SEASONAL DISTRIBUTION AND RELATIVE ABUNDANCE OF MARINE MAMMALS IN THE GULF OF ALASKA

by

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PREFACE

This report is the result of several years of documenting incidental and empirical field sightings of marine mammals in the Gulf of Alaska. The vehicle for consolidating these data was through NOAA's Platforms of Opportunity Program (POP) which began in the early 1970s and was finally developed into an independent program at the National Marine Fisheries Service (NMFS), Northwest and Alaska Fisheries Center in 1975. Support for the research and documentation of the data was in part provided by the U.S. Department of the Interior, Bureau of Land Management through interagency agreement with the Outer Continental Shelf Environmental Assessment Program (OCSEAP) office, Juneau, Alaska by contract (R7120806) to the National Marine Mammal Laboratory (NMML).

The total period of coverage for this two-part contract, known as OCSEAP Research Unit 68, was 1 July 1975 to 30 March 1981. The initial contract period (1 July 1975 to 30 September 1977) called for documenting historical information from the literature; unpublished NMML data, especially from the pelagic fur seal program (1958-74); and sightings of opportunity from ships in the Gulf of Alaska. The Principal Investigators were Clifford Fiscus, Howard Braham, and Roger Mercer. An interim report of those data was provided by Fiscus *et al.* (1976). In addition, an annotated bibliography of marine mammals of Alaska was developed (Severinghaus 1979), and data management procedures and methods were documented (Mercer, Krogman, and Sonntag 1978; Consiglieri and Bouchet 1981). These reports were critical for developing a comprehensive review and data processing program.

The second contract period for RU#68 (11 January 1980 to 30 March 1981) was funded to document sighting data collected since 1978. The Principal Investigators for this period were Lewis Consiglieri, Linda Jones and Howard Braham. The following final report includes all data from 1958 to 1980 in the POP files for the Gulf of Alaska.

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INTRODUCTION

The pelagic and coastal waters over the Outer Continental Shelf of the Gulf of Alaska are expected to be important areas for oil and gas development and tanker traffic. Within the Gulf, four major oil-lease areas have been under consideration for development: (1) Kodiak Shelf, (2) l?airweather-Yakutat in the northeast Gulf of Alaska, (3) Middle ton Platform in the northern Gulf of Alaska, and (4) Shelikof Strait-lower Cook Inlet (Figure 1). Coastal areas near oil-lease sites contain important habitat for breeding marine mammals such as the northern sea lion, *Eumetopias jubatus*, and seasonally migrating and feeding areas for such animals as the gray whale, *Eschrichtius robustus*. Pelagic offshore waters over the continental shelf are also biologically productive and thus important for feeding for most marine mammal species seasonally migrating into and out of the Gulf.

Twenty-six species of marine mammals permanently reside in or seasonally frequent the Gulf of Alaska. Many occur in large numbers in the Gulf each spring and summer, but are few in numbers during winter. This seasonality is especially true of the cetaceans (Table 1). The common and scientific names of all the species we report on for the Gulf are listed below. Species designated with an asterisk (*) are classified as endangered under the U.S. Endangered Species Act of 1973.

ORDER CETACEA
Suborder MYSTICETI

Family BALAENOPTERIDAE
- *Fin whale (*Balaenoptera physalus*)
- *Sei whale (*Balaenoptera borealis)*
- *Blue whale (*Balaenoptera musculus*)
- Minke whale (*Balaenoptera acutorostrata*)
- *Humpback whale (*Megaptera novaeangliae*)

Family ESCHRICHTIIDAE
- *Gray whale (*Eschrichtius robustus*)

Suborder ODONTOCETI (toothed whales)

Family PHYSETERIDAE
- *Sperm whale (*Physeter macrocephalus*)

Family DELPHINIDAE
- Killer whale (*Orcinus orca*)
- Short-finned pilot whale (*Globicephala macrorhynchus*)
- Dan porpoise (*Phocoenoides dalli*)
- Harbor porpoise (*Phocoena phocoena*)
- Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)

Risso's dolphin (Grampus *griseus*)
Northern right whale dolphin (*Lissodelphis borealis)*

Family ZIPHIIDAE
Giant bottlenose whale (*Berardius bairdii*)
Goosebeak whale (*Ziphius cavirostris*)
Bering Sea beaked whale (*Mesoplodon stejnegeri*)

Family MONODONTIDAE
White whale (*Delphinapterus leucas*)

Order CARNIVORA

Family OTARHDAE
Northern sea lion (*Eumetopias jubatus*)
Northern fur seal (*Callorhinus ursinus*)
California sea lion (*Zalophus californianus*)

Family PHOCIDAE
Harbor seal (*Phoca vitulina*)
Elephant seal (*Mirounga angustirostris*)

Family ODOBENIDAE
Walrus (*Odobenus rosmarus*)

Family MUSTELIDAE
Sea otter *(Enhydra lutris*)

The objective of our research was to provide current sighting information concerning seasonal distribution and relative abundance of all marine mammals in the Gulf of Alaska as an exercise in baseline resource assessment. This information thus can be used directly to determine whether certain species might be particularly vulnerable to OCS activities given the nature and extent of occurrence or habitat usage by the animals. To that aim we have emphasized endangered species and discussed individual lease sites separately so as to address particular problem areas dealing with Section 7 of the Endangered Species Act of 1973.

Although we are reporting sighting data from throughout the Gulf, our specific objectives were to provide information on coastal (but not onshore) and pelagic marine mammal occurrences from the northeast region of the Gulf *(i. e.*, from approximately southeast of Yakutat Bay) to west of Kodiak Island. Under subcontract to the Alaska Department of Fish and Game, Game Division, Anchorage, we received two reports in 1975 on distribution and abundance of marine mammals onshore and along the coast of the Gulf of Alaska (Calkins *et al.* 1975) and in Prince William Sound (Pitcher 1975). Data presented in this report primarily reflect observations made offshore. Cooperative efforts have been maintained with Gulf of Alaska OCSEAP Research Units 229 (biology of the harbor seal), 240 (abundance and

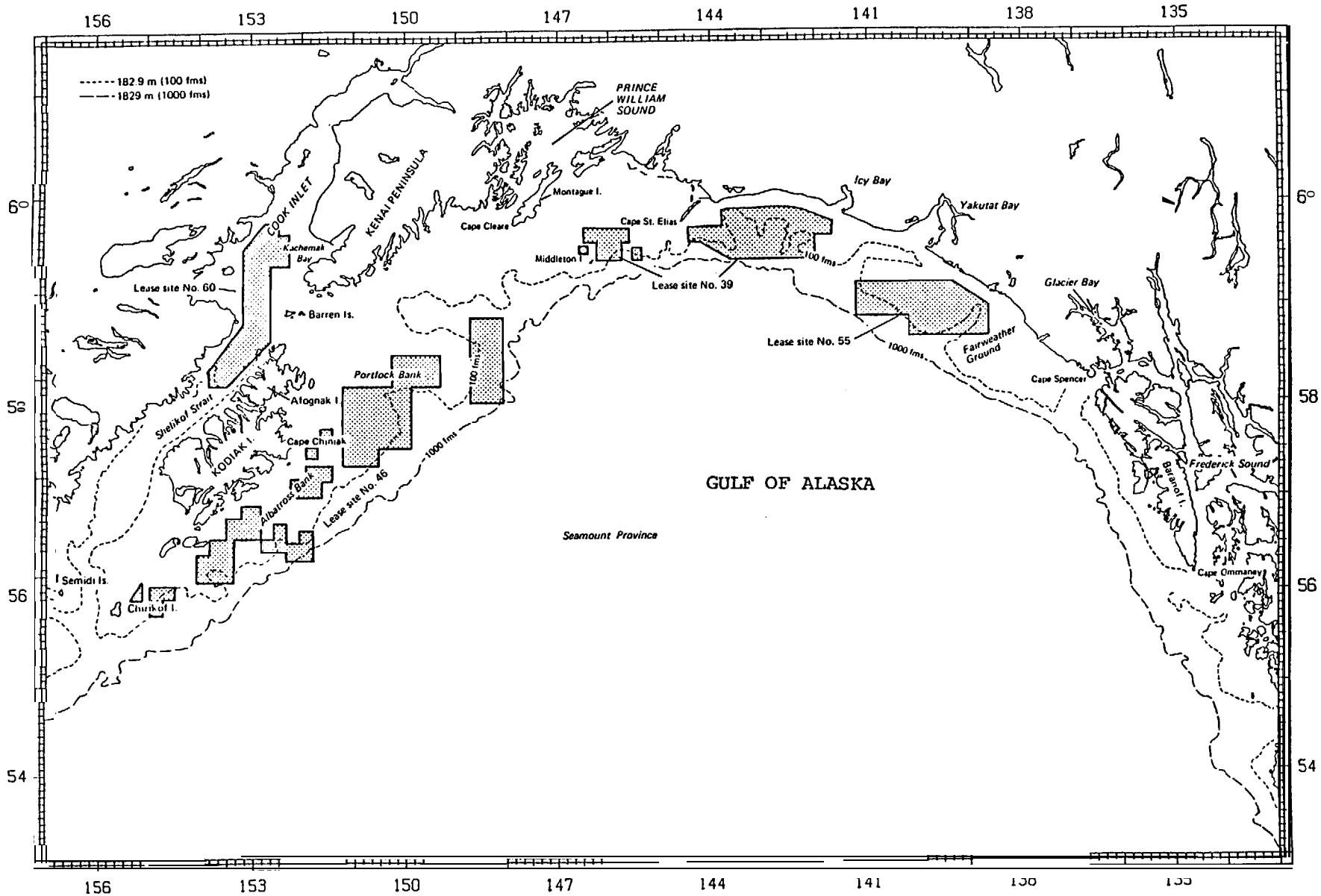

Figure 1.–Gulf of Alaska study area; proposed (as of 1978) Outer Continental Shelf oil and gas.

Table I.–Checklist of marine mammals by season in the Gulf of Alaska (latitude 53*N to coast, longitude 133° to 157°W). O = regularly present, + = greatest frequency, R = rare visitor, – = not known or expected to occur, blank = no recent data available.

Species	Season			
	Winter Jan-Mar	Spring Apr-Jun	Summer Jul-Sep	Autumn Ott-Dec
Cetaceans				
Blue whale[a]	–	R	R	R
Fin whale	R	o	+	R
Sei whale	R	+	o	R
Humpback whale	R	o	+	o
Right whale'	–	R	R	R
Gray whale	+	o	R	o
Sperm whale	–	0	o	0
Minke whale[b](?)		+	+	
Killer whale[b]	o	o	o	0
White whale[b]	0	0	0	0
Pilot whale	–	–	R	–
Giant bottlenose whale		R	R	
Goosebeak whale[b]	o	o	o	o
Bering Sea beaked whale[b](?)				
Dan porpoise[b](?)	0	0	0	0
Harbor porpoise[b]	0	0	0	0
Pacific white-sided dolphin	R	0	+	R
Risso's dolphin	R	R	R	–
Northern right whale dolphin	–	–	R	–
Carnivores				
Northern fur seal	+	o	o	+
Steller sea lion[b]	o	0	0	o
Northern elephant seal	·	R	R	–
Harbor seal[b]	0	o	o	o
Sea otter[b]	0	0	0	0
Walrus	–	R	R	R

[a] Historically abundant seasonally.
[b] Resident.

distribution of the sea otter), and 243 (ecology of the northern sea lion) in order to assure area coverage continuity. Our report, therefore, does not cover coastal and onshore activities of sea lions, harbor seals, or sea otters.

STUDY AREA

The study area included the pelagic and nearshore waters of the Gulf of Alaska from 53°N, north to the Alaska coast, and from 133°W to 157°W (Figure 1). The specific OCS lease sites within the study area included the Northeast Gulf or Yakutat-Fairweather area (lease sale No. 55), Northern Gulf (lease sale No. 39), lower Cook Inlet- Shelikof Strait (lease sale No. 60), and Western Gulf-Kodiak (lease sale No. 46). Defined by the 100-fathom (183-m) contour (Figure 1), the continental shelf extends out to approximately 10 km off Yakutat Bay in the northeast Gulf, to 100 km from the entrance to Prince William Sound in the northern Gulf and to 200 km off Kodiak Island.

Prominent nearshore shoal areas over the continental shelf in the study area are Fairweather Ground in the northeastern Gulf, Middleton Platform in the northern Gulf, both at depths of 60-183 m, and Portlock and Albatross banks south and west of Kodiak Island. Many seamounts occur within the central portion of the study area near 56°N.

Much of the year the Gulf of Alaska is influenced by atmospheric low pressure systems which create cyclonic (counter-clockwise) winds (Royer 1972). Wind shear over the ocean surface is a major factor influencing the movement of subsurface currents. As a result, current flow in the Gulf of Alaska to as far west as the Aleutian Islands is onshore, a divergence away from the central Gulf gyre. The onshore, diverging water is replaced by the upward flow of colder deep-ocean water, causing upwellings rich in nutrients (Sverdrup *et al.* 1942; Favorite *et* al. 1976).

In the North Pacific there is a permanent halocline from the 100- to 200-m depth contours that restricts vertical mixing (Cooney 1972). Seasonal variations in temperature, dissolved oxygen, and nutrients result where large-scale upwellings occur. However, along the continental shelf in water less than 200 m deep, mixing occurs throughout the water column. This results in a zone relatively high in dissolved oxygen and nutrients, yet low in salinity because of seasonal precipitation and river runoff (Shurunov 1970).

METHODS

Data were collected from three main sources: (1) National Marine Mammal Laboratory (NMML) or contract personnel trained under this OCSEAP project and the NMML Dan Porpoise Research Program stationed aboard NOAA and Coast Guard ships from November 1975 through November 1980; (2) the NMML pelagic fur seal program (1958-74); (3) a 1980 OCSEAP dedicated summer vessel cruise (Rice and Wolman 1982); and (4) Platforms of Opportunity Program (POP) observers. POP observers included NOAA and U.S. Coast Guard ship's officers and crew members, U.S. Forest Service naturalists aboard Alaska state ferries,

U.S. observers aboard foreign fishing vessels within our Fisheries Conservation Zone (FCZ), and numerous biologists and citizens onboard private boats. Vessel cruise efforts since 1958, reported here, are summarized in Appendix I.

With the exception of data collected by NMML scientists, most data came as sightings of opportunity; that is, no systematic or analytical procedures were used by the observers to standardize the sampling or the routes taken by the ships. Therefore, two basic types of data exist in our data base: (1) incidental sightings, and (2) sightings associated with effort. Incidental sightings, contributed mainly by POP observers, were chance observations recorded during a vessel's daily routine and consisted of only the sighting information at the time a marine mammal was observed. Effort-associated sightings consisted not only of sighting information at the time of an observation, but the beginning and ending times of the cruise track (during which a trained NMML or contract observer was maintaining a constant watch for marine mammals), ship positions, and environmental parameters (see Consiglieri and Bouchet 1981).

Approximately 40% of our data base contains sightings with quantified effort and virtually all of these occurred after 1975 when this OCSEAP research began. Effort plots are presented by season in Appendix II. Sighting data (combined incidental and effort associated) are presented as symbol plots by species and by season in the "RESULTS." "Seasons" were designated as: Winter – January, February, and March; Spring – April, May, and June; Summer – July, August, and September; and Autumn – October, November, and December.

Sighting records from inexperienced persons are generally unreliable, especially for unfamiliar cetaceans, and are often impossible to evaluate if not accompanied with a detailed description or photograph of the animal(s) sighted. Even under ideal environmental conditions, the identification of marine mammals at sea is difficult. Every effort was made to ensure that the data presented represent accurate species identifications. When possible, POP observers were given slide shows and briefed on marine mammal identification prior to sailing, and all observers were provided with copies of cetacean (Leatherwood *et al.* 1972) and pinniped (Seed 1972) field guides.

Incoming data were subjected to rigorous quality control steps, including computer analysis for errors. Our procedures are fully documented in Consiglieri and Bouchet (198 1), our revised data documentation manual. Sightings were first verified by scrutinizing the accompanying species description, and then subjected to computer quality control programs. Our data management procedures are outlined in Figure 2. Many recordings of data collected over the past several years could not be used as "proof' of specific sightings or species identification. Questionable sightings were classified as tentative, relegated to unidentified status, or rejected. During the early years of our work (1975-77) this category frequently accounted for 50-75% of the data base. Since 1978 only 1O-3O$% of the sightings were unacceptable. Tentative and unidentified sightings are not represented in the species plots in this report.

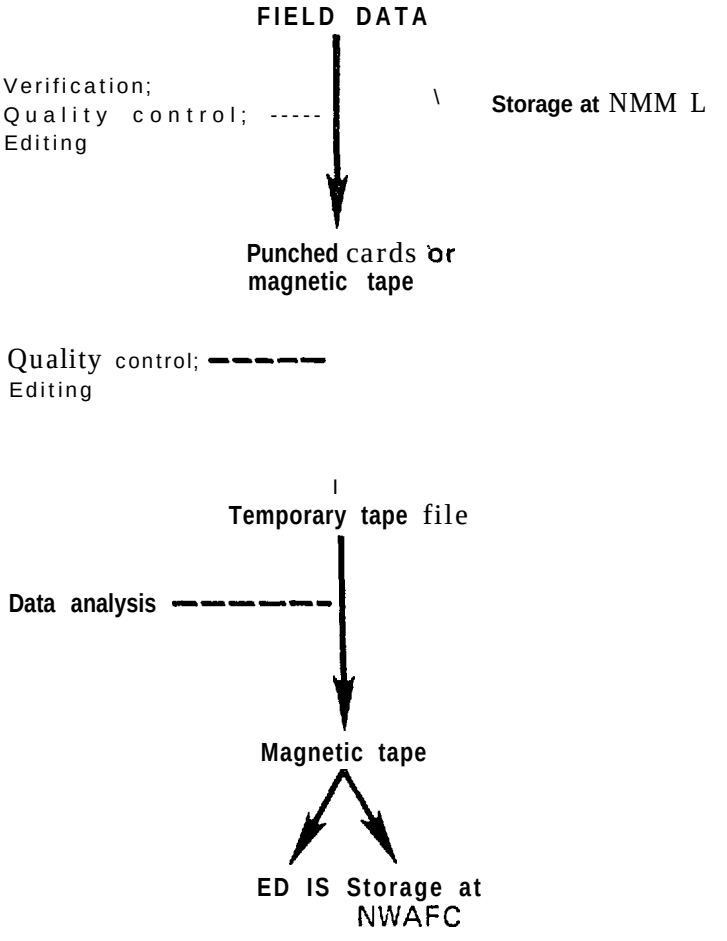

Figure 2.-Platforms of Opportunity Program data management.

We relied heavily on previously published accounts for distribution and abundance projections. Discussion of this historical information is included in the species accounts which follow. Commercial and aboriginal sealing and whaling results were useful in understanding historical distribution and abundance. These topics were discussed at length in Fiscus *et al.* (1976), and thus are not presented in their entirety in this report.

ENDANGERED CETACEANS

Fin Whale (*Balaenoptera physalus*)

The fin whale is the second largest of the six species in the family Balaenoptendae. Common names include firmer and finback whale.

ABUNDANCE

The size of the North Pacific fin whale population isestimated to be 15,800-16,400 (Wada 1975, 1977), and includes the Pacific Ocean north of 20°N, from the coastof North America to 150°E. The size of the population prior to commercial exploitation was estimated at 42,000-45,000 (Ohsumi 1971; Tillman 1975).

The number of fin whales thought to inhabit the eastern North Pacific has been estimated at 7,890-10,130 (Omura and Ohsumi 1974), 8,520-10,970 (Ohsumi and Wada 1974), 9,000 (Rice 1974), 11,790 (Wada 1975), and 10,000-20,000 (Zhirnov *et* al. 1975). The area of the eastern North Pacific essentially includes waters north of 30°N and east to 180°. Our distribution data on fin whales along the coast of North America south ofAlaska indicates that a large portion, if not most, of the eastern North Pacific fin whales occur in Alaska and British Columbia waters during spring and summer. As such, the population size of fin whales from the Gulf of Alaska to the Bering Sea probably does not exceed 10,000 animals.

The eastern North Pacific population of fin whales is thought to be well below the population level which will produce the maximum number of harvestable animals (Allen 1974; Rice 1974; Tillman 1975). Essentially, then, the population is below its former carrying capacity. Allen (1974) estimated that it would take 25-30 years for the population in the eastern North Pacific to recover to 90% of its original size since protection.

DISTRIBUTION

North Pacific fin whales spend the winter months in subtropical to temperate waters and then migrate to subarctic and arctic waters from the Gulf of Alaska to the Chukchi Sea, spring through fall, to feed and apparently rear their young (Nemoto 1959). During the 7- to 8-month period in Alaska, they spend much of their time near the continental shelf (Nemoto and Kasuya 1965). As such, and for OCS evaluation, they should be considered a seasonal nearshore inhabitant.

Winter (January-March)

Although little research effort has been made in the study area during the winter, the paucity of sightings suggests the species is essentially absent. In our data base only five sightings were made (Figure 3), including one sighting of four whales in Shelikof Strait (57°00'N, 154°14'W). These animals were apparently feeding on walleye pollock (Towner in press). The only other sighting occurred approximately 150 km southwest of Yakutat Bay beyond the 2000-m depth contour. In January 1963,20 fin whales were observed in the Gulf of Alaska at 58°00'N, 148°03'W (Berzin and Rovnin 1966). Forsell and Gould (1981) observed a lone fin whale in Uganik Bay (Kodiak Island–57°44'N, 153°28'W) on 24 January 1980.

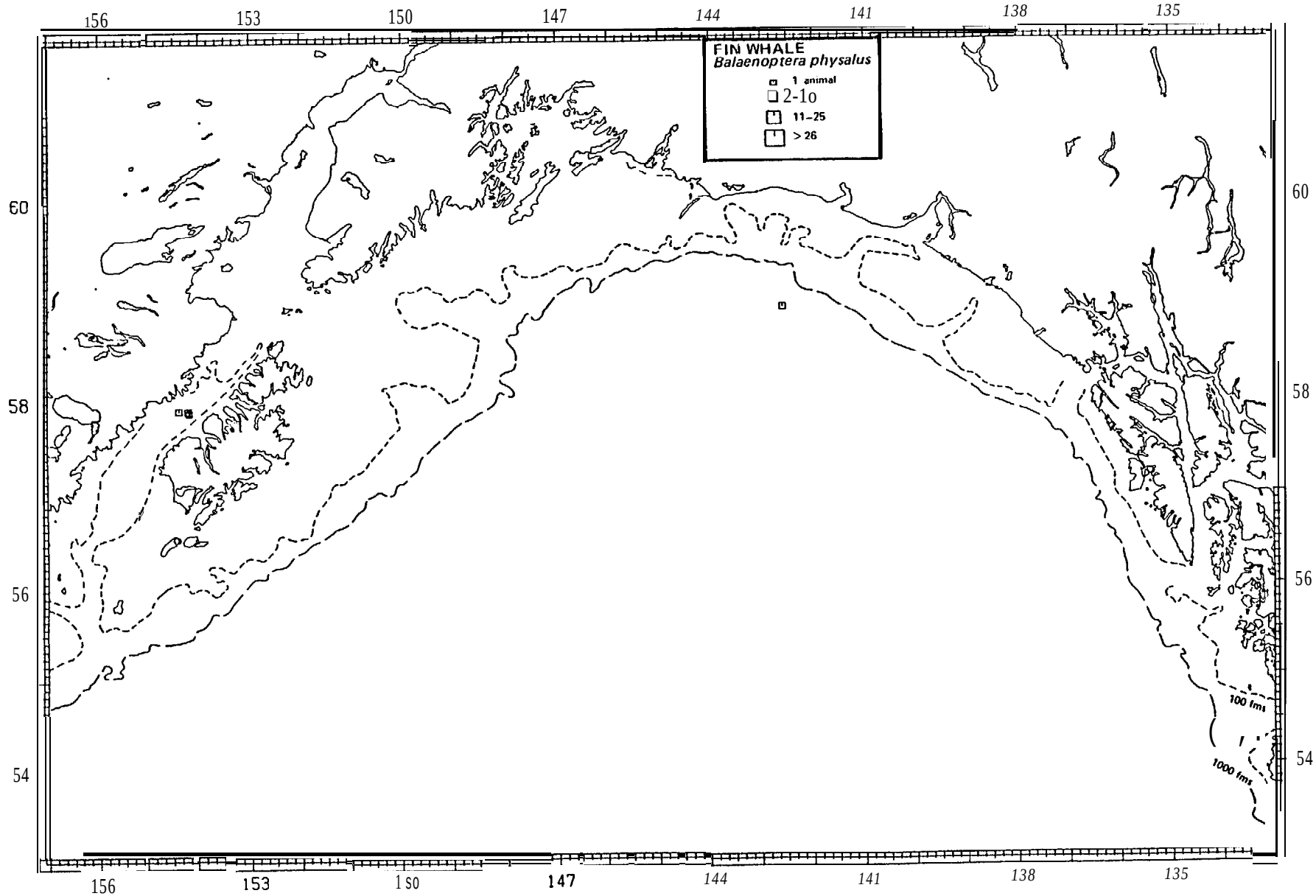

Figure 3.-Fin whale sightings, winter (January-March) 1958-80.

Spring (April-June)

Although a rather substantial number of survey cruises have been conducted in the spring throughout the study area (Appendix II), almost all of the fin whale sightings were made in the western Gulf of Alaska (Figure 4). Most sightings (83%, n = 106) were made over the continental shelf in the Gulf shoreward from the 200-m contour. The largest number of animals were seen south of Montague Island, with most others in the area of Portlock Bank between the east coast of Afognak Island and the continental slope south of Kodiak Island (Figure 4). Fin whales were present during systematic surveys in June 1980 in Prince William Sound by Rice and Wolman (1982); however, in July of the same year, no fin whales were observed. In June 1980, 21 and 63 animals (possibly the same groups) were observed in Shelikof Strait and just west of Chirikof Island (Figure 4).

One tentatively identified fin whale was sighted in March in the Bering Sea near Amak Island. This is the only spring sighting for the southeastern Bering Sea, yet many surveys were conducted there, suggesting that fin whales may not move into the Bering Sea before late May to early June. Animals in the Gulf of Alaska have been suggested to be early migrants into the Bering Sea (Shurunov 1970). However, the fewer sightings made from Kodiak to Unimak islands and near the Trinity Islands and Shumagin Island, may support Berzin and Rovnin's (1966) conclusion that Bering Sea fin whales may not come by way of the Gulf of Alaska, but rather from the North Pacific or Aleutian Islands southwest of our study area.

Summer (July-September)

Fin whales occur in greatest numbers in and adjacent to the study area during summer (Figure 5). They appear to frequent three areas: (1) Prince William Sound (Hall and Tillman 1977), and Hinchinbrook Entrance-Montague Island to Middleton Island; (2) the continental margin and slope from southwest Kodiak Island (Albatross Bank) to the Shumagin Islands. and (3) the continental slope in the southeast Bering Sea, especially near the Pribilof Islands. The absence of sightings in other areas indicates that fin whales are probably selective. A few sightings were made in Yakutat Bay (Figure 5). The nearshore waters from Yakutat Bay to British Columbia were formerly an important summer whaling ground for fin whales (Nasu 1966).

The concentration of fin whales south of Hinchinbrook Entrance and Montague Island, where numerous sightings were made over several years, demonstrates that certain areas of the study area are probably more important than others for this species. Of the 65 sightings in our data base, 88% were made over the shelf in water less than 200 m deep. The group sizes were the same in summer and spring: 40% were of single animals, 25% or more were in pairs, and 35% were of 3 or more.

Summer sightings of numerous fin whales over the past 12-14 years have been noted along the north coast of Kodiak Island (58°N, 153°W) and in bays and shallow waters of Shelikof Strait (T. Emerson, pers. commun. by letter 14 April 1980).

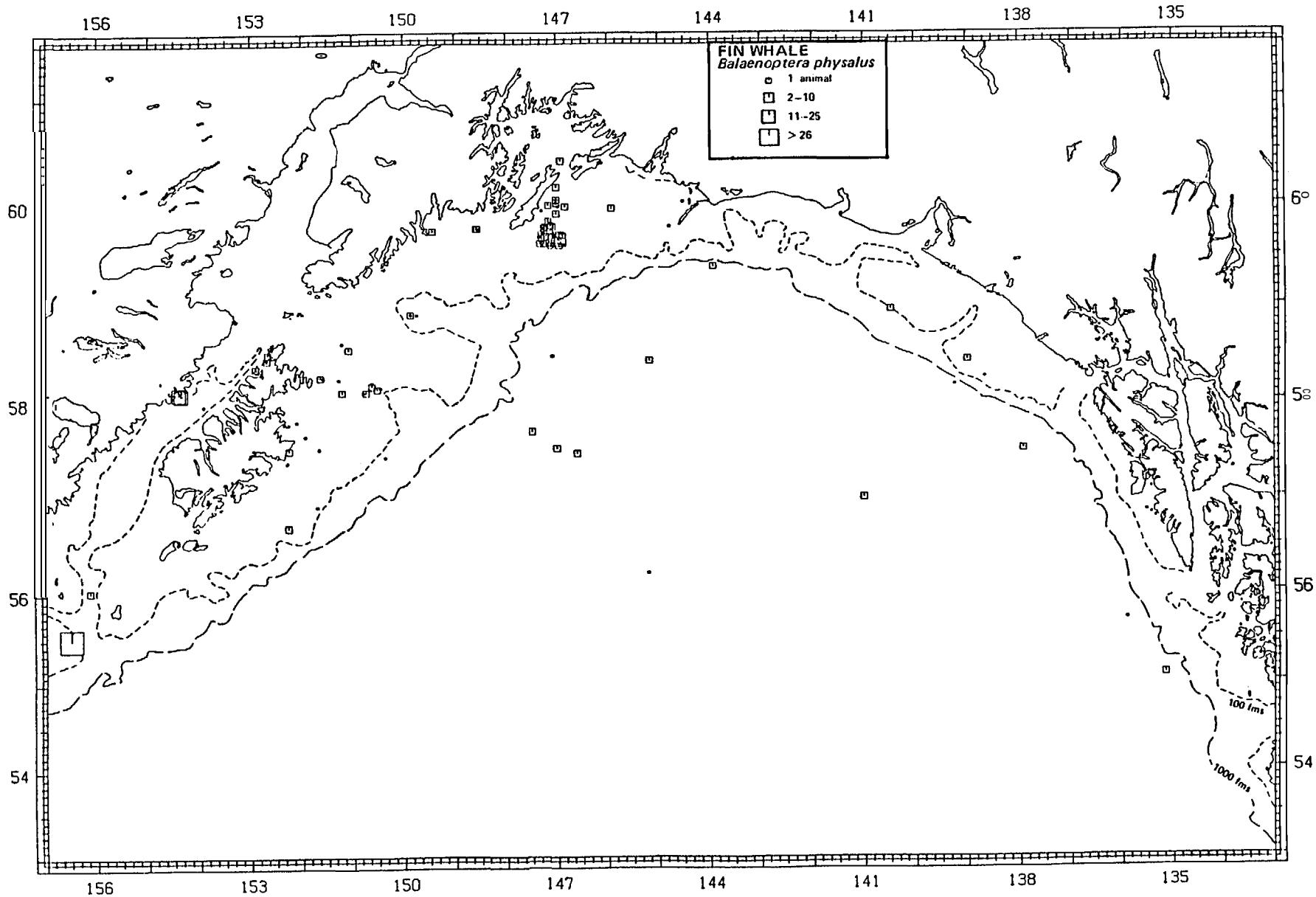

Figure 4.–Fin whale sightings, spring (April-June) 1958-80.

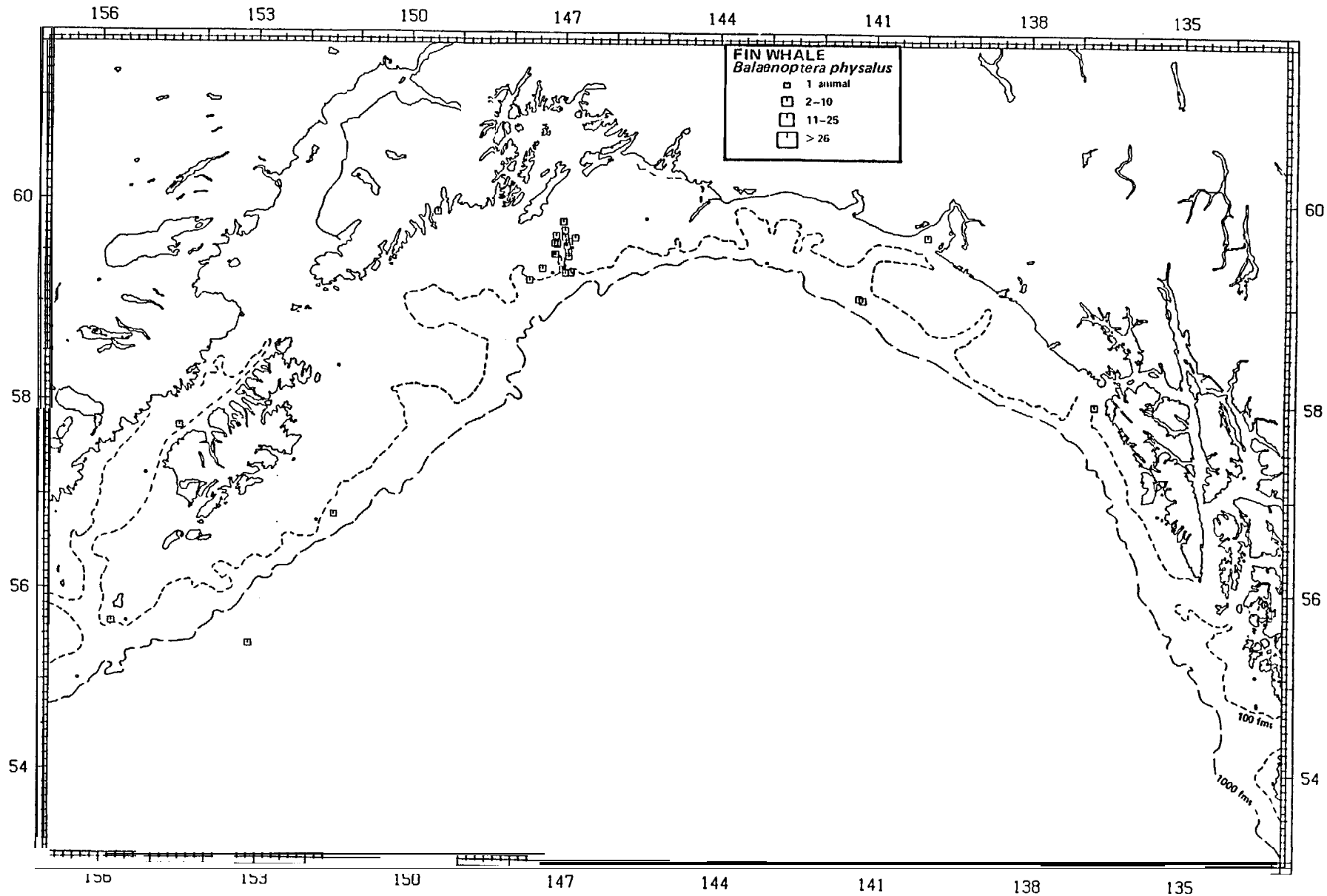

Figure 5.–Fin whale sightings, summer (July-September) 1958-80.

Autumn (October-December)

Because of sparse autumn coverage of the study area very few fin whales have been observed: five sightings (21 total animals), four in water more than 200 m deep (Figure 6). Of the 21 animals observed since 1958, 6 were seen in October, and none were seen in November. Survey coverage was more uniform, yet less during autumn than at any other time of year. Berzin and Rovnin (1966) stated that fin whales rapidly leave the Bering Sea in September. Perhaps the same holds for the Gulf of Alaska.

FACTORS INFLUENCING DISTRIBUTION

Oceanographic

During the height of commercial whaling in the North Pacific, fin whales were taken in areas where biological productivity was high due to the mixing of water masses (Shurunov 1970; Nasu 1974), near centers of gyres (Berzin and Rovnin 1966), and along oceanic fronts (Nasu 1957, 1974) of the continental slope and shelf throughout the study area (Uda 1954). Traditionally, they were taken in these areas in spring and summer, when their prey was at peak abundance. Results from our research also indicate that fin whales occur in areas of upwelling along the continental slope and shelf in the western Gulf of Alaska and to Unimak Pass into the southeastern Bering Sea (Figures 4 and 5).

Feeding and Food Resources

The distribution of fin whales and the timing of their migration patterns in Alaskan waters are governed by the availability y of food (Nemoto 1957, 1959; Sleptsov 196 1; Nasu 1963, 1966; Berzin and Berzin 1966; Nishiwaki 1966). Nemoto (1959) concluded that fin whales migrate back to the same regions at the same time each year because of favorable environmental conditions permitting blooms of phytoplankton and zooplankton. However, fin whales are known to shift their distribution to take advantage of changes in prey as a result of changing oceanographic conditions (Nasu 1974).

It is because of the dynamic, non-uniformity in weather, ocean conditions, and prey availability that fin whales have adapted a generalized feeding strategy. They feed on a variety of prey from zooplankton to fishes, in pelagic as well as coastal waters over the Alaskan continental shelf. Studies of fin whales on whaling grounds in Alaska indicate that they are opportunistic feeders, taking advantage of large dense patches of prey, frequently changing their diet during the season as certain prey become less available while a different prey species becomes more abundant (Nemoto 1959, 1970).

Polyphagous or generalized prey selection behavior by fin whales was suggested by Nemoto (1957) to be a result of the relative scarcity of euphausiids in the North Pacific as, for example, compared to Antarctica where fin whales are engaged in a more monophagous feeding regime on euphausiids. It seems equally likely that fin whales have selected a feeding strategy to take advantage of the great seasonality and high abundance of alternate prey items such as

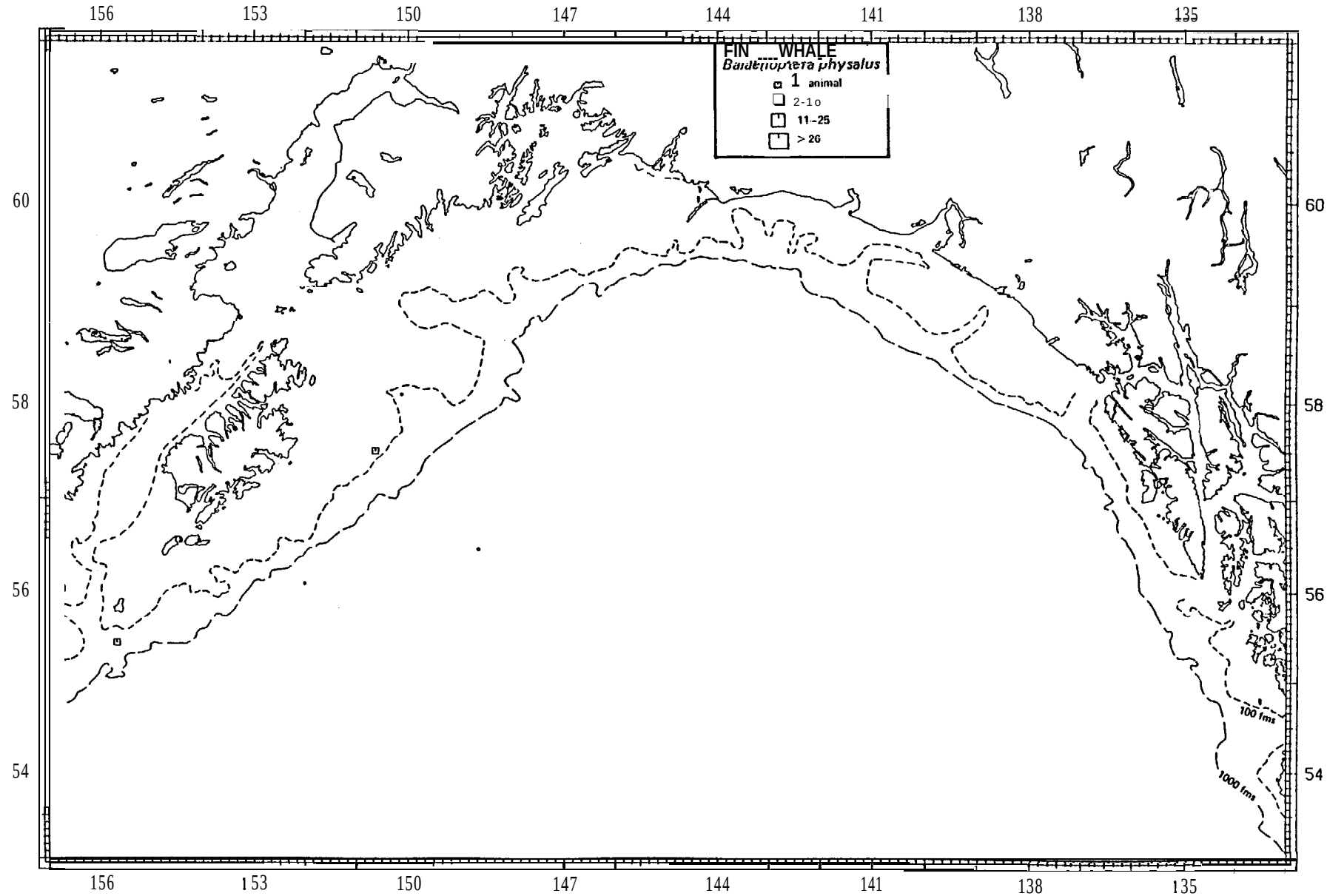

Figure 6.-Fin whale sightings, autumn (October-December) 1958-80.

copepods and fishes. From an analysis of several thousand fin whale gastrointestinal tracts by Japanese and Soviet scientists, a summary of "preferred" prey species was assembled and ranked according to percentage of total occurrence (Table 2). Most of these species are found in all areas in and adjacent to the study area. The geographic areas where certain prey were found in the fin whales landed, then, undoubtedly reflects both effort on the part of the whalers at various times of the year, and prey distribution.

Nemoto (1959) cited examples of prey composition in fin whales taken in the North Pacific, southeastern Bering Sea (58°-61°N), and the eastern Aleutian Islands. Of 4,140 fin whale stomachs examined around the eastern Aleutian Islands from 1954 to 1958, 50% were empty, 35% contained only euphausiids, 12% only copepods, 1.5% both euphausiids and copepods, and less than 1% contained fishes (including squid). Of 158 fin whale stomachs examined in the southeastern Bering Sea in 1957, 54% were empty, 44% contained pollock, and 2% contained copepods. Of 262 fin whale stomachs examined in the North Pacific south and east of the Aleutian Islands and into the Gulf of Alaska from 1952 to 1958, 65% had capelin, 2690 pollock, 670 herring, >1% Atka mackerel, and <1% contained saury.

