohl et al. (1981) were within 37 km of shore. Wahl (1977), however, reported occurrences about 58 and 64 km offshore of Westport, Washington in 1973. There are approximately 3,000 northern sea lions along the Oregon coast (Brown pers. comm.) and another 3,000 along the California coast (Dohl et al. 1981). The nearshore habits and low numbers of northern sea lions in northern California and Oregon suggests this species is quite rare in the lease area.

Family Phocidae
Phoca vitulina

Although there are an estimated 42,000 harbor seals along the west coast of North America (National Marine Fisheries Service 1984), this species probably does not occur in the lease area. Harbor seals rarely venture far from land, and are usually within 22 km of shore (Dohl et al. 1981). Wahl (1977), however, saw a harbor seal 80 km offshore in water several hundred meters deep. Aerial censuses estimate 3,500 harbor seals ashore along the Oregon coast. Recent studies suggest that this number should be doubled (Harvey and Brown unpubl. data). Despite their nearshore abundance, harbor seals are probably extremely rare in the lease area.

Mirounga angustirostris

Northern Elephant seals, which number approximately 100,000 in the North Pacific, are distributed from Alaska south to Mexico (National Marine Fisheries Service 1984). This species and fur seals are the only two pinnipeds commonly seen out of sight of land. Most sightings by Dohl et al. (1981) were over the continental slope or seamounts. Scheffer (1964) reported capture of three elephant seals in longline gear set at 180 m off Florence, Oregon. Typically, elephant seals are solitary when at sea (Antonelis and Fiscus 1980). Pike and MacAskie (1969) reported 32 sightings off British Columbia. The deep water habits and yearly migrations of this species suggest occurrence of some unknown individuals in the study area.

2. Reproduction

Family Balaenidae
Eubalaena glacialis

Like most other baleen whales, right whales move into tropical or temperate waters for breeding and calving during winter. Wintering right whales calve and mate along Oregon, California, and Baja California coasts. Right whales may calve every third year after a gestation period of one year (Gilmore 1978). Breeding may occur in winter. Males reach sexual maturity at 15.2 m; females at 15.8 m (National Marine Fisheries Service 1977). The period of lactation is unknown, but is probably six to seven months (Tomilin 1957).

Family Balaenopteridae
Balaenoptera musculus

Male blue whales reach sexual maturity at approximately three to seven years of age (25 m), and females at two to six years of age (26 m) (Tomilin 1957; Gambell 1975). Pike and MacAskie (1969) reported sexual maturity is reached at 20.5 m in males and 21.5 m in females off British Columbia. Approximately 26% of the 126 blue whales harvested off British Columbia between 1948 and 1959 were sexually immature. Females bear a calf once every two to three years in winter (Rice 1978). Lactation lasts seven to eight months, and the calf is approximately 16

m in length at weaning (Tomilin 1957). The mating season extends over five months (late fall through winter), and gestation lasts twelve months (Rice 1978).

Balaenoptera physalus

Off British Columbia, finwhales were the most numerous large baleen whale harvested. Pike and MacAskie (1969) reported length at sexual maturity to be 17.6 m and 18.2 m for males and females, respectively. Age at maturity is 6 to 12 years (National Marine Fisheries Service 1977). In the early 1960s, pregnancy rate rose to approximately 0.60 (Gambell 1975). In the North Pacific fin whales may breed and calve in winter; the gestation period is approximately 11 to 12 months (Tomilin 1957; Yablokov et al. 1974). Calves are 6.0 to 6.5 m long at birth (Leatherwood and Reeves 1983).

Balaenoptera borealis

In the northern hemisphere, sei whales reach sexual maturity at 6 to 12 years of age, or 12.0 to 13.0 m for males and 12.8 to 13.5 m for females (Tomilin 1957). Females bear a calf once every two to three years, in the winter (National Marine Fisheries Service 1977). After 5 to 7 months the calves are weaned at a length of 8 to 9 m (Tomilin 1957). Mating is generally confined to the winter, although it may occur throughout the year. Gestation is for one year. The pregnancy rate for sei whales off California was thought to be forty percent (Mitchell 1978).

Balaenoptera acutorostrata

Minke whales become sexually mature at 7 to 8 years (National Marine Fisheries Service 1984) or approximately 7 m for males and 8 m for females (Leatherwood and Reeves 1983). Individuals may give birth every year (National Marine Fisheries Service 1984). Mating takes place from December through March off Japan (Tomilin 1957). Births usually occur in the winter, and the gestation period is 10 to 11 months. The newborn are 2.4 to 2.8 m long (Leatherwood and Reeves 1983).

Megaptera novaeangliae

Humpback whales have been harvested off British Columbia and there is some information for this species in the Northwest, although none from the lease area. Pike and MacAskie (1969) reported sexual maturity at average lengths of 11.5 m in males and 11.8 m in females. Breeding and calving lasts from October through March (National Marine Fisheries Service 1984). Calves are 4.5 to 5.0 m long, and nursing continues for 11 months (Leatherwood and Reeves 1983).

Family Physeteridae
Physter macrocephalus

Pike and MacAskie (1969) summarized data on sperm whales taken off British Columbia. Harem schools, composed of 15 to 30 females and immature animals of both sexes, are accompanied by one or two large

bulls. These schools appear off British Columbia in April through June, after the mating season in February and March. Occasionally these schools aggregate into large herds of 50 to 150 individuals. In some years, sperm whales appear again during August and September, when pregnant females are carrying near-term fetuses. Males less than 12 m (recently mature or immature), occur in these harem schools. Medium-size males (12 to 14 m in length) usually appear in loosely grouped bachelor schools from May through September. The largest males (up to 18 m in length) usually occur as solitary animals or are associated with a harem. Off British Columbia males reach sexual maturity at greater than 10 m and females at greater than 9 m.

In June 1979, 41 sperm whales stranded themselves near Florence, Oregon (Snow and Mate 1979). The group was typical of a harem school, with 28 females between 11 and 57 years old, while the males were 14 to 21 years old (Rice et al. unpubl. manuscrpt.). Nine of the dissected females were sexually mature, and three were carrying fetuses. Two months prior to this a large male, 17.7 m in length, was stranded south of Winchester Bay, Oregon (Mate and Harvey, unpubl. data). These observations support the data of Pike and MacAskie regarding reproduction of sperm whales off Oregon, Washington, and British Columbia.

Sperm whales give birth in May through October in the northern hemisphere (Berzin 1971). Lactation generally lasts for one to two years, and the calf is weaned when 6.7 m in length.

Kogia breviceps

Most information on reproduction of pygmy sperm whales has been obtained from stranded animals. Females reach sexual maturity at a length of 2.6 to 2.8 m, males at 2.7 to 3.0 m (Leatherwood and Reeves 1983). Most births appear to take place between autumn and spring, after a gestation period of eleven months. Stranded females have been found which are pregnant and lactating, suggesting this species may give birth each year (National Marine Fisheries Service 1977).

Family Ziphiidae
Berardius bairdii

Baird's beaked whale is one of the few Ziphiids (beaked whales) for which much biological data exists, largely due to commercial harvesting of this species in the North Pacific. Off British Columbia, groups with 10 to 20 individuals were composed mostly of sexually mature males (Pike and MacAskie 1969). Mature males were 9.8 to 11.0 m long. One female was 8.8 m and immature, while another female was 11.3 m long, lactating and multiparous (Pike and MacAskie 1969). Gestation may last about 10 months (National Marine Fisheries Service 1984). Baird's beaked whales reach sexual maturity at eight to ten years. Off Japan, mating occurs in October and November (Rice 1978). McCann (1975) however, reported mating occurs in February with births present in December.

Ziphius cavirostris

Although it occurs worldwide and its taxonomy is well known from strandings, the biology of this species is not well known. Males become sexually mature at about 5.5 m and females at about 6.0 m in length (Leatherwood and Reeves 1983). Newborns are approximately 2.7 m long.

Mesoplodon spp.

There is so little known about the biology of the genus Mesoplodon that the three species that may occur in the lease area have been grouped for this discussion. M. densirostris may reach sexual maturity at nine years of age; at birth calves are probably 1.9 to 2.6 m long (Leatherwood and Reeves 1983). There is no information on M. stejnegeri; in M. carlhubbsi the young may be 2.5 m long at birth (Leatherwood and Reeves 1983).

Family Delphinidae
Orcinus orca

The killer whale reaches sexual maturity at of 0.8 m for males and 4.9 m for females (Bigg and Wolman 1975). In the northern hemisphere births usually occur in autumn (National Marine Fisheries Service 1977). Off Washington breeding occurs in spring and summer (Walker et al. 1975). However, based on whaling records, mating may be year round (Scheffer 1978). Gestation may be 12 to 16 months. Calves are 2.3 m long at birth (Scheffer 1978).

Pseudorca crassidens

The false killer whale may reach sexual maturity at 3.3 to 3.8 m long (Walker et al. 1975). Leatherwood and Reeves (1983) report that newborn calves are usually 1.5 to 1.8 m in length. Other reproductive behavior is unknown.

Globicephala macrorhynchus

Male short-finned pilot whales reach sexual maturity at lengths of 4.2 to 4.8 m, although they probably do not breed until 5.0 m (Leatherwood and Reeves 1983). Females are sexually mature at 3.0 to 3.3 m. Mating may occur in winter; gestation lasts 12 to 16 months (Tomilin 1957; Walker et al. 1975). Females may bear young every two to three years; the newborn is about 1.4 m (Mitchell 1975; Leatherwood and Reeves 1983). Births generally occur from August through winter, weaning occurs at 12 to 16 months (Norris and Prescott 1961; Walker et al. 1975). Some sort of sexual segregation and polygyny may occur if this population behaves like pilot whales off the coast of Newfoundland (Reilly 1978).