The occurrence of certain prey species coincides with concentrations of fin whales. Nasu (1963) reported that fin whales annually occur north of the eastern Aleutian Islands along the continental slope to Cape Navarin (USSR) during the summer, but few are in Bristol Bay. This correlates well with the occurrence of herring and Alaska pollock (Nemoto 1957, 1959). In March 1980, fin whales were observed apparently feeding on large schools of spawning pollock in Shelikof Strait (Towner, in press). Other areas of the North Pacific where whalers found fin whales were south of the Aleutian Islands along the continental shelf to south of Kodiak Island (near the Trinity, Shumagin, Chirikof, and Semidi islands), and into the Gulf of Alaska, especially near Montague Island and Cape St. Elias. These are the same areas where most fin whale prey species are found in abundance (Nemoto 1957, 1970; Nasu 1963; Nemoto and Kasuya 1965; Nishiwaki 1966).

In the North Pacific, copepods occur in abundance in spring, earlier in the year than euphausiids, which peak in summer (Nemoto 1959). Phytoplankton begin to bloom in the early spring, progressively spreading northwest throughout the North Pacific and Gulf of Alaska, with little lag time in the occurrence of the grazing copepods *Calanus cristatus* and C. *plumchrus* (Cooney 1972). By May, copepods become abundant in the upper 200 m of water, providing open-ocean food for northward migrating whales. Fin whales feed on copepods first as the whales migrate north in the spring (Nemoto 1959; Cooney 1972). The pattern of the whales' movement into the Gulf of Alaska and then west toward the Aleutian Islands and Bering Sea seems to be reflected in corresponding sequential changes in prey density. As C. *cristatus* (in copepodite stage V) leave the shallow water to depths below 500 m, usually by August, fin whales shift their prey selection to C'. *plumchrus*, or, more likely, other abundant euphausiids and fishes (Nemoto 1963). Fin whales also shift to C. *plumchrus* as the whales move closer to shore where these copepods are more likely to be abundant in spring and summer (Cooney 1975). However, because C. *plumchrus* occurs in less dense concentrations than C. *cristatus,* fin whales may shift their prey selection to alternate copepods such as C. *pacific us*, *C. finmarchicus*, and *Metridia lucens* (Nemoto 1957). These prey species are taken

Table 2.-Fin whale prey species commonly found in the North Pacific, Gulf of Alaska (GOA), Aleutian Islands, and Bering Sea. Prey species within each group (euphausiids, copepods, fishes) are ranked according to preference. Data compiled from Nemoto (1957, 1959, 1963, 1964), Nemoto and Kasuya (1965), Berzin and Rovnin (1966), and Sleptsov (1961 b). Seasonal and annual variation in prey availability by geographic area probably results in a shift in selecting one preferred prey item over another. Thus, this table of rankings is generalized to reflect an averaging of the available data, which came from the harvesting of fin whales primarily during the 1950s.

Prey group and preferred species	Dominant geographic area where taken
Euphausiids	
Euphausia pacifica	N. Pacific, GOA to SE Bering Sea
Thysanoessa inermis	GOA to SE Bering Sea
T. longipes	N. Pacific-E. Aleut. Is.
T. spinifera	GOA to E. Aleut. Is.-Shelf Slope
T. raschii [1]	Bering Sea shelf
Copepods	
Calanus cristatus	N. Pacific-GOA
C. plumchrus [1]	GOA shelf to Aleut. Is.
Fishes	
Mallotus catevarius (capelin)	N. Pacific-S.. Bering Sea
Theragra chalcogramma (walleye pollock)	N. Pacific-S. Bering Sea
Clupea harengus pallasi (herring)	GOA to S. Bering Sea
Pleurogrammus monopterigius (Atka mackerel)	E. Aleutian Is.
Ommatostrophes sloanei-pacificus (squid)	E. Aleutian Is.
Cololabis saira (saury)[1]	E. Aleutian Is.

[1] Much less frequent.

less frequently, but are important for they are in turn eaten by fishes such as Atka mackerel and saury (Nemoto 1959). These fishes are, to a lesser degree, taken by fin whales.

Euphausiids seem to be the most frequently occurring prey found in fin whale stomachs (Nemoto 1957; Nemoto and Kasuya 1965; Table 2). *Euphausia pacifica*, *Thysanoessa inermis*,

and *T. longipes* are the numerically dominant prey. The distribution of fin whales is directly correlated with the seasonal occurrence of these species, and although not found exclusively from the Gulf to the southeastern Bering Sea, *E. pacifica* is taken in neritic and pelagic waters south of the Aleutian Islands. *Thysanoessa inermis* appears to be taken primarily in the Gulf of Alaska and along the south side of the Alaska Peninsula in waters usually less than 300 m deep, while *T. longipes* predominates north and south of the eastern Aleutian Islands (Nemoto 1957, 1966; Nemoto and Kasuya 1965; Cooney 1975). In 1962, however, fin whales were feeding primarily on *T. longipes* in the Gulf of Alaska, suggesting to Nemoto (1965) that this species was important in regulating the migration pattern of fin whales for that year. *Thysanoessa raschii*, an arctic and subarctic species, occurs primarily over the continental shelf in the eastern Bering Sea. This is an area generally not frequented by fin whales, but T. raschii is a common prey item for fishes such as cod and pollock. These two fishes are also eaten by fin whales (Nemoto 1966). *Thysanoessa spinifera* is probably eaten in shallow waters (less than 100 m) in the Gulf of Alaska, where it is most abundant (Nemoto and Kasuya 1965).

The fact that fin whales were taken frequently with only one or two prey species in their stomachs suggests that fin whales move into an area and concentrate their feeding on aggregates of single zooplankton patches as those prey became abundant. The patchy nature of and need for large volumes of prey probably facilitated selection of a polyphagous feeding strategy. Such behavior meant that more diverse and widespread "habitat" could be utilized by the whales, thus increasing their carrying capacity.

Migration

Berzin and Rovnin (1966) stated that the eastern North Pacific population of fin whales begins its annual northward migration to Alaska in spring from southern breeding areas off California. This migration occurs (1) along the North American coast to the northeast Gulf of Alaska; (2) north in the North Pacific to Kodiak Island, then east into the northeast Gulf of Alaska; and (3) north in the North Pacific to Kodiak Island to Unimak Pass area, then north into the Bering Sea, and west along the Aleutian Islands.

Kellogg (1929) reported that fin whales began showing up first off Vancouver Island in March. Scammon (1874) reported them off Vancouver Island in February. By April and May fin whales begin arriving in the Gulf of Alaska and eastern Aleutian Islands (Nemoto 1959; Berzin and Rovnin 1966). Shurunov (1970) stated that they occur in the western part of the Gulf of Alaska earlier than in other parts of the North Pacific; this cannot be confirmed from our data, although there is a hint that animals show up earlier in the eastern than the western Gulf.

Migration into the Bering and Chukchi seas occurs from June and July to October (Berzin and Rovnin 1966). The southward movement, an apparent migration from the northern feeding grounds to winter calving and breeding areas, may begin by August (Nasu 1974), but usually occurs over a short time period in September. Their movements south are timed, apparently, with decreasing light and diminishing prey supply (Sleptsov 1961*a*,*b*). By September a large percentage of fin whales (not specified in the literature) leaves the Bering

Sea, but some remain north and south of the eastern Aleutian Islands until November (Berzin and Rovnin 1966).

Serological studies indicated that four subpopulations or stocks occur in the North Pacific (Fujino 1960). Fujino identified animals north of the Aleutian Islands having some distinct blood antigens from animals south of the Aleutian Islands near 50°N. Within each of these two regions, however, little yearly fluctuation in antigens has been observed. His conclusion was that fin whales migrate back into the same feeding area annually (Fujino 1960). Although all fin whales moving into the North Pacific and southern Bering Sea share the same general feeding area (Berzin and Rovnin 1966), the degree to which the "subpopulations" intermix is unknown.

To 1965, 847 fin whales were marked with discovery tags; 166 were recovered (WRI 1967). Although many inconsistencies occur in the data, primarily because time of year and location of recovered tags were not reported, recoveries indicated little east-west movement across the North Pacific (Kawakami and Ichihara 1958; Nemoto 1959; Fujino 1960; Ohsumi and Misaki 1975). This supports the hypothesis that fin whales are divided into eastern and western Pacific groups or stocks (Tomilin 1957; Nishiwaki 1966). At least one whale, however, was tagged in the Okhotsk Sea and killed in the Gulf of Alaska (Ivashin and Rovnin 1967). Although the tagging studies have demonstrated that little movement occurs across the North Pacific, the limited data do not disprove the notion that fin whales which migrate into the Gulf of Alaska and southern Bering Sea come from the eastern Pacific Ocean. In fact, there is a tendency to support this hypothesis. In addition, although no confirmed evidence is available to support a specific migration pattern (Kawamura 1975), it appears that the general migration pattern from approximately California to Alaska and return, as described by Berzin and Rovnin (1966) and Rice (1974), is supported by our seasonal distribution data.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

In the North Pacific, fin whales appear to breed from September to June, but with a clear peak from November to January (Tomilin 1957; Ohsumi *et* al. 1958). Gestation appears to last 11-12 months, and lactation is reported by Ohsumi *et* al. (1958) to end when calves reach 12-13.5 m (36-40.5 ft) lengths. Newborn calves are reported to be approximately 6.5 m (20-22 ft) in length. Physical maturity is reached at 22-25 years of age, with sexual maturity being reached at lengths greater than 21 m (63 ft) in males and 23 m (68 ft) in females (Ohsumi *et* al. 1958). As with many baleen species, females are larger than males; the average length attained by females is 24 m (71 ft), and by males is 23 m (68 ft) (Ohsumi *et al.* 1958). Because the bulk of scientific data on the reproductive biology of fin whales comes from the harvest of the whales by means of analysis of fetuses, May through September, interpretation of the data and predicting the reproductive cycles maybe biased.

Mortality

Predation. -Killer whales are probably the only natural predators of fin whales, although we have had no reports of killer whales attacking fin whales.

Other causes. -Other causes of mortality in the study area are poorly understood. Strandings are few, and none are known to have been visible. We have no records of entanglement with fishing gear, nor of collisions with vessels.

Exploitation and development. –The fin whale was one of the most sought after baleen whales by commercial whalers in the North Pacific. Between 1952 and 1962 almost 13,000 were taken above 48°N (Nasu 1963). This total accounted for over 80% of all whales of all species taken on traditional whaling grounds located in the Gulf of Alaska, occurring primarily east of Cape St. Elias and along the south side of Kodiak Island as well as in the eastern Aleutian Islands, and over the continental slope in the southern Bering Sea (Nasu 1963; Berzin and Rovnin 1966).

Humpback Whale (*Megaptera novaeangliae*)

The humpback whale belongs to the family Balaenopteridae (the rorquals) and is the only member of the genus *Megaptera*. Other common names include humpbacked whale and bumpy.

ABUNDANCE

Humpback whales have been protected by the International Whaling Commission (IWC) from commercial whaling by the IWC since 1966. A subsistence take is allowed under IWC charter, but none are taken in U.S. waters.

No estimate of abundance is available for the Gulf of Alaska, but probably only a few hundred regularly frequent the Gulf waters, including Prince William Sound which is believed to seasonally have 50 or more animals (Hall and Johnson 1978). Estimates of the size of the winter breeding population in Hawaii is 400-600 and in Mexico about 100 (Wolman 1978). The North Pacific population is estimated at 850 (Rice 1977) to 1,200 (Rice and Wolman 1982). The humpback whale is the second most depleted endangered species in the North Pacific, using the criteria of population size, following the North Pacific right whale (*Balaena glacialis*).

DISTRIBUTION

Winter (January-March)

Most humpback whales spend the winter months in warm subtropical breeding grounds off Mexico and Hawaii. Winter sightings in the study area are rare. Our winter data include

several sightings from southeast Alaska and one (of two animals) near Cape Chiniak, Kodiak Island (Figure 7). Hall (1979) reported the sighting of a lone humpback in Prince William Sound in February. Forsell and Gould (1981) reported a tentative sighting of a lone humpback whale in Uyak Bay (57°45'N, 153°55'W) on 27 February 1980. Evidence exists that up to 40 humpback whales may overwinter in the inland waters of southeast Alaska (W. Lawton, pers. commun.).

Spring (April-June) and Summer (July-September)

During the spring, humpback whales begin arriving on the northern feeding grounds. Hall (1979) found humpback whales in Prince William Sound as early as May. Unpublished data from salmon trollers in Southeast Alaska (POP files) indicate that humpback whales begin to arrive in that area in early April.

The frequency of occurrence off Kodiak Island, Prince William Sound and southeast Alaska in spring and summer is predictable; that is, these locations are traditional places where humpbacks are seen. Our sightings data might suggest that they are clumped at these three locations (Figures 8 and 9), with very few sightings in between except offshore at Kodiak Island, Cape St. Elias, and Yakutat Bay. Relative sighting data for other species (e.g., Dan porpoise) and effort throughout the Gulf (Appendix II) show that the areas where humpbacks are not generally seen are places where most other marine mammals are in abundance. Therefore, humpbacks are segregating in spring and summer to Kodiak Island (Portlock and Albatross banks), Prince William Sound, and southeast Alaska.

The notion of stock separation for these areas, however, is open to question. Analysis of humpback whale fluke photographs has shown that in some years a whale is found, for example, in Prince William Sound and a year or more later in southeast Alaska. Individuals do, therefore, use at least these two locations among years. How much interchange occurs among years, or even within the same year, is unknown. This is an important point because it has profound implications for managing the species. Under the Marine Mammal Protection Act and Endangered Species Act, both populations and subpopulations (or stocks) must be managed individually; assessment of the potential effects of OCS development on local stocks of a larger eastern North Pacific population fall within this management requirement. No photographs of humpback tail flukes off Kodiak Island are known to exist. A humpback whale photographic sorting system for the west coast (Lawton *et al. 1980) is* being developed, but requires much greater documentation and evaluation before utility is realized.

Sightings data from southeast Alaska salmon trollers and their comments (POP files) indicate that some humpbacks from southeast Alaska inland waters spend part of the summer on the Fairweather Ground, west of Cape Spencer, apparently feeding.

Further information on the distribution of humpback whales comes from old whaling records. Rice (1974:21) stated that "By the early 1960s, the only area remaining in the North Pacific where large numbers of humpbacks congregated in the summer was around the eastern Aleutians and south of the Alaska Peninsula, from 150° to 170°W longitude" and gave the

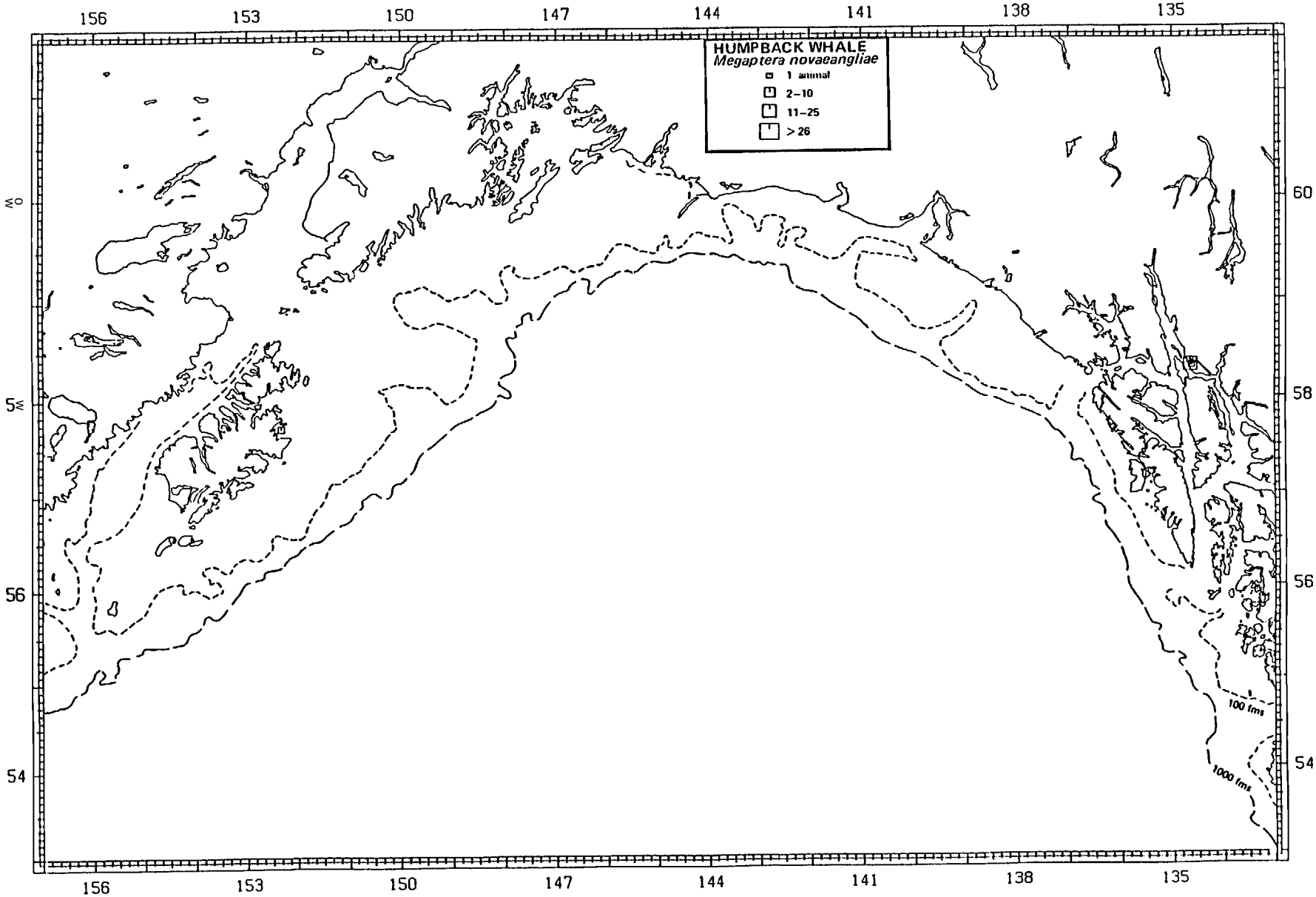

Figure 7.–Humpback whale sightings, winter (January-March) 1958-80.

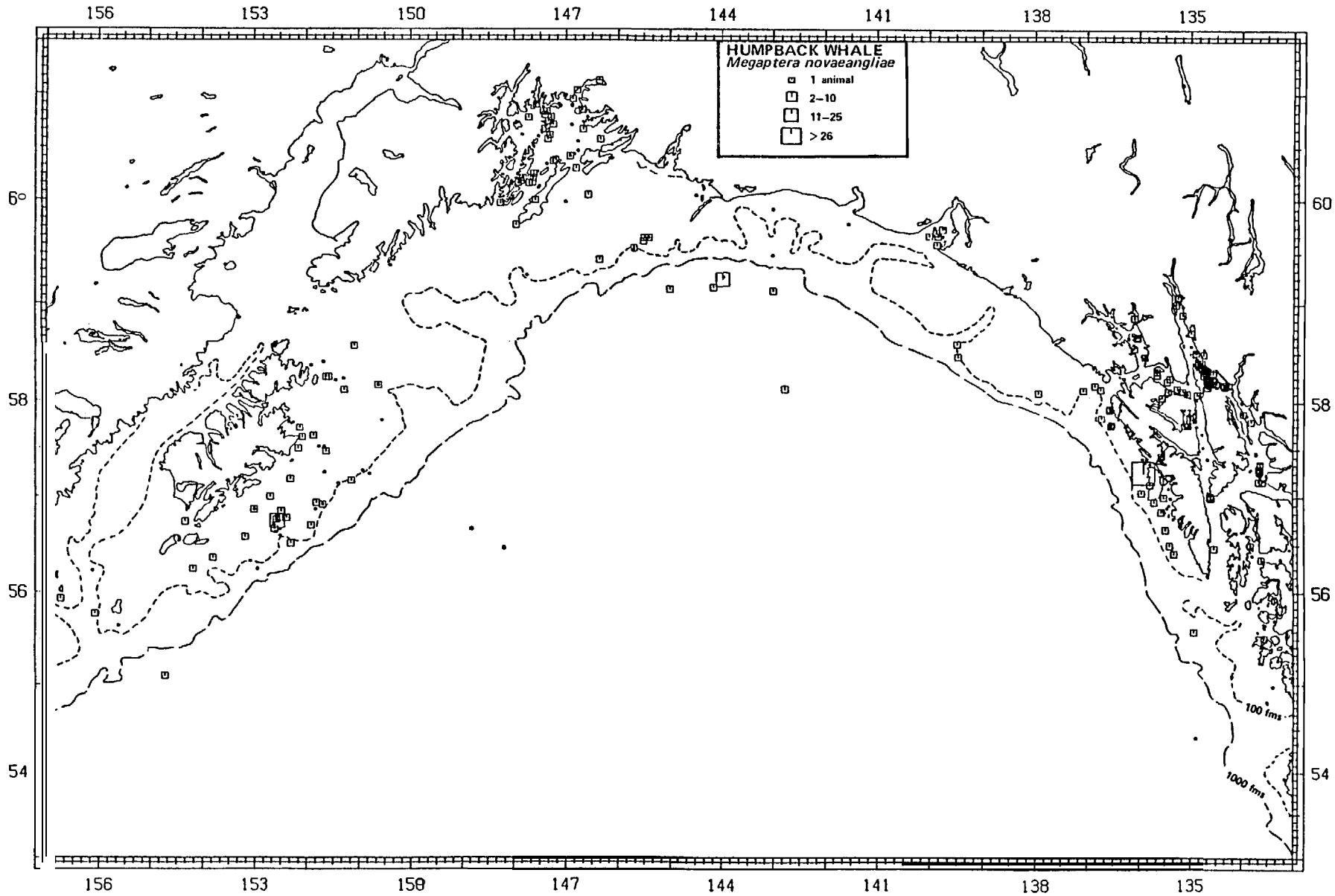

Figure 8.–Humpback whale sightings, spring (April-June) 1958-80.

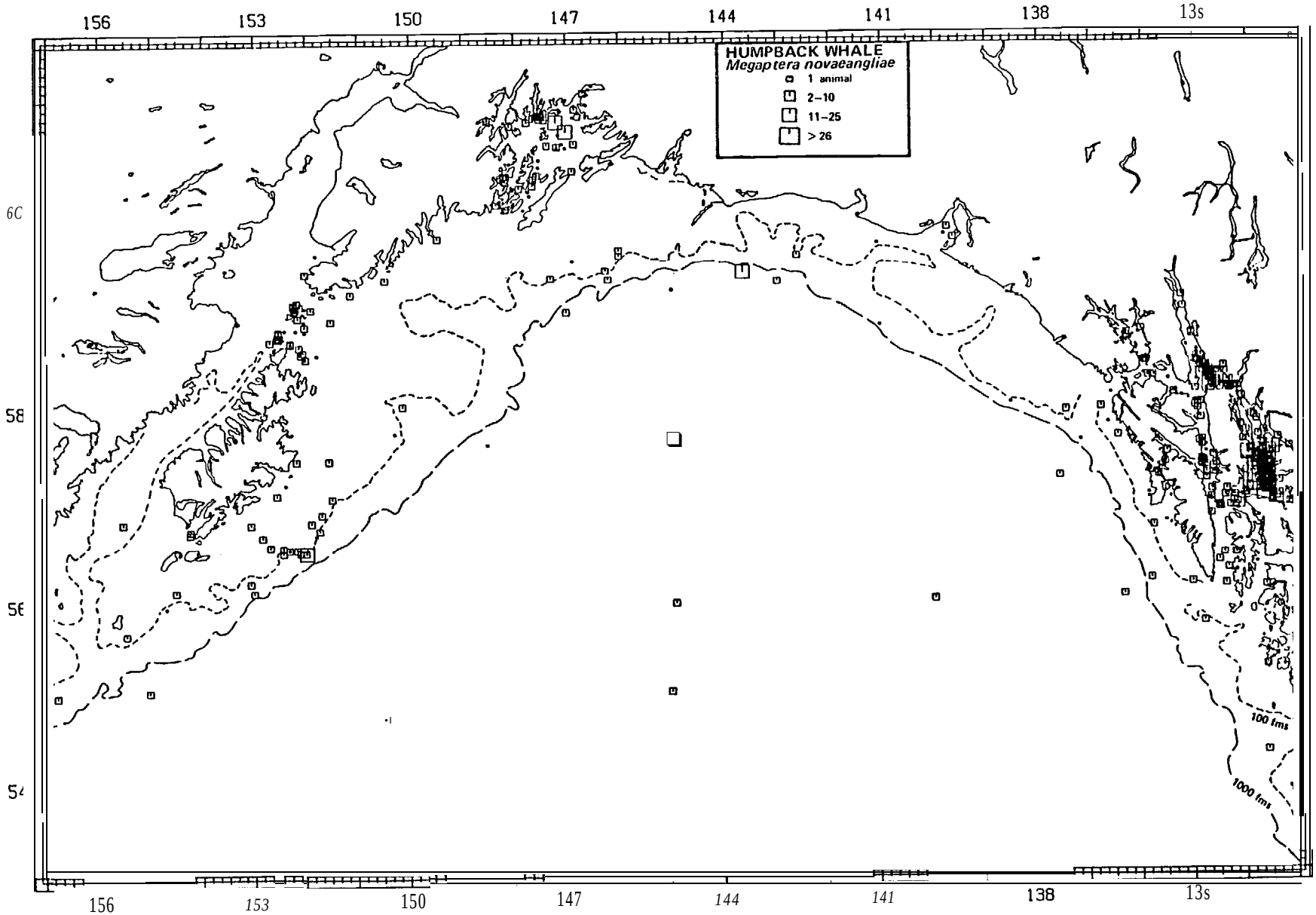

Figure 9.-Humpback whale sightings, summer (July-September) 1958-80.

southern summer limit as northern California. Berzin and Rovnin (1966) gave the distributional limit of summering as Vancouver Island, and the northern limit as the Chukchi Sea. They found large groups (>50 animals) off southeast Alaska, the Fairweather Ground, and the Shumagin Islands, with smaller groups occurring throughout the Gulf of Alaska, eastern Aleutian Islands, and southcentral Bering Sea. Nemoto (1964) noted that the large majority of sightings during summer months were of single animals or pairs. From sightings during a 1962 summer cruise, Berzin and Rovnin (1966) cited the western Gulf of Alaska and eastern Aleutian Islands as the area where humpback whales are likely to occur in summer. The paucity of recent sightings in these areas belies this assumption of today's distribution.

Autumn (October-December)

Humpback whales are present in the northwestern Gulf of Alaska through November, and in southeast Alaska inland waters through December (Figure 10). Hall (1979) found humpbacks in Prince William Sound through November.

FACTORS INFLUENCING DISTRIBUTION

Oceanographic

Winter distribution of humpback whales is associated with oceanic islands and warm waters close to continental coastlines (Berzin and Rovnin 1966; Rice 1974; Wolman and Jurasz 1977). This affinity for nearshore waters is maintained during the rest of the year on northern grounds in the study area. In describing a 1962 Soviet research cruise in the northeastern Pacific, Shurunov (1970) found that humpback whales formed localized concentrations and mainly kept near shore over the continental shelf.

The great majority of our sightings occurred in highly productive fjord-like inland areas (Prince William Sound and southeast Alaska), protected coastal areas and bays, and around islands (e.g., Kodiak, Afognak, and Barren Islands). The few sightings from the central Gulf occurred in the vicinity of the Gulf of Alaska Seamount Province, but it is not certain that these offshore areas of upwelling provide summer-long habitat. It seems likely that these sightings merely represented animals in transit across the Gulf to nearshore areas.

Group size changes through the seasons, smallest in spring and largest in winter. The percentage of sightings of two or fewer animals was 74% for spring and summer and 53% for autumn and winter.

Feeding and Food Resources

Humpback whales, like all of the great rorquals, are seasonal feeders, feeding in the high latitude summer grounds and presumably living mostly off body fat reserves in the subtropical winter breeding grounds (Wolman 1978). "Fasting" in winter, however, is assumed and has not been tested. Though principal prey items appear to vary with location, humpbacks generally feed on schooling fishes and euphausiids.

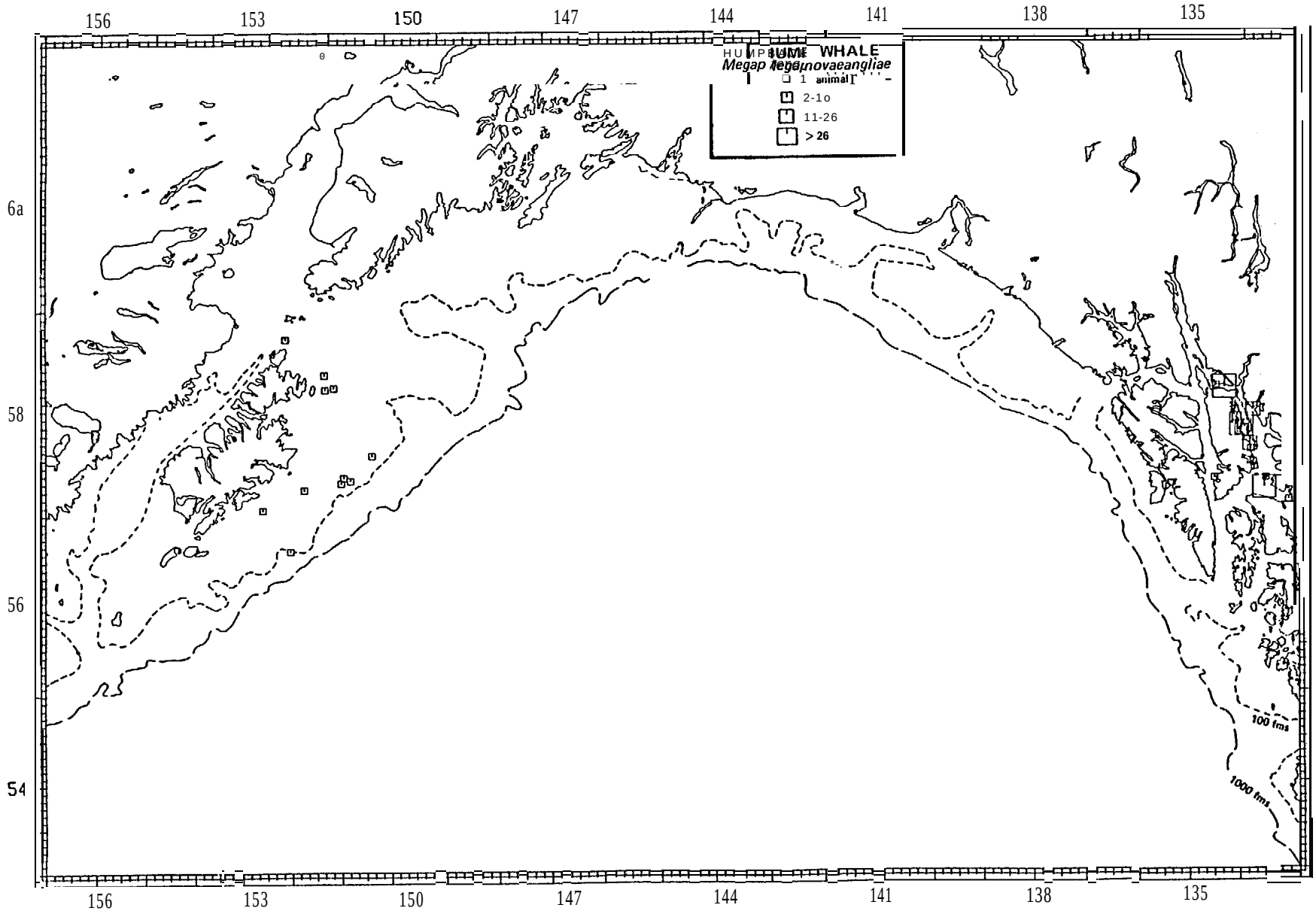

Figure 10.-Humpback whale sightings, autumn (October-December) 1958-80.

Nemoto (1959) found that humpback whales at the Near Islands (central Aleutian Islands) prey on Pacific mackerel (*Scomber japonicus*) and occasionally on small walleye pollock (*Theragra chalcogramma*). He listed their prey as swarming fishes: herring (*Clupea harengus*), walleye pollock, capelin (*Mallotus villosus*), Pacific mackerel, saury (*Cololabis saira*), and euphausiids. Klumov (1963) stated that humpback whales in the northern Pacific fed primarily on fishes, utilizing zooplankton occasionally, but taking no squid. In the Kurile Islands (western North Pacific), he found primarily walleye pollock in humpback whale stomachs, along with pink salmon (*Oncorhynchus gorbuscha*). In the Bering and Chukchi seas, he found humpback whales associated with aggregations of Arctic cod (*Boreogadus saida*), herring, and capelin.

Several methods of feeding on fish and euphausiids are exhibited by humpback whales (Jurasz and Jurasz 1979). In southeast Alaska they "lunge feed" with their open mouth by plowing through concentrated prey, or "flick feed," where they move their flukes forward at the surface, then dive forward through the concentrated feed. A third method reported involves blowing a ring of bubbles (called a "bubble net") around a school of fish, presumably causing the prey to bunch together. The whale then rises, with its mouth open, through the clumped prey.

Migration

There are three discrete wintering areas for North Pacific humpback whales (Berzin and Rovnin 1966; Rice 1977): (1) the coastal waters of Mexico, (2) Hawaiian Islands, and (3) on the Asiatic side, the Ryukyu, Benin, and Marianas islands and Taiwan. About 2- 1/2 months are spent on these wintering grounds (Wolman 1978). The ensuing migration northward to Alaskan waters lasts over 2 months.

Berzin and Rovnin (1966) proposed that the stock wintering in Mexican waters moves north and northwest in the spring and summer toward the eastern Aleutian Islands, with some groups remaining in Canadian coastal waters (southeast Alaska should probably have been included here). Nishiwaki (1966) noted that humpback whales are long distance migrators, citing an example of a group of six humpbacks tagged in the eastern Aleutian Islands being caught later near the Ryukyu Islands off Japan. Three humpbacks tagged off Unalaska in the Aleutian Islands in July and September were killed the next January and February off Okinawa Island, Japan (Kawakami and Ichihara 1958), a distance of approximately 2,500 nmi. Ohsumi and Masaki (1975:187), in reviewing marked and recaptured humpback whales, concluded that "the reliability of interchange between the east and west sides [of the North Pacific] is relatively high in this species." Hall and Johnson (1978) found a group of 15 animals entering Prince William Sound in October 1977 which apparently had not been sighted previously that year in the area. This indicated that movement of humpback whales from one area of the Gulf of Alaska to another does occur, at least occasionally.

We believe that humpbacks wintering in Hawaii and Mexico spend the summer in the Gulf of Alaska, and that humpbacks wintering in Asia summer in the Bering Sea, Aleutian

Islands, and perhaps to Kodiak Island. Some interchange between the Gulf and the Bering Sea may take place, however.

Both northward and southward migrations are staggered throughout spring and autumn, according to the reproductive status of individual whales (Wolman 1978). The first whales to head north are newly pregnant females and immatures of both sexes. Mature animals follow. Females late in lactation head south to breeding grounds first, followed by immatures, adult males, resting females, and, finally, pregnant females. Pregnant females remain on the Alaskan summer feeding grounds longer than others, presumably to accumulate the greater store of energy needed to support the rapidly developing fetus. The average speed of individuals migrating is less than 7 km/hour (Wolman 1978).

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Humpback whales reach sexual maturity at 6-12 yr of age (Nishiwaki 1959). Conception occurs during the winter months in the temperate and tropical breeding grounds, and may occur in the study area as well (overWintering animals?). Gestation is 12 months, with females usually resting at least 1 year after giving birth. A newborn calf may measure up to 5 m and weigh 1,800 kg. Lactation lasts for 11 months. A female humpback may have as many as 15 calves during her lifetime; her life span may last 47 years (Chittleborough 1960, 1965)-this from Southern Hemisphere data.

Mortality

Predation.–Killer whales are probably the only natural predators of humpback whales. We know of no documented attacks of humpback whales by killer whales in the eastern North Pacific. Killer whales are not believed to be an important mortality factor, however.

Other causes. -Other causes for natural mortality are poorly known. Strandings (presumably disease related) are few in the study area. Entanglements in fish nets, a somewhat frequent occurrence off the northeast coast of North America (compare Mitchell and Reeves 1981) (Lien and Merdsoy 1979), and collision with vessels are both undocumented in the study area.

Exploitation and development.–Extensive commercial exploitation of humpback whales in the northeastern Pacific did not begin until the 1960s (Berzin and Rovnin 1966). Prior to this period there were probably about 15,000 individuals in the entire North Pacific population; 28,000 humpback whales were killed between 1905 and 1965 (Rice 1977). The North Pacific population is thus recovering after having been reduced to less than 5% of its original size.

Gray Whale (*Eschrichtius robustus*)

The gray whale is the only species of the oldest living family of baleen whales, Eschrichtiidae. Common names include California gray whale (Rice 1974), devil-fish (Bailey and Hendee 1926), and summer whale (Hughes and Hughes 1960; and by Alaskan Eskimos). The gray whale is known as the winter whale by some local residents of Baja California, and is sometimes called "fin whale" by some Alaskan Eskimos (cf. Marquette and Braham 1982).

ABUNDANCE

In 1966 the IWC charter was amended and the gray whale was designated a Protected Stock; in 1979 it was redesignated as a Sustained Management Stock. A subsistence take by U.S. and Soviet Native Americans is allowed under IWC agreement. The 1980 quota was 179 whales. Two populations or stocks are identified, the eastern North Pacific stock and the western North Pacific or Korean stock.

The Korean stock is very rare (Brownell 1977). Since it may represent a now-isolated group from the eastern North Pacific stock and thus not likely to be influenced by any OCS activities off Alaska, it will not be considered in this report. The eastern North Pacific stock is now estimated to be 15,000-17,000 (Reilly *et al.* 1980; Reilly 1981), of which 13,000-17,000 enter the coastal waters of the Gulf of Alaska twice annually (Rugh and Braham 1979). Estimates of 11,000 (Rice and Wolman 1971) and 18,300 (Adams 1968) were based on fewer data and less rigorous analyses than the estimates by Rugh and Braham (1979) and Reilly (1981). The size of the summer (June-September) resident population in the Gulf, if it occurs regularly, is unknown but probably represents only a few hundred whales, if that. The gray whale population has apparently recovered from the commercial exploitation of the last half of the 19th century and first half of the 20th century, but probably is near its pre-commercial whaling carrying capacity (Reilly in press).

DISTRIBUTION

Winter (January-March)

Throughout December, gray whales migrate out of the Bering Sea (Rugh and Braham 1979) and can be observed from Unimak Pass to southeast Alaska well into January. Few are thought to be in the Gulf of Alaska in February, and, in fact, most leave the study area by mid-January.

The peak of breeding activity occurs south of Alaska during late winter (usually in late December to February). Calving and mating probably do not take place north of California (Rice and Wolman 1971). Pre-parturient females and recently weaned calves (those near the end of the summer feeding period) migrating south with the rest of the population probably represent the most likely (= sensitive) component of the population that could be influenced by OCS development in the Gulf during early winter.

Spring (April-June)

The northward migration into Alaskan waters begins in late March and continues through May (Figure 11). Gray whales are located throughout the Gulf in spring, usually within a few kilometers of shore (Figure 12). A buildup of whales occurs in spring, with more occurring in the Gulf at one time during the first half of spring than the last. Further research on this is required, however. There seems to be few if any major areas where they particularly congregate; however, they have been seen to stop or slow down to feed or interact among themselves and, on occasion, with sea lions, off(1) Cape St. Elias (Kayak Island) (Cunningham and Stanford 1979), (2) off the Barren Islands, (3) along the south coast of Kodiak Island, and (4) at various locations along the south side of the Alaska Peninsula, such as Chignik Bay, west of Kodiak Island (Braham 1978).

Summer (July-September)

The summer distribution of gray whales in the Gulf of Alaska is not well known. Because the migration into the Bering Sea is generally complete by the end of June or early July (Braham *et* al. 1977; Braham 1978), we believe that animals seen in the Gulf during summer and autumn may be resident for this period. Rice and Wolman (1982) saw no gray whales in a survey of the Gulf of Alaska from June to August 1980, although their surveys were generally farther offshore than we believe gray whales migrate. They spent some time near shore, where their lack of sightings further supports our belief that the migration northward is generally over by summer and that few animals remain as summer residents in the Gulf. Occasionally, however, gray whales are seen along the south side of Kodiak Island (especially), in Hinchinbrook Entrance (outside Prince William Sound), and between Cape St. Elias and southeast Alaska in summer (R. McIntosh, pers. commun.; Braham, pers. ohs.); but again very near shore. Our plotted sightings are for Shelikof Strait and off Baranof Island (Figure 13). The significance of these sightings is unclear (i.e., are these animals late spring or early autumn migrants, summer feeding groups, sick animals, or late post-parturient females?).

Autumn (October-December)

Gray whales begin entering the Gulf of Alaska in autumn during their southbound migration *(Figure* 14). Most of the population begins leaving the Bering Sea in early November (Rugh and Braham 1979; Rugh 1982), thus late autumn is when most gray whales are in the Gulf. Whales have been observed off the coast of British Columbia, Washington, and Oregon in September and October (Rice and Wolman 1971), although in small numbers. We believe they do little feeding during the autumn migration. Their speed of travel during autumn (about 7-9 km/hr) is twice as fast as in spring (Rice and Wolman 1971; Rugh and Braham 1979). Their distribution in the Gulf is greater in November, probably by two orders of magnitude, than in September, and more so toward the end of November than earlier. Unfortunately, almost no quantitative information has been gathered, and no systematic studies have been conducted on gray whales in the Gulf of Alaska from September to March (Figure 14).