Grampus griseus

Very little is known of reproductive biology of this species. Males may become sexually mature at about 3.0 m (Mitchell 1975). Births may occur in December, newborn calves are about 1.5 m in length (Leatherwood et al. 1972; Leatherwood and Reeves 1983).

Stenella coeruleoalba

The striped dolphin reaches sexual maturity at approximately 1.8 to 1.9 m (Leatherwood and Reeves 1983). Off Japan, mating occurs in November and December and in May through June (Kasuya 1972). Gestation is 12 months; in Japan births occur in November through December and May through June. Average length at birth is about 1 m, the calf is weaned after 18 months (Kasuya 1972; Leatherwood and Reeves 1983).

Delphinus delphis

Common dolphins become sexually mature at 1.7 to 1.8 m or 7 to 14 years for females and 8 to 12 years for males (Nishiwaki 1972). In the northeastern Pacific mating occurs from January through April and August through November (National Marine Fisheries Service 1974). Births may occur in spring through fall, with a peak in July when the females may move offshore to calve (Tomilin 1957; National Marine Fisheries Service 1974; Evans 1976). The newborns are approximately 0.8 m long and suckle for five to six months (Leatherwood and Reeves 1983). Sexually mature animals may reproduce annually; lactating females show evidence of mating (Tomilin 1957).

Lagenorhynchus obliquidens

Mitchell (1975) reported that Pacific white-sided dolphins become sexually mature at 1.7 to 1.8 m long. Mating occurs in late spring through autumn. Young are born throughout the late spring and summer months (Norris and Prescott 1961). Newborns are approximately 0.8 to 0.95 m long. Gestation lasts 10 to 12 months (National Marine Fisheries Service 1974).

Lissodelphis borealis

The northern right whale dolphin becomes sexually mature at about 2.2 m long in both sexes (Leatherwood and Walker 1976). The 0.8 to 1.0 m long newborn are seen in early spring, indicating that this is the time of birth (Leatherwood and Reeves 1983). Nothing else is known regarding the reproductive biology of this species.

Family Phocenidae
Phocoenoides dalli

Dall porpoise reach sexual maturity at about 1.9 and 1.7 m in length for the males and females, respectively (Mitchell 1975). Calving probably begins in mid to late June (National Marine Mammal Laboratory 1981). The gestation period has been predicted to be 11.4 months (Kasuya 1978). Newborn are generally 0.85 to 1.0 m in length (Leatherwood and Reeves 1983).

Phocoena phocoena

Harbor porpoise attain sexual maturity at a length of 1.3 m for males and 1.5 m for females, roughly the third or fourth year of life

(Fisher and Harrison 1970). Although there are some discrepancies, in most accounts mating occurs in spring through summer. Gestation lasts 11 months (Walker 1975) and the 0.7 to 0.9 m long calves are present in June and July in the North Atlantic (Fisher and Harrison 1970). A similar calving period of June through August is supported by reports of newborn and pregnant harbor porpoises stranded along the Oregon coast (Harvey and Brown, unpubl. data). Lactation may last eight months (National Marine Fisheries Service 1974).

Family Otariidae
Callorhinus ursinus

Mating and parturition occur on the Pribilof, Commander, Kurile, and Robben Islands in the Bering Sea, and off southern California on San Miguel Island (Baker et al. 1970). In late April, bulls begin arriving at the rookery of their birth at the Pribilof Islands. They establish territories which they defend throughout the breeding season. Harems of up to 100 females may occur, although the average is about 40. Adult males only spend a few years as harem masters (10 to 14 years old) before they are replaced by a younger, stronger animal. Females become sexually mature at four or five years of age; over 80% of the females between 6 and 16 years are pregnant (Fiscus 1978). Twins are rare, and when they do occur one of the pups usually dies. The majority of fur seals are born during the first three weeks of July, one day after arriving on the islands (Baker et al. 1970), and females are impregnated within 5 days after parturition. Fur seals begin leaving the islands in October, peak departures occurring in early November.

Approximately 75-80% of females caught off Washington are pregnant (Marine Mammal Division 1979). This suggests that mostly primarily females and juveniles of both sexes occur in the lease area, and that a majority of adult females would be pregnant. All other reproductive activities occur well outside the lease area.

Eumetopias jubatus

The northern sea lion breeds along the west coast of north America from the San Miguel Islands to the Bering Sea. Most are on their breeding islands during May and June (Antonelis and Fiscus 1980). Males and females may become sexually mature as early as three years of age, although four is more common (Mate 1981). Adult males are usually not able to defend a territory, and therefore cannot mate until about 10. Within a few days after arriving on the breeding islands, females bear their young. Pups are generally born in June and July, and remain with their mothers for approximately one year. Mating usually occurs within two weeks of parturition (Gentry and Withrow 1978). Gestation lasts 9 to 10 months with a delay in implantation of 2 to 3 months.

Family Phocidae
Phoca vitulina

Harbor seals mature sexually at three to six years for males and two to five years for females; 85 to 92% of mature females produce a pup (Bigg 1981). Birth season lasts about one to two months, with a

southward clinal variation along the west coast of North America (Bigg 1969). Along the Oregon coast, births generally occur from May through June (Brown and Mate 1983). Lactation lasts for two to six weeks, followed shortly by ovulation and mating (Bigg 1981). The blastocyst is implanted 1.5 to 3 months after conception so timing of birth remains the same from year to year. At birth, young are 1 m long and weigh approximately 10 kg (Newby 1978). Since harbor seals principally live nearshore and pup on land, little reproductive activity occurs in the lease area.

Mirounga angustirostris

Female northern elephant seals may become sexually mature as early as two years of age; however, the majority mature at three to four years (McGinnis and Schusterman 1981). Males begin mating at age six to eight, but it is generally not until eight that animals reach a large enough size to enable them to defend a territory and harem. Female elephant seals begin to arrive on the breeding islands (Farallon, Ano Nuevo, San Miguel, San Nicolas, Guadalupe, and San Benito) off of California and Baja California in late December (Delong 1978). Within a week after arrival the female bears a single 33 kg pup that is nursed for 28 days (McGinnis and Schusterman 1981). An oestrus period of three to five days occurs during the final week of nursing, during which the female is impregnated. After weaning, the female returns to the ocean to feed.

3. Growth

Measurements of growth for marine mammals in the GRLA are scarce. The majority of species have not been collected in this region, or inhabit it only for a short period of time. Estimates of growth, therefore, come principally from studies outside the region. Growth has been determined for some whale species based on records of harvested animals. Growth of pinnipeds has been calculated from collections of animals nearshore. The following account includes only species for which there are estimates of growth in the literature, or where estimates can be derived from existing data.

Family Balaenidae
Eubalaena glacialis

There are at present no estimates of growth for this species in the Pacific. Kraus et al. (1982) reported estimated growth of Atlantic right whales in the Bay of Fundy. The calf grows one meter per month until the second month and thereafter approximately 0.5 m per month until 0.5 years old. There are no data for older individuals.

Family Balaenopteridae
Balaenoptera musculus

Based on records of fetal blue whales B. musculus grow an average of 0.7 m per month for the first eight months of life (Small 1971). Until weaning, calves gain an average of 90 kg per day (Ellis 1980). Because weaning occurs at a length of approximately 15 m, the calf gains a

little less than one m per month. After weaning, growth decreases dramatically to about 0.4 m per year (Ellis 1980). Pike and MacAskie (1969) mention that growth in blue whales is slower for whales off British Columbia, compared to those in the Antarctic.

Balaenoptera physalus

Fetal fin whales grow at approximately 0.54 m per month; after birth they grow 0.95 m per month (Ellis 1980). Further growth, until physical maturity, occurs at about 0.9 m per year.

Balaenoptera borealis

During gestation, a fetal sei whale grows approximately 0.38 m per month. (Ellis 1980). Fetal growth has been predicted based upon fetal length measurements and has been calculated to be 0.3436 kg per day (Lockyer 1977). Before weaning, the calf grows 0.66 m per month. The growth constant after puberty is estimated to be 0.1454 (Lockyer 1977).

Balaenoptera acutorostrata

Lockyer (1981) has derived the following growth equation for the minke whale: $L_t = L\ (1-e^{-k(t+t_o)})$, where L=9.89 m, k=0.2164 yr^{-1}, and t=5.4482 yr.

Megaptera novaeangliae

Based on the lengths of fetuses and weaned calves, a humpback grows approximately 0.42 m per month before parturition, and 0.6 m per month until weaning (Tomilin 1957). There are no estimates for growth after weaning occurs.

Family Delphinidae
Stenella coeruleoalba

Kasuya (1972) found growth of both sexes of striped dolphin was similar until 1.8 m long. During the first year these dolphins grow approximately 0.6 m in length. By four years females are 2.0 m long and have nearly reached their maximum length; males continue to grow until 11 years old when they are about 2.2 m in length.

Family Phocenidae
Phocoena phocoena

Stuart and Morejohn (1980) examined 27 females and 22 males and found linear growth in both sexes. Average growth rate for males was 55 mm/yr while for the females it was 95 mm/yr.

Family Otariidae
Callorhinus ursinus

Males grow at an average of 7.7 kg per year for the first three years, (14.7 cm per year in length) (Baker et al. 1970). Females grow an an average 7.8 cm per year until adulthood.

Family Phocidae
Phoca vitulina

Pups are known to more than double their weight during suckling (Bigg 1969). After examining 134 females and 112 males, Pitcher and Calkins (1979) reported that males grew approximately 11.5 cm per year while the females grew 9.3 cm per year for the first four years. After four to five years growth was much slower; approximately 1.8 and 2.0 cm per year for males and females, respectively. Weight gain was similar, except that the asymptote was not reached until three to four years later than for length.