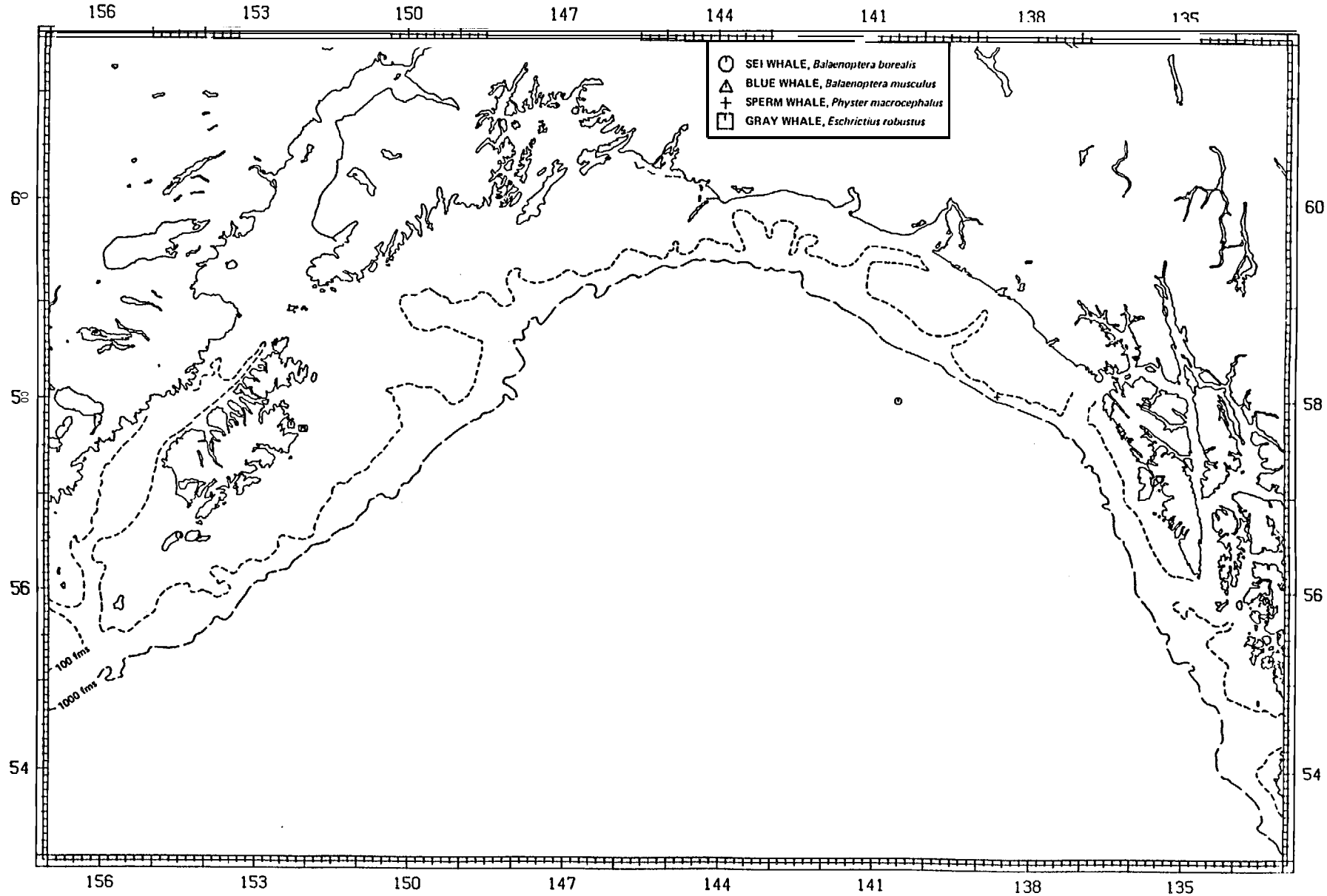

Figure 11.–Gray, sei, blue, and sperm whale sightings, winter (January-March) 1958-80.

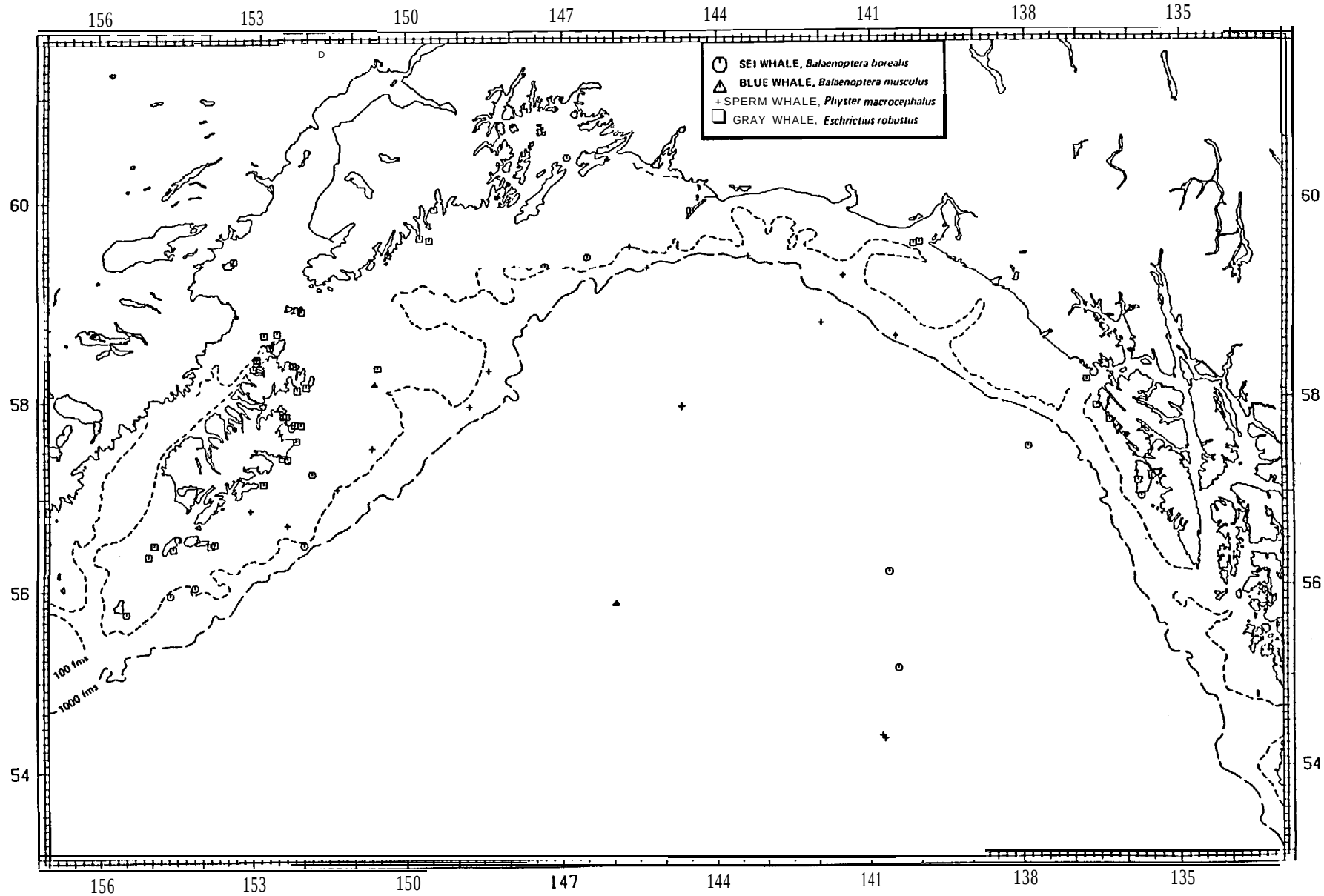

Figure 12.-Gray, sei, blue, and sperm whale sightings, spring (April-June) 1958-80.

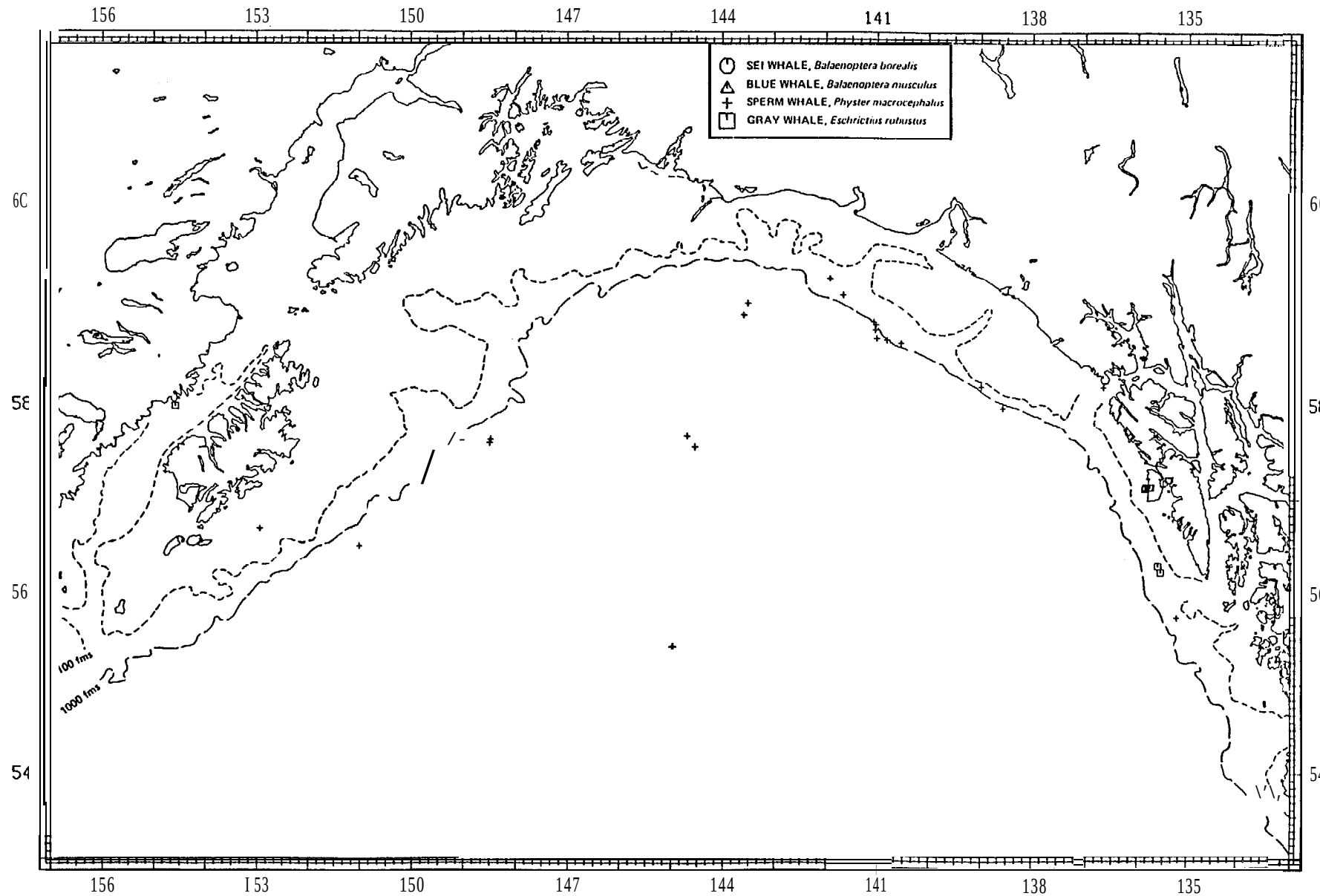

Figure 13.-Gray, sei, blue, and sperm whale sightings, summer (July-September) 1958-80.

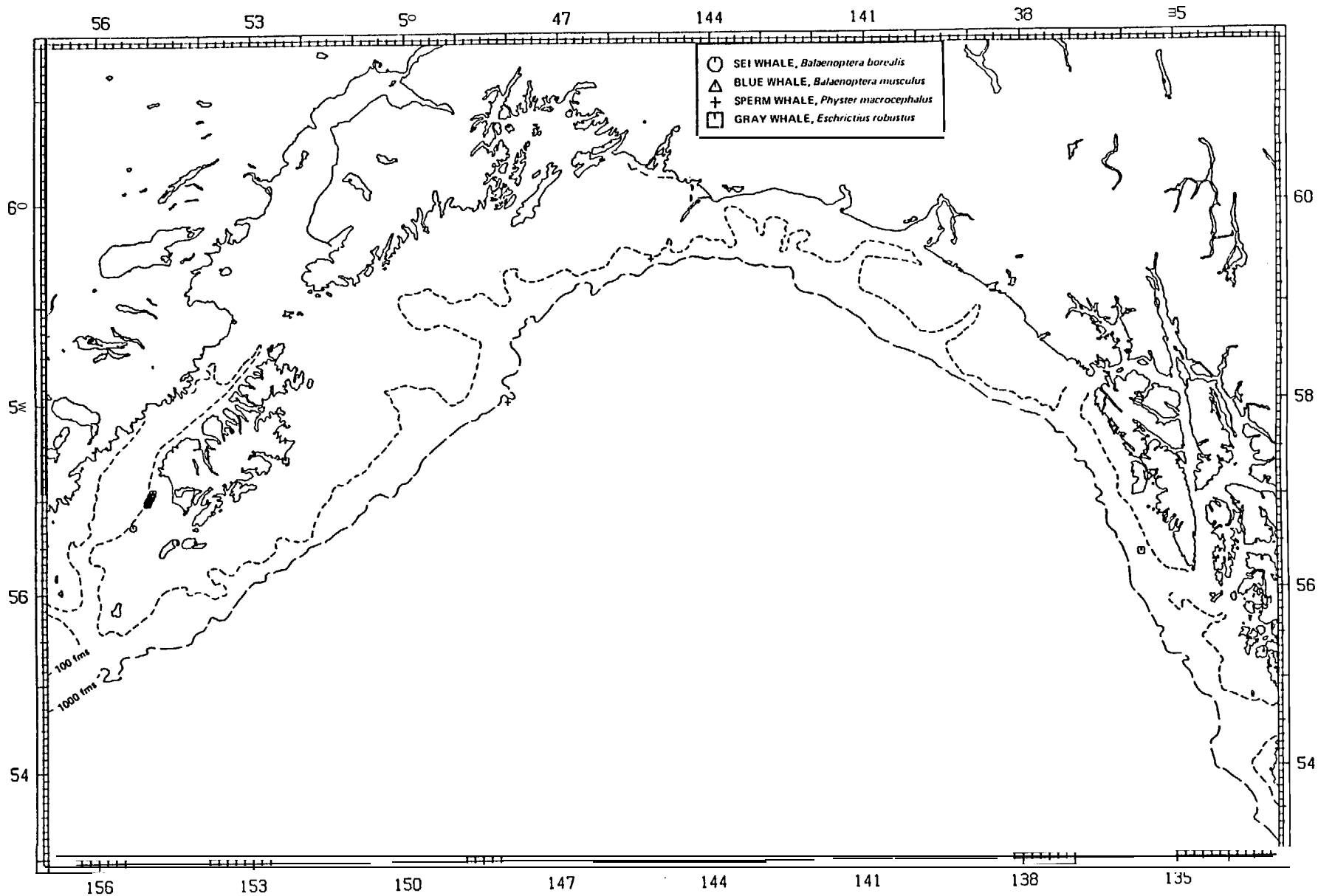

Figure 14.–Gray, sei, blue, and sperm whale sightings, autumn (October-December) 1958-80.

FACTORS INFLUENCING DISTRIBUTION

Oceanographic

There are no data to suggest that the distribution of gray whales in the Gulf of Alaska is influenced or limited by oceanographic features. It is clear, though, that they are a coastal species seldom found for long in waters beyond the 1,800-m isobath (Rice 1965), and are more commonly seen in water less than 100 m deep in Alaska. Hubbs (1958), Ichihara (1958), and Gilmore (1960) all thought the gray whale migration was offshore directly to and from the coast of California and Washington across the outer Gulf of Alaska to and from the Aleutian Islands. Gilmore (1960) hypothesized that their migration was closely associated with the prevailing oceanic currents out to sea, but this was disputed by Pike (1962), who showed that the water current system would probably work against the migration. Data we have collected since 1975 under the OCSEAP now confirms this coastal route throughout their range.

Pike (1962) speculated (accurately) that gray whales stay near the shore throughout their migration, although he had no data to present. He also hypothesized that their affinity for the shore was associated with migrational cues tied to the topography of the coastal mountains and promontories. Although he stated that whales in general may not see well in air, he proposed that gray whales take advantage of the coastal mountain ranges and hills as markers during migration and thus simply follow these cues around the coast and into the Bering Sea. Braham's (1978) hypothesis was that the northward gray whale migration route is most influenced by the availability (and perhaps consistency) of food resources.

Feeding and Food Resources

Gray whales enter Alaskan waters to feed and rear their young. It has previously been assumed that they do little if any feeding away from their feeding grounds in the northern Bering and Chukchi seas (Scammon 1874; Nemoto 1959; Gilmore 1960; Rice and Wolman 1971). Some authors, however, suggest that feeding may occur south of Alaska (Howell and Huey 1930; Pike 1962; Sund 1975; Wellington and Anderson 1978), and for those animals that do not make the complete migration north (Hatler and Darling 1974; Darling 1977). As a result of OCSEAP and other NMFS studies since 1975, Braham (1978) assembled several observations of gray whale feeding behavior and reports that gray whales do probably feed throughout their northward migration in Alaska (first reported in Braham *et al.* 1977). No known data are available, however, to indicate whether they feed in Alaskan waters during their autumn, southbound migration.

While in or near the Gulf of Alaska from March to May, gray whales have been observed to bring mud and sand to the surface and expel it in the same manner as observed when they are feeding in the northern Bering Sea. Three places are noteworthy: (1) along the outer coast of Baranof Island, (2) at Cape St. Elias, and (3) along the southeast coast of Kodiak Island. We have no idea what they may be feeding on; as benthic feeders, they favor ampelisced amphipods in the Bering Sea. They also take euphausiids, tubeworms, decapods, and polychaetes. However, the densities and coastal availability of amphipods are not documented

in the literature. Howard Feder (Univ. Alaska, pers. commun.) reports that amphipods (mostly gammarids) are abundant nearshore in outer Cook Inlet, where soil type may be similar to that found in the northern Bering Sea by Stoker (1978). Sediment type and prey availability are unknown for much of the Gulf coast within a few kilometers of shore; presumably the surf zone where gray whales appear to be feeding consists of sand.

No conclusion is possible at this time as to the prey gray whales select while feeding in the Gulf, but from behavioral observations it is likely that some benthic or epibenthic invertebrates are the target. Schooling fishes, such as herring (*Clupea harengus*) and capelin (*Mallotus villosus*), are common in near coastal waters of Kodiak Island and southeast Alaska and thus fish may also represent a limited food resource during migration. Braham (pers. ohs.) observed gray whales from the air (June 1976, 1977, 1978) apparently feeding at the entrances to Port Moller and Port Heiden (north side of Alaska Peninsula) in a somewhat different fashion than when they feed in the northern Bering Sea. These animals oriented themselves against the current-tide during presumed fish runs. The whales opened their mouths periodically while slowly drifting, or sometimes remained stationary by moving their flukes against the tide. It would be interesting to know if this is an important opportunistic response to tidal changes taken advantage of by whales who might be migrating by such a point–or whether portions of their migration route are timed to these tidal fish runs. Again, however, we cannot be sure the whales were feeding.

Migration

Spring. -Gray whales migrate 9,000-14,000 km each spring from their calving and mating areas off the west coast of Baja California, Mexico to feeding grounds in the Bering and Chukchi seas. Their migration route is entirely coastal, at least to Nunivak Island in the Bering Sea (Braham *et al.* 1977; Braham 1978). Most, if not the vast majority, stay within 2 km of shore while in Alaska, except between the entrance to Prince William Sound and Kodiak Island, and Kodiak Island to the south side of the Alaska Peninsula (Figures 11-14).

The migration usually begins, slowly, from late February to mid-March and ends by late June or early July. In the Gulf of Alaska the spring migration period is approximately April through June. Single adults, including pregnant females, and subadults generally begin first, followed by post-mating males and post-parturient females with their young (Rice and Wolman 1971). Braham *et* al. (1977; and NMFS unpubl. data) observed apparent subadults entering the Bering Sea first. Besides feeding, other behavior associated with mating, and perhaps play, have been observed at Cape St. Elias by Cunningham and Stanford (1979) and near Cape Chiniak, Kodiak Island by R. McIntosh (pers. commun.). Milling about, as well as feeding and sexual behavior, were common, perhaps associated with periods of rest during migration. The peak of the migration midway through the Gulf of Alaska (at Cape St. Elias) for the years 1977 and 1978 was the third week in April (Cunningham and Stanford 1979).

Autumn. –Gray whales leave the Bering Sea during their annual autumn migration south to Baja California and begin entering the Gulf of Alaska in late October; they are usually gone from the Gulf by early January. The peak of the migration in the Gulf is around the last

week in November, although no empirical data are available. This estimate is an extrapolation from the field work of Rugh and Braham (1979) and Rugh (1982) at Unimak Pass and that estimated by Pike (1962) and Rice and Wolman (1971). Data from Kodiak Island (R. McIntosh, pers. commun. to Rugh 1982) and Yakutat Bay (D. Calkins, pers. commun. in Braham *et* al. 1977) suggest that the migration route is as close to the coast as it is in spring. Joyce (1979) observed a group of 20 gray whales approximately 20 km out to sea northeast of Kodiak Island heading in an east-northeasterly direction in November 1979 during poor weather conditions. Whether the animals were en route from Kodiak back to the north coast of the Gulf, or taking a course across the Gulf more out to sea than expected, is unknown.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Gray whales mate and calve during their southbound migration along the west coast of the United States (and perhaps Canada) south of Alaska but usually in coastal waters adjacent to California and Baja California, Mexico (Rice and Wolman 1971). Females generally mate every other year, with conception generally occurring from late December into February. Recent (1981) observations of mating in Mexico strongly suggest conception may extend well into February (Braham pers. ohs.) and perhaps March. Copulatory or sexual behavior has been observed beyond this period-April (Cunningham and Stanford 1979), summer (Darling 1977), June-July (Fay 1963)-but its significance relative to conception is unknown (e.g., these may have been male-male interactions). Parturition occurs in January and February, but sightings of calves along the migration route (Sund 1975) and in or near the calving lagoons (Eberhardt and Norris 1964; Rice and Wolman 1971; Swartz and Jones 1979; Rice *et al.* **1981) suggest the** period may be from late December to perhaps early March. Although it seems highly unlikely, some calving may take place in the Gulf of Alaska.

Lactation lasts to at least August (Rice and Wolman 1971); young calves and their mothers migrate through the Gulf of Alaska during about the second or third to fourth month of the calf's life during the period of lactation in spring and summer. A report to Braham in 1977 from Alaskan Eskimos living on St. Lawrence Island was that young gray whales are weaned by summer,

The total reproductive output ofa female gray whale is unknown; however, if they have an active reproductive life of 40 years, mate every second year, begin mating no earlier than 8 years, and if most (85%, Rice and Wolman 1971) become pregnant during their annual reproductive season, then a female can expect to produce about 12 calves in her lifetime (which live to their first year, assuming 10% calf mortality). Reilly (pers. commun.) believes that some may breed annually. Females become sexually mature at about 12 m and males at about 11 m; female adults are longer than males (Rice and Wolman 1971). The population of gray whales in the eastern North Pacific is believed to have grown about 2.5% per year between 1968 and 1980 (Reilly 1981). It therefore appears to be a reproductively healthy population.

Mortality

Predation. -Killer whales are the only known natural predator of gray whales. Stranded gray whales in Alaska frequently show evidence of killer whale attacks (Fay *et al.* 1979). Several killer whale attacks have been sighted, but few documented in Alaska. In November 1978, a group of approximately six killer whales attacked a group of four gray whales in eastern Unimak Pass; a lone adult gray whale was isolated and attacked by all of the killer whales (R. Sonntag, pers. commun.). The head region of the gray whale was attacked first. The final outcome of the event was not observed, although blood from the gray whale was evident and it is unknown whether the remaining gray whales were also attacked. The gray whales scattered when the killer whales charged; but just prior to the initial charge the larger gray whales surrounded a juvenile animal in an apparent protective display. Baldridge (1972) saw five or six killer whales kill a gray whale calf. He suggested that the calf was held underwater and drowned; the tongue, jaw area, and ventral blubber were consumed.

Killer whale predation on gray whales was reported to Braham (1977, 1978, 1979) by Alaskan Eskimos on St. Lawrence Island. As with predation on bowhead whales (*Balaena mysticetus*), gray whales have been seen to be attacked near the mouth, flippers, and flukes. This would seem to be an effective way to quickly immobilize the prey. Below-surface attacks are usually not reported for obvious reasons, thus killer whale attacks may be more frequent than witnessed. However, we believe that this is not a significant factor in gray whale mortality. More work on stranded animals is needed to ascertain causes of mortality.

Shark predation is unknown to us, but is probably insignificant because of the size of a gray whale (calves excluded, of course) and their coastal migration behavior. Larger sharks generally occur farther offshore than gray whales and are found in more temperate waters than Alaska.

Other causes. -Other causes for natural mortality (e.g., disease) of gray whales are little studied. Gray whales commonly strand along the coast from Mexico to Alaska, although generally this is spotty. Strandings seem to occur regularly in at least three areas (or at least we have noticed them there): (1) offshore to the calving lagoons in Mexico, (2) along the north coast of the Alaska Peninsula, and (3) off St. Lawrence Island. Strandings in Mexico are usually of calves; those animals observed by Braham in the southern Bering Sea appeared mostly to be subadults.

Few observations have been made in the Gulf of Alaska, perhaps because of less study in the area and because of the remoteness of the coastline. Most gray whales studied during strandings are too far decomposed to satisfactorily determine cause of death (Fay 1977; Moore *et* al. 1977). Causes of mortality for four animals (two adults and two immatures) along the coast of Washington State included collision with a boat, fishing net entanglement, and malnutrition (Moore *et* al. 1977). We suspect the greatest cause would be nutritional loss as a result of separation of a calf from its mother, or misdirected orientation of young, first-migrating animals (cf. Wellington and Anderson 1978), with death from killer whales (Fay *et* al. 1979) trailing behind. Mortality, its causes and quantitative estimates of strandings and

their locations, needs much greater study, as does the relative nutritional state of various age and sex classes throughout Alaska, so that an evaluation can be made of differential susceptibility y during the annual life cycle.

-Exploitation.-The eastern North Pacific population was commercially harvested from 1846 to 1946 and was reduced to probably only a few hundred to a few thousand individuals (Rice and Wolman 1971; Reilly 1981). The original population size may have been at or higher than 15,000 (Scammon 1874; Henderson 1972), or as high as 24,000 (Reilly in press). Under international agreement, 179 whales were taken in 1980 by the Soviet government for the Chukchi Eskimos. Alaskan Eskimos are also allowed to take gray whales under this quota; they took two in 1980 (Marquette and Braham 1982). Since 1960, the Soviet Union has averaged an annual reported take of 167, increasing from a low of 10 in 1950 to a high of 207 in 1961 (Zimushko and Ivashin 1980). Since 1950, Alaskan Eskimos have averaged only one gray whale landed per year (Marquette and Braham 1982).

Disturbance

Only one documented case is known of an impact on any portion of the gray whale population from coastal development activities. The event took place from 1957 to 1972 in Laguna Guerrero Negro, Baja California, Mexico, which is one of the four major calving lagoons in Mexico. Beginning in 1957, Mexican salt barges entering and leaving the lagoon mouth and channel dredging inhibited the use of the lagoon and channels by the whales. This was, and is today, one of the three or four major calving lagoons. Over a period of 6 years, the number of gray whales entering the lagoon steadily declined to zero; for 7-8 years no whales returned (Gard 1974). When the dredging ceased (by federal action to protect the whales), the animals gradually returned over a 6-year period to their original numbers.

For an additional overview of this population, including a discussion of biological and industrial development and international cooperative efforts on behalf of the species, see Braham (in press).

Sei Whale (*Balaenoptera borealis*)

The sei whale (pronounced “say”) belongs to the family Balaenopteridae (the rorquals). Two subspecies are recognized: *Balaenoptera borealis borealis*, in the Northern Hemisphere, and *B. b. schlegellii* in the Southern Hemisphere. The sei whale is sometimes referred to as Rudolphi’s rorqual.

ABUNDANCE

Sei whales, like all other large baleen whales, are protected by U.S. law under the Marine Mammal protection Act of 1972 and Endangered Species Act of 1973, and international agreement under the Convention for the Regulation of Whaling (1946). It has been designated

a Protection Stock by the IWC since 1966 in the North Pacific. The entire North Pacific population is estimated at 8,600 (Tillman 1977).

DISTRIBUTION

Winter (January-March)

The distribution of sei whales in the North Pacific during the winter is not well documented. The paucity of sei whale sightings much farther south, along the southern California and Mexico coasts, led Rice (1974) to speculate that they may spend the winter far offshore. Masaki (1976) stated that North Pacific sei whales are found between 20° and 30°N in January and February. Our POP data yielded only one sighting of five animals near the Fairweather Ground during the winter months (Figure 11). We assume that sei whales are very rare in the study area in winter.

Spring (April-June)

Spring is a period of northward migration from the winter resting and reproduction grounds to the summer feeding grounds above 40"N (Masaki 1976). Judging from our data, spring appears also to be the period of greatest relative abundance of sei whales in the Gulf of Alaska. Our data contain 16 (of 18 total for all seasons) sei whales sightings between April and June, distributed throughout the Gulf (Figure 12).

Summer (July-September)

During summer, sei whales are at the northern limit of their range, feeding and preparing for the ensuing southward migration. Using sighting data from Japanese scout vessels, Masaki (1976) depicted the northwestern and northeastern Gulf of Alaska as the areas of greatest sei whale density from May through August. A recent, extensive survey of the Gulf of Alaska (Rice and Wolman 1982) yielded not a single positive sei whale sighting (Figure 13). Sei whales begin their southward migration by late summer.

Autumn {October-December)

By the beginning of autumn, most sei whales depart the study area, moving south (Masaki 1976). Our data show a lone sighting (one animal) north of Chirikof Island (Figure 14).[1]

[1] Even to the experienced eye, it is often difficult to differentiate between fin and sei whales at a distance. Many sightings logged as "either fin or sei" were transcribed as "unidentified whales" and not used in our distribution plots. Because of this verification problem, both sei and fin whale distributions are underrepresented in our data base.

FACTORS INFLUENCING DISTRIBUTION

Feeding and Food Resources

The sei whale has been characterized as a moderately euryphagous animal, preying on a variety of species over its range, yet exhibiting a high degree of prey selectivity within any one area (Klumov 1963). Sei whales are equipped with finer baleen than the other rorquals and can therefore feed on smaller organisms. They may utilize two types of feeding behavior-swallowing and skimming. In the swallowing, or gulping, mode, sei whales capitalize on tightly grouped prey organisms (e.g., squid, macroplankton, fishes). In the skimming mode, they feed on sparsely distributed prey (e.g., smaller plankton) (Nemoto 1959). The sei whale can also be characterized as a surface-oriented animal, having adapted more readily to the uppermost water column than to waters below 50 m (Klumov 1963).

Sei whales feed actively in the Gulf of Alaska. Kawamura (1973) found that 63% of sei whales examined over a 5-year period from Pacific waters north of latitude 40"N contained food in their stomachs, as opposed to less than 40% for animals south of 40°N.

Analyses of prey found in sei whales are available from the Gulf of Alaska (Nemoto and Kasuya 1965), the central North Pacific-Aleutian Islands area (Nemoto 1957), and the southern portion of the North Pacific (Kawamura 1973). Copepods (*Calanus plumchrus*, copepodite Stage V) were the main food item in the eastern North Pacific (Nemoto 1957; Kawamura 1973). In the Gulf of Alaska, C. *plumchrus* occurs from the surface to a depth of 500 m, and is most abundant in the spring (Cooney 1975).

Calanus cristatus is the other species of copepod eaten by sei whales in the North Pacific, mostly in areas well offshore (Nemoto and Kasuya (1965). Surprisingly, euphausiids are not a major prey item. Of sei whale stomachs sampled between 1952 and 1956 in the North Pacific, Nemoto (1957) found 107 (35%) contained only copepods, 12 (2.5%) contained only squid, and each of the following categories comprised less than 1%: euphausiids, copepods and fish, fish, and fish and squid. These findings led Klumov (1963) to state that the distribution of North Pacific sei whales is associated with calanoid copepods and, secondarily, with squid (*Ommatostrephes sloanei pacificus*). Klumov (1963) estimated that an average-sized sei whale requires about **600-800** kg of food per 24 hours.

Rice (1961) described a baleen infection or genetic condition which resulted in the deterioration and loss of the baleen of 8% (3 of 39 animals) of sei whales landed in northern California. Though none of the affected animals had copepods or euphausiids in the stomachs, two stomachs (from otherwise healthy animals) were full of anchovy (*Engraulis mordax*).

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Reproductive activity in sei whales occurs in the winter months, when the animals are in warmer southern waters. Most sei whales in the North Pacific are born around November, and conception occurs around December (Masaki 1976). Sexual maturity is reached at about 7 years of age in both sexes, and body length is about 13 m. Age at sexual maturity is 16 years. Gestation is estimated to take 10-11 months and lactation spans about 11 months. (Masaki 1976).

Mortality

Killer whales are probably the only predators of sei whales. Other causes for natural mortality are undocumented.

Exploitation and Development

The sei whale did not experience heavy commercial exploitation in the North Pacific until 1963 (Omura and Ohsumi 1974). Some 945 animals were caught by Japanese whalers in the Gulf of Alaska alone in 1963 and 1,082 in 1964. Averaging sighting and catch per unit effort results, Tillman (1977) estimated a pre-exploitation (1963) population size of 42,000 for the North Pacific. Comparing current estimates and removals, an 80% population decrease occurred within one decade after exploitation began.

Blue Whale (*Balaenoptera musculus*)

The blue whale is the largest member of the family Balaenopteridae. In the Northern Hemisphere one subspecies is recognized, *Balaenoptera musculus musculus*, and two other subspecies, *B. m. intermedia* and *B. m. brevicauda*, are recognized from the Southern Hemisphere. The other common name for the blue whale is sulphur bottom whale.

ABUNDANCE

The blue whale was classified as a Protected Species (all stocks) by the IWC in 1965.

Ohsumi and Wada (1972) artificially divided the North Pacific population into an Asian stock and an American stock, and estimated the initial (pre-modern whaling) populations at 1,200-1,300 and 3,500-3,600 animals, respectively. The total initial size of the North Pacific population then is estimated to be 4,800 animals. Based on whale marking results, Ohsumi and Wada (1972) believed that the total North Pacific population decreased from 1,400 in 1963 to about 1,000 (± 700) in 1965. They then used a population model to arrive at a 1972 estimate of 1,500. This "increase" (1,000 to 1,500) does not necessarily reflect an actual increase in

individual animals, but probably the technique of estimation. The most recent (1975) North Pacific blue whale population estimate is 1,530 (Wada 1977), based on Japanese sighting data.

DISTRIBUTION

Winter (January-March)

During winter, blue whales are located in subtropical breeding grounds in the North Pacific between Baja California and Taiwan (Berzin and Rovnin 1966; Rice 1978*b*). Neither our data nor the literature can confirm that blue whales are in the study area during winter (Figure 11).

Spring (April-June)

Blue whales begin to arrive in the Gulf of Alaska in late spring. Our data show only two spring sightings in the study area: two individuals, May 1960 at 58"1O'N, 150°37'W on Portlock Bank; and five individuals, June 1960 at 55°50'N, 145°58'W over the Gulf of Alaska Seamount Province (Figure 12).

Summer (July-September)

Most blue whales arrive on the North Pacific feeding grounds by June and July. From pelagic whaling results, two general areas of abundance in or near the study area were (Berzin and Rovnin, 1966; Ohsumi and Wada 1972; Rice 1974): (1) eastern Gulf of Alaska, from 130°W to 140°W, and (2) south of the eastern Aleutian Islands, from 160°W to 180°W.

Our data show only two sightings during summer: one individual, July 1975 at 57°07'N, 152°21 'W on Albatross Bank; and one individual, August 1978 at 55°43'N, 154°54'W near Chirikof Island (Figure 13). No blue whales were observed during an extensive summer survey of the Gulf of Alaska in 1980 (Rice and Wolman 1982). Pike and MacAskie (1969) noted that off British Columbia, blue whales were found singly or in small groups of two or three individuals, occurring well offshore.

Autumn (October-December)

We have no autumn blue whale sightings in our data base (Figure 14). They usually migrate south out of the study area by September (Berzin and Rovnin 1966).

FACTORS INFLUENCING DISTRIBUTION

Feeding and Food Resources

In the North Pacific, blue whales feed almost exclusively on euphausiids (Nemoto 1957, 1970; Klumov 1963; Rice 1978*b*). Examination of their stomachs revealed the following euphausid species: *Euphausia pacifica*, *Thysanoessa inermis*, *T. longipes*, *T. spinifera*, and

Nematoscelis difficilis. Of 971 blue whales taken by Japanese pelagic whalers between 1952 and 1965 in the North Pacific, 455 contained only euphausiids, 5 contained euphausiids and copepods, 1 held shrimp (*Sergestes*), 6 held only copepods, and 504 were empty (Nemoto 1970).

Klumov (1963) cited a 1955 occurrence in which a right whale (*Balaena glacialis*) and a blue whale were killed in the same vicinity in the Sea of Okhotsk on the same day. The right whale's stomach contained only copepods (*Calanus plumchrus*) whereas the blue whale's stomach contained only euphausiids (*Euphausia pacifica*). Klumov interpreted this as confirming his belief that blue whales actively select their prey (euphausiids) and do not compete with the copepod-eating right or sei whales.

Rice (1978*b*) estimated that an average blue whale, weighing some 80 tons, probably consumes about 4 tons of krill daily during the summer months.

Migration

Based on a 1964 Soviet cruise, Berzin and Rovnin (1966) assumed the wintering grounds of blue whales to be from California west to about 160°W. Rice (1978*b*) also noted that some blue whales spend the winter between Taiwan and southwestern Honshu, Japan. According to Berzin and Rovnin (1966), the spring migration northward begins in April and May. The "American stock" moves along the west coast ofNorth America to Vancouver Island, where it splits in two directions. A portion of the population moves north to the Queen Charlotte Islands and northern Gulf of Alaska. The rest of the population moves west toward the Aleutian Islands. Autumn migration begins in September and follows the same spring pattern but in reverse.

Catch data from the North Pacific indicate that blue whale abundance peaks in the eastern Gulf of Alaska in July, and near the eastern Aleutian Islands in June (Rice 1974). Marking studies revealed little apparent movement of blue whales on the feeding grounds. In summarizing Japanese whale marking results, Ohsumi and Masaki (1975a) found that of 14 blue whales marked in the North Pacific, 12 were recaptured in the same areas marked. Two whales marked in the western Gulf of Alaska moved to south of the eastern Aleutian Islands. They concluded that the blue whale migration in northern waters is limited or restricted geographically (or regionally) compared to the other large cetaceans. In summarizing Soviet marking results in the North Pacific, Ivashin and Rovnin (1967) noted that a blue whale marked off Vancouver Island, British Columbia, was killed a year later near the southern end of Kodiak Island. Klumov (1963) believed that individual populations (or stocks) do not mix.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Breeding occurs on the tropical winter grounds and sexual maturity occurs at about 10 years of age (Rice 1978*b*). This corresponds to a size of about 20.5 m in males and 21.5 m in

females (Pike and MacAskie 1969). Females grow longer than males at maturity. Gestation is about a year, with females resting 1-2 years between calves (Rice 1978*b*).

Mortality

Killer whales are probably the only natural predators of blue whales. Given the low population level of the North Pacific blue whale population, predation by killer whales may have a significant effect on population growth. That is, of course, speculative; any mortality of adults, however, will be important if annual gross recruitment is low. Since recovery does not appear to have been great since the end of commercial exploitation, recruitment is probably low.

Exploitation and Development

Some 6,900 blue whales were taken in the North Pacific between 1910 and 1965. Given an initial (pre-modern whaling) North Pacific population of 4,800 animals, a take of at least 6,900 undoubtedly resulted in severe depletion. Although North Pacific blue whales have been protected for 15 years, any increase in the population has not manifested itself in increased sightings in the Gulf of Alaska, an area of former abundance.

Vessel traffic has been documented as a possible cause of death to at least two blue whales. On 6 July 1980 the carcass of a 17-m male blue whale was retrieved from the bow of a ship upon arrival at Los Angeles, California. The young whale apparently was killed by the ship, according to preliminary findings. On 24 October 1980, a 175-m container ship (*Evershine*) bound for Seattle, Washington, from San Francisco, California, struck a 16.2-m blue whale and pushed it into port still pinned to the bow of the ship. While the master of the vessel noticed a significant decrease in speed, the whale was not discovered until the ship docked in Seattle. Whether the animal died as a result of the accident was not determined, but the animal was moderately decomposed when inspected.

Sperm Whale *(Physeter macrocephalus)*

The sperm whale is the largest member of the Odontoceti and belongs to the family Physeteridae. The specific name *catodon* appears in much of the older literature, but *macrocephalus* is now correctly recognized (Rice 1977). Another common name is cachalot.

ABUNDANCE

The International Whaling Commission currently recognizes two stocks of sperm whales in the eastern and western North Pacific (1 980). The boundary between the two stocks roughly follows a line from Amchitka Pass in the western Aleutian Islands (50°N, 180°) southeast to the Hawaiian Islands (20°N, 160°W).

Population estimates of the commercially exploited components range from about 515,000 in 1947 (initial) to approximately 375,ooo in 1978 (Table 3). Only exploitable males (> age 13) and mature females are included. The total North Pacific population, including all age classes, is estimated at 740,000 individuals (Rice 1978*c*).

DISTRIBUTION

Soviet and Japanese catch and effort records show little harvesting of sperm whales in the study area over the past several decades (Ohsumi 1980), indicating this species is not as abundant in the Gulf of Alaska as it is further south. Our relatively few sightings (Figures 11-14) confirm this.

Winter (January-March)

Sperm whales are distributed across the entire North Pacific between the equator and about 40"N during winter (Berzin 1970). We have only one sighting in our data, that in 1979 of a single animal on the Fairweather Ground (Figure 11),

Spring (April-June)

Pike and MacAskie (1969) reported that "maternity schools" appear off the coast of British Columbia in April, May, and early June, and that bachelor schools are present at least throughout spring and summer.

Sperm whales are characteristically located, and hunted, in deeper waters near the continental slope and off the shelf (Smith 1980; Ohsumi 1980). However, 55% (6 of 11) of our spring sightings were where water depths were less than 2,000 m, and most of these in water 200 m deep (Figure 12). If our data are representative of the actual distribution of the species, then they are widely distributed in the study area in spring, especially near the continental slope.

Summer (July-September)

During a 1980 summer survey of the Gulf of Alaska, Rice and Wolman (1982) sighted sperm whales "over deep water beyond the continental shelf on 6 occasions, totalling 37 individuals. " This is characteristic of our database for summer (Figure 13). Summer sightings may indicate that their distribution is shifted farther east in summer than in spring, for an unknown reason.

Autumn (October-December)

Sighting only a few sperm whales in the study area in autumn (Figure 14) is consistent with the report that the whaling season ended near the study area by early autumn, with animals moving south (Pike and MacAskie 1969).

Table 3.–Sperm whale population/stock estimates for the North Pacific in 1947 and 1978 ($x10^3$).

Year of estimate	Sex and age class	Western stock	Eastern stock	Combined
1947	Males (> age 13)	137.7	97.6	235.3
1947	Females (mature)	164.3	116.5	280.8
1978	Males (> age 13)	65.3	67.4	132.7
1978	Females (mature)	132.2	111.4	243.6
% 1978/1947 Males		*47.4%*	*69.1%*	
% 1978/1947 Females		80.5%	95.6%	

FACTORS INFLUENCING DISTRIBUTION

Oceanographic

Adult females and immature sperm whales are found primarily in offshore waters where surface temperatures are greater than 10*C (Nishiwaki 1966; Veinger 1980). Pike and MacAskie (1969) noted that the northern limit of females off British Columbia lies along the 15*C surface isotherm, near 50"N during the summer. Therefore, adult females and immature sperm whales (maternity schools?) are undoubtedly rare visitors to the study area.

Feeding and Food Resources

Sperm whales generally feed from midwater to the ocean floor (Berzin 1959). The preponderance of bottom-dwelling species in sperm whale stomachs, along with the occasional entanglements of sperm whales in submarine cables, led Heezen (1957) to speculate that the lower jaw plows the bottom sediment for food as the whale swims. This has not, of course, been confirmed. They undoubtedly feed in the water column as well.

There appears to be a shift in frequency of prey taken by sperm whales from squid in the northwestern Pacific to fish in the northeastern Pacific. The only pelagic sampling of sperm whale stomachs in the Gulf of Alaska (Okutani and Nemoto 1964) revealed that fish are indeed the predominant food. Okutani and Nemoto (1964) only reported on the squid found in these stomachs. The identity of the fish species taken by sperm whales is extrapolated from whales taken in the Bering Sea, after Berzin (1959). Most frequent in the stomach samples was the smooth lumpsucker *Aptocyclus ventricosus*, with ocean perch (*Sebastodes* sp.) the second most frequent species. In all, eight families of fishes were found in sperm whale stomachs: Agonidae,

Scorpaenidae, Plagyodontidae, Rajidae, Petromyzonidae, Cottidae, Cyclopteridae, and Macruridae. Important squid species found in harvested whales from the Gulf of Alaska and west coast of the United States were *Moroteuthis robustus*, *Gonatopsis borealis*, and *Gonatus magister* (Rice 1963; Okutani and Nemoto 1964).

Migration

The complex social structure of sperm whales plays an important role in migration. Maternal family groups (after Ohsumi 1971), also known as harems, or maternity or mixed schools, are composed of adult females, immature females and males, and adult breeding males (schoolmasters). As the immature males approach sexual activity, they form bachelor schools separate from the family group. Adult males not participating in mating join the bachelor schools or become loners during the breeding season. These animals move farther north in spring and summer to productive feeding grounds in Alaska, whereas most females with young remain farther south, out of the study area.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Both sexes reach sexual maturity at approximately 10 years, but males between 10 and 25 years of age probably do not mate (Ohsumi 1966). One or more older, breeding bulls may mate with the mature females in maternal family groups. Mating occurs from April to August in the temperate waters of the eastern North Pacific (extrapolated from California, after Rice 1968). Gestation and nursing last approximately 15 months and 24 months, respectively (Ohsumi 1966; Best 1968). Sperm whales may live up to 70 years (Ohsumi 1966).

Mortality

Predation.–Due to the sperm whale's deep diving capability and aggressive behavior when attacked, predation by killer whales is probably not a significant mortality factor. One would expect that some form of social control plays a part in stabilizing sperm whale populations, as well as in defense.

Other causes. -Sperm whales are known to strand in large groups outside of the study area. A recent mass stranding in the eastern North Pacific occurred at Florence, Oregon in June 1979. Forty-one sperm whales, nearly all mature, died. The cause of death of these animals is unknown.

Exploitation and Development

Harvesting sperm whales in the North Pacific has been continuous for more than three centuries (Berzin 1970). Post-World War II harvesting increased from less than 500 to 16,357 sperm whales by 1968 (Tillman 1976). The ratios of 1978/1947 males and females (see Population Status) indicates less intense harvesting of the eastern stock. Since 1966, all

whaling for the North Pacific sperm whale has been reduced, averaging about 7,000 animals in the late 1970s (Rice 1978*c*). The 1980/81 catch limit imposed by the International Whaling Commission was 890 males, all to be taken in the western division (IWC 1980).

Right Whale (*Balaena glacialis*)

The right whale belongs to the family Balaenidae, and is one of two species in that group. The second species is the bowhead or Greenland right whale, *Balaena mysticetus*. Subspecies are recognized for the Northern Hemisphere (*Balaena glacialis glacialis*) and the Southern Hemisphere (*B. g. australis*). Other common names are the black right whale and Pacific right whale.

ABUNDANCE

The North Pacific right whale, though protected by international agreement since 1937 and protected under U.S. law by the Marine Mammal Protection Act of 1972 and Endangered Species Act of 1973, hovers on the brink of extinction. Recent estimates indicate that less than 200 animals compose the entire North Pacific population (Wada 1973, 1975). *Balaena glacialis* is the most depleted of all cetaceans in the North Pacific Ocean (Table 4).

DISTRIBUTION

During the nineteenth century, the "Kodiak Ground," which encompassed the entire waters of the Gulf of Alaska from Vancouver Island to the eastern Aleutian Islands, was renowned as one of the best summer areas for hunting right whales (Scammon 1874). This species also occurred in the southern Bering Sea and all across the North Pacific Rim at about 50°N latitude during the summer.

Whaling records indicate that within the study area this species was taken mostly in the shelf waters to the east and south of Kodiak Island, presumably because of higher densities in this area.

Omura *et* al. (1969) and Klumov (1962) reported seeing this species in the southern Bering Sea, Aleutian Islands, and the western Gulf of Alaska from May to August. They noticed an increase in the number of sightings in June and July in the coastal waters of Alaska and near land masses. Pike and MacAskie (1969) noted only three offshore sightings, each of single individuals seen in July or August from 1958 to 1969. Two were from 50°N, 145°W; one from 54°N, 155°W. Thirty-one sightings of right whales were reported by Rice and Fiscus (1968) and Gilmore (1956) off California and Mexico, during 1955-67. A 1980 summer survey of the Gulf of Alaska found no right whales (Rice and Wolman 1982).

The POP data base contains only four sightings, all tentative, of right whales in the Gulf of Alaska, totaling seven animals: (1) one individual in July 1977 at 56°27.5'N, 135°38.4'W, off Cape Ommaney; (2) four individuals on 27 March 1979 at 59°35.8'N,

Table 4.–Rank order status of endangered whales in the North Pacific Ocean based on available information on indices of abundance, recovery from commercial exploitation, and apparent likelihood of recovery.

Species	Relative status[a]	Population size estimates		Present range	Annual harvest	Domain	Data source
		Present	Pre-exploitation				
N.E. Pacific right whale	nearing extinction?	Tens-150	unk.	North Pacific	None	contin. shelf	Wada (1973, 1975)
Humpback whale	very rare	1,200	15.000	Bering Sea, Chukchi Sea, GOA, Hawaii, Mexico, N. Japan	None	coastal	Rice (1978a)
Bowhead whale	very rare	>2,200[b]	20,000± >10,000	Bering, Chukchi, Beaufort, and Ohkotsk seas	17[c]	contin. shelf	Braham *et al.* (1979); Bockstoce and Botkin (1980)[d]; Eberhardt and Breiwick (1980)
Blue whale	very rare	1,600	4,900-6,000	N.E. Pacific south	None	pelagic	Wada (1975, 1977)
Sei whale	uncommon	8,600	40,000-42,000	N. Pacific south	None	pelagic	Ohsumi *et* al. (1971); Tillman (1976)
Fin whale	locally common	14,000-19,000	44,000	N. Pacific, Bering and Chukchi seas	None	contin. shelf	Ohsumi and Wada (1974)
Gray whale	common	15,000-17,000	15,000-24,000	N.E. Pacific, N.W. Pacific, Bering Sea, and Arctic Ocean	180	coastal	Henderson (1972); Rugh and Braham (1979); Reilly *et* al. (1980)
Sperm whale	common	740,000	516,000[e]	N. Pacific Rim south	1,890[f]	pelagic	IWC (1980); Rice (1978c)

[a] Relative to their former, pre-commercial population level.
[b] Bering Sea-Arctic Ocean estimate only; Ohkotsk Sea estimate unknown, but probably is several hundred.
[c] 1981 IWC quota for landed animals; strike quota is approximately 32 anually for quota period 1981-83.
[d] Bockstoce and Botkin (1980).
[e] Exploitable component only,
[f] 1980/81 IWC catch limit, western stock only.

139°55.8'W, in Yakutat Bay; (3) one individual on 20 August 197'9 at 58°52'N, 141°03'W, off Fairweather Ground; and (4) one individual on 16 October 1980 at 58*48 .1'N, 145°00.3'W, approximately 56 km south southwest of Cape St. Elias.

FACTORS INFLUENCING DISTRIBUTION

Feeding and Food Resources

The little available data indicate that Pacific right whales primarily feed on at least three species of copepods (*Calanus plumchrus, C. finmarchicus,* and C. *cristatus*) and on a small quantity of euphausiids (*Euphausia pacifica*) (Klumov 1962; Omura *et* al. 1969).

Right whales are surface feeders and usually do not descend to depths greater than 15-20 m (Klumov 1962). The copepod C. *finmarchicus* occupies the O- to 25-m surface zone, and does not move vertically during the 24-hour cycle.

Interspecific competition with copepod-eating sei whales has been mentioned as a possibly significant limiting factor in the recovery of right whales in the North Pacific (Mitchell 1974). Given the available abundance of food and the present low number of both right and sei whales, this seems highly unlikely.

Migration

Very little is known about seasonal movements of right whales in the Gulf of Alaska. Extrapolating from movements of other large whales and from sparse sighting data, it may be assumed that right whales breed in subtropical and temperate waters during the winter and spring and migrate to the temperate northern waters in spring, staying over the shelf. Gilmore (1956) believes that waters off British Columbia, Washington, Oregon, and California were former wintering grounds of North Pacific right whales.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Right whales mate and calve in winter months in lower latitudes. Sexual maturity of females has been given at a length 15.5 m and for males at 15 m (Omura *et al.* 1969). Gestation is estimated at 1 year and calves are thought to be weaned by the age of 6-7 months. A newborn calf measured 5-6 m in length. Recent work by R. Payne (N.Y. Zoological Society, pers. commun.) indicates that female southern right whales off the coast of Argentina breed once every three years, and have a gross annual recruitment rate (total calves per total population sampled) of approximately 6-7%.

Mortality

Killer whales are probably the only predators of right whales. Given a very small population size such as exists in the North Pacific and the presumed susceptibility to attack by killer whales (right whales are slow swimmers), any predation-related mortality will have a significant effect on the recovery of this population.

Exploitation and Development

Whaling records (Townsend 1935) indicate that approximately 40% of 2,118 right whales harvested in the North Pacific were taken in the Gulf of Alaska. Whaling was so intense in the late 1800s and early 1900s that the right whale population rapidly declined to a level of commercial extinction. One of the reasons the right whale was such an attractive target for whalers is that it was a very slow swimmer, and was prized for its large amount of oil and baleen.

During the 1934-35 whaling season only two right whales were taken off Alaska (Norman and Fraser 1949) The most recent catches included one right whale taken accidentally by Canadian shore whalers near Vancouver Island in 1951 (Pike 1962), and three whales taken by Japan on Albatross Bank near Kodiak Island in 1961 for research under permit by the International Whaling Commission.

A recent case of a right whale washing ashore on Long Island, New York, with deep slashes on the carcass (presumably from the propeller of a large vessel) illustrates that this species may be more vulnerable than some other endangered whales, because of its low population size.

SMALL CETACEANS

Minke Whale (*Balaenoptera acutorostrata*)

The minke whale is the smallest of the rorquals (family Balaenopteridae). Three subspecies are recognized worldwide: *Balaenoptera acutorostrata davidsoni* (Scammon, 1872) in the North Pacific, *B. a. acutorostrata* in the North Atlantic, and *B.* a. *bonaerensis* in the Southern Hemisphere. Other common names associated with the minke whale include little piked whale, sharp-headed firmer whale, lesser rorqual, pike whale, and Davidson's whale.

ABUNDANCE

Minke whales are currently designated as a Sustained Management Stock by the IWC. No North Pacific population estimates are available, though the species may be regarded generally as abundant in the North Pacific and the study area.

DISTRIBUTION

Winter (January-March)

During winter, Rice (1974) reported minke whales from coastal California south to the Islas Revillagigedos, Mexico. Our POP data show only five sightings (all of single animals) during winter: two about 10-20 nmi south of Icy Bay about 10-20 nmi and three near Sitka, in southeast Alaska (Figure 15). A 1979-80 winter bird survey of nearshore waters around Kodiak Island yielded no minke whale sightings (Forsell and Gould 1981).

Spring (April-June) and Summer (July-September)

Beginning in spring, minke whales commonly occur over the continental shelf to inland waters of the Gulf of Alaska. Well over 95% of all minke whales sighted were within the 183-m (100-fathom) contour; most were in shallow coastal waters (Figures 16 and 17). Their appearance in the Gulf is more ubiquitous than the other rorquals, owing in part to their presumed greater abundance than other species. They remain, however, a coastal species in the Gulf seemingly more dispersed in spring than in summer (Figures 16 and 17), where they seem to be concentrated near Kodiak Island, Prince William Sound, and in the northeast Gulf.

According to Rice (1974), minke whales are distributed from Baja California north to the Chukchi Sea, and are most abundant in Alaskan waters in summer. Scattergood (1949) noted that whalers found minke whales abundant at Port Hobron and Akutan Island (eastern Aleutian Islands), but not very common in British Columbia or southeastern Alaskan waters. A 1980 summer survey found minke whales scattered from southeast Alaska to Kodiak Island, mostly near shore (Rice and Wolman 1982). Only 3 sightings out of 33 occurred in the deep waters of the Gulf of Alaska. The master of a U.S. Fish and Wildlife Service vessel has observed minke whales in Viekoda, Uganik, and Uyak bays (Kodiak Island) during the summer months over the past dozen or so years (T. Emerson, pers. commun.). Personnel onboard a NOAA research vessel conducting hydrographic studies in Yakutat Bay observed at least one minke whale continuously over a l-month period. Movements in summer may be limited; movements into (spring) and out (autumn) of the Gulf appear to be represented in our data plots, from scattered sightings (Figures 16-18). However, movements of individual animals cannot be confirmed.

Autumn (October-December)

Minke whales are virtually absent from many parts of the coastal waters of the Gulf during autumn but, again, we have little sighting effort in these areas (Appendix II). We have records of only three sightings since 1958 (Figure 18). In general, minke whales may leave the Gulf by October.

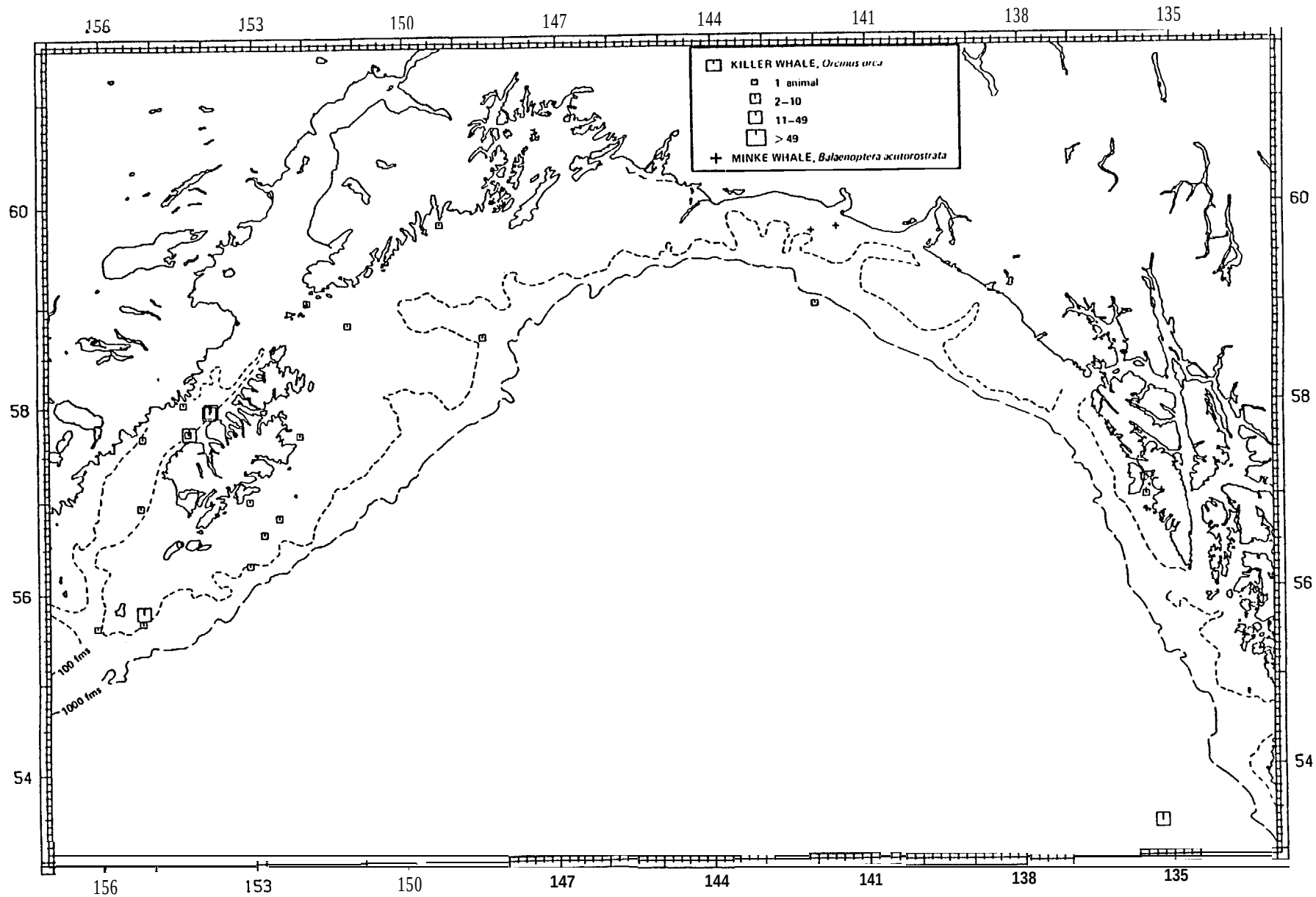

Figure 15.-Minke and killer whale sightings, winter (January-March) 1958-80.

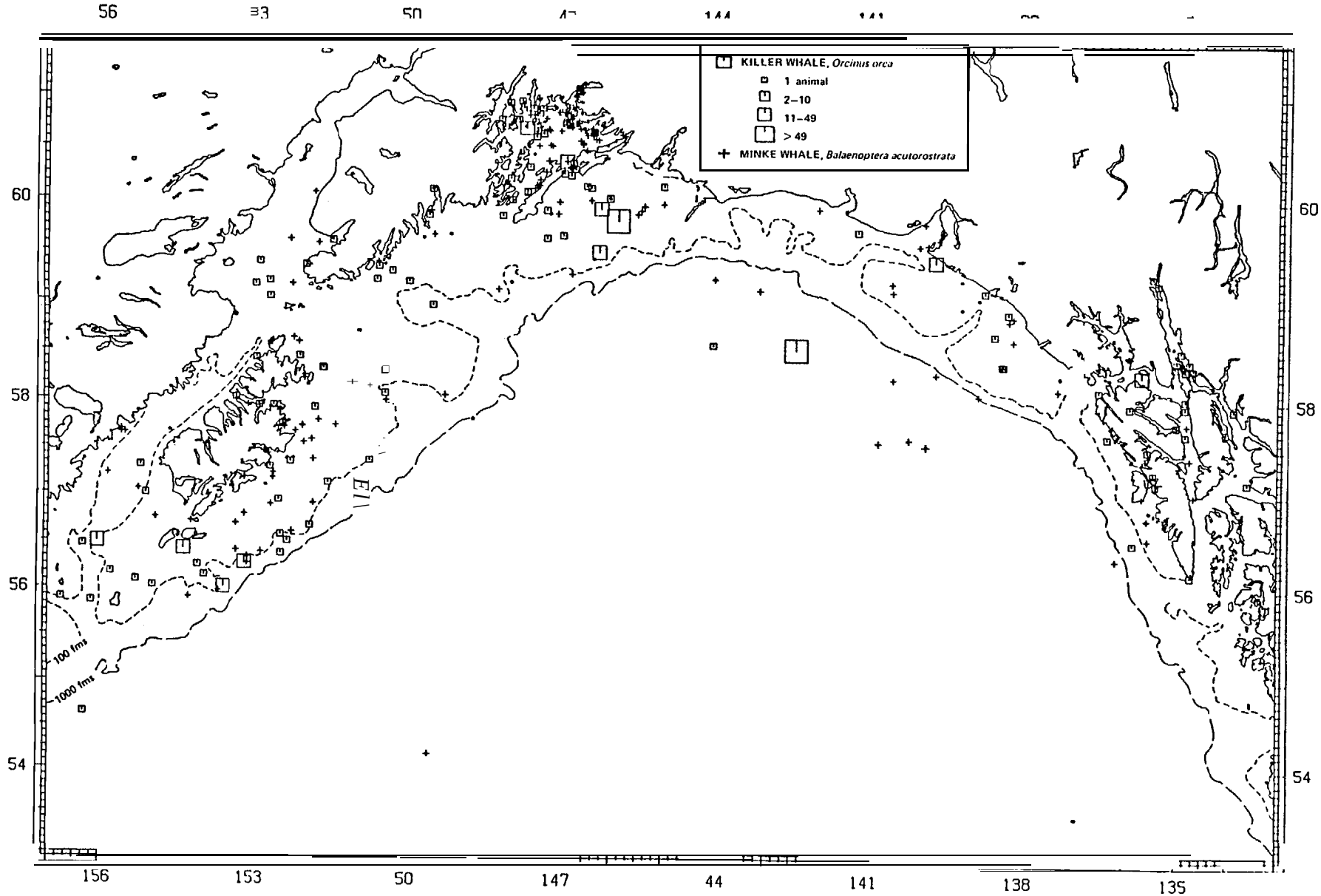

Figure 16.–Minke and killer whale sightings, spring (April-June) 1958-80.

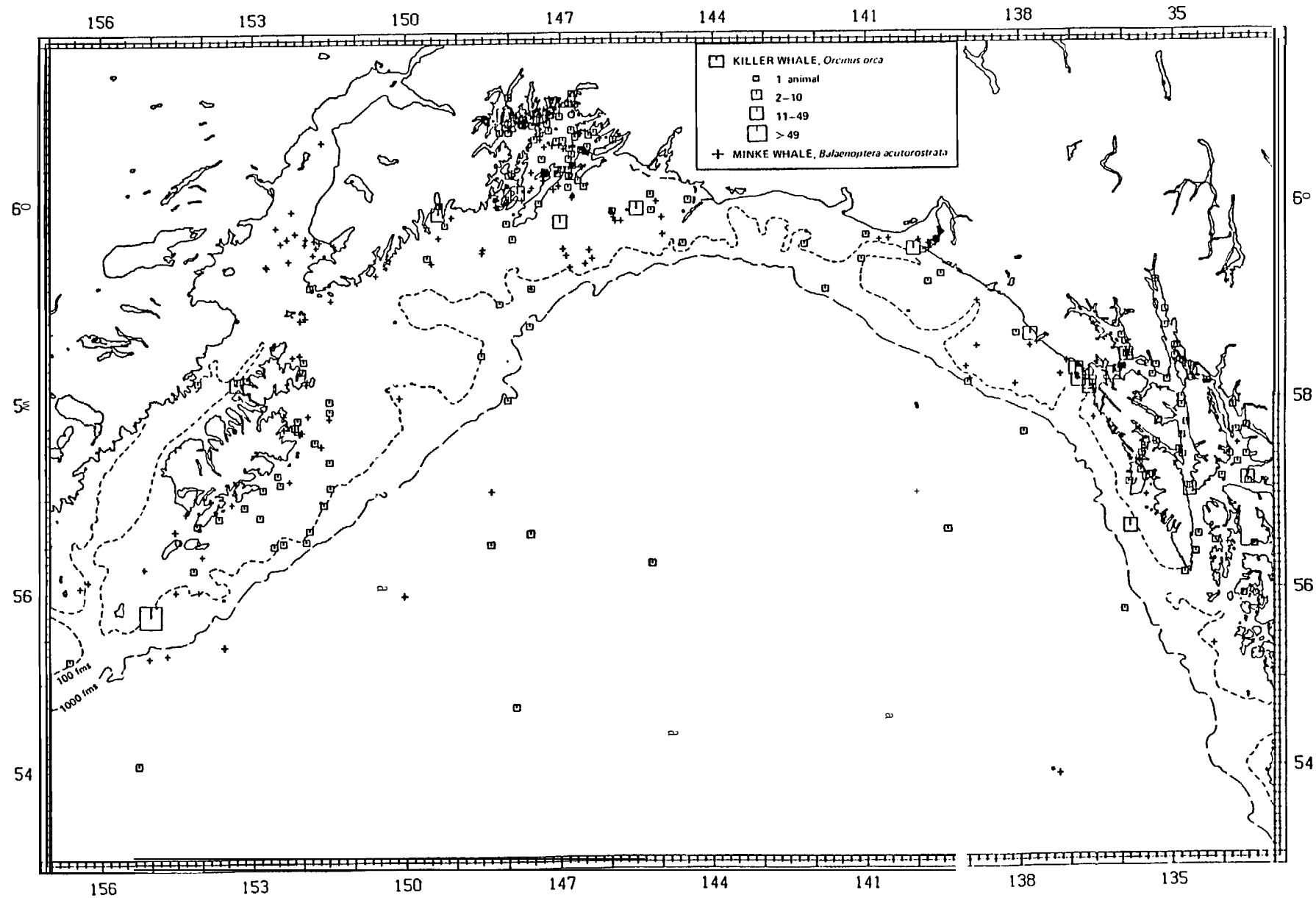

Figure 17.–Minke and killer whale sightings, summer (July-September) 1958-80.

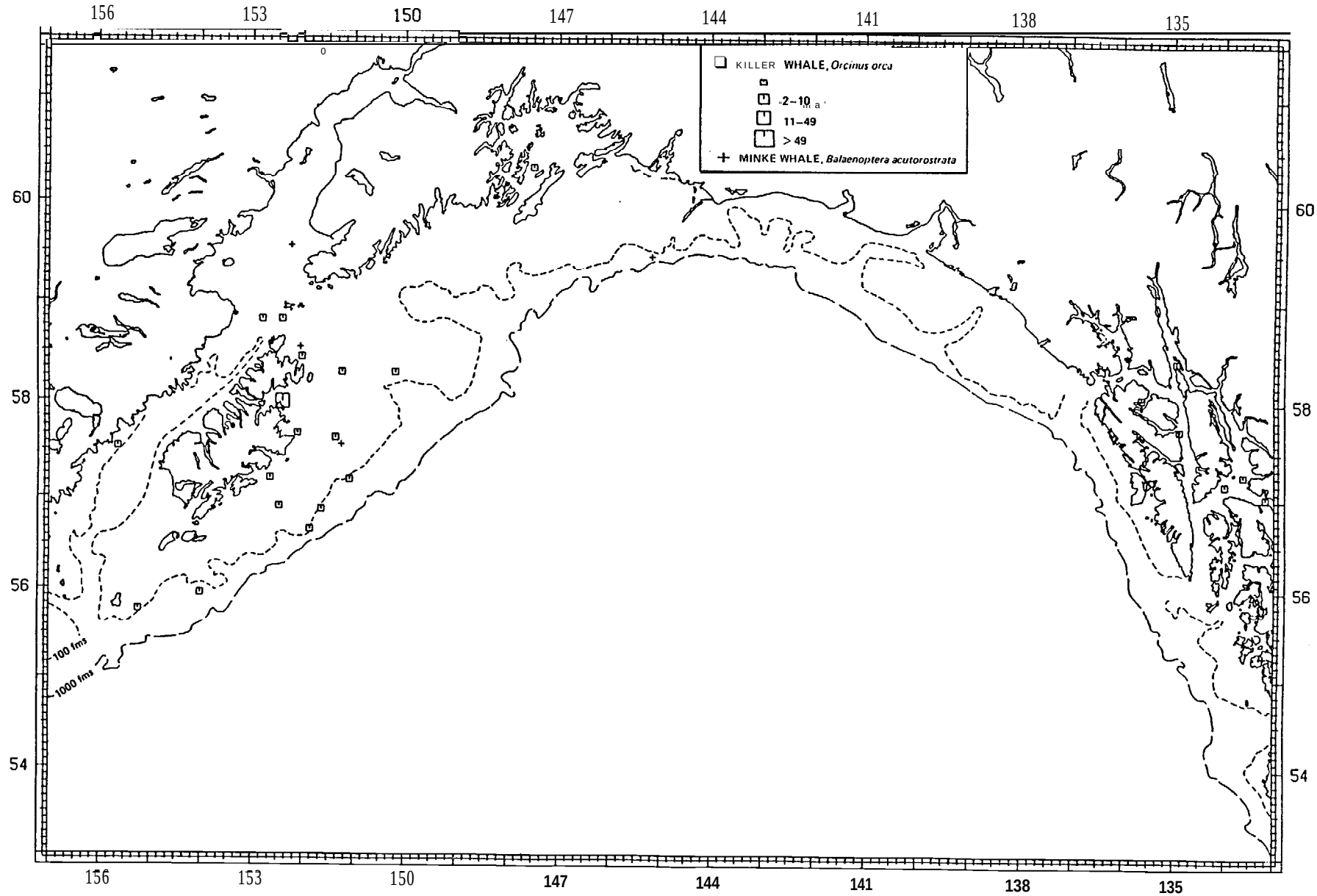

Figure 18.–Minke and killer whale sightings, autumn (October-December) 1958-80.

FACTORS INFLUENCING DISTRIBUTION

Feeding and Food Resources

Minke whales are polyphagous feeders, capitalizing on locally abundant fishes and euphausiids. They utilize the swallowing mode of feeding, as described by Nemoto (1959).

Euphausiids are the preferred prey of minke whales in the North Pacific, followed by swarming fish and copepods (Nemoto 1959). Nemoto further found that minke whales in the coastal waters of the Okhotsk Sea fed mainly on *Euphausia pacifica*, but also sand lance (*Ammodytes personatus*) and Alaska pollock (*Theragra chalcogramma*). In addition, Omura and Sakiura (1956) found cod (*Gadus macrocephalus*), herring (*Clupea harengus*), hake (*Laemonema morsam*), anchovy (*Engraulis japonica*), saury (*Cololabis saira*), and squid in the stomachs of minke whales taken off coastal Japan.

In the western North Atlantic, Sergeant (1963) found capelin (*Mallotus villosus*) to be the dominant food organism; cod, herring, salmon, squid, and shrimp were also eaten.

Migration

Omura and Sakiura (1956) suggested that minke whales migrate northward along the coast of Japan early in the spring, and southward in the autumn. They reported that sexual segregation occurs during migration, with mature animals and a portion of the adolescent population migrating to the northernmost feeding grounds; immature whales, especially males, remain in southern waters. They also stated that minke whales in Japanese waters were never taken in offshore waters beyond 185 km. Our understanding of minke whale migration in the northeast Pacific is very poor.

Dorsey (1982) recognized individual minke whales in Puget Sound, Washington over a 3-year period, tentatively identifying nonoverlapping home ranges, suggesting a seasonal population.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Masaki (1979) calculated that the mean age at sexual maturity among antarctic minke whales dropped from 14 years prior to 1944 to about 6 years presently, and suspected that this change was associated with the overall decline in baleen whale numbers. The implication is that minke whales are reproducing at a younger age and capitalizing on abundant food sources now available because of reduced competition with blue, fin, and sei whales, which are severely reduced in numbers. This same phenomenon, if real, may have occurred in the study area, though it is impossible to document because minke whales have never been harvested (ergo, not sampled) intensively in the eastern North Pacific. Masaki (1979) estimated the mean age of recruitment as 6 years for males and 7 years for antarctic females. The minimum calving

interval for antarctic females is 14 months, the gestation period about 10 months, and the physiological maximum pregnancy rate, 0.86 (IWC 1979; 1981). Reproductive parameter estimates are not available for the North Pacific.

Mortality

One documented case ofa minke whale being pursued and eaten by killer whales in the Gulf of Alaska occurred on 29 April 1976 at 58°22'N, 138°21'W (M. Caunt, pers. commun.). It is not known to what degree minke whale populations are affected by killer whale predation or disease.

Exploitation and Development

Historically, the minke whale has never been harvested intensively in the eastern North Pacific. This fact led Rice (1971) to state that the population was probably at carrying capacity.

Killer Whale (*Orcinus orca*)

The killer whale belongs to the family Delphinidae and is the only the only member of the genus *Orcinus*. Other common names include orca, blackfish (correctly applied to pilot whales), and grampus (correctly applied to Risso's dolphin).

ABUNDANCE

No world or North Pacific population estimates are available. Ford and Ford (1981) reported that 26 pods, comprising 250-300 killer whales, inhabit British Columbia waters. Based on our sighting data, killer whales may be categorized as ubiquitous and perhaps abundant in the Gulf of Alaska.

DISTRIBUTION

Killer whales have been observed in all the major oceans and seas of the world (Leatherwood and Dahlheim 1978), and appear to increase in abundance as one moves shoreward and toward the pole in the colder waters of both hemispheres (Mitchell 1975). In the Pacific Ocean they are more likely associated with subarctic waters than polar or tropical. Killer whales are reported to be seasonal residents from the high Arctic and northwestern Alaska (Bailey and Hendee 1926; Cook 1926; Bee and Hall 1956; C. Fiscus observation 92 km north of Point Barrow); the western Chukchi Sea (Sleptsov 1961a) and Bering Strait (Nikulin 1946); the eastern Aleutian Islands, especially near Unalaska Island (Murie 1959; Kawamura 1975; Braham *et al.* 1977); the North Pacific Ocean (Scammon 1874; Ohsumi *et* al. 1976); and near Kodiak Island and in Prince William Sound (Pitcher 1975; Fiscus *et al.* 1976; Hall and Tillman 1977). Braham and Dahlheim (1982) reported that some killer whales are probably year-round residents, frequenting nearshore waters in the study area more than elsewhere in Alaska.

Autumn (October-December) and Winter (January-March)

Killer whales were numerous around Kodiak Island and adjacent shelf waters in autumn and winter, but not elsewhere in the Gulf of Alaska (Figures 15 and 18). Waters near Kodiak Island appear to contain habitat suitable for killer whales at virtually any time of the year. Forsell and Gould (1981) reported three sightings (10, 10, and 20 animals) from nearshore Kodiak waters in February 1980.

Spring (April-June) and Summer (July-September)

In spring, killer whales are distributed throughout the Gulf, but essentially only over the continental shelf in waterless than 183 m (100 fathoms) deep (Figure 16). In summer, they seem to concentrate south and east of Kodiak, over Portlock Bank, in Prince William Sound, in inland waters of southeast Alaska, and to a lesser degree are seen in waters more than 100 nmi offshore (Figure 17). This latter occurrence is perhaps a reflection of some animals on migration south. Group size is larger in summer and spring (20% single animals) than in fall or winter (35% single animals), with group size varying from 1 to 100 except for one group estimated to be of 500 killer whales observed off Middleton Island (59°48'N, 145°53'W) on 29 April 1972 (Jim Branson, pers. commun.). This "group" actually occurred over several square miles.

FACTORS INFLUENCING DISTRIBUTION

Feeding and Food Resources

The distribution and movements of killer whales are in part related to availability of prey (Mitchell 1975; Dahlheim 1981). Inshore migration of finfish, such as salmon (*Oncorhynchus spp.*) and other shoaling fishes, are common killer whale prey in southeast Alaska, Prince William Sound, and along the north side of the eastern Aleutian Islands and Alaska Peninsula (Sleptsov 1961*b*; Rice 1968; Hall 1981).

The relative occurrence and density of other marine mammals that are potential prey for killer whales change from southeastern Alaska to northern Alaska. Predation on gray whales and walruses (*Odobenus rosmarus*) (Nikulin 1941; Fay *et al.* 1979) maybe common in the Bering, Chukchi, and Beaufort seas. White whales (*Delphinapterus leucas*) and bowhead whales (Scammon 1872; Cook 1926; C. Oozeva, pers. commun.) may occasionally be taken by killer whales; however, the level of predation on these two species is unknown.

Northern and California sea lions (*Eumetopias jubatus* and *Zalophus Californian us*), elephant seals (*Mirounga angustirostris*), minke whales, Dan porpoises (*Phocoenoides dalli*), and harbor porpoises (*Phocoena phocoena*) *are* commonly taken by killer whales near the Aleutian Islands, in the Gulf of Alaska, and generally in the eastern North Pacific (Nishiwaki and Handa 1958; Rice 1968; Barr and Barr 1972). Sleptsov (1961*c*) stated that killer whales in the western North Pacific switch to marine mammal prey species in summer when fish are less abundant or not available, and in winter months when fish descend to deep water. Hall

(1981) observed similar prey selection by killer whales in Prince William Sound. Sleptsov (1961*c*) and Hall (1981) also reported that when fish are abundant, killer whales appear to exclude marine mammals from their diet. Dan porpoises and northern sea lions frequently have been seen near and on occasion directly interacting with killer whales without direct aggression by the killer whales (pers. ohs.). Over several years of observation in Puget Sound, Balcomb *et al.* (1980) observed only one incident of killer whale predation on other marine mammals, this on a harbor porpoise. Killer whales exhibit a high degree of group hunting, particularly when feeding on marine mammals.

Movements of killer whales in the North Atlantic are reported to be related to the migrations of rorquals, seals, and herring (*Clupea* spp.) (Sergeant and Fisher 1957; Jonsgård and Lyshoel 1970). In inland waters of the northeast Pacific their movements are reported to be related to the movements of fishes, such as salmon (Balcomb *et al.* 1980), particularly in summer and autumn.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Nishiwaki and Handa (1958) believed that in the western North Pacific the peak of breeding for killer whales is between May and July, with a gestation period is 12-16 months. In Puget Sound, Balcomb *et al. (1980)* reported that newborns are seen during spring, summer, and autumn, and that a definite calving period had not yet been determined. Body lengths of 4.9 m for females and 6.7 m for males are given as measurements at sexual maturity (Jonsgård and Lyshoel 1970). The calving interval and age at sexual maturity remain uncertain, although Balcomb *et al. (1980)* reported that in Puget Sound the calving interval for adult females was 3-4 years, and the overall birth rate, 0.125. A differential fecundity rate was noted by Balcomb *et al. (1980),* with two females in a Puget Sound pod producing most of the calves over several years.

Mortality

The killer whale is not known to have any natural enemies, and mortality related to parasites or intraspecific aggression is undocumented. Strandings of this species are infrequent.

Exploitation and Development

Other than occasional catches by Japanese coastal whalers and infrequent live-catches for aquaria (now banned by law), there is no documented human-related mortality in the North Pacific. Killer whales have been taken on a sustained basis, with little or no data to show the effect of the harvest, by a directed Norwegian take off the coast of Norway. Soviet whalers took 906 killer whales in Antarctic waters in 1979-80. There is now an IWC moratorium on the taking of *Orcinus* in Antarctica.

Dan Porpoise (*Phocoenoides dalli*)

The Dan porpoise belongs to the family Delphinidae. It is one of the true porpoises and the only member of its genus. Other common names include Dan's porpoise and True's porpoise. True's may, however, be a separate subspecies, *Phocoenoides dalli truei*.

ABUNDANCE

Dan porpoises are protected under U.S. law by the Marine Mammal Protection Act of 1972. Bouchet (1981), using sighting data, estimated a North Pacific population (not including California, Oregon, and Washington coastal waters) of 837,460 to 1,342,518 animals and the Gulf of Alaska population at 136,671 to 253,865. His density estimates in the Gulf of Alaska range from 0.277 to 0.514 animals/nmi^2.

DISTRIBUTION

Dan porpoises are distributed from Baja California along the west coast of North America, across the North Pacific Ocean to the coastal waters of Japan. The northern limit of the species reported by Nishiwaki (1967) is Cape Navarin (62°N) in the Bering Sea. More recently, Dan porpoises were observed by U.S. observers as far north as 66"N (NMML unpubl. data), though few sightings occur north of 61°N.

Alaska is a region in which Dan porpoises have been reported to be abundant. Pike and MacAskie (1969) stated that the largest number of Dan porpoises occurs in regions over the continental shelf in the northern Gulf of Alaska between Kodiak Island and Icy Strait.

Autumn (October-December) and Winter (January-March)

Dan porpoises are present throughout the Gulf of Alaska during these periods (Figures 19 and 22). Their habit of approaching vessels and their conspicuous "roostertail" (spray thrown as a result of vigorous swimming activity) make these small cetaceans highly visible, "even during poor observing conditions. The distribution of Dan porpoises does not appear to be correlated with the bathymetry of the Gulf during these periods. Most sightings during autumn and winter were of groups of 2-20 animals.

Spring (April-June) and Summer (July-September)

As during autumn and winter, Dan porpoises are ubiquitous in the Gulf of Alaska during the spring and summer (Figures 20 and 21). There are very few sightings of single animals; most are of groups of 2-20 animals. Sightings of larger (>20 animals) groups during this period occurred almost exclusively over the shelf and slope throughout the Gulf.

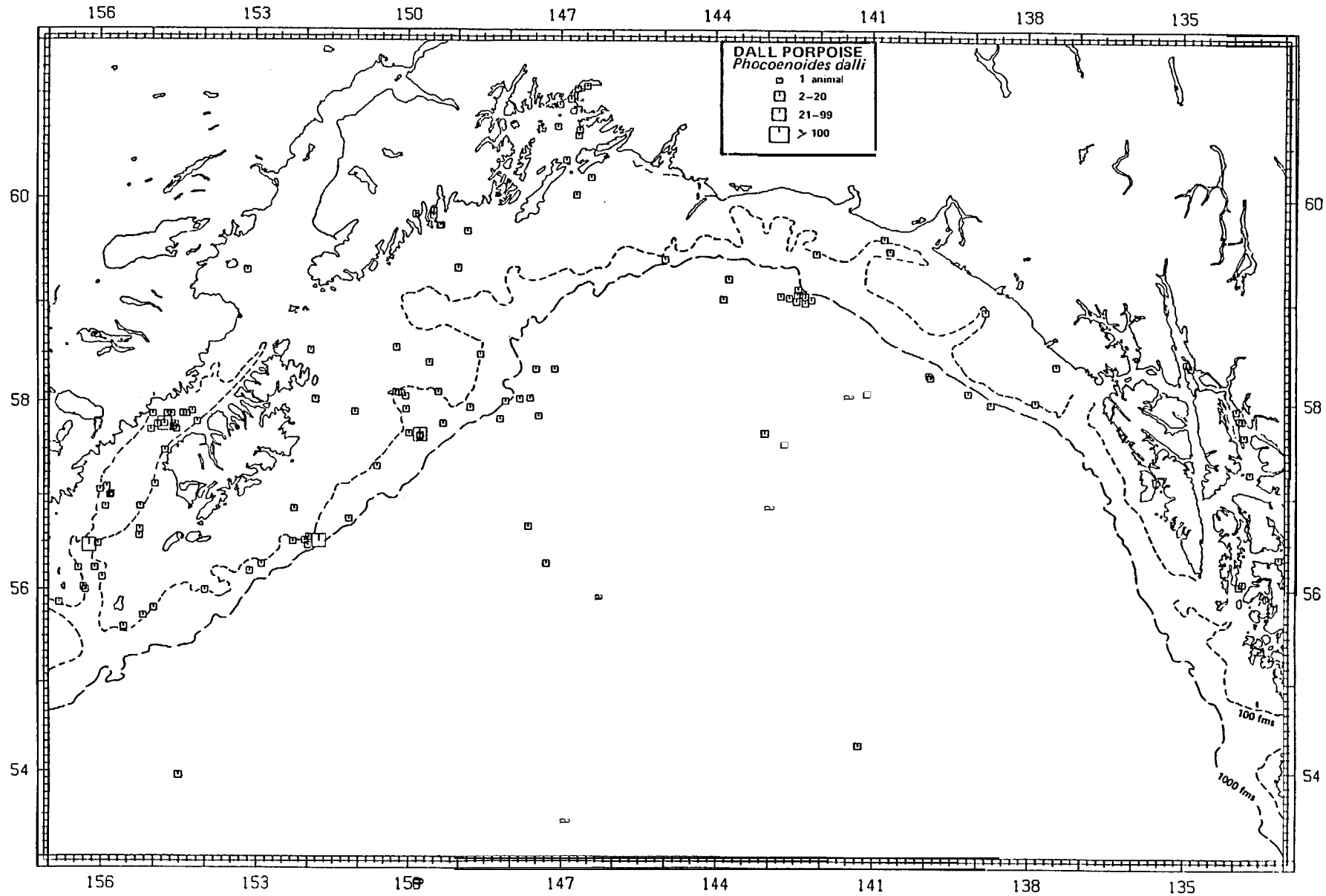

Figure 19.–Dall porpoise sightings, winter (January-March) 1958-80.