4. Migration

The majority of marine mammals in the eastern north Pacific use the region which includes the lease area as a migratory route. Most large baleen whales travel from polar feeding grounds to equatorial and temperate waters for breeding and calving. Few baleen whales are likely to stay for prolonged periods. Pinnipeds, which use this area, may be more inclined than whales to feed there. Movements of fur seals in the area are directly related to migration from the Bering Sea. The following discussion will group similar species to avoid repetition.

Families Balaenidae and Balaenopteridae

Generally, the large baleen whales of the North Pacific migrate between the Bering, Beaufort, and Chuckchi Seas and their summering areas in the temperate or equatorial Pacific. During summer, when mating and calving are in progress, different species may be either coastal or pelagic.

Blue whales in the eastern Pacific leave Baja California in May and head north, passing well off central California, and arriving off Vancouver Island in June (Rice 1974). Thus, they are near Gorda Ridge in late May. Migration proceeds northward to the Bering Sea. On return, animals pass through the lease area during September.

Movements of fin and sei whales are similar. However, they probably migrate later than blue whales, and do not penetrate as far north (Rice 1974). The minke whale migration is similar in timing, but minke whales move farther north than the others. The 100 humpback whales that migrate along the west coast of North America generally occur near the lease area in summer. Based on old whaling records, peak humpback abundance off Washington was in June through August (Tomilin 1957).

Family Physeteridae
Physeter macrocephalus

Male sperm whales occur as far north as the Bering and Okhotsk Seas during summer. Females do not typically go as far north. In fall, all migrate south of 40°N (Leatherwood et al. 1972) where breeding

concentrations occur off the continental slope of California. The majority are off Mexico and Baja California during winter.

Kogia breviceps

Migratory patterns are unknown for pygmy sperm whales in the Pacific. If movements of whales in the Atlantic are similar, animals move north in the spring to feed and south in the fall to breed in warmer waters (Gunter et al. 1955).

Family Ziphiidae

Very little is known about beaked whale movements, because there are so few sightings at sea. Also, Mesoplodon species are difficult to identify in the water. Records of Berardius suggest it may congregate for breeding off central California from July through October, and is seen off British Columbia in August (Leatherwood et al. 1972). Therefore, it may occur in the GRLA in summer. For the remainder of the species in the family, there are no data on seasonal movements.

Family Delphinidae
Orcinus orca

Observations of killer whales suggests movement south in winter. Most records off southern California occur in fall, winter, and early spring, although animals are seen throughout the year (Norris and Prescott 1961). Migration of this species may be tied to food supply (National Marine Fisheries Service 1974). Killer whales have appeared along the central Oregon coast in April and May for the last three years (Harvey, unpubl. data). Thus, killer whales may travel through the lease region during spring as they move north for the winter.

Globicephala macrorhynchus

Pilot whales may move north during summer and south in winter in response to changes in water temperature (Leatherwood et al. 1972). In certain regions, they appear to move inshore during winter to prey upon concentrations of spawning squid, and then to move offshore for the remainder of the year. Spawning squid occur during spring and summer off Oregon, so pilot whales are probably most abundant nearshore during summer, and may be in the lease area during winter.

Grampus griseus

Risso's dolphin probably migrate into higher latitudes in warmer months, and then south during winter (National Marine Fisheries Service 1977). This hypothesis is supported by sightings off central California in winter, and occurrence off British Columbia in summer. It is likely that this dolphin travels through the lease region in spring and fall.

Delphinus delphis

Based upon surveys and telemetry studies it appears that common dolphins move northwesterly from July through November, and south from

December through June (Evans 1976). Usually confined to the eastern tropical Pacific, movement into the lease area would only be expected during warm months, and even then infrequently.

Lagenorhynchus obliquidens

The Pacific white-sided dolphin is most common in inshore waters of California during winter when squid are most abundant (Norris and Prescott 1961). North-south migrations are unknown for this species. Animals in the region of the lease area might move inshore during summer when squid are spawning; in winter they would be more likely to move offshore into the lease area.

Lissodelphis borealis

The northern right whale dolphin is considered a cold water species, moving south and inshore when the water cools off southern California (Leatherwood and Walker 1976). These movements may be a response to locally abundant squid populations. This species probably occurs in the lease area throughout the year, with local inshore movements during summer.

Family Phocenidae
Phocoenoides dalli

Dall porpoise are a cold water species, but may move south into California waters in October through June (Leatherwood et al. 1972). The rest of the year, P. dalli should be abundant in the lease area; it probably occurs there throughout the year.

Family Otariidae
Callorhinus ursinus

The vast majority of fur seals are in the Bering Sea during breeding season from May through July. In October, females and immatures migrate south and probably reach the lease area during December (Gentry 1981). The number of fur seals off Oregon, Washington, and California continues to increase from January through March (Kajimura 1984). In late March, the northward migration begins. Animals are infrequent in the area after early June.

Eumetopias jubatus

The Steller sea lion occurs off Oregon throughout the year; however, the greatest numbers are present during the peak in breeding from August through September (Mate 1975). The number of adult males drops precipitously at the end of September; the females leave in October. Migration northward from California and southward from Alaska occurs after the breeding season (Schusterman 1981). If these animals occur in the lease area, it is probably from October through March.

Family Phocidae
Phoca vitulina

Harbor seals are probably nonmigratory, although tagged individuals have been seen up to 250 km from the tagging site (Bonner and Witthames 1974). They are most likely to be nearshore during breeding season, from July through August. They might occur offshore near the lease area during the winter.

Mirounga angustirostris

Northern elephant seals begin to mass on the breeding islands in late November, and remain there until March (McGinnis and Schusterman 1980). Although the animals leave the region and migrate to feeding areas, the specific locations of these are unknown. Newly weaned animals are common off Oregon from May to September. Adults may occur in the lease area at this time.

5. Food habits

Few studies of marine mammal feeding ecology have been carried out in the lease area. Much of the work on feeding ecology has been done in California. For the last six years, records of the prey of marine mammals along the Oregon coast have been kept, although most of these data have not been published. The vast majority of feeding studies rely on stranded animals and therefore there is little information on feeding in offshore waters, such as the Gorda Ridge lease area. The following discussion summarizes the feeding habits of marine mammal species which may use the lease area. Certain species are grouped because their feeding habits are similar.

Family Balaenidae
Eubalaena glacialis

This species feeds mainly on copepods filtered from the water (National Marine Fisheries Service 1977). In the North Pacific the principal copepod eaten is Calanus finmarchicus; the euphausiid, Thysanoessa inermis, is also eaten.

Family Balaenopteridae
Balaenoptera musculus

In the Antarctic, blue whales feed primarily on the euphausiid, Euphausia superba, but they also take large numbers of amphipods, and five other species of euphausiids (Lockyer 1976). Off Baja California blue whales appeared to be feeding in shoals of the red crab, Pleuroncodes planipes (Rice 1974).

Balaenoptera physalus

Fin whales eat squid, euphausiids, capelin, herring, and lanternfishes (Leatherwood et al. 1972). In the north Pacific, prey are primarily anchovies (Engraulis mordax), euphausiids (Thysanoessa

spinifera and Euphausia sp.), herring(Clupea harengus), and the squid (Gonatus fabricii) (Tomilin 1957).

Balaenoptera borealis

In the North Pacific sei whales feed principally on fish, squid, and crustaceans (Tomilin 1957). In particular, they capture copepods, euphausiids, sauries (Cololabis saira), anchovies, herring, sardines (Sardinops sagax), jack mackerel (Trachurus symmetricus), and squid (National Marine Fisheries Service 1977).

Balaenoptera acutorostrata

Minke whales in the North Pacific eat euphausiids, copepods, sand lance (Ammodytes hexapterus), and anchovies (Mitchell 1974). Tomilin (1957) reported them to take pollock (Theragra chalcogramma) and capelin (Mallotus villosus).

Megaptera novaeangliae

Tomilin (1957) summarized the feeding habits of M. novaeangliae in the North Pacific. Prey include mysids, euphausiids, shrimp, capelin, herring, and sand lance. Zenkovich (1937) reported 48% contained fish, 9.6% fish and pelagic crustaceans, 10% fish and benthic crustaceans, 2% just pelagic crustaceans, and 32% benthic crustaceans.

Family Physeteridae
Physeter macrocephalus

The feeding habits of sperm whales in the North Pacific are well known compared to those of other large whales. They eat almost exclusively cephalopods, primarily Moroteuthis robustus, Gonatopsis borealis, Onycoteuthis sp., Ommastrephes bartrami, and Histioteuthis sp. (Berzin 1971, Kawakami 1976). On occasion they take fish such as Sebastes sp., cod, and Alepisaurus sp. Sperm whale stomachs have also been reported to contain boots, wire, glass floats, coconuts, and other flotsam (Berzin 1971). Thirty-eight sperm whales of the 41 which stranded in June of 1979 had mostly Moroteuthis, Histioteuthis, and Gonatid squids in their stomachs (Harvey, unpubl. data).

Kogia breviceps

Pygmy sperm whales feed almost entirely on cephalopods, although occasionally they eat pelagic crustaceans, such as shrimps and giant mysids (National Marine Fisheries Service 1977).

Family Ziphiidae

Beaked whales exist primarily on cephalopods and deep water fishes. There is specific information only for Berardius bairdii. Baird's beaked whale is known to consume squid, octopus, rockfish, herring, sardines, and cod (Tomilin 1957, Leatherwood et al. 1972). Individuals of this species take Gonatus fabricii and Onycoteuthis sp. in the north Pacific (Mitchell 1975).

Family Delphinidae
Orcinus orca

Killer whales in the North Pacific eat a variety of nekton. Nishiwaki and Handa (1958) examined 364 killer whales off Japan and found they consumed cod, flatfishes, sardines, squid, octopus, dolphins (primarily True's, Dall's, and Pacific white-sided dolphins), large whales, and seals. Salmon composed 1.6% of the stomach contents. Walker (1975) described the diet of killer whales as consisting of baleen whales, sea otter, aquatic birds, fish, cephalopods, seals, and sea lions. Ten killer whales collected from Alaska to southern California contained California sea lion, Steller sea lion, northern elephant seal, harbor porpoise, Dall porpoise, minke whale, opah (Lampris regius), Pacific halibut (Hippoglossus stenolepis), squid, and possibly blue shark (Prionace glauca).

Pseudorca crassidens

False killer whale feeding habits are not well documented, but they are known to eat cephalopods and fishes such as mahimahi, tuna, and bonito off Hawaii (Orr 1972, Mitchell 1975).

Globicephala macrorhynchus

Tomilin (1957) lists cephalopods and such fishes as clupeids and gadids, as food of pilot whales. Daugherty (1966) states that squid and mackerel are common food organisms. The nearshore movements of this species are generally governed by the availability of squid.

Grampus griseus

Risso's dolphins have been poorly studied. Walker (1975) gives fish and cephalopods as their food, while Yablokov (1974) states that squid are more important. A single beachcast specimen in Washington contained squid: Onycoteuthis banksii, Octopoteuthis sicula, Chiroteuthis veranyi, Gonatus fabricii, and some gonatids (Stroud 1968).

Stenella coeruleoalba

Most information on feeding habits of this species is from Alaska. Miyazaki et al. (1973) found deep water fish included in the diet: Myctophidae, Nemichthyidae, Emmelichthyidae, Chauliodontidae, Paralepididae, Sternoptychidae, Gempylidae, Lutjanidae, Priacanthidae, and Gonostomatidae. They also found the squids Todarodes pacificus and Symplectoteuthis luminosa as well as the shrimps Bentheogennema borealis, Pasiphaea sp., Acanthephyra sp., and Aristeinae sp.

Delphinus delphis

Evans (1976) examined stomach contents of 30 individuals collected from September through January. Sixty-three percent of the food was fish (93% anchovy), and 37% was squid (99% Loligo opalescens). In March and July these animals ate mostly bathylagid and myctophid fishes, as well

as hake and anchovy. Squid accounted for 23% of the diet and crustaceans 7%. During September, 61 animals were examined and anchovy and Loligo were the dominant foods. Nishiwaki (1972) found these dolphins to feed primarily on migrating fish, herring, sardines, and squid.

Lagenorhynchus obliquidens

The following food items have been found in Pacific white-sided dolphins: cephalopods, herring, sardine, anchovy, saury, mackerel, capelin, hake, and crustaceans (Mitchell 1975; Walker et al. 1975; National Marine Fisheries Service 1974).

Lissodelphis borealis

Northern right whale dolphins eat squid such as Loligo opalescens, and myctophid fishes and anchovies (Norris and Prescott 1961; Leatherwood and Walker 1976).

Family Phocenidae
Phocoenoides dalli

Dall porpoise prey on saury, Loligo opalescens, hake, jack mackerel, saury, and other bathypelagic fishes (Norris and Prescott 1961; National Marine Fisheries Service 1974).

Phocoena phocoena

In the North Pacific, harbor porpoise feed on herring, squid (Gonatus and Loligo), sardines, capelin, and shad (Alosa sapidissima) (Wilke and Kenyon 1952; Scheffer 1953; Leatherwood and Reeves 1978).

Family Otariidae
Callorhinus ursinus

Kajimura (1984) provides the most detailed data on feeding habits of North Pacific fur seals. Off Oregon, 49 animals examined had eaten shad, herring, anchovy, hake, saury, rockfish, and six taxa of cephalopods. Fur seals off Washington (N=2628) principally ate herring, capelin, eulachon, anchovy, rockfish, salmon, hake, sablefish, and squid (Onycoteuthis sp.). Fur seals feed primarily at night and are considered opportunistic feeders (Kajimura 1984).

Eumetopias jubatus

Steller sea lions are thought to feed opportunistically, primarily in shallow water. In the North Pacific they eat flatfishes, rockfishes, capelin, sand lance, sculpins, cod, pollock, smelt, greenling, and salmon (Pike 1958, Mathisen et al. 1962, Fiscus and Baines 1966). In Oregon, Roffe and Mate (1984) observed Steller sea lions eating salmonids and lampreys in the Rogue River.

Family Phocidae
Phoca vitulina

Harbor seals feed almost exclusively near shore. In Oregon and northern California, they consume sand lance, English sole, rex sole, sanddabs, staghorn sculpin, dover sole, herring, salmon, slender sole, lamprey, and tomcod (Graybill 1981, Bowlby 1981, Brown and Mate 1983, Roffe and Mate 1984). On occasion they may eat Loligo or Octopus sp.

Mirounga angustirostris

The northern elephant seals eat deep water species. In individuals from central California, Morejohn and Baltz (1968) found the remains of 50 cuskeels (Chilara taylori), one flatfish, and two brown catsharks (Apristurus brunneus). Antonelis and Fiscus (1980) described the examination of stomach contents from four elephant seals in Oregon. They contained cephalopods: Gonatidae, Gonatus sp., Gonatotopsis borealis, Chiroteuthis sp., Octopoteuthis sp., Onycoteuthis borealijaponicus, Rossia pacifica, and Octopus sp. In addition, lamprey, sanddab, and rex sole were found.

6. Commercial exploitation

The harvesting of marine mammals falls under the jurisdiction of laws included in the Marine Mammal Protection Act of 1972 (MMPA) and by the International Whaling Commission (IWC). These two sets of regulations effectively limit or prohibit harvesting most marine mammals along the west coast of the United States. The MMPA restricts the taking of marine mammals within the territorial waters of the U.S. The northern fur seal is an exception; it is harvested under international agreements. The harvest of fur seals is restricted to the breeding islands in the Bering Sea, and no pelagic sealing is allowed. The MMPA is enforced within the 200-mile U.S. economic zone. The lease area extends slightly seaward of this point, so enforcement of the MMPA would only be required in the landward portion. Outside the territorial waters of the U.S., however, the IWC promulgates nonbinding whaling regulations for all member nations. The following discussion summarizes the harvesting of marine mammal species which may inhabit the lease area and which are harvested outside it. Species not harvested in the North Pacific are not included in the discussion.

Family Balaenopteridae
Balaenoptera acutorostrata

The minke whale is now the only baleen whale commercially harvested in the North Pacific. The IWC has provided a 1984/85 catch limit of 320 minke whales for the western Pacific. These whales will probably be harvested by Japan. The IWC voted for a complete moratorium beginning with the 1985/86 season, so no whales may be taken at that time. There is no commercial exploitation of any baleen whales in the lease area.

Family Ziphiidae
Berardius bairdii

Baird's beaked whale is presently harvested by the Japanese off their coast. This animal does not come under the IWC jurisdiction, but Japan has agreed to limit their catch of this species to 40 individuals in 1985.

Family Delphinidae

The tuna purse seine fishery in the eastern tropical Pacific was responsible for killing a large number of common, striped, spinner, and spotted dolphins. Evans (1976) estimated 21,000 individual common dolphins were killed during fishing in 1973. Today the number has been drastically reduced so that few are taken in the fishery.

Phocoenoides dalli

Dall porpoise are taken incidental to the salmon catch in the Japanese North Pacific gillnet fishery. Recently, U.S. observers estimated 32,000 Dall porpoise were taken in 1980 by salmon gillnets in the North Pacific (National Marine Mammal Laboratory 1981). Research is in progress, in an attempt to decrease the take, and to provide better estimates of the population size and number of individuals affected.

Family Otariidae
Callorhinus ursinus

The harvest of fur seals has been under jurisdiction of the treaty between Japan, Canada, U.S.S.R. and the U.S. since 1957. This convention was designed to achieve maximum sustained productivity of fur seal resources and to determine the relationship of fur seals to other marine living resources. The harvest is taken on St. Paul Island in the Bering Sea. Approximately 12,000 fur seals were harvested in 1984, all of them males of five years age or less (Lander and Kajimura 1982). The future of the harvest is uncertain and may in fact be phased out in the next few years.

C. Gaps In The Data

We know practically nothing about marine mammals in the GRLA. Marine mammals are particularly difficult to study because they rarely appear at the surface, are hard to catch, are scarce, intelligent, and oftentimes wary of humans. In addition, it is relatively costly to investigate marine mammal behaviors because of the ship time needed to gather sufficient information. All these problems have contributed to the lack of data for marine mammals in the GRLA. Only a few studies, outlined above, have been carried out in the region, and none have concentrated in the lease area itself.

The most obvious gap in the data for this region is the lack of information dealing with the abundance and distribution of species occurring in the ridge area. A year long study needs to be carried out

in the GRLA in which the number and location of the various marine mammal species which occupy this region are determined. Areas of concentration and notes on their behavior would provide at least baseline data.

The difficulty in collecting many species in sufficient numbers for detailed analysis would preclude gathering much data on reproduction, growth, or food habits. Some of this information can be gleaned from visual observations in the GRLA, however much of it requires the collection of the specimen.

We therefore recommend that shipboard censuses of the area be performed with intent to gather as much information as possible on the kinds, numbers, and habits of marine mammals inhabiting the GRLA. Once this is accomplished, these data should be supplemented with opportunistic or directed collections of important species in the area.