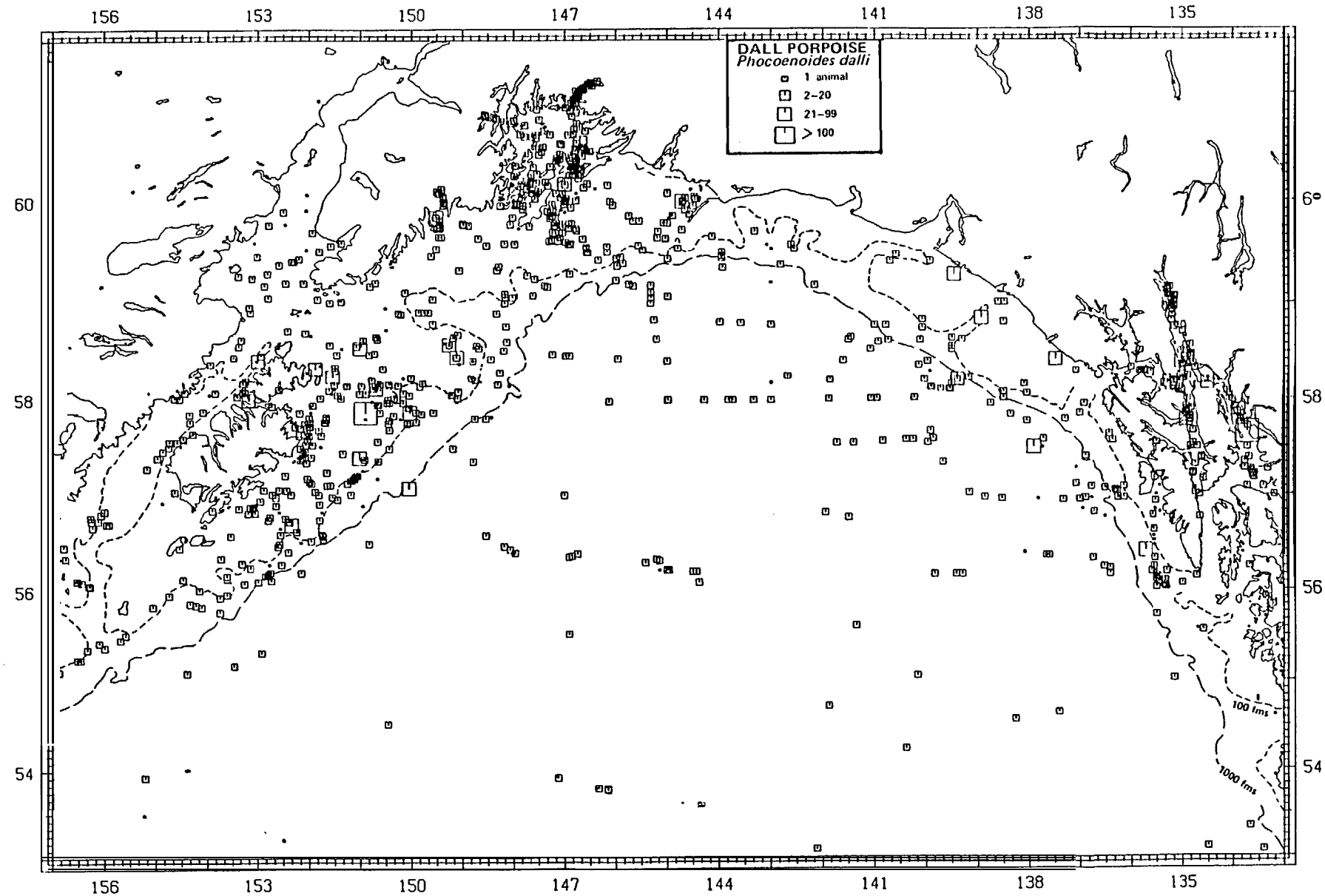

Figure 20.–Dall porpoise sightings, spring (April-June) 1958-80.

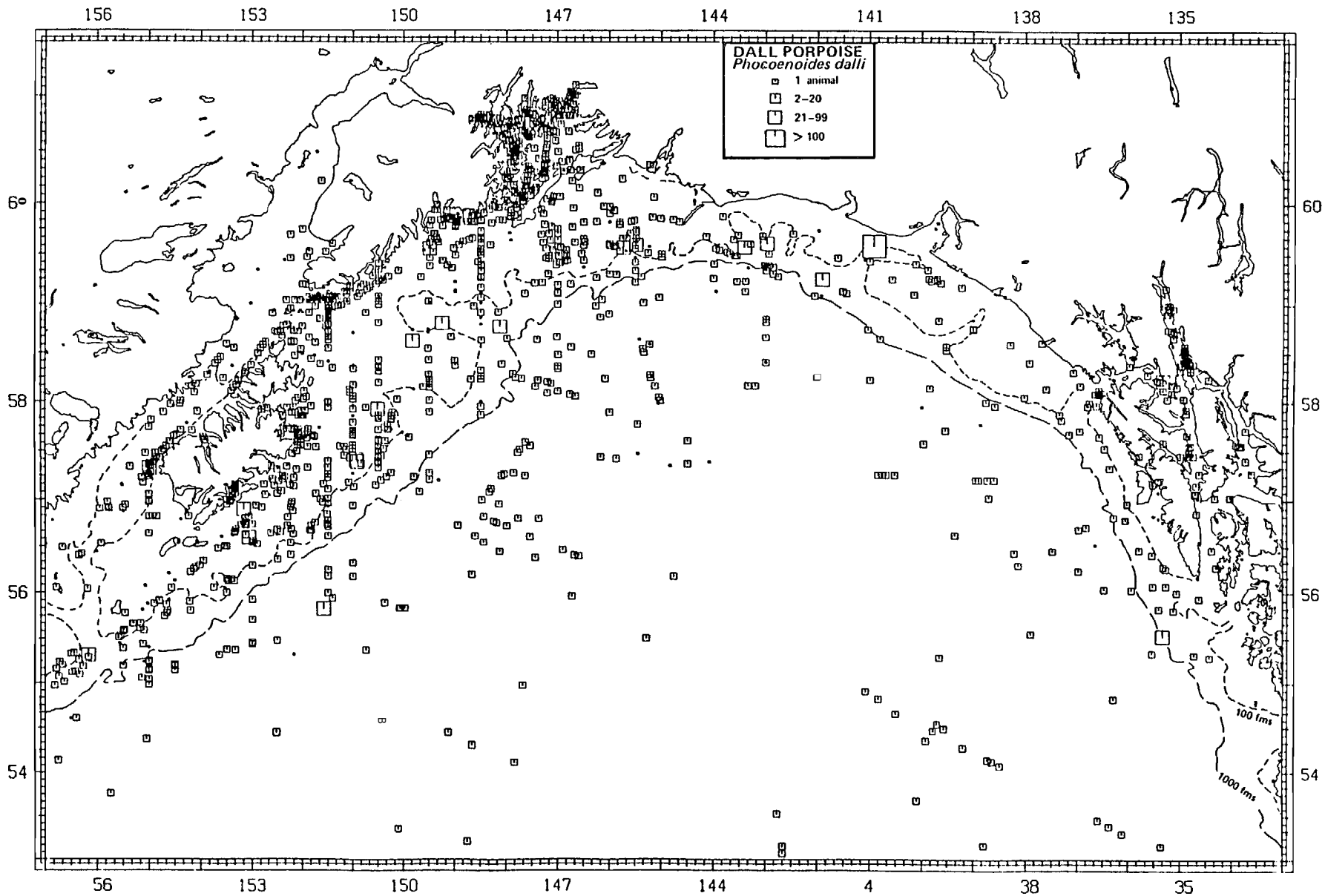

Figure 21.–Dall porpoise sightings, summer (July-September) 1958-80.

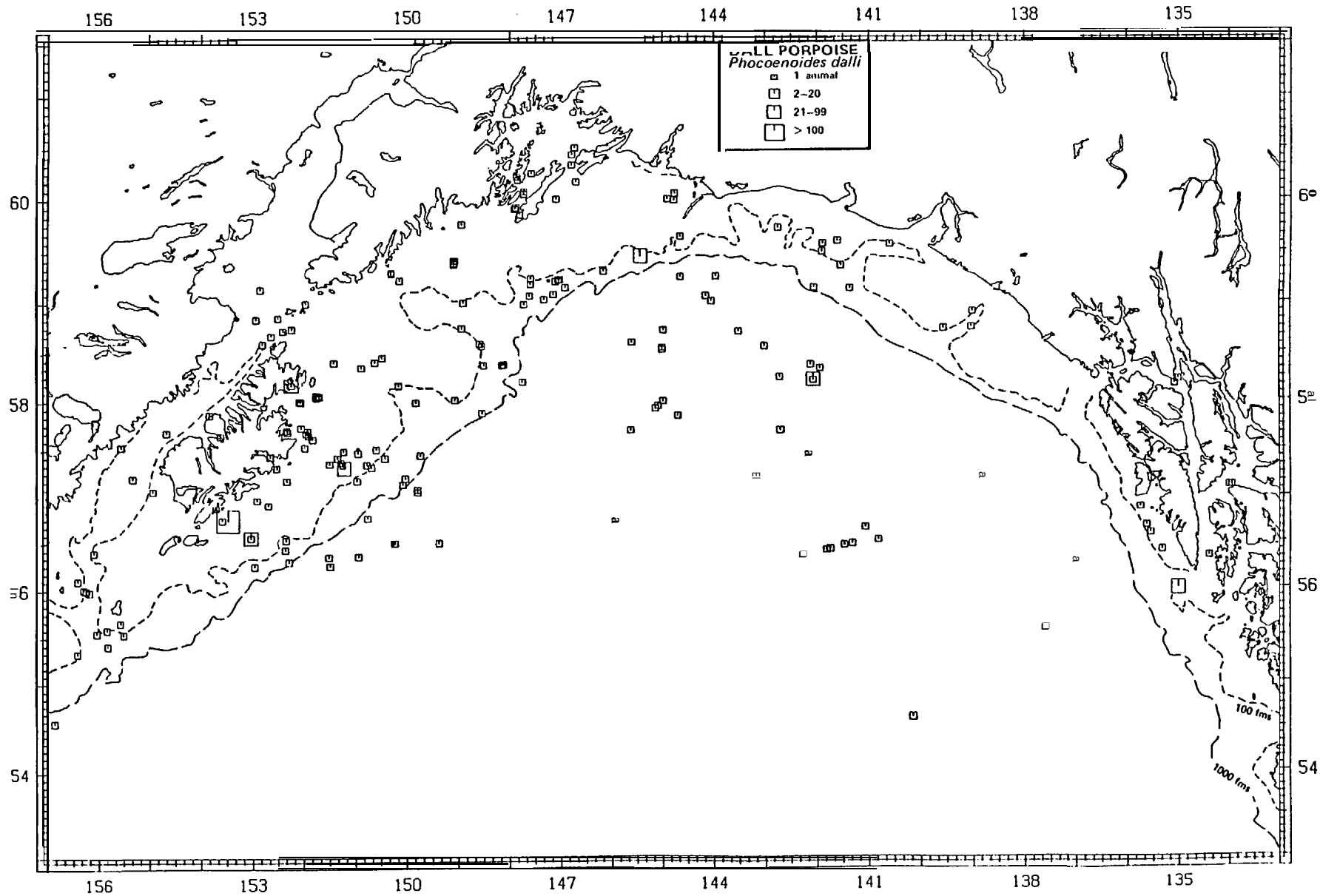

Figure 22.–Dall porpoise sightings, autumn (October-December) 1958-80.

FACTORSI INFLUENCING DISTRIBUTION

Oceanographic

Scheffer (1949), from 72 observations totaling 350 individuals, reported that Dan porpoises tend to occur in wide straits and in areas where ocean currents merge. Cowan (1944) noted that the species tends to occur in channels between islands in Alaska. Hall (1979), working in Prince William Sound, observed that Dan porpoises were only rarely seen in water less than 10 fathoms deep. Our data (Figures 19-22) show that Dan porpoise are abundant throughout the Gulf of Alaska, over the continental shelf as well as offshore. The exceptions are shallow turbid areas such as upper Cook Inlet and Icy Bay.

Feeding and Food Resources

Data on the feeding habits of Dall porpoises in the study area are sparse. Scheffer (1949) found only capelin (*Mallotus villosus*) in the stomachs of two females taken during the summer in the Gulf of Alaska. He also reported hake (*Merluccius productus*), squid (*Loligo opalescens*), and a single horse mackerel (*Trachurus symmetricus*) from the stomachs of Dall porpoises taken off Oregon and northern California. Fiscus and Niggol (1965) found only squid (no species given) remains in stomachs from animals taken off California. In analyzing the stomach contents of 25 animals taken in Monterey Bay, California, Loeb (1972) found that hake and squid (L. *opalescens*) were the most frequent food items taken year-round, with herring (*Clupea harengus*), juvenile rockfish (*Sebastes* sp.), anchovy (*Engraulis mordax*), and squid (*Gonatus* sp.) also being preferred prey species. In the coastal waters of Japan, Wilke *et* al. (1953) found two species of squid (*Ommastrephes sloani pacific us* and *Watasenia scintillans*), lantern fish (myctophids), and a deep water gadid, *Laemonema morosum*, in Dan porpoises. Extensive sampling of stomachs from Dan porpoises taken incidentally in the Japanese high seas salmon gillnet fishery (50°N, 170°E) indicates that myctophids (primarily *Protomyctophum thompsoni*) were the most abundant food species for this area, with squid (*Gonatus* sp.) also being taken (Crawford 1981).

Migration

Kasuya (1976) found evidence that Dan porpoises may migrate northward in summer and southward in winter along the coast of Japan. On the other side of the Pacific, Leatherwood and Fielding (1974) describe seasonal onshore-offshore movements of Dan porpoises off southern California. Farther north, in Monterey Bay, Loeb (1972) found Dan porpoises present every month of the year. Fiscus and Niggol (1965) reported sighting Dan porpoises from the California, Oregon, and Washington coasts, between the 100-fathom contour and 75 miles seaward during winter months. Pike and MacAskie (1969) stated that Dan porpoises have been recorded from Ocean Station Vessel Papa (50°N, 145*W) for every season. Hall (1979) found that the Dan porpoise population in Prince William Sound declined from summer to fall and was "clearly lower" in spring and winter. Thus, the literature indicates that Dan porpoises are present year-round throughout the eastern North Pacific and that local migration may occur along the coast, and seasonal onshore-offshore movement occurs. There

is no evidence of any long migration in the study area. As seen from our data, Dan porpoises are found during every season in the study area (Figures 19-22).

Dan porpoises usually travel in small schools of 2-10 animals, Modal group size is four. Larger groups of up to 226 Dan porpoises have been reliably recorded from the Gulf of Alaska, and in 1980 a group of approximately 3,000 animals was recorded in southeast Alaska, but such large groups are exceptional.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

A study of the literature as well as studies of fetuses, neonates, small juveniles, and adults indicated to Morejohn (1979) that Dan porpoises probably breed and calve year-round in northeastern Pacific waters from Alaska to southern California. In Prince William Sound, Hall (1979) reports sighting Dan porpoises with calves only during spring and late summer. In the western Pacific, Kasuya (1978) reported parturition from August to September. Examination of the reproductive status of Dan porpoises taken in the Japanese high seas salmon gillnet fishery indicates that breeding and parturition occur from June to August in this area (50°N, 170°E) (Newby 1982). Females breed annually in this area. Males are sexually mature at 5.7 years (183 cm), females at 3.3 years (171 cm). Neonates weigh about 16.5 kg and are 95 cm long. Weaning is thought to occur at 1 to 2 months. The birth ratio of males to females is 1:1, and there is no significant difference in length or age between males and females. Dan porpoises may live up to 24 years. However, current aging techniques (dentine or cementum of teeth) requires further study. As these figures are based on samples from a harvested population from the central North Pacific near the Aleutian Islands, some of the estimates (*i.e.* age at sexual maturity and calving interval) may not be representative for animals in the study area.

Mortality

Killer whales are natural predators of Dan porpoises (Barr and Barr 1972; Balcomb and Goebel 1976). Parasites were found in the livers (*Campula oblonga*, a fluke), lungs (*Halocercus dalli*, a nematode), and mammary glands (*Crassicauda* sp., a nematode) of Dan porpoises taken in the Japanese high seas salmon gillnet fishery in sufficient numbers as to possibly debilitate the porpoise and thereby reduce herd productivity and possibly predispose the affected animal(s) to other environmental trauma (Conlogue *et al.*, in press). Except for occasional entanglement in fishing gear (NMFS 1979), the Dan porpoise population in the Gulf of Alaska is apparently not affected directly by man, assuming Dan porpoises in the Gulf are not part of the population or stock taken incidentally by the Japanese high seas gillnet fishery. Information on incidental mortality from fishing operations in the study area is limited to Matkin and Fay's (1980) report of 41 Dan porpoises taken in a Prince William Sound gillnet fishery during the 1978 season. In the western North Pacific, the Japanese high seas and land-based salmon gillnet fishery entangled (and killed) an average estimate of 3,220 Dan porpoises annually from 1955 to 1975 (NMFS 1980). Given the abundance of this animal, it is unlikely

that incidental take in the salmon gillnet fishery area significantly affects the Gulf of Alaska population, if a separate population. This requires further study.

Pacific White-Sided Dolphin (*Lagenorhynchus obliquidens*)

The Pacific white-sided dolphin belongs to the family Delphinidae and is one of six members of the genus *Lagenorhynchus*. Other common names include hookfin dolphin and, much less often, the Pacific striped dolphin or porpoise (more appropriately applied to *Stenella coeruleoalba*). It is nicknamed "lag."

ABUNDANCE

Nishiwaki (1972) reported a population of 30,000-50,000 animals near Japan alone. Fox (1977) estimated about 24,000 white-sided dolphins inhabit a 1,535,870 km' area off southern California and Baja California. No population estimates are available for the Gulf of Alaska, though the species may be regarded as seasonally abundant.

DISTRIBUTION

Pacific white-sided dolphins range from Baja California to the Aleutian Islands in the eastern North Pacific as well as off the coast of Japan in the western North Pacific (Nishiwaki 1972; Leatherwood and Reeves 1978). Recent sightings in the central North Pacific indicate that this species may occur at least seasonally across the entire North Pacific crescent (NMFS unpubl. data).

Scheffer (1950), in discussing the distribution of Pacific white-sided dolphins on the coast of North America, reported skeletal remains of single animals from Valdez, Montague Strait (Prince William Sound), and Sitka, but no sightings of live animals in Alaska waters. He concluded that the white-sided dolphin was uncommon in subarctic waters. Pike and MacAskie (1969) relate that research vessels operating in the northern Gulf of Alaska never reported observing white-sided dolphins, and reported only one sighting (5O animals) above latitude 52*N (June 15, 1961; at 55°00'N, 134°36'W). Our data indicate that this species occurs seasonally in the Gulf of Alaska.

Winter (January-March)

Our data base contains only six sightings during winter (Figure 23): east of Chirikof Island (55 °45'N, 155°20'W) in the southwest portion of the study area, and over Fairweather Ground in the eastern Gulf. Two of the Chirikof Island groups were of approximately 100 and 800 animals. We were unable to find any previous published records of this species' occurrence in the Gulf of Alaska during winter. Our data indicate that Pacific white-sided dolphins are present during winter; however, the paucity of sightings suggests to us that they are rare during this time of year.

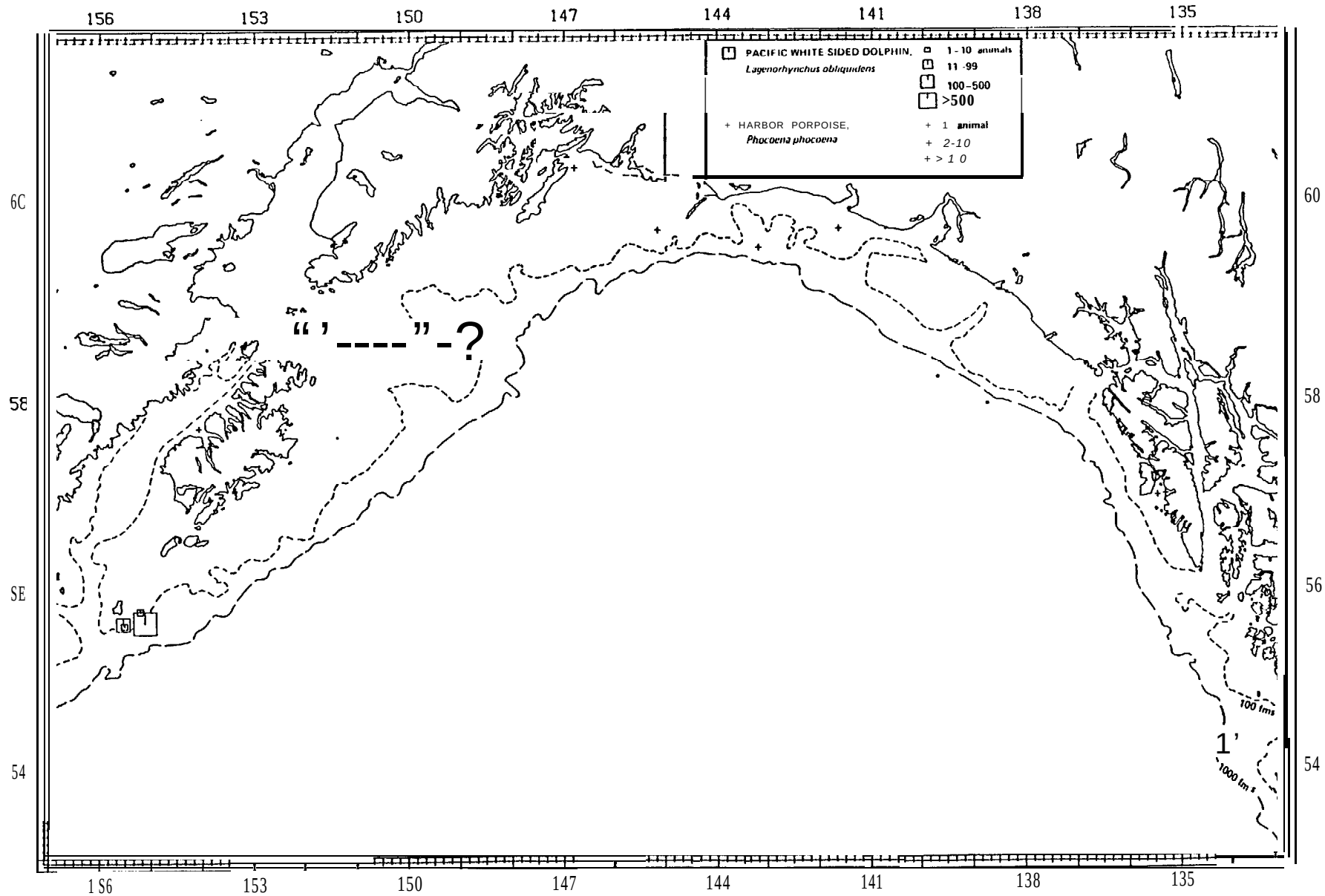

Figure 23.-Pacific white-sided dolphin and harbor porpoise sightings, winter (January-March) 1958-80.

Spring (April-June)

With the exception of one spring sighting over Portlock Bank (57°57'N, 150°33'W), all sightings were in the eastern Gulf of Alaska (Figure 24). Seven groups of more than 100 animals were seen; one consisted of approximately 2,000–the largest group on record in the eastern North Pacific above 40°N.

Summer (July-August)

During summer, Pacific white-sided dolphins appear to concentrate over the Fairweather Ground and Portlock Bank (Figure 25). Maximum group size was 1,000 individuals; 11 other groups consisted of 100 or more individuals.

Autumn (October-December)

Pacific white-sided dolphins are found in both the northeast and northwest Gulf of Alaska during autumn (Figure 26). Of 13 groups observed, only one comprised more than 100 animals. This group of 140 dolphins was sighted near Middleton Island on 18 October 1980 at 59°14'N, 147°02'W, and was accompanied by Dan porpoises. Hall and Tillman (1977) reported 500 white-sided dolphins sighted in October just outside Montague Strait, Prince William Sound.

FACTORS INFLUENCING DISTRIBUTION

Oceanographic

Our data (Figures 23-26) indicate that Pacific white-sided dolphins in the Gulf of Alaska are associated with the continental slope. Throughout the year, the great majority of sightings occurred near the 100-fathom isobath, most often between the 100- and 1,000-fathom isobaths. Very few sightings were made over depths greater than 1,000 fathoms.

Feeding and Food Resources

Available data indicate that Pacific white-sided dolphins are opportunistic feeders, eating a variety of fish species as well as squid. Houck (1961) reported that a stranded young white-sided dolphin from northern California had a stomach full of sauries (*Cololabis saira*), and one jack mackerel (*Trachurus symmetricus*) *33* cm long wedged in its esophagus. Prey species from 33 white-sided dolphins collected by Kajimura *et* al. (1981) off California 1-130 km seaward of the continental shelf included northern anchovy (*Engraulis mordax*), hake (*Merluccius products),* saury, and several species of squid (*Loligo opalescent, Gonatus* sp., *Gonatopsis borealis,* and *Onychoteuthis borealijaponicus*). Wilke *et al. (1* 953) reported that lantern fish (Myctophidae) and squid (probably *Watasenia scinteillans*) were major prey items, with anchovy (*Engraulis japonica*) and mackerel (*Scomber japonicus*) also present in white-sided dolphins taken from waters off Japan.

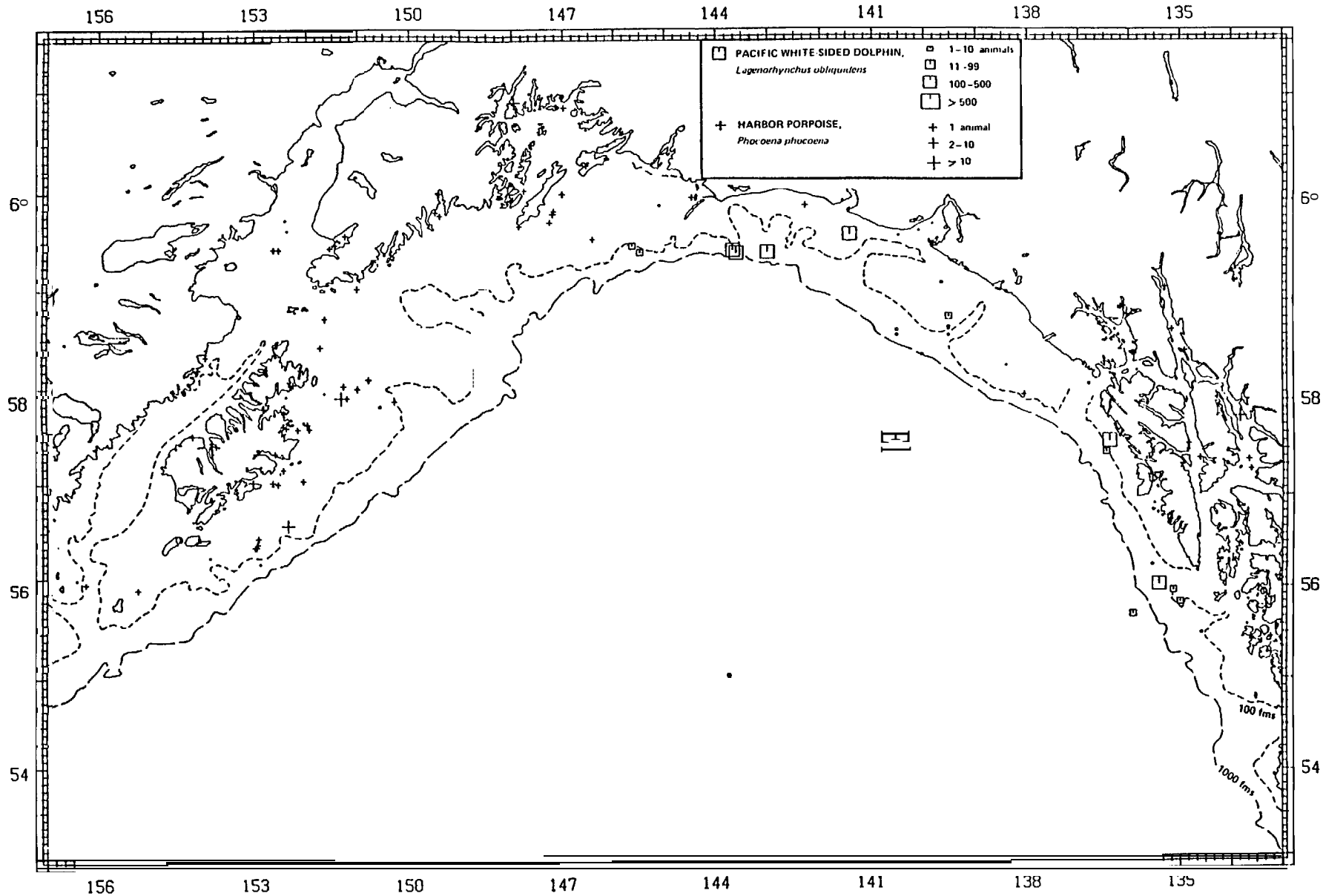

Figure 24.–Pacific white-sided dolphin and harbor porpoise sightings, spring (April-June) 1958-80.

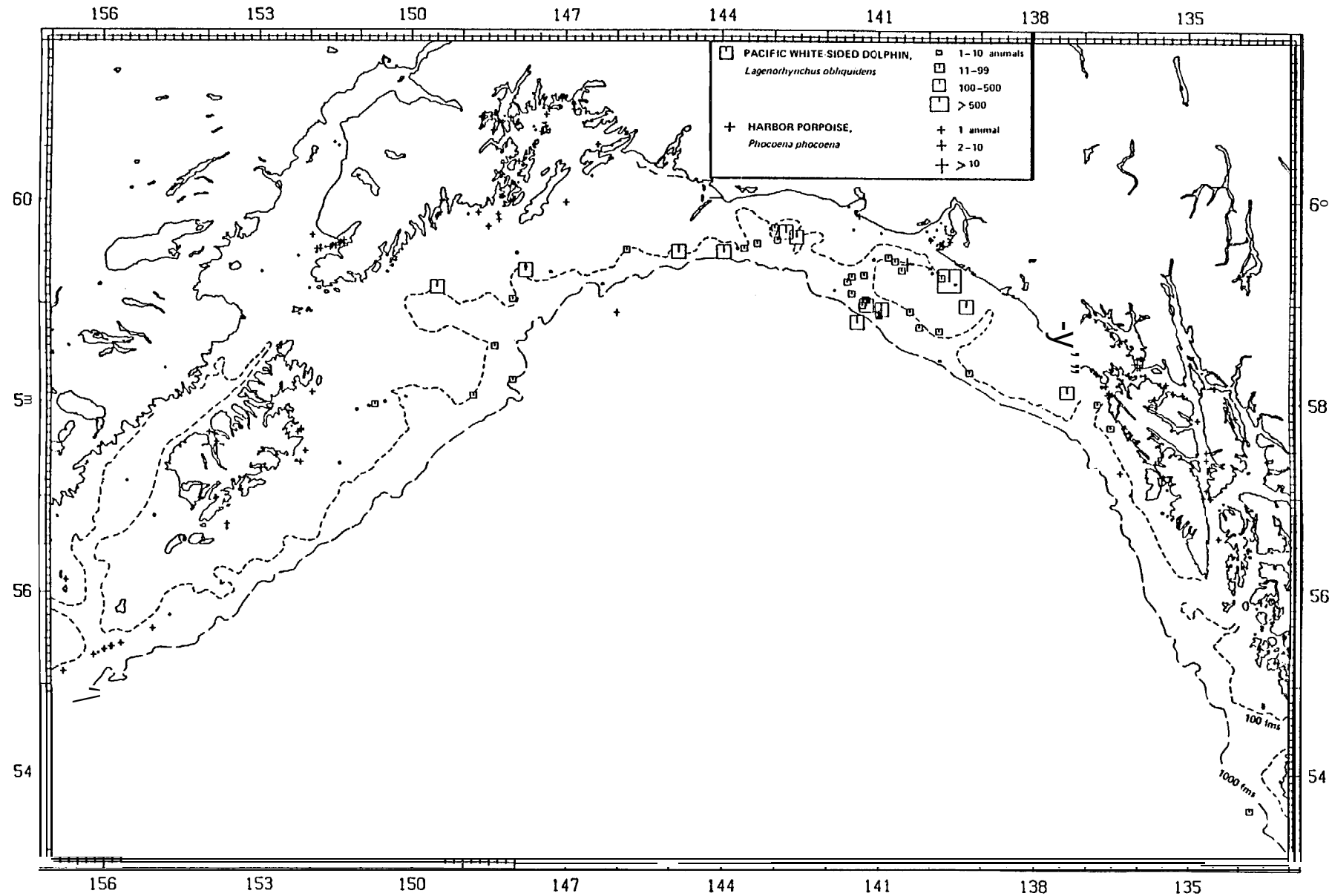

Figure 25.–Pacific white-sided dolphin and harbor porpoise sightings, summer (July-September) 1958-80.

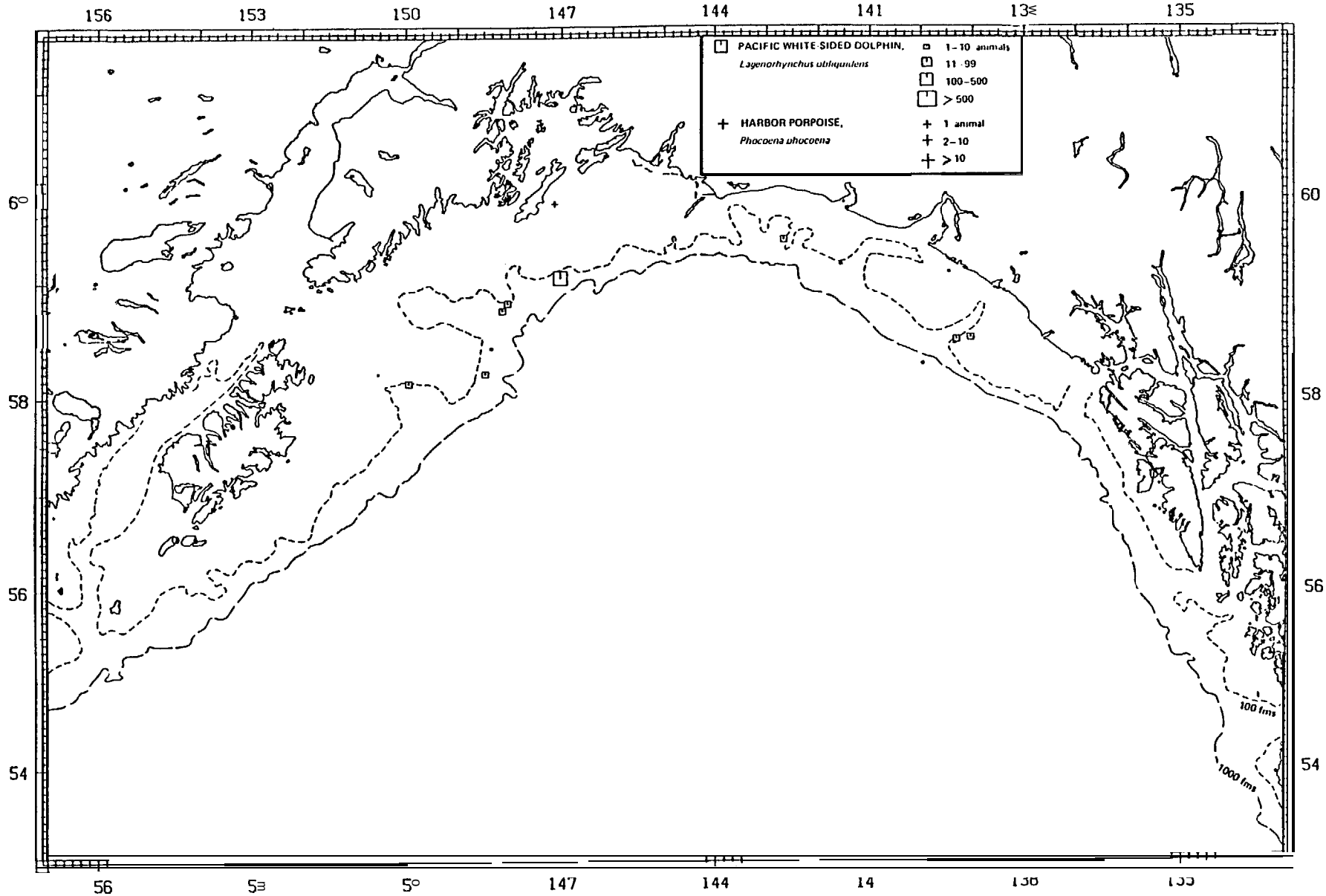

Figure 26.–Pacific white-sided dolphin and harbor porpoise sightings, autumn (October-December) 1958-80

Migration

Leatherwood and Reeves (1978) stated that with the approach of summer, Pacific white-sided dolphins off southern California move north and offshore near the edge of the continental shelf. Presumably these and other animals in the mid-latitudes shift their distribution farther north, but it is premature to consider this a migration as thought of in other species. Migration needs much more study in most small cetaceans.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Reproduction in Pacific white-sided dolphins is poorly understood. Mature males reported by Harrison *et* al. (1969) ranged from 170 to 180 cm. Tomilin (1957) reported lengths of 180 and 183 cm for two females carrying fetuses.

Mortality

Some natural mortality undoubtedly occurs from killer whales, and perhaps from large sharks; however, this is undocumented. Central nervous system infestation by air sinus trematodes has been reported by Dailey and Walker (1978) as a possible cause of occasional strandings of this species. Fifty-one white-sided dolphins were collected for live public display from 1966 to 1972 (Walker 1975). A small number of individuals are taken incidentally in tuna and bonito nets in tropical waters (NMFS 1980), but fishery-related mortality is not documented in the Gulf of Alaska.

Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise belongs to the family Delphinidae. It is one of four members of the genus *Phocoena*. The others are *P. sinus*, which occurs in the upper Gulf of California, Mexico, and *P. dioptrica* and *P. spinnipinnis*, which occur in the Southern Hemisphere. Other common names for the harbor porpoise include common porpoise, herring hog, and puffing pig.

ABUNDANCE

No population estimates for harbor porpoises are currently available for the entire North Pacific or Gulf of Alaska. Hall (1979) estimated a winter population of 590 in Prince William Sound, and 946 in the summer. Judging from the great amount of apparently suitable habitat throughout the Gulf of Alaska and our numerous POP sightings, the total Gulf of Alaska population size is undoubtedly large.

DISTRIBUTION

The harbor porpoise is a boreal-temperate zone species (Gaskin *et al.* 1974) found along much of the North Pacific coast between Point Barrow, Alaska (Hall and Bee 1954), and central California (Daugherty 1965; Nishiwaki 1966a; Gaskin *et al.* 1974) or as far south as Mexico (Pike 1956). Harbor porpoises are usually sighted singly or in pairs.

Spring (April-June) and Summer (July-September)

Spring sightings are numerous in the Kodiak Island area; two large groups (12 and 25 animals) occur here during this season (Figure 24). Kachemak Bay, Prince William Sound, Yakutat Bay, and southeast Alaska are other areas where harbor porpoises regularly occur during spring and summer (Figures 24 and 25).

Autumn (October-December) and Winter (January-March)

Sightings during autumn and winter were surprisingly sparse (Figures 23 and 26). The areas where harbor porpoises were sighted during spring and summer yielded very few autumn or winter sightings, which may be due in part to poor observing conditions and reduced coverage. Thus, though harbor porpoises are assumed to be year-round residents, this assumption is not evident when reviewing our sighting data. Forsell and Gould (198 1) reported only 9 animals (on 368 transects) in November 1979 and 24 animals (on 499 transects) in February 1980 while conducting seabird surveys in the nearshore waters of Kodiak, but believed that *Phocoena* were probably much more abundant than their observations indicated. Cruise tracks of POP vessels in the Gulf are, for the most part, farther offshore than the expected normal nearshore distribution of *Phocoena*; therefore, harbor porpoise distribution in the study area is probably under-represented in our data.

FACTORS INFLUENCING DISTRIBUTION

Oceanographic

Harbor porpoises are generally seen in coastal environs such as harbors, bays, and the mouths of rivers (Tomilin 1957). Sightings have been made by Hall (1979) near Prince William Sound, and one of the authors (L. D. C.) saw animals concentrated in Icy Bay in and along the edge of turbid water plumes from river runoff.

Feeding and Food Resources

Harbor porpoises feed primarily on small gadoid and clupeoid fishes. Smith and Gaskin (1974) reported that stomach contents from eastern Canadian coastal specimens contained 50?6 cod, 30% herring, and 15% mackerel. They dive to depths of at least 70 m (presumably in search of food), as evidenced by two porpoises caught in a net set on the ocean bottom off the Washington coast (Scheffer and Slipp 1948). Hall (1979) speculated that the harbor porpoises

he observed were feeding in the more turbid water from the Copper River, perhaps on forage species concentrated where Copper River water mixes with Gulf of Alaska water.

Migration

Researchers believe that there is a seasonal migration on the east coast of North America. Neave and Wright (1969) reported that harbor porpoises move north in late May and south in early October, while Gaskin *et* al. (1974) predicted an inshore movement in summer and an offshore movement in winter. Hall's (1979) previously discussed findings of a winter population only slightly more than half that of summer indicate some sort of winter dispersion; whether this dispersion is to other inshore habitats or offshore is unknown.

FACTORS INFLUENCING POPULATION GROWTH

Reproduction

Tomilin (1957) noted that there is little difference in time of breeding between North Atlantic, North Pacific, and Black Sea stocks. Mating for the Black Sea harbor porpoise occurred from the end of June until October, with a peak in occurrences in August (Tsalkin 1940, cited in Tomilin 1957). Slijper (1962) reported mating in the North Atlantic from July to October. Calves are born after a gestation period of 10-11 months. The peak calving period is in May and June (Tomilin 1957). Harbor porpoises reach sexual maturity at 3-4 years of age (Gaskin *et al.* 1974).