V. SUMMARY AND CONCLUSIONS

There are comparatively few studies of the nekton living within the Gorda Ridge Lease Area. Most of those concerned with the fishes, cephalopods and shrimps have been done off Newport, Oregon, in the northernmost part of the proposed lease area. Studies of mammals have generally been more broadly distributed.

Many species are particularly difficult to study. Marine mammals are hard to sample for both technical and legal reasons. For instance, cetaceans cannot be actively sampled at all because they are protected by law and public sentiment. Thus, our knowledge of them is generally limited to distributional records, data from old whaling catches in other regions, and information gained from occasional strandings. The available information tends to consist of incidental observations rather than coherent long-term data series.

Much of the ocean floor within the GRLA is rocky or uneven, preventing bottom trawling. There have been no studies of these areas using traps or set lines. Although some camera studies of rocky areas exist, few nektonic organisms have been photographed because of avoidance and relative scarcity.

Some information exists from extra-limital studies of species occurring within the GRLA. In general, this information is sparse and often does not significantly augment information from within area studies, although there are exceptions.

1. Distribution and abundance

Knowledge of the occurrence of species of mammals, fishes, cephalopods and shrimps in the GRLA is good, although information on distributions within the area is generally lacking. Certainly the common species occurring near the surface or at moderate depths are well known, although new records of species are not uncommon. Deeper water pelagic species are much less well known and benthic species occurring on rough or rocky bottom are poorly known. Most deep water benthic species occurring on rocky bottoms are probably known from other parts of the GRLA. However, because of the generally poor sampling of rough areas, there may be previously unrecorded and possibly unknown species present.

Abundances of species within the GRLA are poorly known. Few attempts have been made to estimate populations of mammals actually within the area. Estimates of pinniped rookery populations (seals and sea lions) do exist, although how their numbers relate to occurrence of individuals within the GRLA is unknown. Sizes of GRLA populations of some fishes, cephalopods, and shrimps can be estimated from quantitative midwater and benthic trawl catches. However, so many qualifications must be applied to each estimate that presently it seems wiser not to

make them. Among the factors affecting abundances are avoidance, escapement, sea surface temperatures, and season.

2. Reproduction

Little is known about the reproduction of organisms in the GRLA. Few mammals are known to reproduce in the area. Presumably almost all of the fishes, cephalopods, and shrimps in the area do reproduce within its boundaries. However, for most, nothing is known of their reproduction. For the rest, with few exceptions, little is known about their reproduction.

Early life histories of most of the animals are unknown. For many species, larvae are unknown or presently unidentifiable. A number of commercially importantly species (Dover sole, rex sole, Sebastes spp.) have larvae and juveniles which occur within the GRLA. Whether or not these larvae, which occur far west of the continental shelf and slope where adults live, are lost to the coastal population is completely unknown.

3. Growth

Almost nothing is known about the growth of nekton within the GRLA. Although maximum sizes have been recorded for many species, and life span and age-size relationships are known for a few, information on actual growth rates is very rare.

4. Migrations

Many species are known to migrate through or within the GRLA. Some large cetaceans and pinnipeds occur seasonally in the region while in route to or from feeding or breeding grounds elsewhere. Large numbers of albacore tuna migrate north through the area in the summer. No evidence suggests that any micronekton have horizontal migrations there.

Many species of fishes, shrimps, and cephalopods perform diurnal vertical migrations in the upper 800 or 1000 meters of the water column. The behavior of some of these species is fairly well described, and attempts have been made to relate migration to environmental factors such as time of day and season. Species differ in pattern of migration and in which part of the population migrates. Some migrate to or near the surface, but others, deeper living, remain in the mesopelagic zone. In at least one species of myctophid fish, only juveniles migrate; adults remain at depth.

5. Food habits

Food and feeding habits of many of the important species of mammals and fishes have been studied. Generally patterns are known, although detailed information relating food to environmental or ontogenetic

changes is available for only a few species. Food habits of shrimps and cephalopods are virtually unknown, largely because of the damage done by these groups to their food during ingestion, but also due to lack of study.

6. Commercial exploitation

A North American commercial fishery exists presently for only one fish species in the GRLA, Thunnus alalunga (albacore). Larvae of commercially important species of the continental shelf do occur in the area, but whether they represent potential contributions to the coastal populations is problematical.

Formerly, the large cetaceans which occur within the area were hunted. Only two species, Balaenoptera acutorostrata (minke whale) and Physeter macrocephalus (sperm whale) have been recently hunted in the North Pacific. However, no hunting has been allowed in the 200- mile U.S. fishery economic zone since 1974, and there is no prospect that the situation will change in the foreseeable future. There is a harvest of Callorhinus ursinus (northern fur seal), but it occurs only ashore in the Bering Sea.

Commercial exploitation of fishes (other than albacore), shrimp, or cephalopods in the GRLA seems unlikely. No reports exist of high concentrations of commercially valuable species in the area, although such concentrations, particularly of Cololabis saira (saury) might occur. There are probably large deepwater fish (such as macrourids) present, but their populations are almost certainly too low to support an economically viable commercial fishery, even if their flesh is palatable.

VI. ACKNOWLEDGEMENTS

We thank R. Brodeur (Oregon State University), R. Brown (Oregon Dept. Fish and Wildlife), T. Dark (National Marine Fisheries Service), M. Guin (Oregon State University), K. Jefferts (National Marine Fisheries Service), A. Kendall (National Marine Fisheries Service), R. Starr (Oregon Dept. Fish and Wildlife), and M. Yoklavich (Oregon State University) for supplying information, references, and advice concerning this project. We appreciate the many hours contributed by M. Yoklavich in editing and typing versions of this manuscript.

VII. LITERATURE CITED

Ahlstrom, E.H. 1965. Kinds and abundance of fishes in the California current region based on egg and larval surveys. CalCOFI Rept. 10: 31-52.

Alverson, D.L. 1961. Ocean temperatures and their relation to albacore tuna (Thunnus germo) distribution in waters off the coast of Oregon, Washington, and British Columbia. J. Fish. Res. Bd. Canada, 18:1145-1152.

Anderson, M.E. 1978. Notes on the cephalopods of Monterey Bay, California, with some new records for the area. Veliger 21:255-262.

Antonelis, G.A. and C.H. Fiscus. 1980. The pinnipeds of the California current. Cal. Coop. Ocean. Fish. Inv. Rep. 21:68-78.

Ayers, R.J. and J.M. Meehan. 1963. Catch locality, fishing effort, and length-frequency data for albacore tuna caught in Oregon, 1951-60. Oregon Fish Comm. Inv. Rep. 2: 180 p.

Baker, R.C., F. Wilke, and C.H. Baltzo. 1970. The northern fur seal. U.S. Fish Wildl. Serv. Circ. 336. 19 p.

Bell, R.R. 1962. Age determination of the Pacific albacore of the California coast. Calif. Fish Game 48:39-48.

Bates, R.D. 1984. Ichthyoplankton off Washington, Oregon, and northern California October-November 1981. Nat. Mar. Fish. Serv. NWAFC Proc. Rep. 84-12. 41 p.

Berry, F.H. and H.C. Perkins. 1966. Survey of pelagic fishes of the California Current area. U.S. Fish Wildl. Serv., Fish. Bull. 65:625-682.

Berzin, A.A. 1971. (The sperm whale), 394 p. A.V. Yablokov (ed.). Translated by Israel Program for Scientific Translations, Jerusaleum, 1972.

Best, P.B. 1975. Review of world sperm whale stocks. Adv. Comm. Resour. Res. Sci. Consult. Mar. Mammal, Bergen, Norway, Aug. 31 to Sept. 9, 1976. FAO, U.N.

Bigg, M.A. 1969. The harbour seal in British Columbia. Fish. Res. Bd. Canada, Bull. 172.

_____. 1981. Harbour seal, Phoca vitulina (Linnaeus 1758) and P. largha (Pallas, 1811), p. 1-27. In: Ridgway, S.H. and R.J. Harrison (eds.), Handbook of marine mammals. Acad. Press, London.

_____, and A.A. Wolman. 1975. Live-capture killer whale (Orcinus orca) fishery, British Columbia and Washington, 1962-73. J. Fish. Res. Bd. Canada, 32:1213-1221.

Bonner, W.N. and S.R. Witthames. 1974. Dispersal of common seal (Phoca vitulina) tagged in the wash, East Anglia. J. Zool. 174:528-531.

Bowlby, C.C. 1981. Feeding behavior of pinnipeds in the Klamath River, northern California. M.A. Thesis, Humboldt State Univ., Arcata, Calif. 74 p.

Brown, R.F. and B.R. Mate. 1983. Abundance, movements, and feeding habits of harbor seals, Phoca vitulina, at Netarts and Tillamook Bays, Oregon. Fish. Bull. 81:291-301.

Brownell, R.L., C. Schonewald, and R.R. Reeves. 1978. Preliminary report of world catches of marine mammals 1966-1975. MMC - 76/17.

Butler, T.H. 1980. Shrimps of the Pacific coast of Canada. J. Can. Fish. Aquat. Sci., Bull. 202:1-280.

Clark, J.B. 1984. Ichthyoplankton off Washington, Oregon, and northern California May-June 1981. Nat. Mar. Fish. Serv., NWAFC Proc. Rep. 84-11. 45 p.

_____, and A.W. Kendall, Jr. 1985. Ichthyplankton off Washington, Oregon, and northern California, April-May 1983. NWAFC Proc. Rept. 85-10. 48 p.

Clarke, M.R. 1966. A review of the systematics and ecology of oceanic squids. Adv. Mar. Biol. 4:91-300.

Clemens, H.G. 1961. The migration, age, and growth of Pacific albacore (Thunnus germo), 1951-1958. Calif. Fish Game, Fish Bull. 115:1-128.

Clemens, H.B. and W.L. Craig. 1965. An analysis of California's albacore fishery. Calif. Fish Game, Fish Bull. 128: 301 p.

Daugherty, A.G. 1966. Marine mammals of California. Calif. Dept. Fish Game, Sacramento, CA 86 p.

Delong, R.L. 1978. Northern elephant seal, p 206-211. In: D. Haley (ed.), Marine mammals of eastern North Pacific and Arctic waters. Pac. Search Press, Seattle, WA.

Dohl, T.P. 1981. Marine mammal and seabird study of central and northern California. Annual Progress Report. Cent. Coast. Mar. Stud., Univ. Calif. Santa Cruz. 246 p.

Ellis, R. 1980. The book of whales. Alfred A. Knopf, N.Y. 202 p.

Eschmeyer, W.N. and E.S. Herald. 1983. A field guide to Pacific coast fishes from the Gulf of Alaska to Baja California. Houghton Mifflin Co., Boston. 336 p.

Evans, W.E. 1976. Diastribution and differentiation of stocks of Delphinus delphis Linnaeus, in the northeastern Pacific. Advis. Comm. Mar. Resour. Res. Sci. Consult. Mar. Mamm., Bergen, Norway, Aug 30 to Sept. 9. Food and Agr. Organ., U.N.

Fiscus, C.H. 1978. Northern fur seal, p. 152-159. In D. Halet (ed.), Marine mammals of eastern Pacific and Arctic waters. Pac. Search Press, Seattle, WA.

Fiscus, C.H. and G.A. Baines. 1966. Food and feeding behavior of Steller and California sea lions. J. Mammal. 47: 195-200.

Fiscus, C.H. and K. Niggol. 1965. Observations of cetaceans off California, Oregon, and Washington. U.S. Fish. Wildl. Serv., Spec. Sci. Rep. Fish. 498. 27 p.

Fisher, H.P. and R.J. Harrison. 1972. Reproduction in the common porpoise (Phocoena phocoena) of the north Atlantic. J. Zool. Lond. 161:471-486.

Fisher, J.P. 1980. Reproduction, growth, feeding and distribution of the mesopelagic fish Tactostoma macropus. M.S. Thesis, Oregon State Univ. 77 p.

Forss, C.A. 1966. The oplophorid and pasiphaeid shrimp from off the Oregon coast. Ph.D. Thesis, Oregon State Univ. 54 p.

Gambell, R. 1975. A review of population assessments of Antarctic fin whales. Adv. Comm. Mar. Resourc. Res. Sci. Consult. Mar. Mamm., Bergen, Norway, Aug. 31 to Sept. 9, 1976. Food and Agric. Organ., U.N.

Gentry, R.L. 1981. Northern fur seal, Callorhinus ursinus (Linnaeus 1758), p 143-160. In: Ridgway, S.H. and R.J. Harrison (eds.), Handbook of marine mammals. Acad. Press, London.

_____, and D.E. Withrow. 1978. Steller sea lion, p 166-171. In: D. Haley (ed.), Marine mammals of eastern North Pacific and Arctic waters. Pac. Search Press, Seattle, WA.

Gilmore, R.M. 1978. Right whale, p 62-69. In: D. Haley (ed.), Marine mammals of eastern North Pacific and Arctic waters. Pac. Search Press, Seattle, WA.

Graybill, M.R. 1981. Haulout patterns and diet of harbor seals, Phoca vitulina, in Coos Bay, Oregon. M.S. Thesis, Univ. Oregon, Eugene. 56 p.

Guiguet, C.J. 1954. A record of Baird's dolphin (Delphinus bairdi) in British Columbia. Can. Field-Nat. 68:136.

Handley, C.D. 1966. A synopsis of the genus Kogia (pygmy sperm whales), p 62-69. In: K.S. Norris (ed.), Whales, dolphins, and porpoises. Univ. Calif. Press, Berkeley.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada, Bull. 180. 740 p.

Howe, K.M., D.L. Stein, and C.E. Bond. 1980. First records off Oregon of pelagic fishes Paralepis atlantica, Gonostoma atlanticum, and Aphanopus carbo. Fish. Bull., U.S. 77:700-703.

Hreha, L.H. 1974. Oregon albacore tuna fishery statistics, 1968-72. Oregon Fish Comm. Data Rep. 5. 120 p.

Huey, L.M. 1930. Capture of an elephant seal off San Diego, California, with notes on stomach contents. J. Mammal. 11: 229-231.

Iverson, R.T.B. 1961. Food of albacore tuna, Thunnus germo (Lacepede) in the central and northeastern Pacific. Pacific Tuna Biol. Conf., Honolulu, HI, August 1961, 49 pp.

_____. 1962. Food of albacore tuna, Thunnus germo (Lacepede), in the central and northeastern Pacific. U.S. Fish Wildl. Serv., Fish. Bull. 62:459-481.

Iwamoto, T. and D.L. Stein. 1974. A systematic review of the rattail fishes (Macrouridae:Gadiformes) from Oregon and adjacent waters. Occasional Papers of the Calif. Acad. Sci. 111:1-79.

Jefferts, K. 1982. Zoogeography and systematics of cephalopods of the northeastern Pacific Ocean. Ph.D. Thesis, Oregon State University, Corvallis, OR. 291 p.

Johnson, J.H. 1962. Sea temperatures and availability of albacore off the coasts of Oregon and Washington. Trans. Am. Fish. Soc. 91:269-274.

Jones, R.E. 1981. Food habits of smaller marine mammals from northern California. Proc. Cal. Acad. Sci. 42:409-433.

Judkins, D.C. and A. Fleminger. 1972. Comparison of foregut contents of Sergestes similis obtained from net collections and albacore stomachs. Fish. Bull., U.S. 70:217-223.

Kajimura, H. 1984. Opportunistic feeding of the northern fur seal, Callorhinus ursinus, in the eastern North Pacific Ocean and eastern Bering Sea. NOAA Tech. Rep. NMFS SSRF-779. 49 p.

_____, C.H. Fiscus, and R.K. Stroud. 1980. Food of the Pacific white-sided dolphin, Lagenorhynchus obliquidens, Dall's porpoise, Phocoenoides dalli, and northern fur seal, Callorhinus ursinus, off California and Washington; with appendicies on size and food of Dall's porpoise from Alaska waters. NOAA Tech. Mem. NMFS F/NWC-2. 30 p.

_____, M. Perez, A.E. York, and R.H. Lander. 1979. Marine mammal division, p 46-47. Fur seal Investigations- 1978. NWAFC Proc Rept. 79-1.

Kasuya, T. 1972. Growth and reproduction of Stenella coeruleoalba based on the age determination by means of dentinal growth layers. Sci. Rep. Whales Res. Inst. 24:57-79.

Kawakami, T. 1976. Squids found in the stomach of sperm whales in the northeastern Pacific. Sci. Rep. Whales Res. Inst. 28:145-152.

Keene, D.F. 1974. Tactics of Pacific northwest albacore fishermen - 1968, 1969, 1970. Ph.D. Thesis, Oregon State University. 102 pp.

Kellogg, R. and V.B. Scheffer. 1947. Occurrence of Stenella euphorsyne off Oregon coast. Murrelet 30:267-269.

Kendall, A.W. Jr., and J. Clark. 1982. Ichthyoplankton off Washington, Oregon, and northern California April- May 1980. NMFS, NWAFC Proc. Rep. 82-11. 44 p.

_____, and J. Clark. 1982. Ichthyoplankton off Washington, Oregon, and northern California August 1980. Nat. Mar. Fish. Serv., NWAFC Proc. Rep. 82-12. 43 p.

Ketchen, K.S. 1980. Tuna fishing prospects for Canadian west coast fishermen. Can. Ind. Rep. Fish. Aquatic Sci. 121:1-37.

Krygier, E.E. and W.G. Pearcy. 1981. Vertical distribution and biology of pelagic decapod crustaceans off Oregon. J. Crust. Biol. 1:70 - 95.

_____, and C.A. Forss. 1981. A new Acanthyphyra (Crustacea, Decapoda, Caridea) from the northeast Pacific Ocean. J. Crust. Biol. 1:96-104.

_____, and R.A. Wasmer. 1975. Description and biology of a new species of pelagic penaeid shrimp, Bentheogennema burkenroadi, from the northeastern Pacific. Fish. Bull., U.S. 73:737-746.

Kubodera, T. 1978. Systematics and morphological changes with growth in the early life stages of pelagic squids of the family Gonatidae in the subarctic Pacific region. M. Fish. Sci. Thesis, Hokkaido Univ., 102 p.

_____, and K. Jefferts. 1984. Distribution and abundance of the early life stages of squid, primarily Gonatidae (Cephalopoda, Oegopsida), in the northern North Pacific (Part 2). Bull. Nat. Sci. Mus., Ser. A 10:165-193.

Laevastu, T. and C. Fiscus. 1978. Review of cephalopod resources in the eastern North Pacific. NWAFC Proc Rept.

_____, and I. Hela. (eds.). 1970. Fisheries oceanography. Coward and Gerrish Ltd., Bath , England. 238 pp.

Lander, R.H. and H. Kajimura. 1982. Status of northern fur seals, p. 319-345. In Mammals In The Seas, FAO Fisheries Series 5, Vol. IV, ISBN 92-5-100514-1.

Lane, R.K. 1965. Wind, nearshore ocean temperature, and the albacore tuna catch off Oregon. Res. Briefs, Ore. Fish Comm. 11:25-28.