Mortality

Harbor porpoises are preyed upon by killer whales (Balcomb and Goebel 1976) and sharks. The most significant cause of natural mortality, however, appears to be parasitization. Major organs affected are the lungs (nematodes), and the liver and pancreas (trematodes) (Gaskin et *al.* 1974). Multiple parasitism associated with significant organ damage has been indicated in stranding mortalities on the East Coast (Dailey and Stroud 1978; Geraci and St. Aubin 1979).

Harbor porpoises are killed incidental to set and drift gillnet fishing throughout the West Coast (NMFS 1980). Though no overall estimate is available for incidental mortality, Matkin and Fay (1979) predicted that as many as 58 harbor porpoises would be killed in the Prince William Sound-Copper River fisheries in 1978. This may be a significant cause of mortality in the local population and warrants study.

White Whale (*Delphinapterus leucas*)

The white whale, more commonly called beluga or belukha, is one of only two species in the family Monodontidae. The other species is the narwhal, *Monodon monoceros*.

ABUNDANCE

White whales are abundant in Alaskan waters, particularly north of 60°N, and are neither endangered nor classified as protected. They are harvested by Alaskan Eskimos (and other native Americans) residing in coastal villages of the Bering, Chukchi, and Beaufort seas, who in recent years (1977-79) have landed approximately 187 white whales annually (Seaman and Burns 1981).

The Alaska state population is at least 9,000 (Braham *et al.* 1984) and perhaps as high as 16,000 (J. Burns, pers. commun.). The stock or population occurring in Cook Inlet and adjacent waters of the Gulf of Alaska is estimated to be 300-500 (Klinkhart 1966). Murray and Fay (1979) conducted surveys in Cook Inlet and believe that the size of that population has not changed appreciably since the 1960s. However, they believe that the actual population size is perhaps 3-4 times larger than the estimated 300-500, and attribute the discrepancy to underestimation due to the aerial survey methods employed by Klinkhart.

DISTRIBUTION

White whales are distributed throughout Alaskan waters, where at least two stocks are generally recognized: one in the Cook Inlet-Gulf of Alaska region and the second in the Bering, Chukchi, and Beaufort seas. The greatest numbers of animals occurs in the "Bering Sea population" (so named for this report) which may be further divided into groups occurring in Bristol Bay, Norton Sound, Kotzebue Sound, along the northwestern coast of Alaska, and those which migrate into the Canadian Beaufort Sea. At present, however, no clear evidence exists to confirm stock differences for these groups. Further studies are warranted.

Almost all white whales reported to our POP data base in the study area were seen north of 60"N in upper Cook Inlet (Figures 27 and 28; see also Murray and Fay 1979). This may be in part an artifact of increased observer effort, but we believe it is a true representation of their distribution at least for the spring and summer months. We have no autumn and winter sightings of white whales in Cook Inlet, but we have been told that they are present year-round, having been seen following boats through thin ice and in open water near Kenai and Nikishki (upper Cook Inlet) during winter and spring (R. Dahlheim, pers. commun.).

Documented sightings outside Cook Inlet are:

1) Barren Islands-3 individuals on 12 April 1978 at 58°48.9'N, 152°1 1.9*W (Figure 27).

2) Marmot Bay, between Kodiak and Afognak Islands–1 individual on 8 March 1977 at 58°00'N, 152°52'W (NMFS unpubl. data).

3) Yakutat Bay–26 individuals on 31 May 1976 at approximately 59°45'N, 139°50'W (Calkins 1977). A resident group of 10-20 is suspected (S. Hinckley, pers. commun.).

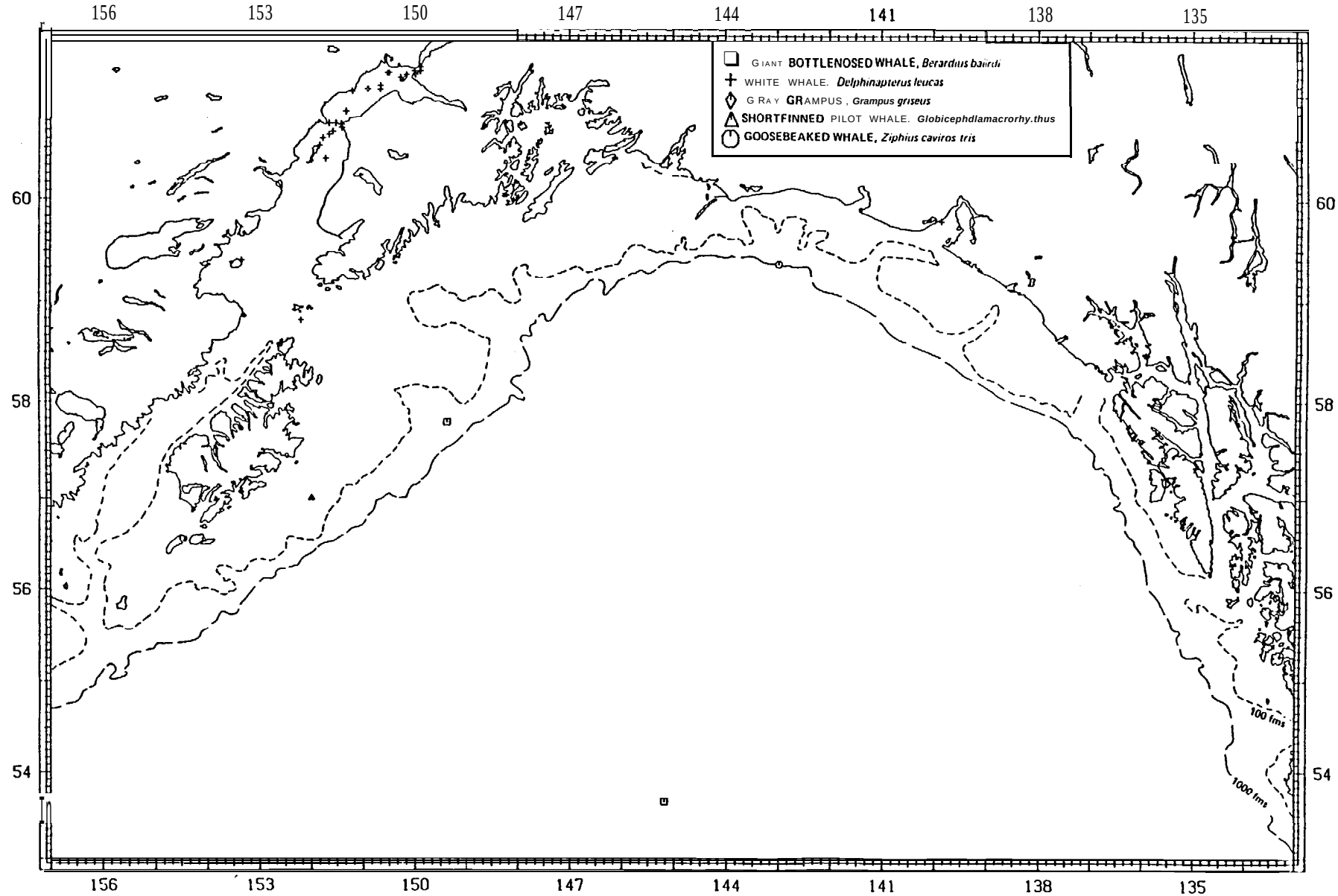

Figure 27.–White whale, giant bottlenose whale, goosebeak whale, shortfinned pilot whale, and Risso's dolphin sightings, spring (April-June) 1958-80.

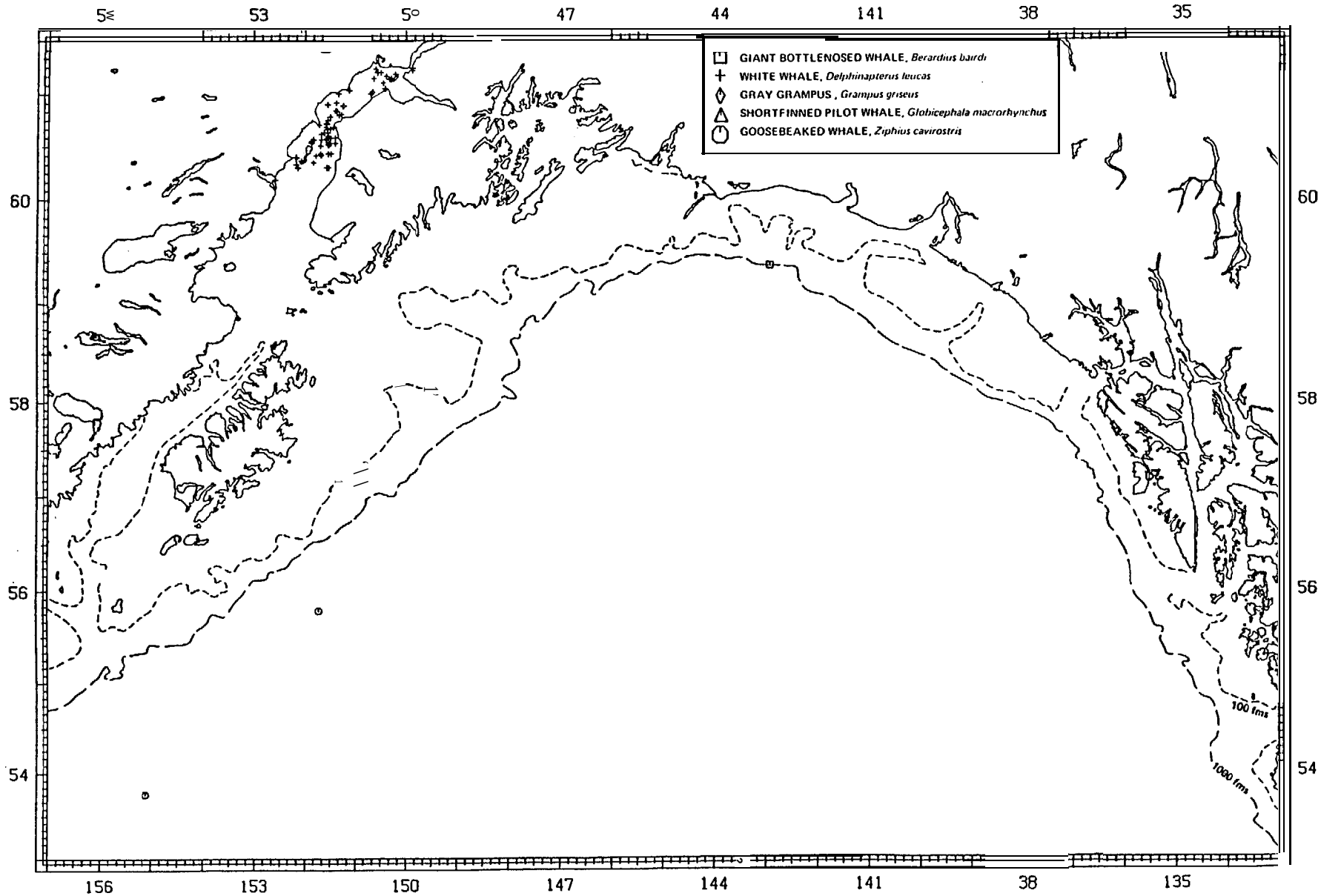

Figure 28.–White whale, giant bottlenose whale, goosebeak whale, shortfinned pilot whale, and Risso's dolphin sightings, summer (July-September) 1958-80.

4) Montague Island–1 individual on 29 March 1976 at 59°57'N, 147°22'W (Harrison and Hall 1978).

5) Shelikof Strait–2 individuals on 16 July 1975 at 58°00'N, 154°11'W (Harrison and Hall 1978).

6) Tacoma, Washington–a single tentative white whale on 23 April 1940 at 47°16'N, 122°33'W (Scheffer and Slipp 1948).

Local fishermen have observed 10-20 white whales in Yakutat Bay annually over the past decade (S. Hinckley, pers. commun.).

FACTORS INFLUENCING DISTRIBUTION

The movements and seasonal distribution of white whales in Cook Inlet and the Gulf of Alaska are influenced by the availability of fish, especially smelt and salmon smelt (Kleinenberg *et al.* 1964; Klinkhart 1966). The animals returning to Yakutat Bay annually apparently are following local salmon runs. Their movements in Cook Inlet are also limited by ice to at least Kenai, and the tide, which can reach a 10-m flux. Since they generally associate themselves with shallow waters, bays, and estuaries, which are frequently turbid and warmer than offshore waters and are important areas for fish runs, it is not surprising that most sightings in Cook Inlet (at least during summer) are north of 60"N and along the coast.

FACTORS INFLUENCING POPULATION GROWTH

Although only one study has been conducted in the Gulf on this species in the past 15 years, Murray and Fay (1979) concluded that the population has not changed in numbers. Presumably, the major factor limiting population growth is the availability of habitat (space and food). Because white whales seem to be generally confined to Cook Inlet and the population may not be increasing, we believe that the carrying capacity for white whales has been reached. In fact, their presence in Yakutat Bay may indicate the carrying capacity has been exceeded in Cook Inlet. Obviously, greater study of life history (especially recruitment), distribution, and data on availability of prey among years is needed to support this preliminary conclusion.

North Pacific Giant Bottlenose Whale (*Berardius bairdii*)

The North Pacific giant bottlenose whale belongs to the family Ziphiidae. The other common name associated with this species is Baird's beaked whale.

ABUNDANCE

There are no population estimates available for the giant bottlenose whale. The few POP sightings indicate that this species may not be very abundant in the Gulf of Alaska.

DISTRIBUTION

The giant bottlenose whale is endemic to the North Pacific, ranging from St. Matthew Island in the Bering Sea, through the Gulf of Alaska and south to southern California (Rice 1974).

No giant bottlenose whale sightings were logged during the cetacean survey of the Gulf of Alaska in 1980 (Rice and Wolman 1982). During a 1979 autumn survey of coastal waters of California, two schools of four animals each were observed north of San Francisco (Duffy 1980). Rice (1978*d*) observed pod sizes of 3-17 animals off California in the 1960s. Our data (Figures 27 and 28) show only three positive sightings in the study area since 1958:

1) 4 animals on 20 June 1976 at 53°39'N, 145"1O'W.

2) 5 animals on 12 June 1977 at 57°48'N, 149°23'W.

3) 9 animals on 11 September 1977 at 59°22'N, 142°57'W.

FACTORS INFLUENCING DISTRIBUTION

Whaling records from Japan indicate a greater density of giant bottlenose whales in waters beyond the 1,000-m contour of the continental shelf (Nishiwaki and Oguro 1971).

Giant bottlenose whales feed primarily on squids and groundfishes (Nishiwaki 1972; Rice 1978*d*). Migration in the western North Pacific seems to coincide with the seasonal occurrence of squid, *Todorades pacificus*, and other cephalopods (*Gonatus* spp.)(Nishimura 1970). Deep sea fishes are consumed when available (Nishiwaki and Oguro 1971), and the stomachs of some specimens have contained benthic animals such as ascidians, sea cucumbers, starfishes, and crabs (Nishiwaki 1972).

FACTORS INFLUENCING POPULATION GROWTH

Studies of giant bottlenose whales offJapan indicate that mating peaks during October and November and that calving occurs from November to July, with a peak in March and April (Kasuya 1977). Similar periods for mating and calving are assumed to hold true for the eastern North Pacific. The predominance of males in catches off the coast of British Columbia may mean a geographical segregation between the sexes. Sexual maturity is attained at an age of 8-10 years and maximum longevity may be 70 years (Kasuya 1977).

Virtually nothing is known about natural mortality. Fisheries-related mortality in the North Pacific is limited to animals taken by Japanese coastal whaling operations. Since 1969, an average of 62 per year have been taken; 33 per year over the past 5 years (1976-80) (committee for Whaling Statistics 1980).

Goosebeak Whale (*Ziphius cavirostris*)

The goosebeak whale is a toothed whale belonging to the family Ziphiidae (beaked whales), and is the only member of the genus *Ziphius*. Another common name for this species is Cuvier's beaked whale.

ABUNDANCE

No population estimates are available for the goosebeak whale. Though it may be the most abundant of the beaked whales in the eastern North Pacific, the lack of sighting data leads us to conclude that this species is scarce in the Gulf of Alaska.

DISTRIBUTION

The goosebeak whale is found in all oceans of the world, except the Arctic and Antarctic (Moore 1963). Mitchell (1968) noted that strandings of this species are widespread and presumed a continuous distribution from Alaska to Baja California. At sea sightings are rare in the Gulf of Alaska. Rice and Wolman (1982) reported two sightings [included in Figures 27 and 28), one animal at approximately 59°22'N, 143°W and six at 55°47'N, 151"43'W. The only other POP sighting, of a single animal, occurred at 53°45'N, 156°05'W on 30 July 1977. Harrison (1979) sighted a lone goosebeak whale just to the west of the study area (54°00'N, 160°35'W) in April 1977' over 2,560 m of water. Although there are few sightings in our data base, we believe goosebeak whales are more abundant than the available records indicate.

FACTORS INFLUENCING DISTRIBUTION

Goosebeak whales appear to inhabit the deeper waters of the Pacific. The three sightings from the Gulf of Alaska occurred where water depths were 1,200, 5,800, and 4,400 m, respectively. Off Japan, they are taken in the coastal small whaling operations where water depths are greater than 1,000 m (Omura *et al.* 1955; Nishiwaki and Oguro 1972).

Nishiwaki and Oguro (1972) reported squid and deep-sea fish (no species given) were found in the stomachs of goosebeak whales taken off Japan. Squid were found in the stomachs of an animal stranded on Amchitka Island, Alaska (Kenyon 1961), and another in California (Mitchell and Houck 1967).

FACTORS INFLUENCING POPULATION GROWTH

Data from Japanese coastal whaling operations indicate that males become sexually mature at about 5.3 m in length, and females at 5,5 m. Neonates are thought to be about 2.3 m at birth (Omura *et al.* 1955). Nishiwaki and Oguro (1972) noted that 87% of all goosebeak whales taken off Japan were mature and speculated that the population was stable.

Virtually nothing is known about causes of natural mortality. Their pelagic distribution and deep diving ability may protect goosebeak whales from killer whales. Goosebeak whales

strand generally as singles, but stranding reports have emphasized their osteology rather than pathology. Fishery-related mortality is limited to a directed Japanese fishery in the western North Pacific: 85 animals were caught there during 1948-52, and 189 during 1965-70 (Omura *et al.* 1955; Nishiwaki and Oguro 1972).

Bering Sea Beaked Whale (*Mesoplodon stejnegeri*)

The Bering Sea beaked whale belongs to the family Ziphiidae, and is one of eleven members of the genus *Mesoplodon*. Other common names include Stejneger's beaked whale and sabertooth whale.

ABUNDANCE

No population estimates are available for this species. Judging from the complete lack of sighting records, the Bering Sea beaked whale may be scarce in the Gulf of Alaska.

DISTRIBUTION

The known range of *M. stejnegeri* extends from Akita Beach, Japan, north to the Commander and Pribilof islands in the Bering Sea, through the Gulf of Alaska south to Yaquina Bay, Oregon (Moore 1963). The distribution of this species is based upon rare strandings and sightings such as a floating carcass examined off Cape Edgecumbe in the Gulf of Alaska (Fiscus *et* al. 1969). Although very little is known about the distribution and abundance of these whales, it is possible that they principally inhabit the deeper waters of the continental shelf, as has been suggested for the Atlantic species *M. bidens* (Moore 1966). During a June-July northern sea lion vessel survey in the central Aleutian Islands, Loughlin *et* al. (in press) sighted seven groups of *Mesoplodon* in water between 730-1,280 m deep. Pod size ranged from 5 to 15 animals. We have no sighting data on *M. stejnegeri* in the Gulf of Alaska. Undoubtedly, this is due in part to their pelagic distribution and inconspicuousness at sea.

FACTORS INFLUENCING POPULATION GROWTH

Virtually nothing is known about the food habits, reproductive biology, or natural mortality of *Mesoplodon* species.

Risso's Dolphin (*Grampus griseus*)

Risso's dolphin belongs to the family Delphinidae, and is the only member of the genus *Grampus*. Other common names include grampus, gray grampus, and white-headed grampus.

ABUNDANCE

Risso's dolphins are protected under the Marine Mammal Protection Act of 1972 (Public Law 92-522) and as amended. Although no abundance estimates are available, this species is common in the lower latitudes and rare in subarctic waters such as the Gulf of Alaska.

FACTORS INFLUENCING DISTRIBUTION

In their comprehensive review of Risso's dolphin distribution in the northeastern Pacific, Leatherwood *et* al. (1980) reported that sightings between 45° and 5 1°N occurred mostly in summer, and essentially beyond the continental shelf. They related these northern sightings to warming ocean surface temperatures. Normal distribution is from the equator to central California. Guiget and Pike (1965) reported four sightings of Risso's dolphins from Ocean Station Vessel Papa (50°N, 145°W) during 1958-60. More recently, Reimchen (1980) reported a March 1978 sighting of 14 Risso's dolphins at 54°11'N, 133°01 'W–close to shore off the northwest tip of Queen Charlotte Island. No spring to autumn sightings are in our data base (Figures 27 and 28).

Three winter sightings were made, one providing the northernmost record for the species in the North Pacific (Braham 198 1). On 9 and 12 March 1976, Braham observed three groups of Risso's dolphins totaling seven animals: three individuals at 49°50'N, 128°30'W, two at 49°52'N, 128°37'W, and two at 55°49'N, 145°56'W. All were heading north toward the Gulf of Alaska; the 12 March sighting was in the Gulf. These sightings, and those of Reimchen (1980), occurred approximately 3-4 months earlier than when these dolphins are generally seen (cf. Guiguet and Pike 1965; Leatherwood *et al.* 1980). Whether these early seasonal sightings were chance, representative of their normal temporal and spatial distribution, or related to unseasonably warmer surface temperatures or prey availability, is unclear. Water temperatures may be the limiting factor for this tropical and temperate warm water species. During a 1980 Gulf ofAlaska marine mammal survey, no Risso's dolphins were observed (Rice and Wolman 1982). Cephalopods are the major prey of this species (Nishiwaki 1972).

FACTORS INFLUENCING POPULATION GROWTH

Life history information on Risso's dolphin is sparse. Males become sexually mature at about 3 m and newborns are about 1.5 m long (Leatherwood, in press). Little is known about causes of natural mortality. Guiget and Pike (1965) reported a heavy intestinal parasite load in one animal collected in British Columbia, but estimates of debilitation were lacking. Other than an occasional shooting of a Risso's dolphin (Orr 1966), there is no evidence of human-related effects; but again, research is lacking.

Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

The short-finned pilot whale belongs to the family Delphinidae, which comprises two species. The other is the long-finned pilot whale, G. *malaena*. Subspecies of the short-finned

pilot whale with alternate specific names are G. *scammonii* and G. *sieboldii*. Other common names include blackfish and pothead.

ABUNDANCE

No population estimates are available for pilot whales in the eastern North Pacific, but the species may be categorized as rare in the study area (Reilly 1978).

DISTRIBUTION

Pilot whales normally range no farther north than California. They are known from Alaskan waters on the basis of only a few published accounts. A specimen reported as G. *scammonii* (sometimes applied to pilot whales off California) was taken near Kanatak on the Alaska Peninsula in September 1937 (Orr 1951). Four pilot whales were sighted in the Gulf of Alaska from the MV *Fort Ross* in August 1957 at 54°48'N, 143°47'W, about 400 miles west of Dixon Entrance (Pike and MacAskie 1969). Our data show a single sighting in May 1977 at 57*N, 152°W of five pilot whales (Figure 27).

FACTORS INFLUENCING DISTRIBUTION

The preferred food of the pilot whale is squid, and the abundance of pilot whales in several areas has been correlated with the abundance of these cephalopods (Leatherwood and Dahlheim 1978).

Pilot whales travel in groups of a few to several hundred animals and are frequently observed in association with other cetaceans. Although their seasonal movements are poorly known, populations may shift northward in the summer and south in the winter in response to changes in water temperature (Leatherwood *et al.*, in press). Migrations may also be the result of breeding or calving activities (Norris and Prescott 1961).

FACTORS INFLUENCING POPULATION GROWTH

Little is known about the reproductive characteristics of the shortfinned pilot whale. Preliminary indications from pilot whales taken in the coastal waters of Japan are that males become sexually mature at about age 14 and females at age 8, and that gestation is about 14.5 months (Kasuya 1981). The oldest pregnant female Kasuya found was 35 years old, indicating a relatively long reproductive life for these small cetaceans. Age determinations indicate that short-finned pilot whales are long-lived animals, frequently reaching 50 years (Sergeant 1962, Kasuya 1981).

Other than predation by killer whales, virtually nothing is known about natural causes of mortality. Pilot whales are known to strand *en masse* in warmer waters, but not in the study area. The only harvesting of short-finned pilot whales in the eastern North Pacific is occasional live capture for aquaria. Pilot whales are taken in the Japanese coastal whaling operation, and

since 1969 the take has ranged from 3 to 181, with only 17 per year taken since 1975 (Committee for Whaling Statistics 1980).

Northern Right Whale Dolphin (*Lissodelphis* borealis)

The northern right whale dolphin belongs to the family Delphinidae. The other member of the genus, *L. peronii*, inhabits the Southern Hemisphere.

ABUNDANCE

Nishiwaki (1972) estimated a total North Pacific population of 10,000 animals. Leatherwood and Walker (1975) believed this was a conservative estimate, but offered no new estimate.

DISTRIBUTION

The northern right whale dolphin is usually found in temperate waters between 30"N and 50"N (Leatherwood and Walker 1975). Scammon (1874) and Nishiwaki (1966) reported sightings as far north as the southern Bering Sea. Pike and MacAskie (1969) reported sighting two right whale dolphins at 50"N, 145°W on 2 July 1959. Guiguet and Shick (1970) reported a school of approximately 200 northern right whale dolphins on 13 February 1970 near 48°23'N, 126°52'W. These two sightings are the northernmost well-documented sightings in the eastern North Pacific that we know of. A recent summer survey of the Gulf of Alaska yielded no sightings (Rice and Wolman 1982). The POP database contains no positive sightings of right whale dolphins in the study area. Three tentative sightings from the study area are as follows:

1) One animal on 13 July 1977 at 55°48'N, 155"1O'W.

2) Two animals with a group of Pacific white-sided dolphins (100 total) on 26 February 1980 at 55°39'N, 155°24'W.

3) Two animals on 28 July 1980 at 58 °40'N, 143°00'W.

A potential problem with right whale dolphin identification in the North Pacific is their strong resemblance to northern fur seals (*Callorhinus ursinus*) when the seals are porpoising. From a distance, or in rough weather, the two species appear similar in color and aspect (slender torso, dorsal fin absent).

FACTORS INFLUENCING DISTRIBUTION

Northern right whale dolphins are often found in the company of Pacific white-sided dolphins in lower latitudes. Yet, though white-sided dolphins move into the Gulf of Alaska with

regularity during the spring and summer months, right whale dolphins do not. It maybe that right whale dolphins have a narrower sea temperature tolerance.

From a very small number of stomachs examined for contents (strandings and collected animals from California), it was found that mesopelagic fishes (primarily Myctophidae, but also Bathylagidae, Melamphidae, and Paradepidae) were the most frequent food items present (Leatherwood and Walker 1975). Leatherwood and Walker (1975) mentioned that squid, *Loligo opalescent*, appears to be an important food item for this species.

FACTORS INFLUENCING POPULATION GROWTH

From a sample of 20 animals (10 each, male and female), it is apparent that sexual maturity occurs in males at about 210-220 cm in length, and in females at about 200 cm (Leatherwood and Walker 1975). This is the extent of current knowledge on reproductive parameters for this species.

Predation on northern right whale dolphins by other species is undocumented, and strandings are infrequent and most often of single animals. There are no recent reports of mortality incidental to fishing activities in the eastern North Pacific (NMFS 1980).

CARNIVORES

The emphasis of our research was on pelagic sightings of marine mammals, especially cetaceans, and, since seals, sea lions, and the like are more frequent inhabitants of coastal waters or on land, we have fewer data in general for the carnivores. In addition, there are numerous recent papers and reports covering these species' biology and natural history; thus our discussion here is abbreviated and principally addresses distribution. Only data with effort were plotted.

Northern Fur Seal (*Callorhinus ursinus*)

The range of the northern fur seal is from the east coast of Asia to the west coast of North America from 35"N (subarctic boundary) to approximately 60°N. A few sightings have been made beyond this range. Even though they can be found over a wide range of the North Pacific, their greatest concentration is found in the summer and early fall near their breeding islands. Of the total fur seal population of approximately 1.5-1.75 million, the majority, an estimated 1.0- 1.3 million, return to the Pribilof Islands in the Bering Sea. The remainder go to the Commander Islands (USSR) in the southwestern Bering Sea, San Miguel Island off southern California, the Kurile Islands (USSR) in the western North Pacific, and Robben Island (USSR) in the Sea of Okhotsk.

Not all the fur seals return to their birth places during the summer; some immature seals (those 1 to 2 years old) may remain at sea year-round. Fur seals can be found in the Gulf of Alaska year-round, although the majority of sightings in the Gulf were in spring (Figures 29-32). This is not a result of sighting effort since the greatest effort among all seasons has been in summer.

In May and early June, mature males show up on the Pribilof Islands in advance of pregnant and estrous females. Breeding and post-parturient activities take place through the remainder of summer. As such, fewer animals, in total, are expected to be in the Gulf of Alaska than in the southern Bering Sea. The incidence of single animals, an index to group size, changes from 49% single sightings in the Gulf in winter to a high of 80% in summer (Figure 33).

Some of the fur seals, most likely older males, may overwinter in the Gulf (Alexander 1953). Younger males and females are most often found farther south along the edge of the continental shelf of British Columbia, Washington, Oregon, and California. A large concentration of wintering fur seals apparently occurs nearshore to Baranof Island (see inset Figure 29). If these animals return to the Pribilof Islands each year, then their route is likely to take them across the Gulf near or through some OCS lease areas (e.g., Fairweather Ground). Fur seals were seen in the Gulf of Alaska during winter on the edge of Portlock Bank and in the center of the Gulf in deep water. Unfortunately, the amount of survey effort during winter is low.

Animals occurring in the southern part of their range begin their northward migration in spring and by late April, May, and in June they are found in the Gulf in large numbers (Figure 30). Sightings in spring undoubtedly reflect those animals which have left the Bering Sea in autumn and winter for warmer Gulf waters as well. A majority of the animals in spring were seen within 100 miles of the shelf break between southeast Alaska and the southwest tip of Kodiak Island. Most occurred along the shelf break towards Kodiak Island, although this may in part be biased by observer effort.

In summer there have been many fewer sightings in the Gulf than earlier in the year, and those occurred along the shelf edge and principally in the western Gulf near Kodiak Island (Figure 31). This may indicate that seals coming up from south of the Gulf of Alaska just head straight across the Gulf once they reach southeast Alaska in spring and summer. The summer concentrations of sightings continue west from Kodiak Island near the shelf break to Unimak Pass. Virtually no fur seals have been seen in Shelikof Strait, and this pattern continues in inland waters throughout the Gulf, in all seasons.

Very few fur seals have been sighted in the Gulf of Alaska during autumn (Figure 32). All sightings were scattered throughout the central to western Gulf. Most of the fur seals seen during autumn were found from just south of Unimak Pass to the Pribilof Islands in a broad strip approximately 200 miles wide, 250 miles long, north-northwest of Unimak Pass.

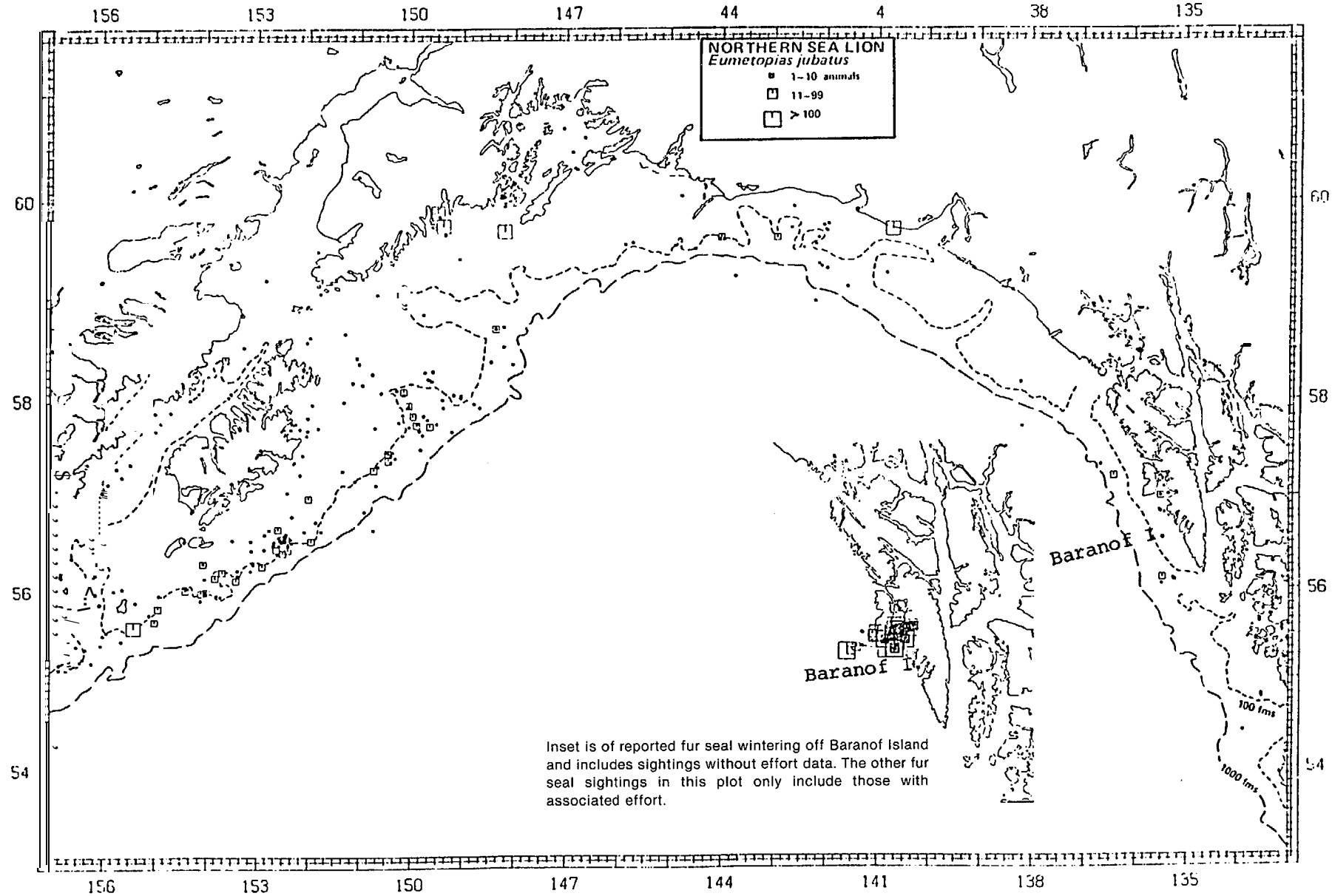

Figure 29.–Northern fur seal sightings, winter (January-March 1958-80.

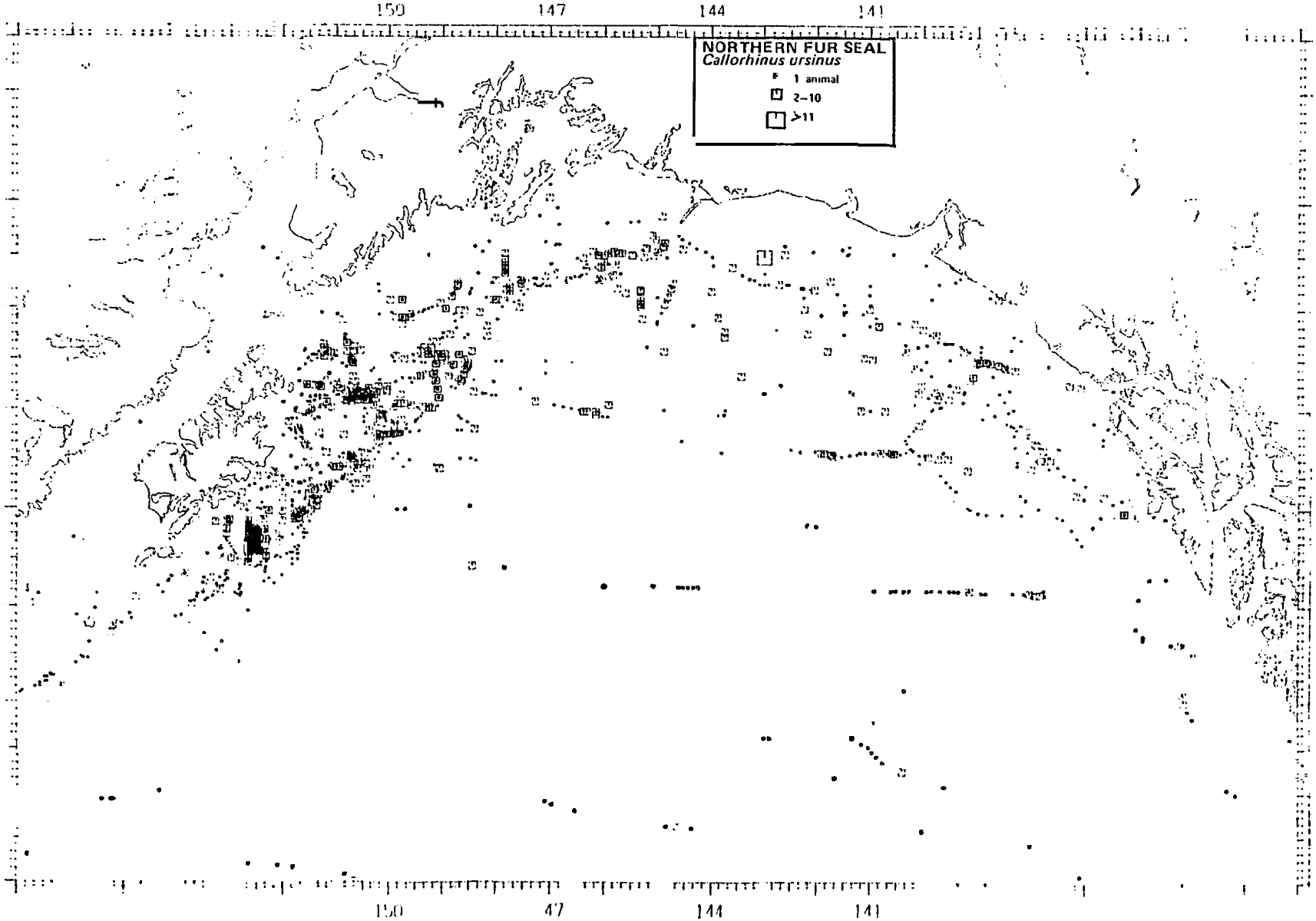

Figure 30.–Northern fur seal sightings, spring (April-June) 1958-80.

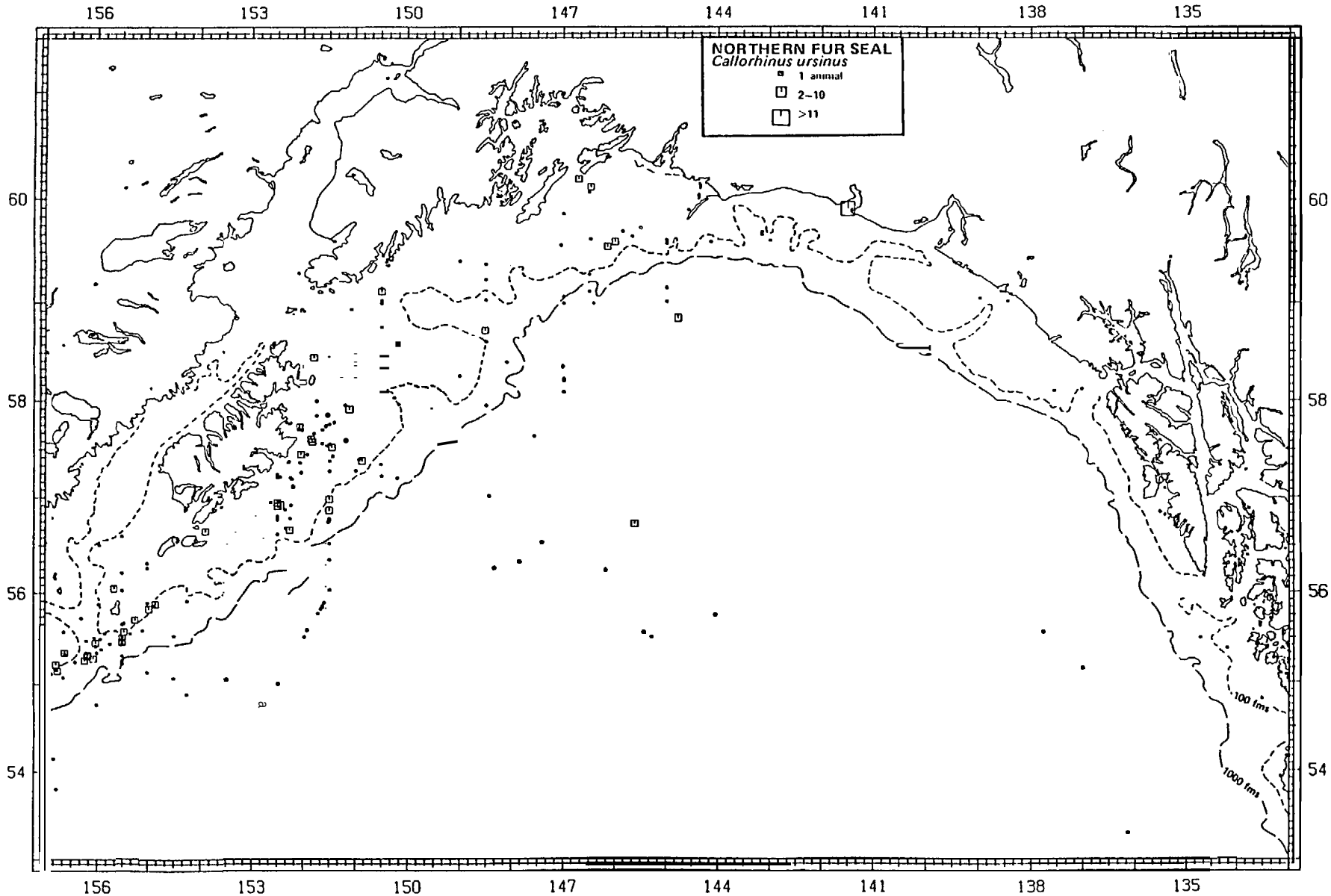

Figure 31.–Northern fur seal sightings, summer (July-September) 1958-80.