Laurs, R.M. 1983. The North Pacific albacore- an important visitor to California current waters. Calif. Coop. Oceanic Fish. Invest. Rep. 24:99-106.

_____, and R.J. Lynn. 1977. Seasonal migration of North Pacific albacore, Thunnus alalunga, into North American coastal waters; distribution, relative abundance and association with transition zone waters. Fish. Bull., U.S. :795-822.

_____, P.C. Fielder, and D.R. Montgomery. 1984. Albacore tuna catch distribution relative to environmental features observed from satellites. Deep-Sea Res. 31:1085-1099.

Leatherwood, S. and M.R. Fielding. 1974. A summary of distribution and movements of Dall's porpoise, Phocoenoides dalli, off southern and Baja California. Working paper #42, FAO, United Nations, ACMRR meeting Dec. 16-19, 1974, La Jolla, CA.

_____ and W.A. Walker. 1978. The northern right whale dolphin, Lissodelphis borealis in the eastern North Pacific. In: Behavior of marine mammals. Vol. 3, Natural history of whales. Plenum, N.Y.

_____, W.E. Evans, and D.W. Rice. 1972. The whales, dolphins, and porpoises of the eastern North Pacific, A guide to their identification in the water. Naval Undersea Center, NUC TP 282.

_____, R.R. Reeves, W.F. Perrin, and W.E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent waters: A guide to their identification. NOAA Tech. Rep. NMFS Circ. 444. 245 p.

_____, and R.R. Reeves. 1983. The Sierra Club handbook of whales and dolphins. Sierra Club.

Majors, A.P., A.L. Coan, N. Bartoo, and F. Miller. 1982. Summary of 1981. North Pacific albacore fishery data. Southwest Fish. Ctr. Adm. Rep. LJ-82-12. 35 pp.

Marine Mammal Division. 1979. Fur seal investigations, 1978. NWAFC Proc. Rept. 79-1.

Matarese, A.C. and D.L. Stein. 1980. Additional records of the sculpin Psychrolutes phrictus in the eastern Bering Sea and off Oregon. Fish. Bull, U.S. 78:169-171.

Mate, B.R. 1975. Annual migrations of the sea lions, Eumetopias jubatus and Zalophus californianus along the Oregon coast. Rapp. P.-v. Reun. Cons. int. Explor. Mer 169:455-461.

_____. 1981. Marine mammals, p 374-457. In: Maser, C., B.R. Mate, J.F. Franklin and C.J. Dyrness. Natural history of Oregon coast mammals. US. Dept. Agric. Forest Serv., Gen Tech. Rept. PNW-133.

Mathisen, O.A., R.T. Baade, and R.J. Lopp. 1962. Breeding habits, growth, and stomach contents of the Steller sea lion in Alaska. J. Mammal. 43:469-477.

Mcann, C. 1975. A study of the genus Berardius Duvernoy. Sci. Rept. Whales Res. Inst. 27:111-137.

McGinnis, S.M. and R.J. Schusterman. 1981. Northern elephant seal Mirounga angustirostris Gill, 1866, p. 329-349. In S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Volume 2 Seals. Academic.

McGowan, J.A. and T. Okutani. 1968. A new species of enoploteuthid squid, Abraliopsis (Watasenia) felis, from the California current. Veliger 11:72-79.

Meehan, J.M. and L.H. Hreha. 1969a. Oregon albacore tuna fishery statistics, 1961-67. Ore. Fish Comm., Data Rept. Ser. 1.

_____. 1969b. Fish Commission exploratory and oceanographic cruises for albacore, 1959-67. Ore. Fish Comm., Data Rept. Ser. No. 3.

Mercer, R.W. and M. Bucy. 1983. Expermiental squid jigging off the Washington coast. Mar. Fish. Rev. 45:56-62.

Miller, D.J. and R.N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Fish Game, Fish Bull. 157. 249 p.

Milne, D.S. 1968. Sergestes similis Hansen and S. consobrinus n. sp. (Decapoda) from the northeastern Pacific. Crustaceana 14:21-34.
Mitchell, E. 1975. Report of the meeting on smaller cetaceans. Montreal, April 1-11, 1974. J. Fish. Res. Bd,. Canada 32:889-983.
_____. 1978. Finner whales, p 36-45. In: D. Haley (ed.). Marnie mammals of eastern North Pacific and Arctic waters. Pac. Search Press, Seattle, WA.
Miyazaki, N., T. Kusaka, and M. Nishiwaki. 1973. Food of Stenella coeruleoalba. Sci. Rep. Whales Res. Inst. 25:265-275.
Morejohn, G.V. and D.M. Baltz. 1970. Contents of the stomach of an elephant seal. J. Mammal. 51:173-174.
National Marine Mammal Laboratory. 1981. Report of the incidental take of marine mammals particularly Dall's porpoise, Phocoenoides dalli, in the Japanese salmon fishery. Northwest Alaska Fish. Cent., Nat. Mar. Fish. Serv., Seattle. 70 p.
National Marine Fisheries Service. 1974. Marine Mammal Protection Act of 1972, Annual Report, 1973/74. U.S. Dept. Comm., Natl. Ocean. Atm. Adm., Nat. Mar. Fish. Serv.
_____. 1977. Marine Mammal Protection Act of 1972, Annual Report, 1976/77. U.S. Dept. Comm., Natl. Ocean. Atm. Adm., Nat. Mar. Fish. Serv.
_____. 1984. Marine mammal protection act of 1972; Annual report 1983/84. U.S. Dept. Comm., Nat. Ocean. Atm. Adm., Nat. Mar. Fish. Serv. 146 p.
Nelson, J.S. 1984. Fishes of the world. John Wiley and Sons, N.Y.
Newby, T.C. 1978. Pacific harbor seal, p.184-119. D. Haley (ed.), Marine mammals of eastern North Pacific and Arctic waters. Pac. Search Press, Seattle, WA.
Nishiwaki, M. 1972. General biology, p.3-204. In: S.H. Ridgway (ed.), Mammals of the sea: Biology and medicine. Charles C. Thomas, Springfield.
_____, and C. Handa. 1958. Killer whales caught in coastal waters of Japan for recent 10 years. Sci. Rep. Whales Res. Inst. 13:85-96.
Norris, K.S. and J.H. Prescott. 1961. Observations of Pacific cetaceans of Californian and Mexican waters. Univ. Calif. Publ. Zool. 63:291-402.
Okutani, T. and J.A. McGowan. 1969. Systematics, distribution and abundance of epiplanktonic squid Decapoda (Cephalopoda) larvae from the California current April, 1954-March, 1957. Bull. Scripps Inst. Oceanogr. 14:1-90.
Oregon Dept. Fish Wildlife. 1977. Annual Report Fisheries. 147 pp.
_____. 1982. 1981-82 Biennial Report. 88pp.
Orr, R.T. 1972. Marine mammals of California. Univ. Calif. Press, Berkeley. 64 p.
Owen, R.W., Jr. 1968. Oceanographic conditions in the northeast Pacific Ocean and their relation to the albacore fishery. U.S. Fish Wildl. Serv. Fish Bull. 66:503-526.
Osterberg, C., W.G. Pearcy, and H. Curl Jr. 1964. Radioactivity and its relationship to oceanic food chains. J. Mar. Res. 22:2-12.
Otsu, T. 1960. Albacore migration and growth in the North Pacific Ocean as estimated from tag recoveries. Pac. Sci. 14:257-266.
_____, and R.N. Uchida. 1963. Model of the migration of albacore in the north Pacific Ocean. Fish. Bull. 63:33-44.

Owen, R.W. 1968. Oceanographic conditions in the northeast Pacific Ocean and their relation to the albcaore fishery. Fish. Bull. 66:503-526.

Pearcy, W.G. 1962. Egg masses and early development stages of the scorpaenid fish Sebastolobus. J. Fish. Res. Bd. Can. 19:1161-1173.

_____.1964. Some distributional features of mesopelagic fishes off Oregon. J. Mar. Res. 22:83-102.

_____. 1965. Species composition and distribution of pelagic cephalopods from the Pacific Ocean off Oregon. Pac. Sci. 19:261-266.

_____. 1970. Vertical migration of ocean shrimp, Pandalus jordani: a feeding and dispersal mechanism. Calif. Fish Game 56:125-129.

_____. 1973. Albacore oceanography off Oregon-1970. Fish. Bull.,U.S. 71:489-504.

_____. 1977. Variations in abundance of sound scattering animals off Oregon, p. 647-666. In N.R. Anderson and B.J. Zahuranec (eds.), Oceanic sound scattering prediction. Plenum.

_____, and J.W. Ambler. 1974. Food habits of deep-sea macrourid fishes off the Oregon coast. Deep-Sea Res. 21:745-759.

_____, and C.A. Forss. 1966. Depth distribution of oceanic shrimps (Decapoda; Natantia) off Oregon. J. Fish. Res. Bd. Can. 23:1135-1143.

_____, and C.A. Forss. 1969. The oceanic shrimp Sergestes similis off the Oregon coast. Limnol. Oceanogr. 14:755-765.

_____, M.J. Hosie and S.L. Richardson. 1977. Distribution and duration of pelagic life of larvae of dover sole, Microstomus pacificus, rex sole, Glyptocephalus zachirus; and petrale sole, Eopsetta jordani, in waters off Oregon. Fish. Bull., U.S. 75:173-183.

_____, E.E. Krygier, R. Mesecar, and F. Ramsey. 1977. Vertical distribution and migration of oceanic micronekton off Oregon. Deep-Sea Res. 24:223-245.

_____, and R.M. Laurs. 1966. Vertical migration and distribution of mesopelagic fishes off Oregon. Deep-Sea Res. 13:153-165.

_____, H.V. Lorz, and W. Peterson. 1979. Comparison of the feeding habits of migratory and non-migratory Stenobrachius leucopsarus (Myctophidae). Mar. Biol. 51:1-8.

_____, and R.S. Mesecar. 1971. Scattering layers and vertical distribution of oceanic animals off Oregon, p. 381-394. In G.B. Farquhar (ed.), Proc. Int. Symp. Biol. Sound Scattering in the Ocean, Maury Cent. Ocean Sci.

_____, D.A. Panshin, and D.F. Keene. 1974. Catches of albacore at different times of the day. Fish. Bull., U.S. 73:691-693.

_____, D.L. Stein, and R.S. Carney. 1982. The deep-sea benthic fish fauna of the northeastern Pacific Ocean on Cascadia and Tufts abyssal plains and adjoining continental slopes. Biol. Ocean. 1:375-428.

Peden, A.E. and M.E. Anderson. 1978. A systematic review of the fish genus Lycodapus (Zoarcidae) with descriptions of two new species. Can. J. Zool. 56:1925-1961.

Pike, G.C. 1958. Food of the northern sea lion. Fish. Res. Bd. Canada, Pac. Coast Stn. Rep. 112:18-20.

_____, and I.B. MacAskie. 1969. Marine mammals of British Columbia. Fish. Res. Bd. Canada, Bull. 171. 54 p.

Pinkas, L., M.S. Oliphant, and I.L.K. Iverson. 1971. Food habits of albacore, bluefin tuna, and bonito in California waters. Calif. Fish Game Bull. 152. 105 p.

Pitcher, K.W. and D.G. Calkins. 1979. Biology of the harbor seal, Phoca vitulina richardsi, in the Gulf of Alaska. Final Rept., OCSEAP, Contract 03-5-002-69.

Rathbun, M.J. 1904. Descriptions of new decapod crustaceans from the west coast of North America. Proc. U.S. Nat. Mus. 24:885-905.

Reilly, S.B. 1978. Pilot whale, p.113-119. In: D. Haley (ed.), Marine mammals of western North America and Arctic waters. Pac. Search Press, Seattle, WA.

Renfro, W.C. and W.G. Pearcy. 1966. Food and feeding apparatus of two pelagic shrimps. J. Fish. Res. Bd. Can. 23:1971-1975.

Rice, D.W. 1974. Whales and whale research in the eastern North Pacific, p.170-194. In: W.G. Schevill (ed.), The whale problem: A status report. Harvard Univ. Press, Cambridge.

_____. 1977. A list of the marine mammals of the world. NOAA Tech. Rep. NMFS SSFR-711. 15 p.

_____. 1978. Blue whale, p. 31-35. In D. Haley (ed.), Marine mammals of eastern North Pacific and arctic waters. Pac. Search Press, Seattle, WA.

Rice, D.W. 1978. Sperm whales, p. 82-87. In D. Haley (ed.), Marine mammals of eastern North Pacific and arctic waters. Pac. Search Press, Seattle, WA.

Rice, D.W. 1978. Beaked whales, p. 88-95. In D. Haley (ed.), Marine mammals of eastern North Pacific and arctic waters. Pac. Search Press, Seattle, WA.

Richardson, S.L. 1973. Abundance and distribution of larval fishes in waters off Oregon, May-October 1969, with special emphasis on the northern anchovy, Engraulis mordax. Fish. Bull. 71:697-711.

_____, J.L. Laroche, and M.D. Richardson. 1980. Larval fish assemblages and associations in the northeast Pacific Ocean along the Oregon coast, winter-spring 1972-1975. Estuarine and Coastal Mar. Sci. 11:671-699.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N.Lea, and W.B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. Amer. Fish. Soc., Spec. Publ. 12. 174 p.

Robinson, S.M.C. and G.S. Jamieson. 1984. Report on a Canadian commercial fishery for flying squid using drift gill nets off the coast of British Columbia. Can. Ind. Rep. Fish. Aquat. Sci. No. 150.

Roest, A.I., R.M. Storm, and P.C. Dumas. 1953. Cuvier's beaked whale (Ziphius cavirostris) from Oregon. J. Mammal. 34:251-252.

Roffe, T.J. and B.R. Mate. 1984. Abundance and feeding habits of pinnipeds in the Rogue River, Oregon. J. Wildl. Manage. 48:1262-1274.

Roper, C.E.F., M.J. Sweeney, and C.E. Nausen. 1984. Vol. 3 Cephalopods of the world: An annotated and illustrated catalogue of species of interest to fisheries. FAO Fish. Synop. 125. 277 p.

Scheffer, V.B. 1953. Measurements and stomach contents of eleven delphinids from the northeast Pacific. Murrelet 34:27-30.

_____. 1964. Deep diving of elephant seals. Murrelet 45:9.

_____. 1978. Killer whale, p.120-127. In: D. Haley (ed.), Marine mammals of eastern North Pacific and Arctic waters. Pac. Search Press, Seattle, WA.

_____, and J.W. Slipp. 1948. The whales and dolphins of Washington with a key to the cetaceans of the west coast of North America. Am. Midl. Nat. 39:441-443.

Schusterman, R.J. 1981. Steller sea lion Eumetopias jubatus (Schreber, 1976), p. 119-141. In S. H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals. Academic.

Sloan, N.A. 1984. Canadian-Japanese experimental fishery for oceanic squid off British Columbia, summer 1983. Can. Ind. Rep. Fish. Aquat. Sci. No. 152.

Small, G.L. 1971. The blue whale. Columbia Univ. Press, NY. 248 p.

Smoker, W. and W.G. Pearcy. 1970. Growth and reproduction of the lanternfish Stenobrachius leucopsarus. J. Fish. Res. Bd. Can. 27: 1265-1275.

Snow, C.D. and B.R. Mate. 1979. Sperm whale stranding: Why?. Oregon Wildl. Aug. 1979.

Stein, D.L. 1978a. Occurrence of Bathylaco nigricans (Pisces, Alepocephalidae) off the coast of Oregon. Syesis 11:281.

_____. 1980a. Aspects of reproduction of liparid fishes from the continental slope and abyssal plain off Oregon, with notes on growth. Copeia 1980:687-699.

_____. 1980b. Description and occurrence of macrourid larvae and juveniles in the northeast Pacific Ocean off Oregon, U.S.A. Deep-Sea Res. 27A:889-900.

_____. 1985. Towing large nets by single warp at abyssal depths: methods and biological results. Deep-Sea Res. 32:183-200.

_____, and C.E. Bond. 1978. A new deep-sea fish from the eastern North Pacific Psychrolutes phrictus (Pisces: Cottidae (Psychrolutinae). Nat. His. Mus. L.A. Co. Contr. Sci. 296:1-9.

_____, and W.G. Pearcy. 1982. Aspects of reproduction, early life history, and biology of macrourid fishes off Oregon, U.S.A. Deep-Sea Res. 29:1313-1329.

Stroud, R.K. 1968. Risso dolphin in Washington state. J. Mammal. 49:347-348.

Stuart, L.G. and G.V. Morejohn. 1980. Developmental patterns in osteology and external morphology in Phocoena phocoena. In: W.F. Perrin and A.C. Myrick (eds.), Age determination of toothed whales and sirenians. Int. Whaling Comm. Spec. Issue 3.

Tomilin, A.G. 1957. Mammals of the U.S.S.R. and adjacent countries; Cetacea. Translated by the Israel Program for Scientific Translations Ltd., Jeruslaem.

Tyler, H.R. Jr., and W.G. Pearcy. 1975. The feeding habits of three species of lanternfishes off Oregon, USA. Mar. Biol. 32:7-11.

VanHyning, J.M. and A.R. Magill. 1964. Occurrence of the giant squid (Moroteuthis robusta) off Oregon. Res. Briefs Fish. Comm. Oreg. 10:67-68.

Wahl, T.R. 1977. Sight records of some marine mammals offshore from Westport, Washington. Murrelet :21-23.

Walker, E.P., F. Warnick, S.E. Hamlet, K.I. Lange, M.A. Davis, H.E. Uible, and P.F. Wright. 1975. Mammals of the world. 3rd edition. John Hopkins Press, Baltimore, MD. 1500p.

Wasmer, R.A. 1972a. Zoogeography of pelagic shrimps (Natantia: Penaeidea and Caridea) in the North Pacific Ocean. Ph.D. Thesis, Orgeon State Univ. 232 p.

Wilke, F. and K.W. Kenyon. 1952. Notes on the food of fur seal, sea lion, and harbor porpoise. J. Wildl. Manage. 16:396-397.

Willis, J.M. and W.G. Pearcy. 1980. Spatial and temporal variations in the population size structure of three lanternfishes (Myctophidae) off Oregon, U.S.A. Mar. Biol. 57:181-191.

_____. 1982. Vertical distribution and migration of fishes of the lower mesopelagic zone off Oregon. Mar. Biol. 70:87-98.

Wolman, A.A. 1978. Humpback whale, p.46-53. In: D. Haley (ed.), Marine mammals of eastern North Pacific and Arctic waters. Pac. Search Press, Seattle, WA.

Yablokov, A.V., V. M. Bel'kovich, and V.I. Borisov. 1974. Whales and dolphins. Nuaka, Moscow. 472 p.

Young, R.E. 1972. The systematics and areal distribution of pelagic cephalopods from the seas off southern California. Smith. Contr. Zool. 97:1-159.

Zenkovich, B.A. 1937. (The humpback or long-limbed whale.) Vestn. Dal'nevost. Fil. Akad. AN SSSR 27:37-62. (in Russian).