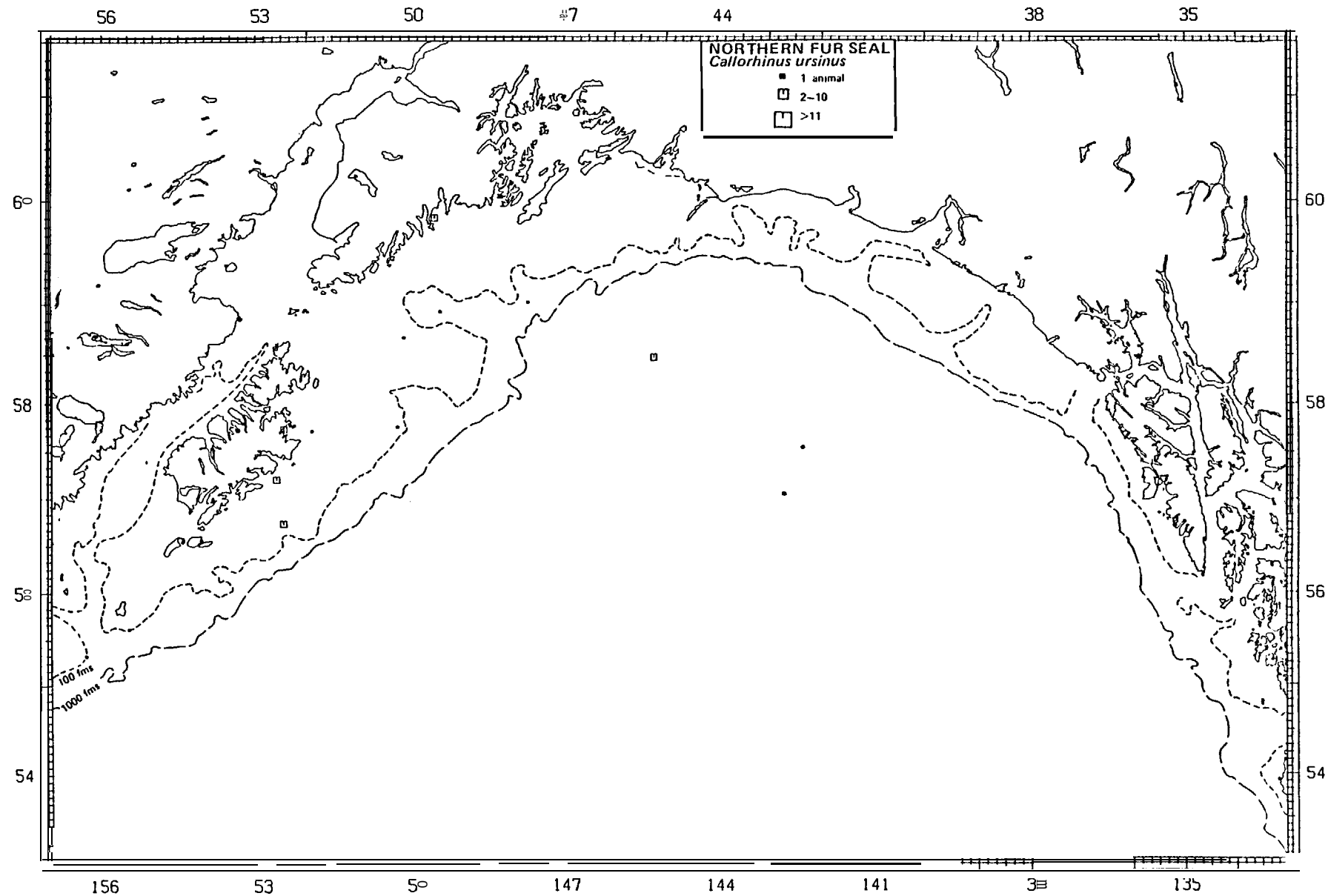

Figure 32.–Northern fur seal sightings, autumn (October-December) 1958-8

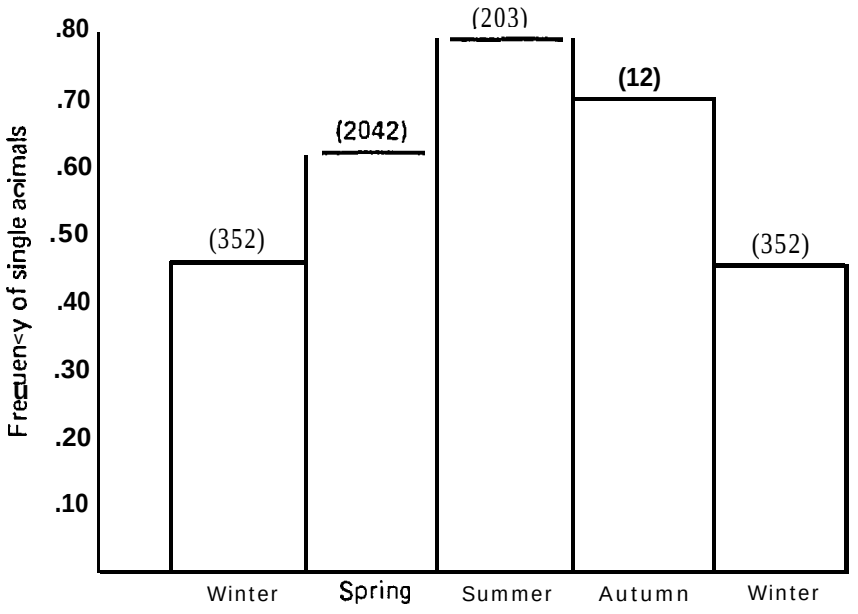

Figure 33.-The proportion of single fur seals by season and total sightings of all groups (numbers in Parentheses) in the Gulf of Alaska. 1958-80. Data was not standardized for effort among seasons or years,

Northern sea lion (*Eumetopias jubatus*)

The northern or Steller sea lion is ubiquitous over the continental shelf of the Gulf of Alaska. Calkins *et al.* (1975) described in detail the various haulout areas and rookeries for sea lions. They found 91 different rookeries and hauling areas in the northeast Gulf of Alaska alone, from Cape Elias to Pt. Elrington. Pitcher Inlet at Sugarloaf Island supports one of the largest rookeries in the northern Gulf (Calkins *et al.* 1975). Marmot Island, off Afognak Island (north of Kodiak Island), equals Sugarloaf Island in numbers of sea lion population, and Cape Barnabas and Two-headed Island on and near Sitkalidak Island also support large numbers of sea lions (Calkins *et al.* 1975). The adults begin to gather on breeding rookeries in late May and leave in late June or early July.

Northern sea lions, at sea, frequent continental shelf waters virtually to the exclusion of waters deeper than 2,000 m, and during much of the year they occur in greatest numbers near the 200-m depth contour.

In winter sea lions were found primarily around Kodiak Island, and most sightings were near the continental shelf break on Portlock and Albatross banks (Figure 34). Whether this is

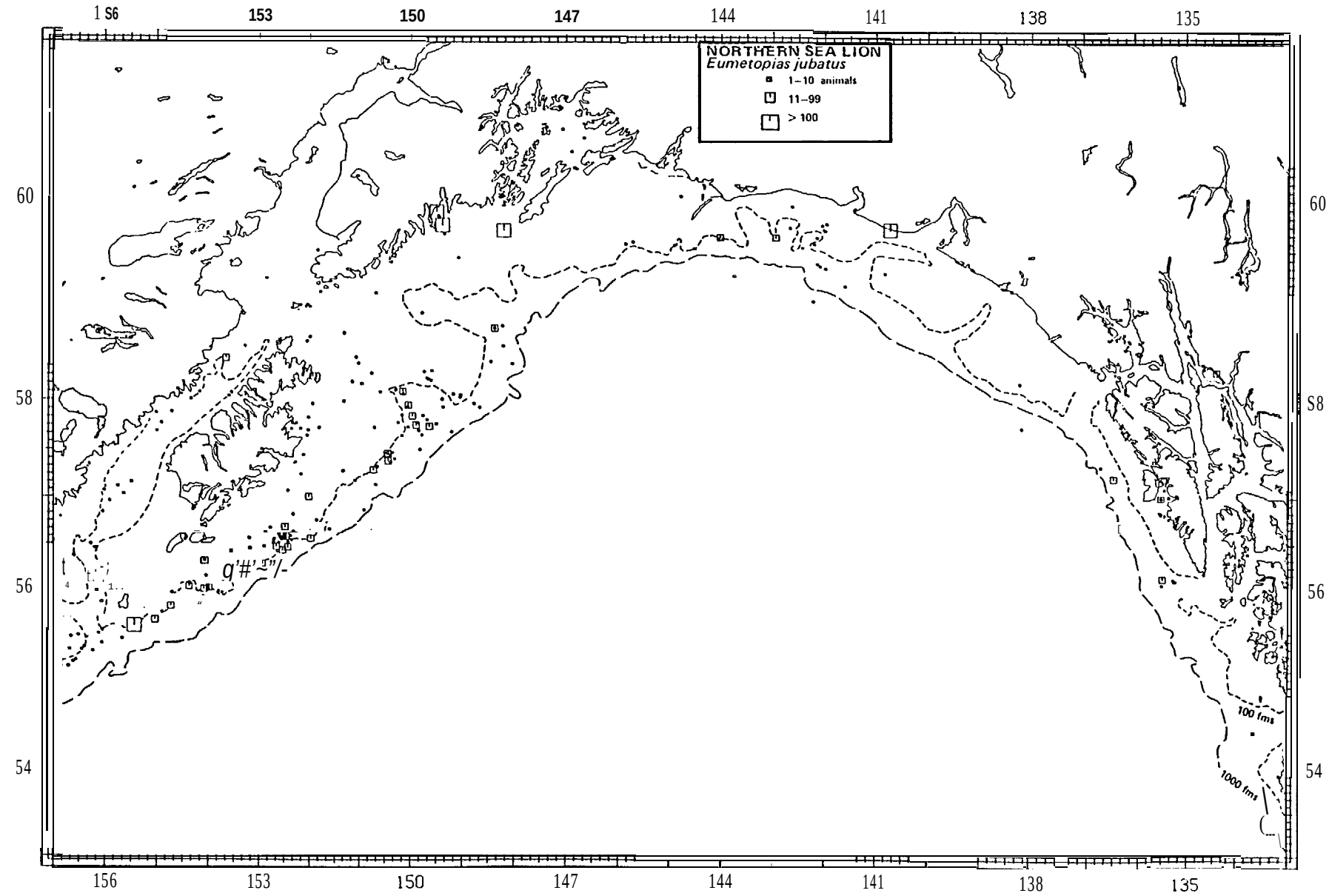

Figure 34.-Northern sea lion sightings, winter (January-March) 1958-80,

an artifact of watch effort is unknown. In the northeast Gulf there were three significant concentrations nearshore between Icy and Yakutat bays, and off Montague Island to the Kenai Peninsula. As in summer and autumn, sea lions appear farther offshore (to the 200-m contour) than in spring (Figures 34-37). The areas of large numbers of sea lion sightings are: Kayak Island area, Montague Island, Portlock Bank (east of Afognak Island), south edge of Kodiak Island, and the Trinity Islands.

Summer sightings (Figure 36), like those in spring, occurred more often from Yakutat Bay to Unimak Pass, but large numbers were off Kodiak Island. Group sizes were larger off southwest Alaska and at Kodiak Island than elsewhere. Sightings were more widespread shoreward from the 200-m contour than in other months, probably a reflection of animals moving shoreward to haul out and to breed.

In summer, adult sea lions are on or close to the breeding rookeries, but during the rest of the year, except perhaps winter, large groups of sea lions make feeding forays that range from 5 to up to 15 miles from shore. Those that do venture farther to sea are more likely to be found as singles or in smaller groups of 2-12 (Fiscus and Baines 1966). Plots of sea lion sightings in summer showed large groups near important breeding areas, as well as at or near the 200-m contour, especially from the Trinity Islands to Yakutat Bay (offshore). It is noteworthy that many sightings occur off the 200-m contour while adj scent sightings are at that depth. This suggests that perhaps something other than the shelf break at these depths is influencing their distribution. Since it is most likely that animals sighted out at sea are feeding, we presume their distribution reflects areas of fish distribution and abundance, and perhaps areas of important upwellings.

In autumn, sea lions were seen mainly on Albatross and Portlock banks and along the continental shelf break to the Shumagin Islands (Figure 37). Few sightings were reported from the Shumagin Islands to Unimak Pass. The fewer sightings in autumn is a reflection of reduced effort; however, it is also likely that significant numbers of animals in early autumn (e.g., September and October) were hauled out on land to moult.

California Sea Lion (*Zalophus californianus*)

The first, and only, known California sea lion sighting in the Gulf of Alaska is that of an adult male on Elrington Island, Prince William Sound, in June 1973 (K. Schneider, pers. commun.)

The California sea lion's major breeding area is off the coast of Baja California, Mexico to San Miguel Island in southern California (Peterson and Bartholomew 1967). The population is estimated to be more than 100,000 animals (Maser *et al.* 1981). Following the pupping and breeding season in May and June many of the adult males move north. During winter there have been regular sightings of California sea lions in southern British Columbia, with the greatest numbers seen in February (Bigg 1973). There are no Platforms of Opportunity

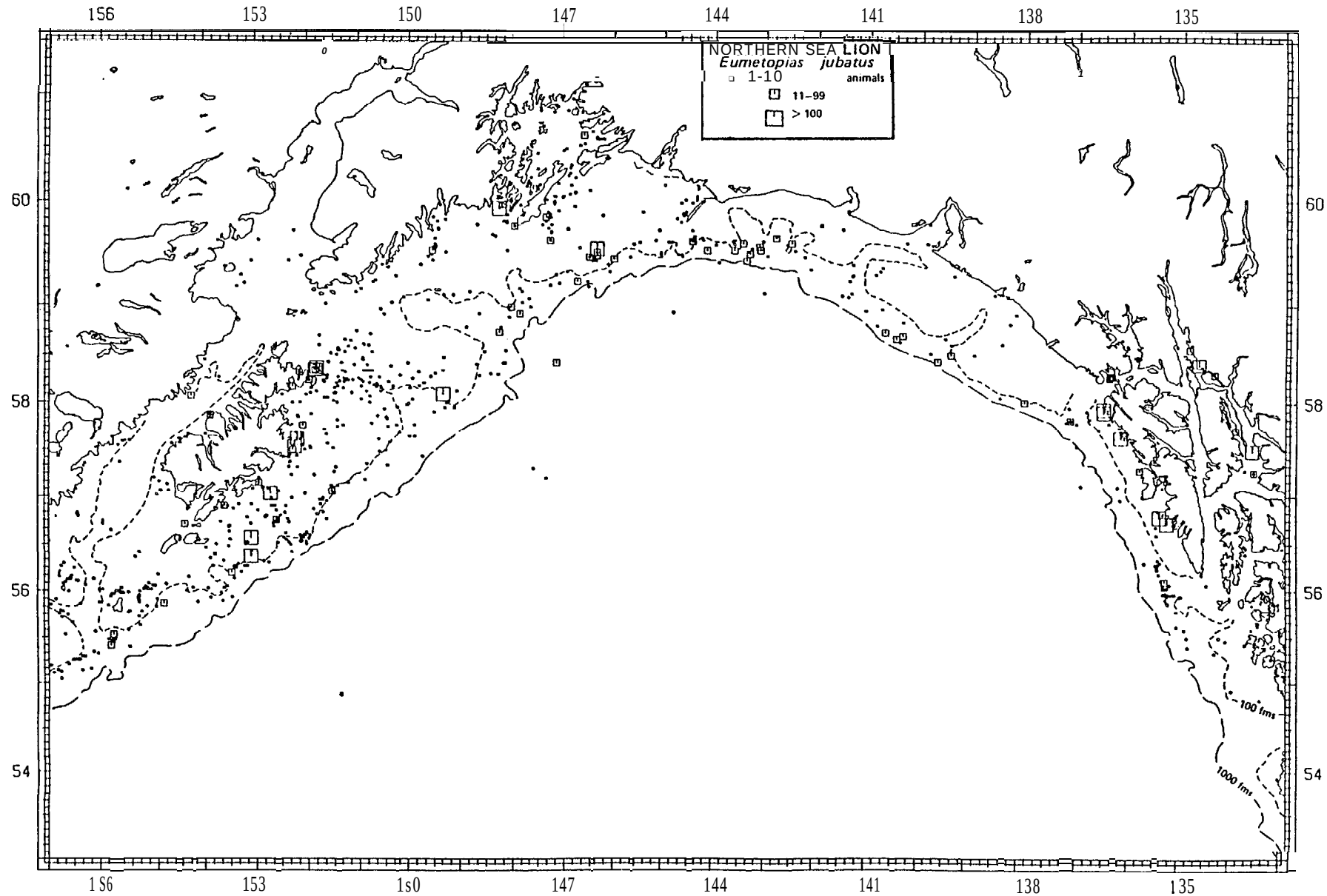

Figure 35.-Northern sea lion sightings, spring (April-June) 1958-80.

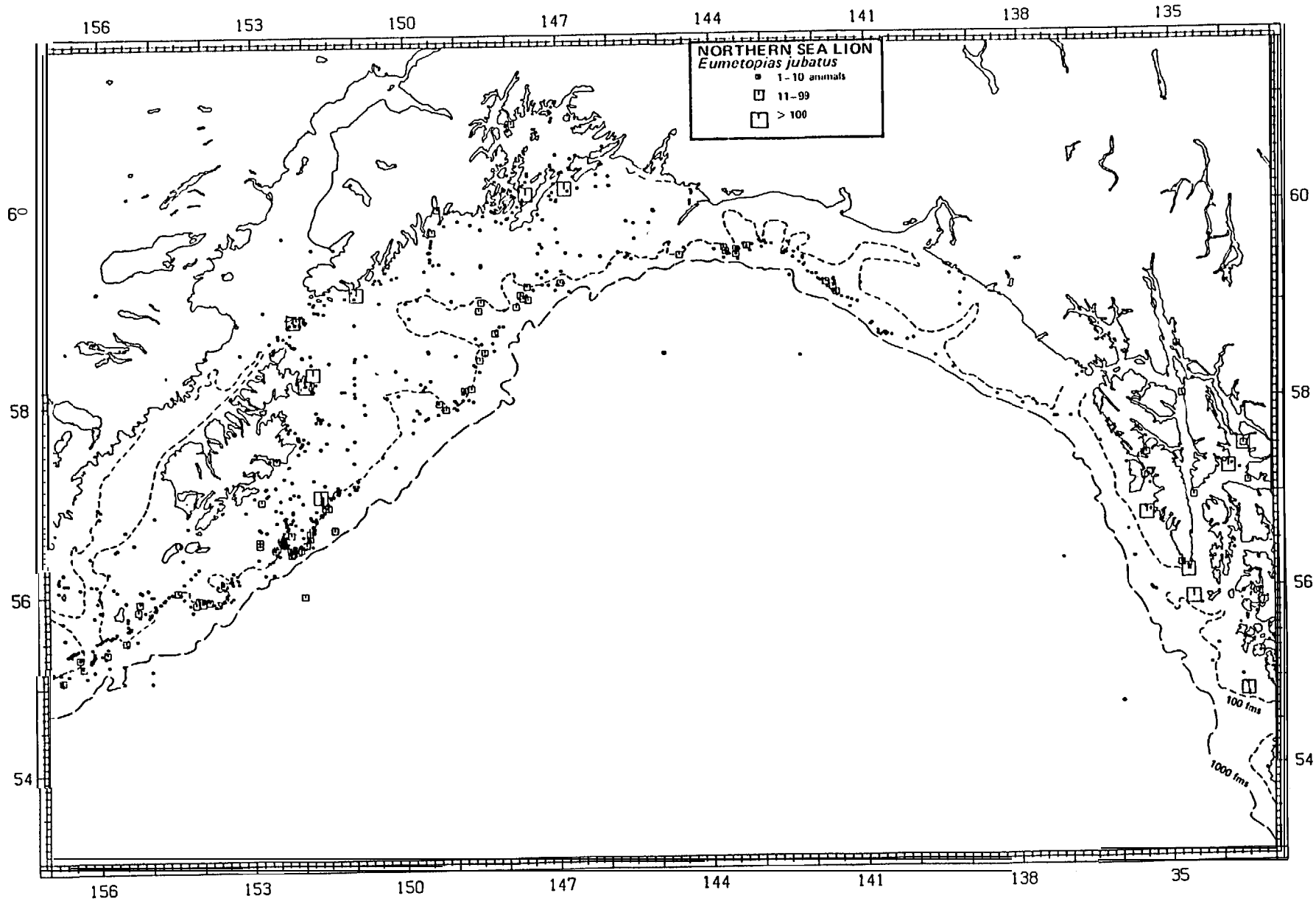

Figure 36.–Northern sea lion sightings, summer (July-September) 1958-80.

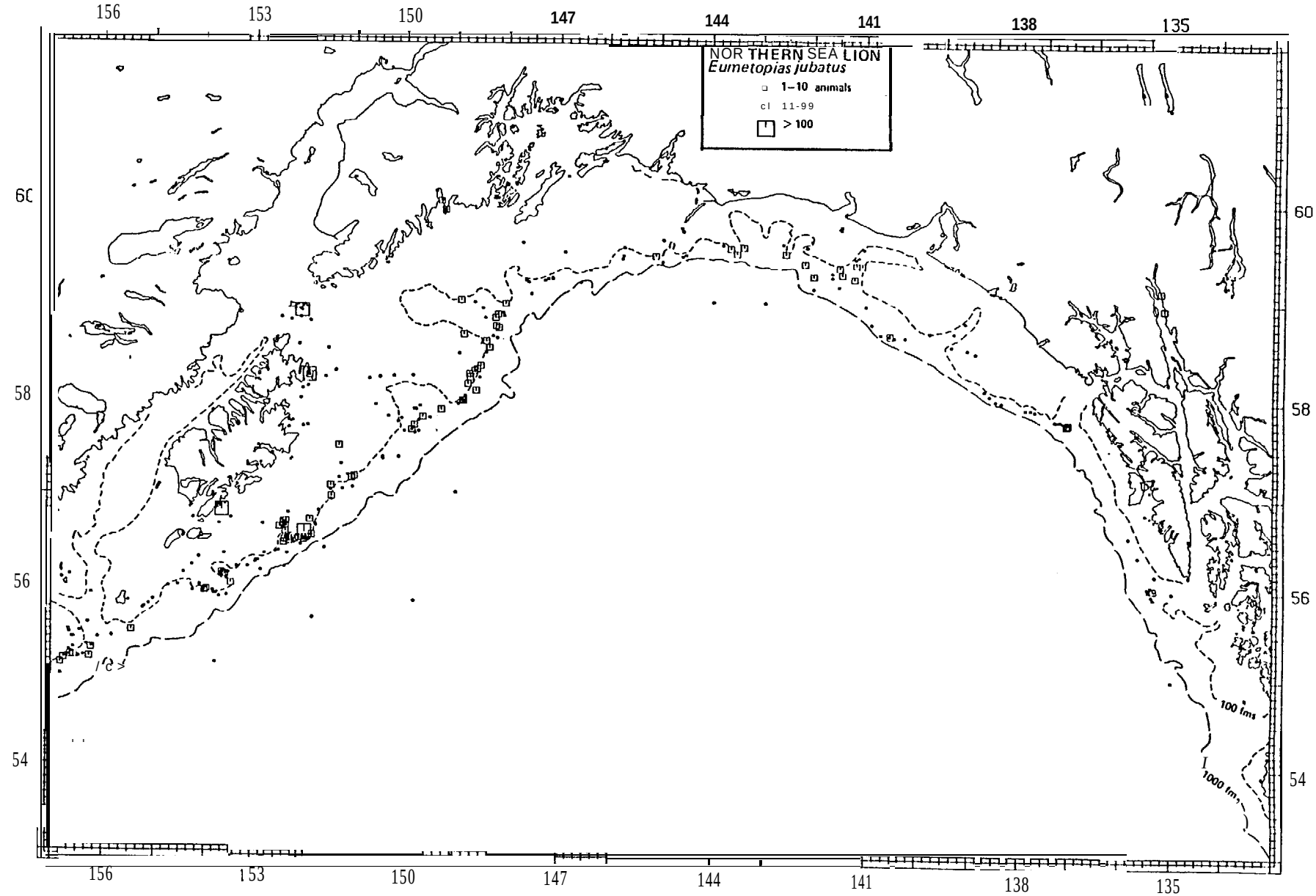

Figure 37.-Northern sea lion sightings, autumn (October-December) 1958-80.

sightings in the Gulf of Alaska, although this does not preclude the possibility of stray animals in this area, as illustrated by Schneider's sighting.

Harbor Seal (*Phoca vitulina*)

The harbor seal is distributed along virtually the entire rim of the Gulf of Alaska (Pitcher and Calkins 1979). It is generally found near shore and in relatively sheltered waters (Figures 38-41), but occurs occasionally well offshore. Figures 39 and 40 show a number of sightings offshore, though still over the shelf. Pitcher (1977) reported a number of harbor seals being spotted up to 50 miles off the coast, these usually being single animals,

The world's largest breeding colony of harbor seals is found in the Gulf of Alaska on Tugidak Island, southwest of Kodiak Island. In September 1976 the minimum population was estimated to be 13,000 seals (Pitcher and Calkins 1977).

In the Gulf of Alaska male harbor seals reach sexual maturity at 5 to 6 years of age and females usually by 5 years. Ovulation and breeding take place in late June to late July, with pupping occurring from 20 May to 25 June (Pitcher and Calkins 1979).

Using frequency of occurrence as an indicator of prey importance, fishes made up approximately 74% of the harbor seal diet, cephalopods 22% and decapod crustaceans 4%. Pollock (*Theragra chalcogramma*), octopus (Octopus sp.), and capelin (*Mallotus villosus*) were the most important prey species overall, with Pacific cod (*Gadus macrocephalus*), herring (*Clupea harengus*), and sand lance (*Ammodytes hexapterus*) also being eaten (Pitcher and Calkins 1979).

Harbor seal habitat, feeding habits and distribution are thoroughly covered by Pitcher and Calkins (1979), for the Gulf of Alaska, and by Pitcher (1977) for Prince William Sound.

Northern Elephant Seal (*Mirounga angustirostris*)

Though the northern elephant seal is normally found in its breeding range of Cabo San Lazaro, Baja to Point Reyes in California during the months of November through February, it has been known to occasionally venture north into Alaskan waters (De Long 1978). The northward migrants are usually bulls, perhaps moving north to take advantage of the waters rich in food because of their need to match food intake to their rapid growth (Radford *et al.* 1965). The population was estimated to be approximately 60,000 in 1977 (LeBoeuf and Bonnell 1980).

We know of seven sightings from Alaskan waters (Table 5).

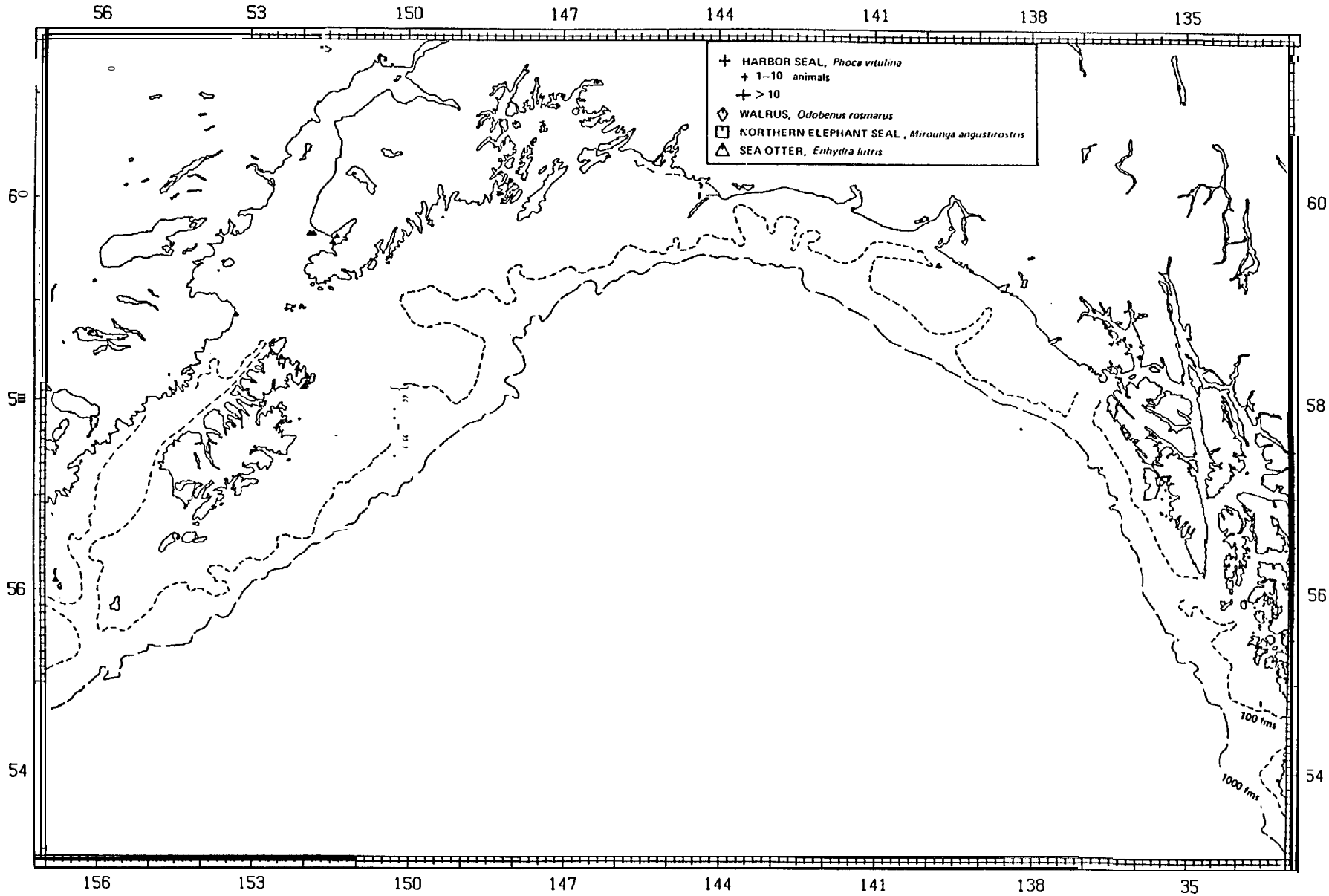

Figure 38.–Harbor seal, northern elephant seal, walrus and sea otter sightings, winter (January-March) 1958-80

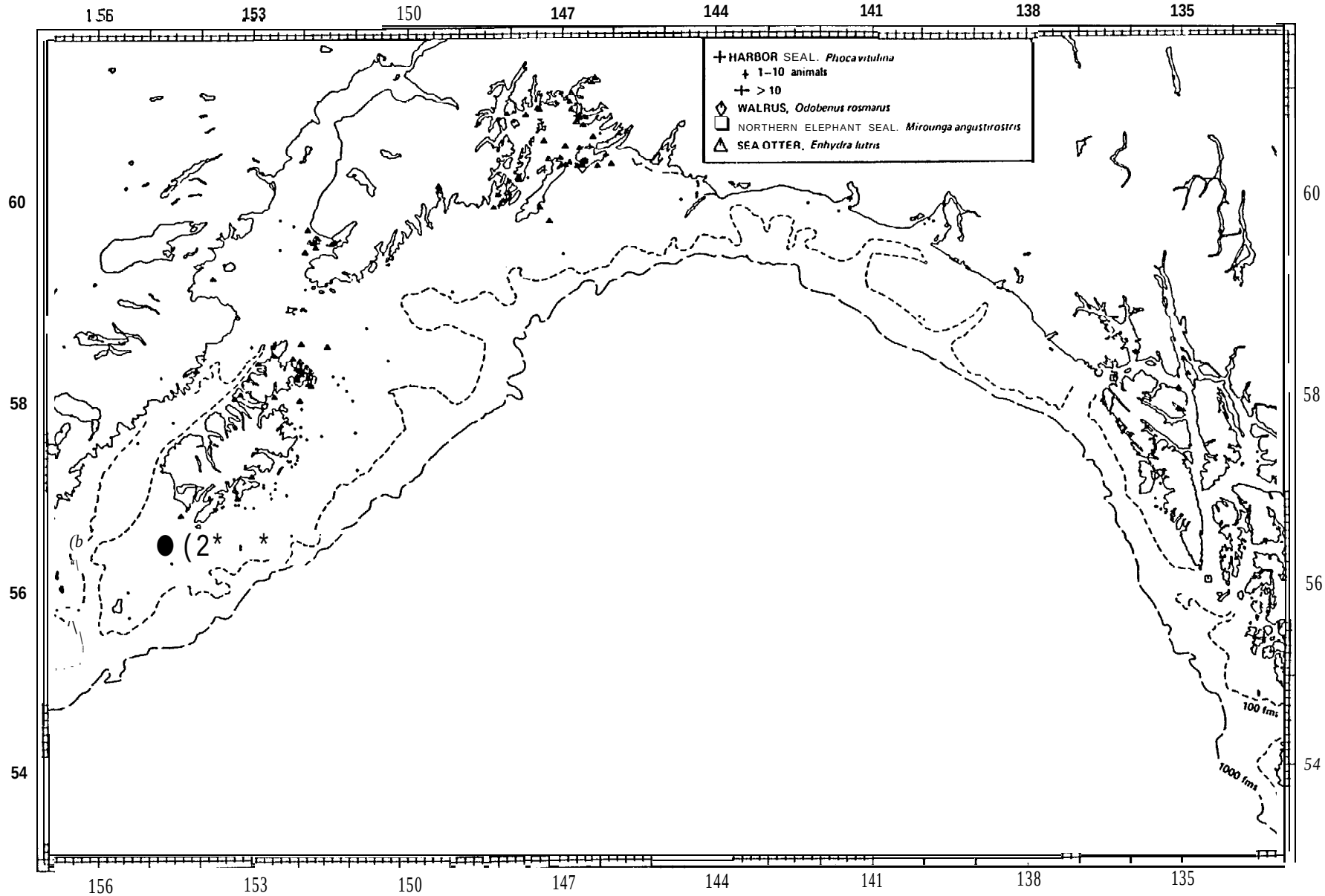

Figure 39.-Harbor seal, northern elephant seal, walrus and sea otter sightings, spring (April-June) 1958-80.

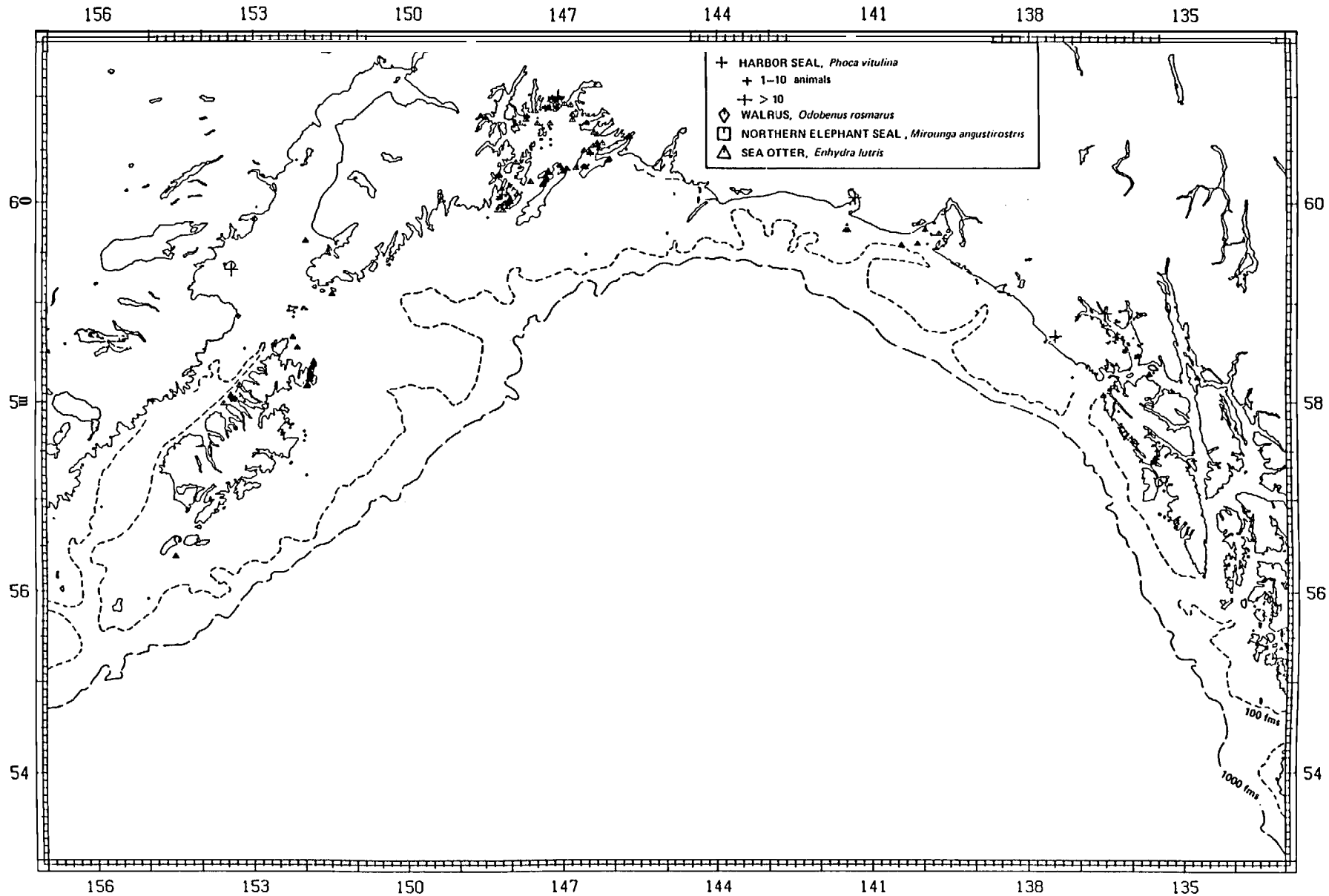

Figure 40–Harbor seal, northern elephant seal, walrus and sea otter sightings summer (July-September) 1958-80.

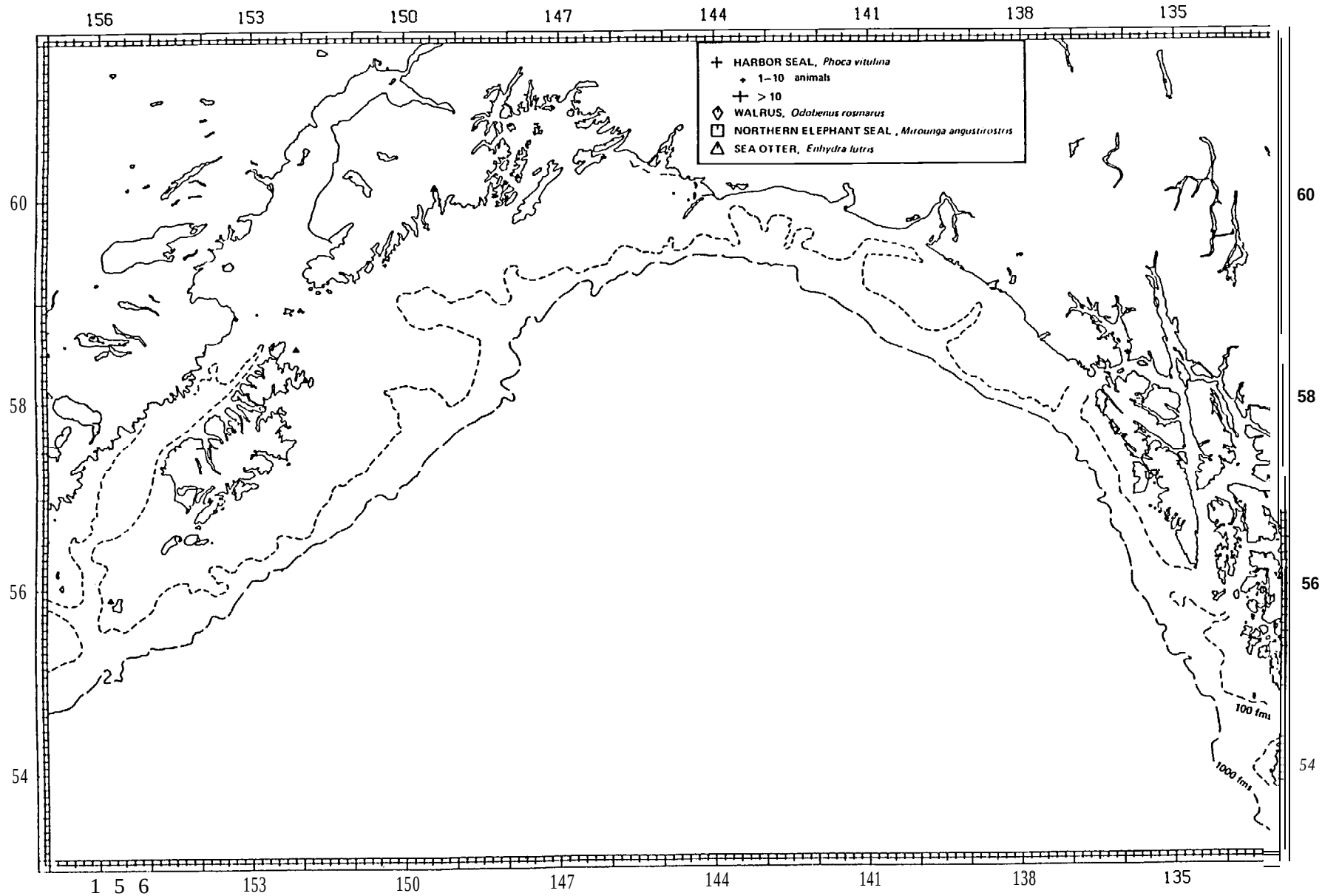

Figure 41.-Harbor seal, northern elephant seal, walrus and sea otter sightings, autumn (October-December) 1958-80.

Table 5.–Sightings of elephant seals in Alaskan waters.

Date	Location	Description	Source
February 1940	Prince of Wales Island, SE Alaska	Dead adult male	Willet 1943
5 May 1962	56°04'N 134°31'W	A live male	POP files (Figure 38)
1 June 1972	58°12'N 136°21'W	Dead	POP files (Figure 38)
April 1975	Middleton Island	Dead immature male	D. Calkins, pers. commun.
29 May *1975*	59°21'N 145°51'W (near Middleton I.)	Alive	POP files
4 July 1977	Ugamak Island (Unimak Pass)	Young male	D. Withrow, pers. commun.
July *1978*	Ugamak Island	Young male	D. Withrow, pers. commun.

Walrus (*Odobenus rosmarus*)

The normal range of the Pacific walrus extends from Bristol Bay in the southeastern Bering Sea to the Chukchi Sea, and, for the most part, is closely associated with the movement of pack ice. Aerial surveys flown in 1975 resulted in a population estimate of about 200,000 animals (± 40%) in the Bering and Chukchi seas (Estes and Gilbert 1978). Though most of these animals follow the ice northward in late spring and summer, a large and increasing number spend the summer on Round Island, in northern Bristol Bay. The Round Island population (composed almost exclusively of males) increased from about 2,000 in 1958 (Kenyon 1978) to 8,000-10,000 in 1976 (Krogman *et al.* 1979), to 12,000-18,000 by 1981, (J. Taggart, pers. commun.). As this population has increased, so has the number of sightings south of the Alaska Peninsula and in the Gulf of Alaska.

Murie (1959) reported records of walrus sightings from the 1700s to the early 1900s, though not in any numbers. Calkins *et al. (1975) reported* sighting *records* of *walruses in* Prince William Sound and Cook Inlet. Bailey and Faust (1981) sighted a single walrus at both Spitz and Mitrofania islands on 5 July 1979 and reported an observation of three walruses in Chignik Bay in July 1979. The Alaska Department of Fish and Game has received sightings

of walruses over the past 4 years from the south side of the Alaska Peninsula to Icy Bay, most frequently around Sanak Island, 60 nmi east of Unimak pass (J. Burns, pers. commun.).

Two walrus sightings, both from Cook Inlet, are in the POP files (Figure 40). Personnel aboard the NOAA ship *Rainier* sighted a lone walrus at 61°15'N, 149°53'W on 2 July 1979. From the NOAA ship *Fairweather* a lone sighting of a walrus was made at 59"50'N 152°59'W on 14 July 1979.

Given the current high (expanding) Bering Sea walrus population, it is reasonable to expect some occasional sightings in the Gulf of Alaska.

Sea Otter (*Enhydra lutris*)

Sea otters were sighted near shore during all seasons (Figures 37-40). Sightings were restricted to coastal waters, mainly near Afognak Island and Prince William Sound. Tentative sightings farther offshore (not depicted) in all probability represent storm-blown sea otters or misidentified northern fur seals.

DISCUSSION

Northeast Gulf (Site No. 55)

Endangered Cetaceans

The northeast Gulf of Alaska is (or was historically) a seasonal feeding or migratory area for all species of endangered cetaceans, especially the area adjacent to Fairweather Ground and southeast ofYakutat Bay. Virtually the entire population of gray whales migrates nearshore between the sale site and the coast twice annually, with some animals undoubtedly entering at least the mouth of Yakutat Bay. Increased boat traffic associated with oil development may also have a negative impact on gray and humpback whales. As previously related, vessel traffic in Baja California displaced breeding gray whales. On the other hand, migrating gray whales pass through areas of heavy vessel traffic off California twice annually and apparently are little disturbed. If anything, heavy vessel traffic around Yakutat B ay may cause an offshore dip in the normal migratory route.

Studies are currently in progress to determine what effects vessel traffic is having on the humpback whale population in southeast Alaska. The results of these studies will be directly relevant, as some of the humpbacks found in or near lease site No. 55 probably spend some time in southeast Alaska waters and/or Prince William Sound as well, during any year. Some 5-10 humpback whales have been noted in Yakutat Bay over the past decade by local fishermen, often in association with herring runs in late June and early July. These animals move in and out of the bay (thus they could be different groups using the area). During the

summer of 1981, only a few humpback whales were sighted in the bay (Sarah Hinckley, NMFS, pers. commun.). Whether this apparent decrease in use of the bay is related to increased vessel activity or natural environmental changes (i. e., a shift in prey abundance) is uncertain.

The northeast Gulf of Alaska was not known as a former area of particular abundance for the highly endangered right whale, yet these cetaceans are coastal in nature and the nearshore waters of the eastern Gulf were probably part of the migratory corridor for right whales moving from coastal Californian and Mexican breeding grounds to summering grounds in the western Gulf and eastern Aleutian Islands. It is of interest to note that three of the four tentative sightings of right whales since 1977 occurred in the northeast Gulf ofAlaska, though these cannot be cited as proof that right whales occur there. Right whale numbers are so low throughout the North Pacific that they are probably on the verge of extinction. Any type of disturbance, direct or indirect, from OCS development would be especially deleterious.

Blue and sei whale sightings have been very rare in the entire study area over the past 20 years, yet the northeast Gulf is an area of previous high density. We believe that blue and sei whale populations are significantly depleted throughout the Gulf of Alaska, especially blue whale populations, and thus, as in the case of right whales, any disturbance related to OCS development would have a negative impact on them.

Fin whales appear to favor the central and western areas of the Gulf of Alaska during summer months, with few apparently remaining in the eastern Gulf. They do, however, pass through lease site No. 55 during spring and autumn.

Sperm whales occasionally traverse lease site No. 55; mostly solitary old bulls and gregarious young males. Their generally offshore distribution, along with their benthic feeding habits, should ensure relatively little disturbance to the population in the northeast Gulf of Alaska.

Small Cetaceans

Six species of small cetaceans appear to use the northeast Gulf as summer feeding grounds: minke whale, killer whale, white whale, Pacific white-sided dolphin, Dan porpoise, and harbor porpoise.

Minke whales are known to be seasonal residents ofYakutat Bay and to visit the shelf, slope, and deepwater areas to the south and southeast. Both killer whales and white whales are observed annually entering Yakutat Bay in connection with salmon runs-killer whales in small groups, and white whales in groups of 10 to 20. The white whales have been observed for the past decade, yet their numbers remain low. The nearest population of white whales resides in Cook Inlet, over 360 nmi distant.

Dan porpoises have been observed both in the open areas of Yakutat Bay and throughout the waters of the northeast Gulf. Ten to twenty harbor porpoises have been observed in Yakutat Bay. The presence of calves with adults indicates local breeding may

occur. Pacific white-sided dolphins apparently use lease site No. 55 as an important summer feeding area. Of the entire Gulf of Alaska, most sightings of white-sided dolphins occurred over this lease site. As this species tolerates vessel traffic and often bowrides in southern California waters, disturbance due to increased OCS-related vessel activity should be minimal. However, as white-sided dolphins often travel in groups of 100 to several thousand animals and are surface oriented, the potential for direct contract with oil in the case of a leak or blowout is greatest at lease site No. 55, more so than at other lease sites in the Gulf of Alaska.

Northern Gulf (Site No. 39)

Endangered Cetaceans

The northern Gulf of Alaska is an important feeding ground for at least one species of endangered cetacean, and is an important migratory corridor for two others. Fin whales appear to congregate in the northern Gulf around Middleton Island during the summer months, some moving farther north into Prince William Sound. Humpback whale sightings in this area are relatively sparse. As lease site No. 39 lies directly between two recognized humpback whale summering grounds, it should be considered an important transition area for animals moving between Prince William Sound and southeast Alaska. This needs study because we do not know how much, if any, exchange occurs. The migratory route of gray whales takes these endangered cetaceans along the nearshore waters of the northern Gulf. A potential area of disturbance to gray whales during migratory periods (November-January and March-June) is the eastern shore of Kayak Island. Gray whales have been observed right in the surf of Kayak Island and there may be some bunching of whales at this place as pulses of animals prepare to round Cape St. Elias.

Bull sperm whales and sei whales are present, but apparently not in large numbers during spring and probably summer. Right whales were historically present in the northern Gulf of Alaska, yet we have no positive sightings. We assume that right whales are present in this area during spring, summer, and early autumn, but in very low numbers. Blue whale sightings in this area are likewise nonexistent, yet their historical centers of abundance lay to the east and west in the Gulf.

Small Cetaceans

Killer whales and minke whales are present in the northern Gulf during spring and summer, and possibly year-round, though sightings are sparse in autumn and winter. The few white whales that move into Yakutat Bay during summer salmon runs probably pass through lease site No. 39 en route from Cook Inlet. Goosebeak and giant bottlenose whales inhabit the deep waters around the southern perimeter of this sale site, but are rare. Dan porpoises are abundant in the northern Gulf from spring through autumn, and are probably year-round residents, though winter sightings are few. Harbor porpoise sightings are sparse, though this species is abundant in nearby Prince William Sound, and the Copper River delta. Pacific white-sided dolphins appear to favor the slope between the 100- and 1,000-fathom contours in the

northern Gulf. Several sightings of large groups (> 100 animals) of white-sided dolphins are on record during both spring and summer.

Western Gulf-Kodiak (Site No. *46)*

Endangered Cetaceans

The migratory path of gray whales takes most of the entire population along the eastern nearshore edge of Kodiak Island, numbers being highest during April and May and in late November and December. Except near the Trinity Islands and Chirikof Island (south of Kodiak Island), gray whales probably pass near shore rather than through the sale site blocks proper. Direct effects from an oil well blowout, coupled with persistent onshore winds and currents, would likely only occur shoreward from the lease sites. Present vessel disturbance is expected to be minimal in this area, as most traffic is fisheries-related and occurs during the late spring, summer, and early autumn when gray whales are generally not present. An exception might be when vessel traffic is moving into nearshore coastal waters of Kodiak. An unquantified but small number of gray whales are known to migrate through Shelikof Strait. The effects of increased use of vessels or other OCS activities on the gray whale migration are unknown, but alternate use of Shelikof Strait by gray whales during their migration may be one clue to its displacement, should it occur.

Humpback whales use the entire lease area for feeding during spring, summer, and autumn, occurring very close to shore and seaward over Albatross and Portlock banks. As with southeast Alaska and Prince William Sound, lease site No. 46 and the coastal waters of Kodiak Island are principal areas frequented by humpback whales for at least 7-8 months per year. These areas probably include vital and certainly important habitat for this species in the eastern North Pacific.

Sperm whales occur along the slope and over the deep water in and near lease site No. 46, yet are apparently few and disturbance to the population in this area from OCS development should be minimal. Females with calves remain in warmer southern waters all year.

Fin whales are seen throughout lease site No. 46, most often in small groups. However, in July of 1980 a group of approximately 63 animals was sighted between Chirikof Island and the Trinity Islands. This sighting represents the largest known group ever observed in this study area. These animals apparently were traveling. Calves were present. The significance of such a large group is not certain, but we believe the animals were capitalizing on nearby locally abundant food resources.

Sightings of blue whales, right whales, and sei whales were very infrequent, or nonexistent, over the past decade in the western Gulf of Alaska. Lease site No. 46 was historically a popular whaling area for these species, hence we believe these whales are still present but in numbers too small to provide an abundance or density estimate. Blue and right

whale populations in the North Pacific maybe particularly vulnerable to any adverse activities, thus delineation as to numbers and habitat use would be valuable information for investigating possible OCS development.

Small Cetaceans

Year-round small cetacean residents in lease site No. 46 include killer whales, Dan porpoises, and harbor porpoises. We currently have no documented resident pods of killer whales (i.e., repeat sightings of recognizable individual animals), yet they are seen with enough regularity, and their local food resources are generally abundant, that we assume some occur year-round. Dan porpoises have been sighted in all seasons throughout Alaska south of the Bering Sea, and are ubiquitous and abundant in the study area. They are attracted to vessels, on occasion, but the effects of this and subsequent development and increased traffic are unknown. Studies of ship avoidance have not been conducted. Harbor porpoises likewise are present year-round singly or in small groups, and almost always are seen in coastal, shallow waters. Sightings taper off as the continental slope is approached. Certain areas seem to support populations of harbor porpoise in the presence of light, seasonal ship traffic (Monterey, California; Copper River Delta, Alaska). However, in other areas (San Francisco Bay, California; Puget Sound, Washington), with year-round heavy vessel traffic and development activity, population declines have been witnessed (Leatherwood and Reeves 1978). Given the serious lack of behavioral and life history data on harbor porpoises in the North Pacific, it is difficult to do more than speculate on particular areas of vulnerability. We believe, however, that harbor porpoises will be impacted by coastal development, especially concentrated onshore support facilities.

It is unclear whether minke whales remain in the western Gulf of Alaska during the late autumn and winter. The numerous bays and coastal areas that provide habitat for humpback whales and harbor porpoises similarly provide seemingly ideal habitat for minke whales. However, our records contain no winter sightings in this area, and only a few autumn sightings. They are a coastal and nearshore species in the Gulf, feed heavily on fishes, and frequent the lease areas. Thus, they too might be vulnerable to impact (at least individuals), but the level or extent, of course, is unknown.

Pacific white-sided dolphins appear to move west along the edge of the continental shelf as far as Portlock Bank during the summer, although sightings are fewer in the western than the eastern Gulf of Alaska. Data on goosebeak whales and Bering Sea beaked whales are insufficient to make any assessment. White whales, northern right whale dolphins, giant bottlenose whales, Risso's dolphins, and short-finned pilot whales are rare visitors to this area and their centers of population abundance appear farther south (except the white whale). The effects of OCS development on these populations are likely to be minimal or negligible.

Lower Cook Inlet-Shelikof Strait (Site No. 60)

Endangered Cetaceans

Only three species of endangered cetacean are expected to occur in lease site No. 60: humpback whale, fin whale, and gray whale. We have no sightings of any of these three species in the actual sale site, yet each species has been seen in close proximity to the site. Effort in this area is sparse and may account, in part, for the few sightings of all species.

Humpback whales begin moving into the northwest Gulf of Alaska during the spring and use the area around the Barren Islands as a summering ground. Fin whales, as evidenced by sightings in central Shelikof Strait in March 1980, at least occasionally overwinter in or migrate early into this area. A group of approximately 21 fin whales was observed nearshore in Kinak Bay (58 °05'N, 154°22'W), Shelikof Strait in June 1980 very near the southern perimeter of lease site No. 60. Thus it is likely that fin whales occupy at least the southern section (upper Shelikof Strait) of this lease site from late winter through late spring, and possibly through summer as well. An unknown, but small, percentage of the entire gray whale population passes through (or very near) the southern section of lease site No. 60 twice annually during spring and autumn migrations.

Small Cetaceans

Killer and minke whales inhabit this sale site at least from spring through autumn. The resident white whale population in Cook Inlet appears to remain mostly in the upper end, though we expect some animals to occupy the lower end as well. Surprisingly few sightings of harbor porpoises were made in this area, though they are probably year-round residents here. Dan porpoises were found during all seasons in this lease site.

CONCLUSIONS AND RECOMMENDATIONS

Catch per unit effort (CPUE) data for population estimates have not been available for the balaenopterid whales (blue, sei, fin, minke, humpback) since their protection in the 1960s and early 1970s and do not exist for the right whale. Sperm whale population estimates have varied widely over the past decade, though numbers based on catch per unit effort are current and indicate healthy stocks. In fact, the gray whale is the only endangered cetacean for which we have good confidence of how many pass through the Gulf of Alaska.

Offshore migratory routes and patchy distributions of endangered cetaceans result in limited success of vessel surveys over large areas. A 1977 Japanese vessel survey, covering 22,143 linear nautical miles of the North Pacific, yielded sightings of 11 fin, 33 sei, 7 blue, 6 humpback, and 4 right whales (Wada 1979). Obviously, indices of abundance and population estimates extrapolated from such low figures are of limited utility. Rice and Wolman (1982) covered 3,303 linear nautical miles in the Gulf of Alaska in 1980 and saw too few endangered

cetaceans to calculate statistical y valid population estimates. They estimated a Gulf of Alaska summer population of 159 fin whales (based on 13 animals seen during transects) and 306 (25 animals seen) humpback whales (without confidence limits), yet other 1980 POP data indicate that their fin whale estimate was low. Sightings of 21 and 63 fin whales (two groups) were made in the general area bounded by the Semidi Islands, Chirikof Island, and middle Shelikof Strait in June 1980 (unpubl. POP data).

This example of differing counts of fin whales is where the utility of our marine mammal Platforms of Opportunity Program is realized. At very little cost, suspected areas of high cetacean density may be discovered, incorporated into the POP system and made available for planning studies in the Alaska region. To provide greater meaning to abundance and distribution assessment, the accumulation of greater amounts of data including systematic studies in known or probable high density areas will be necessary.

Based on our combined shipboard experience of over 150,000 nmi in Alaskan waters during all seasons since 1958, we believe that prevailing sea states and low ceilings eliminate the practicality of offshore aerial surveys except during summer. Scott and Winn (1980:3), comparing aerial and vessel surveys of humpback whales, concluded that "the shipboard platform yielded sampling estimates that were both more accurate and precise than the aerial estimates and that shipboard platforms be used when practical." The utility of aerial survey is greater coverage in a shorter time period at somewhat reduced expense, depending on aircraft versus vessel charter costs.

After assessment of the estimated population sizes, evidence for recovery (potential), and seasonal use of habitat in or adjacent to the four OCS lease sites in the Gulf of Alaska, we believe that a ranking can be made of the potential for vulnerability by species by lease area (Table 6). The gray whale ranks high among all species because it might be the species most likely affected throughout the Gulf from onshore activities such as tanker traffic and coastal oil spills. However, the right and humpback whales are clearly the more "vulnerable" species because of their low population sizes. In term of endangered status, right and humpback whales are of particular concern.

The following abbreviated research subjects are recommended for the endangered species. These studies should add to our understanding of habitat use, areas of concentration, and population structure.

Fin *Whales*

1. Conduct aerial or vessel surveys of the Shelikof Strait, Kodiak Island, and Semidi Island area to ascertain the seasonal distribution and density of fin whales. Systematic surveys would help determine temporal or spatial use patterns near and adjacent to the existing oil lease areas from lower Cook Inlet to Kodiak Island. These areas, and to a lesser degree off Yakutat (Fairweather Ground), are identified areas of fin whale occurrence.

Table 6.–Relative rankings of endangered whales by lease site in the Gulf of Alaska believed to be affected by oil and gas activities should any effects result. Ranks were judged to be related to each species population status (relative to each other) and evaluated on the basis of abundance, time spent in or adjacent to each lease site, and habitat use patterns. These are subjective judgments by the authors.

Northern GOA (Lease No. 39)	Kodiak (Lease No. 46)	Northeast GOA (Lease No. 55)	Shelikof Strait-Lower Cook Inlet (Lease No. 60)
Gray whale	Humpback whale	Gray whale	Humpback whale
Humpback whale	Gray whale	Humpback whale	Fin whale
Right whale	Right whale	Right whale	Gray whale
Fin whale	Fin whale	Blue whale	Right whale
Blue whale	Blue whale	Sei whale	
Sei whale	Sei whale	Fin whale	
Sperm whale	Sperm whale	Sperm whale	

2. Aerial photogrammetry ofindividual sizes of each group may provide insight to herd (or population) composition and give some indication of production. Generally speaking, no data are available on the presence of fin whale calves in the Gulf of Alaska.

3. Radiotagging of individuals in large groups may provide insight into group cohesiveness and movements from this area to other areas in the Gulf of Alaska. This may provide further information on the identity of stocks or geographic units which remain in one area during the year, or whether the animals are diffusely distributed and simply move in and out of the study area among seasons.

Gray Whales

1. Aerial surveys and onshore observations canvassing the waters north of Kodiak and Afognak islands during spring and autumn migration should be conducted to determine what percentage of this population migrates through Shelikof Strait rather than along the southeastern coast of Kodiak Island.

2. Aerial surveys and shore observations at proposed lease site support shore facilities (Kodiak Island, Yakutat Bay, others) to document the frequency versus offshore migratory patterns are needed.

3. Feeding and behavior observations during migration should be conducted to determine what time is spent feeding and to document feeding areas, and thus assess the importance of feeding and these areas to the movements of gray whales.

Humpback Whales

1. Collection of fluke photographs throughout the Gulf of Alaska to determine interchange between apparently local populations, and provide clues to migratory routes between winter and summer grounds and within Alaskan waters; and potential stock identity.

2. Documentation of previously unreported summering areas. Recent studies have focused on Prince William Sound and southeast Alaska. Our data indicate Yakutat Bay, the Barren Islands, and other coastal waters and bays (e.g., Chiniak Bay and Alitak Bay) of Kodiak Island are areas which also provide important seasonal habitat (food supplies?). Little or no documentation of numbers, movements, or behavior are available, however.

Right, Blue, and Sei Whales

It seems likely that the numbers of right and blue whales in the Gulf of Alaska are so low that any population increases (and there is no basis to assume these two populations are increasing) would go undetected for at least several decades. The North Pacific sei whale population, on the other hand, appears to be viable, yet sightings in the Gulf ofAlaska are few. They are likely found farther south in summer. However, their apparent scarcity maybe due to their habit of traveling singly or in very small groups.

Continuation and upgrading of the POP through cooperation with more groups, supplying better training for more individuals, and greater dedication to quantifiable observer effort is warranted before any additional conclusion can be reached concerning the presence and possible vulnerability of right, blue, and sei whales-of most whales, for that matter.

Sperm Whale

As few sperm whales enter the study area (relative to their more southern center of distribution), no specific studies are recommended. Most pelagic studies can be generalized to study all species. Coastal or site-specific studies have special relevance (e.g., gray whale migration, humpback or fin whale concentrations off Kodiak or Shelikof Strait, respectively).

Other Cetaceans

Other than Hall's (1979) estimate of 1,946 harbor porpoises inhabiting Prince William Sound and the nearby Copper River delta, no abundance or refined distribution estimates are

available in the Gulf of Alaska for this species. The same may be said of minke and killer whales as well. As these three species frequent nearshore waters, their distribution is underrepresented in our data base. The amount of presumably acceptable habitat in the Gulf of Alaska is large, particularly around Kodiak Island and Shelikof Strait. A habitat classification scheme (based on presumed requirements) may prove useful in extrapolating distribution and abundance estimates. Further study of the food resources and oceanographic literature is recommended as an extension of our study. Nearshore aerial or small craft surveys conducted during periods of (presumed) maximum (summer) and minimum (winter) abundance would delineate current habitat use, or at least presence and absence, and provide the basis for density or abundance estimates as well.

In addition, such surveys, when combined with offshore vessel surveys, should aid in determining seasonal onshore-offshore movements of these small cetaceans as well as of fin, gray, and humpback whales which seasonally frequent nearshore waters.

C. Harrison (pers. commun.) sighted 117 groups of Dan porpoises during aerial surveys in the Gulf of Alaska and Bering Sea, yet observed no roostertailing behavior. Thus it may be that roostertailing occurs mainly as a response to vessels. If Dan porpoises slow-roll normally, then vessel sighting surveys may miss a (significant?) portion of the animals present due to their inconspicuousness. Simultaneous aerial-vessel studies are needed to determine:(1) Dan porpoises attraction/avoidance to vessels, and (2) a rough percentage of Dan porpoises which roostertail (thus increasing the likelihood of being observed) in the presence of vessels. Appropriate correction factors may then be applied to current estimation techniques (Bouchet 1981).

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APPENDIX A

List of vessel cruises, 1958-80, from which marine mammal sighting data were used. Data came from National Marine Mammal Laboratory (NMML) personnel during pelagic fur seal (PFS), OCSEAP (OCS) related, and Dan porpoise (DP) research, and from vessels which contributed as part of the marine mammal Platforms of Opportunist y Program (POP). "Dates" are the approximate cruise periods.

Dates	Vessel	Observers
23 Feb - 11 Jun 1958	Lindy (C)*	NMML (PFS)
11 May - 1 Jun 1958	Trinity (C)	NMML (PFS)
3 Mar - 2 Jun 1960	Tacoma (C)	NMML (PFS)
21 Apr - 25 Aug 1960	Windward (C)	NMML (PFS)
6 Feb - 5 Mar 1961	Harmony (C)	NMML (PFS)
5 May - 20 Sep 1962	Tacoma (C)	NMML (PFS)
October 1962	Harmony (C)	NMML (PFS)
24 Jun - 11 Sep 1963	Harmony (C)	NMML (PFS)
June 1964	Harmony (C)	NMML (PFS)
18 May - 24 Aug 1968	New St. Joseph (C)	NMML (PFS)
21 Mar - 24 Aug 1974	Fairweather (N)	POP
28 Jan - 5 Mar 1975	Oceanographer (N)	POP
5 Mar - 15 Aug 1975	McArthur (N)	POP
3 Apr - 13 Jul 1975	Oregon (N)	POP
22 Apr - 26 Aug 1975	Rainier (N)	POP
28 Apr - 9 Jun 1975	Townsend Cromwell (N)	POP
6 May - 22 Ott 1975	Davidson (N)	POP
9 May - 23 Jun 1975	Discoverer (N)	POP
31 May - 10 Aug 1975	Tordenskjold (C)	POP
5 Aug - 5 Dec 1975	Discoverer (N)	POP
7 Apr - 30 Apr 1976	Discoverer (N)	POP
29 Apr - 22 Jun 1976	Polar Star (G)	POP
9 Mar - 2 Apr 1976	Surveyor (N)	NMML (OCS)
6 Jun - 25 Jun 1976	Surveyor (N)	NMML (OCS)
8 Jun - 22 Jun 1976	Miller Freeman (N)	NMML (OCS)
18 Feb - 3 Nov 1976	Davidson (N)	POP
19 Feb - 27 Ott 1976	McArthur (N)	POP
19 Feb - 21 Sep 1976	Rainier	POP
29 Feb - 16 Sep 1976	Midgett (G)	POP
6 Apr - 28 Oct 1976	Discovery (C)	POP
26 Jun - 13 Dec 1976	Surveyor	POP
21 May - 21 Sep 1976	Tordenskjold (C)	POP
4 Aug - 27 Aug 1976	Moana Wave (RV)	NMML (OCS)
20 May - 17 Aug 1976	Discoverer (N)	POP
27 Apr - 16 Jun 1977	Discoverer (N)	POP
22 Jun - 13 Jul 1977	Surveyor (N)	POP
16 Feb - 25 Mar 1977	Miller Freeman (N)	NMML (OCS)
18 Jul - 29 Sep 1977	Miller Freeman (N)	POP
10 Apr - 1 Sep 1977	Oregon (N)	POP
2 Jun - 21 Sep 1977	Professor Siedlicki (RV)	POP

APPENDIX A (Continued)

hates	Vessel	Observers
21 Mar - 20 Ott 1977	Discovery (C)	POP
23 Oct - 16 Dec 1977	Morgenthau (G)	POP
10 Sep - 31 Ott 1977	Rush (G)	POP
10 Jun - 10 Sep 1977	Alaska Ferries (F)	POP
3 M y - 22 Aug 1977	McArthur (N)	POP
13 Apr - 28 Aug 1977	Rainier (N)	POP
17 May - 13 Sep 1977	Fairweather (N)	POP
13 Mar - 23 Apr 1977	Discoverer (N	POP
20 Jul - 21 Nov 1977	Surveyor (N)	POP
1 Jun - 2 Nov 1977	Davidson (N)	POP
6 Mar - 5 May 1977	Surveyor (N)	POP
27 Jul - 17 Nov 1977	Discoverer (N)	POP
26 May - 4 Sep 1977	Alaska Ferries (F)	POP
15 Jul - 7 Sep 1977	Midgett (G)	POP
25 Aug - 24 Ott 1977	Boutwell (G)	POP
13 Jul - 28 Jul 1977	Rush (G)	POP
5 Jan - 24 Dec 1977	For. Vessel Ohs. Program	POP
21 May - 11 Jun 1978	Discoverer (N)	NMML (DP)
14 Jun - 14 Jul 1978	Western Viking	NMML (OCS)
18 Jun - 1 Sep 1978	Commander (C)	NMML (DP)
20 Jun - 9 Jul 1978	Surveyor (N)	NMML (DP)
21 Jun - 29 Jun 1978	Cobb (N)	NMML (DP)
21 Jun - 15 Jul 1978	Seahawk (C)	NMML (DP)
8 Aug - 15 Sep 1978	Surveyor (N)	NMML (DP)
26 Ott - 28 Nov 1978	Rush (G)	NMML (DP)
13 Jan - 1 Aug 1978	Mellow (G)	POP
20 Jan - 7 Sep 1978	Fairweather (N)	POP
22 Jan - 16 Jun 1978	Midgett (G)	POP
11 Feb - 9 Jun 1978	Miller Freeman (N)	PGP
14 Feb - 20 Apr 1978	Surveyor (N)	POP
1 Mar - 15 May 1978	Discoverer (N)	POP
21 May - 29 Nov 1978	Jarvis (G)	POP
8 Apr - 23 Ott 1978	Oregon (N)	POP
4 Jun - 4 Sep 1978	Alaska Ferries (F)	POP
24 Jun - 19 Dec 1978	Storis (G)	POP
16 Apr - 29 Jul 1978	Jolene (P)	POP
19 Apr - 28 Aug 1978	Rainier (N)	POP
8 May - 21 Ott 1978	Discovery (C)	POP
24 May - 21 Aug 1978	McArthur (N)	POP
27 Jun - 5 Ott 1978	Davidson (N)	POP
10 Aug - 16 Dec 1978	Morgenthau (G)	POP
20 Aug - 28 Ott 1978	BoutWell (G)	POP
26 Aug - 20 Nov 1978	Miller Freeman (N)	POP
8 Nov - 26Dec 1978	Shore-R. Macintosh	POP

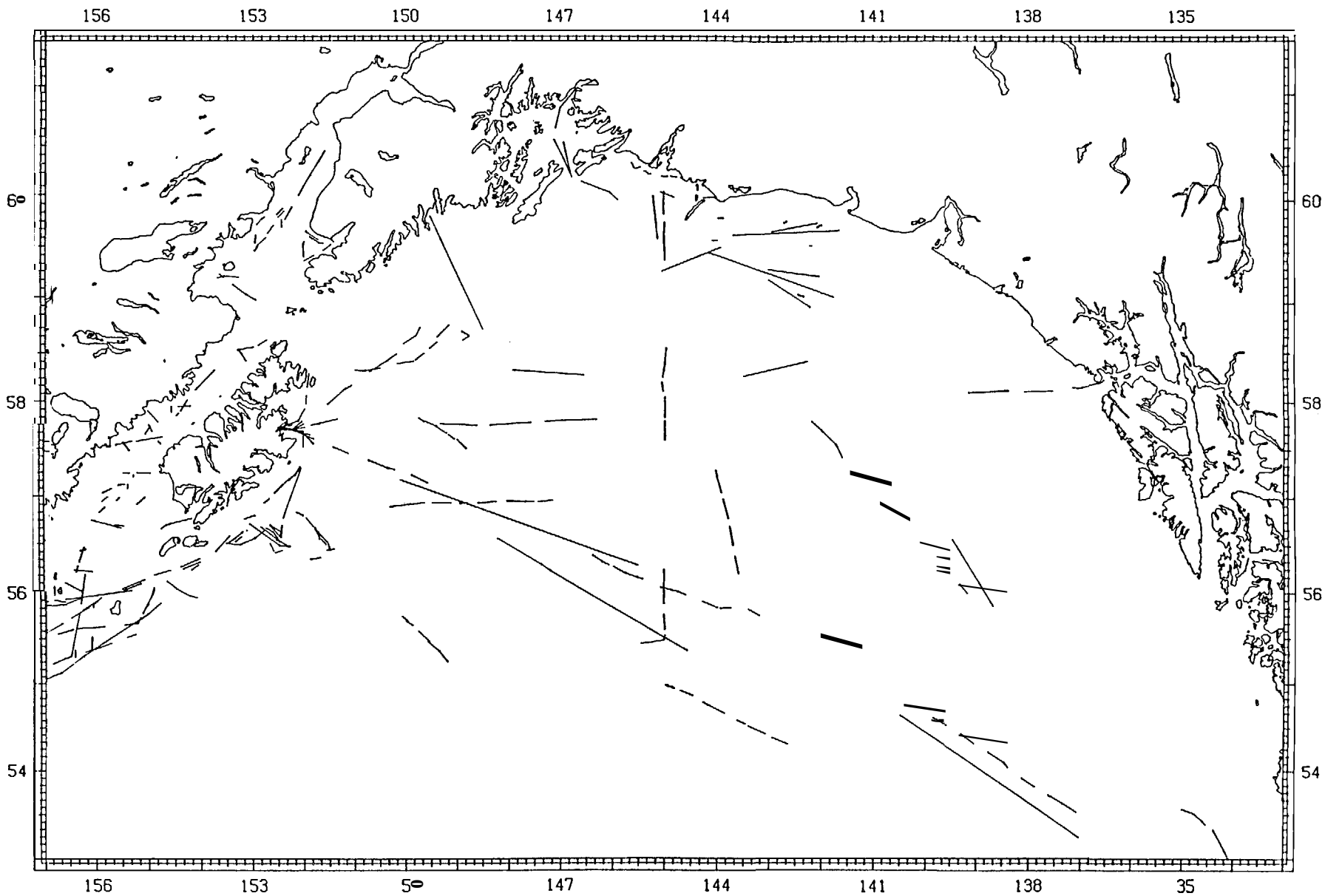
APPENDIX A (Continued)

Dates	Vessels	Observers
14 Jan - 10 Dec 1978	For. Vessel Ohs. Program	POP
6 Jun - 11 Aug 1979	Oshoro Maru (RV)	NMML (DP)
7 Jan - 17 Nov 1979	Discoverer (N)	POP
17 Jan - 22 Dec 1979	Miller Freeman (N)	POP
28 Jan - 6 Sep 1979	Fairweather (N)	POP
31 Jan - 13 Dec 1979	McArthur (N)	POP
3 Feb - 18 Nov 1979	Surveyor (N)	POP
19 Feb - 27 Jun 1979	Midgett (G)	POP
3 Mar - 9 Apr 1979	Boutwell (G)	POP
21 Feb - 2 May 1979	Davidson (N)	POP
29 Mar - 20 Aug 1979	Rainier (N)	POP
11 Apr - 3 Nov 1979	Jarvis (G)	POP
19 Jun - 1 Aug 1979	Munro (G)	POP
10 Jun - 11 Sep 1979	Alaska Ferries (F)	POP
3 Jul - 16 Aug 1979	Paragon II (C)	POP
7 Jul - 18 Aug 1979	Boutwell (G)	POP
22 Feb - 12 Apr 1979	Polar Sea (G)	NMML (OCS)
1 Jan - 28 Dec 1979	For. Vessel Ohs. Program	POP
18 Jul - 26 Aug 1980	US Dominator (C)	NMML (OCS)
6 May - 18 Sep 1980	Davidson (N)	POP
8 Ott - 30 Ott 1980	Miller Freeman (N)	NMML (PFS)
13 Jun - 11 Aug 1980	Arete (F)	POP
12 May - 12 Nov 1980	Lt. Station Five Fingers (G)	POP
19 Jun - 21 Jul 1980	Stellar (F)	POP
7 Aug - 13 Sep 1980	Munro (G)	POP
16 Jun - 14 Sep 1980	Resolute (G)	POP
25 May - 14 Jul 1980	Midgett (G)	POP
7 Jun - 22 Jul 1980	Storis (G)	POP
9 Feb - 15 Jun 1980	Firebush (G)	POP
5 Apr - 14 Aug 1980	Fairweather (N)	POP
21 May - 10 Ott 1980	Oceanographer (N)	POP
31 May - 6 Sep 1980	Alaska Ferries (F)	POP
30 Jul - 10 Sep 1980	Rush (G)	POP
5 Jun - 13 Aug 1980	Oshoro Maru (RV)	NMML (POP)
.2 Jan - 28 Dec 1980	For. Vessel Ohs. Program	POP
31 May - 5 Ott 1980	Surveyor (N)	NMML (OCS)
19 Aug - 27 Aug 1980	Rainier (N)	NMML (OCS)
11 Jan - 11 Mar 1980	Midgett (G)	NMML (OCS)
5 Feb - 30 Mar 1980	Discoverer (N)	NMML (OCS)
15 Jan - 7 Mar 1980	Miller Freeman (N)	NMML (OCS)
12 Mar - 28 Mar 1980	Miller Freeman (N)	NMML (OCS)
22 Apr - 2 May 1980	Miller Freeman (N)	NMML (OCS)

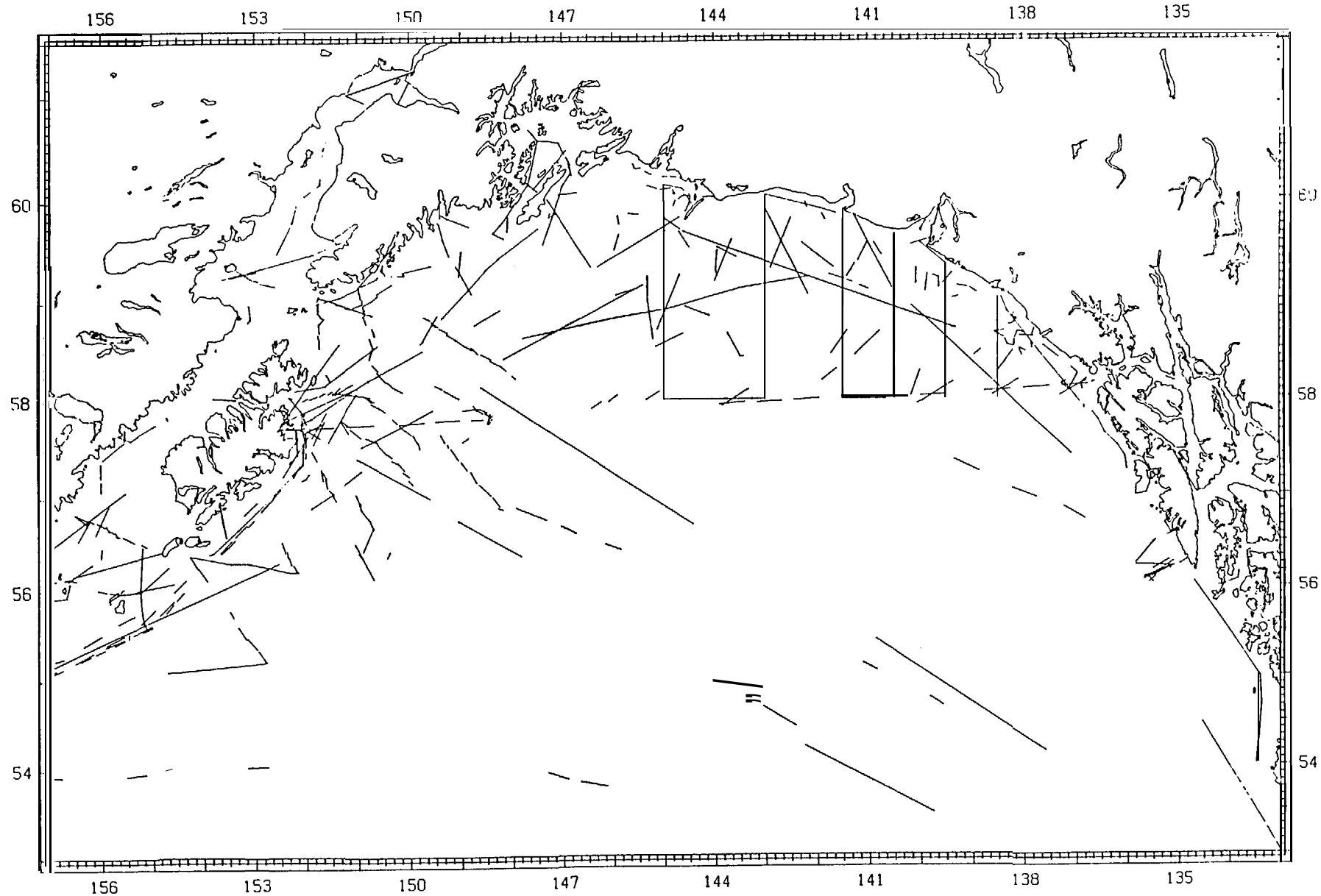
* (N) - NOAA; (G) - Coast Guard; (C) - Charter; (F) - Forest Service; (RV) For. Government or University Research Vessel; (P) - Privately owned.

APPENDIX B

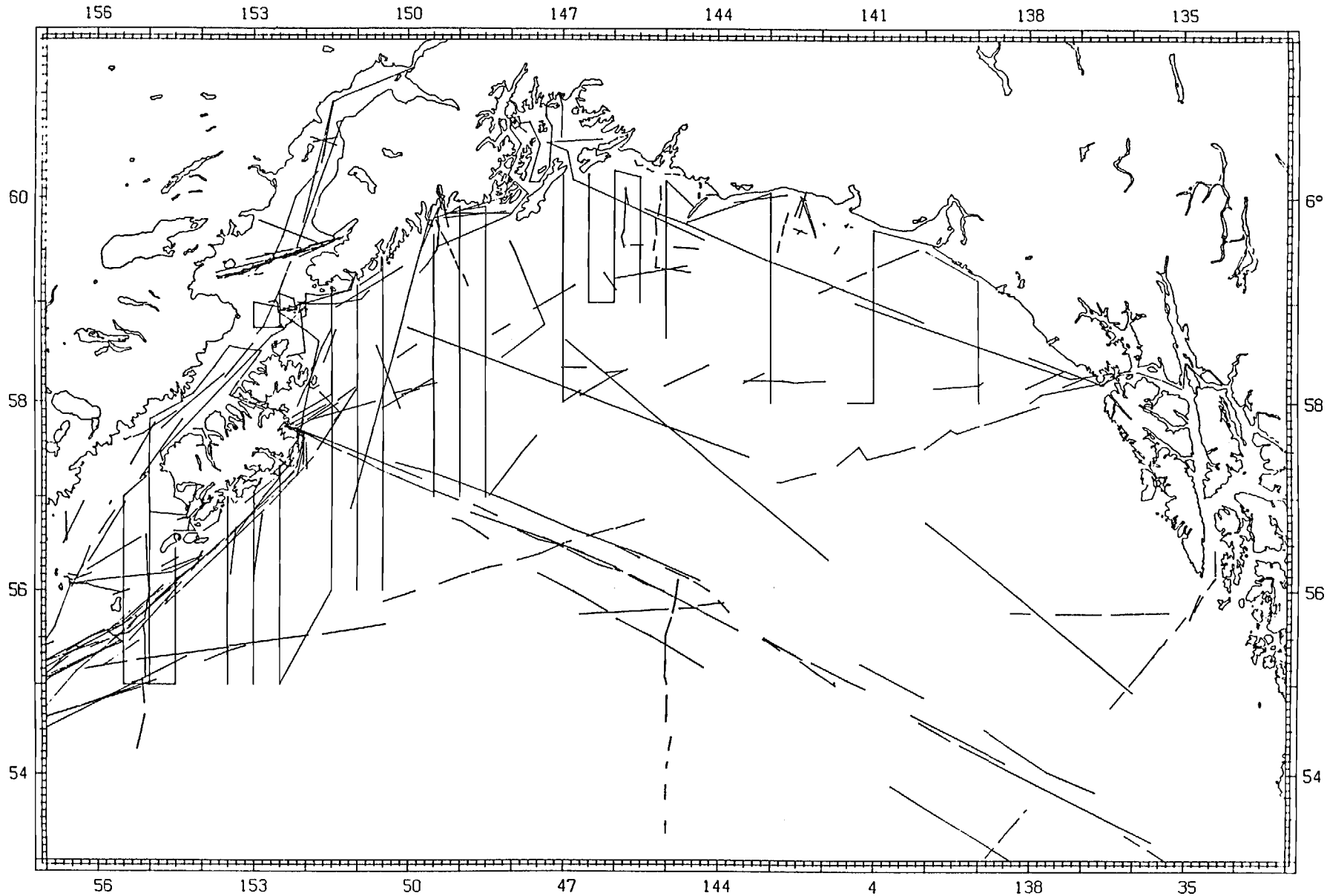
Effort plots: cruise tracks for ships where there was specific watch effort for marine mammals. Effort included beginning and ending time and position of each cruise leg when an observer was actively scanning the sea surface for marine mammals; and sighting position. Most data are from 1975 to 1980.



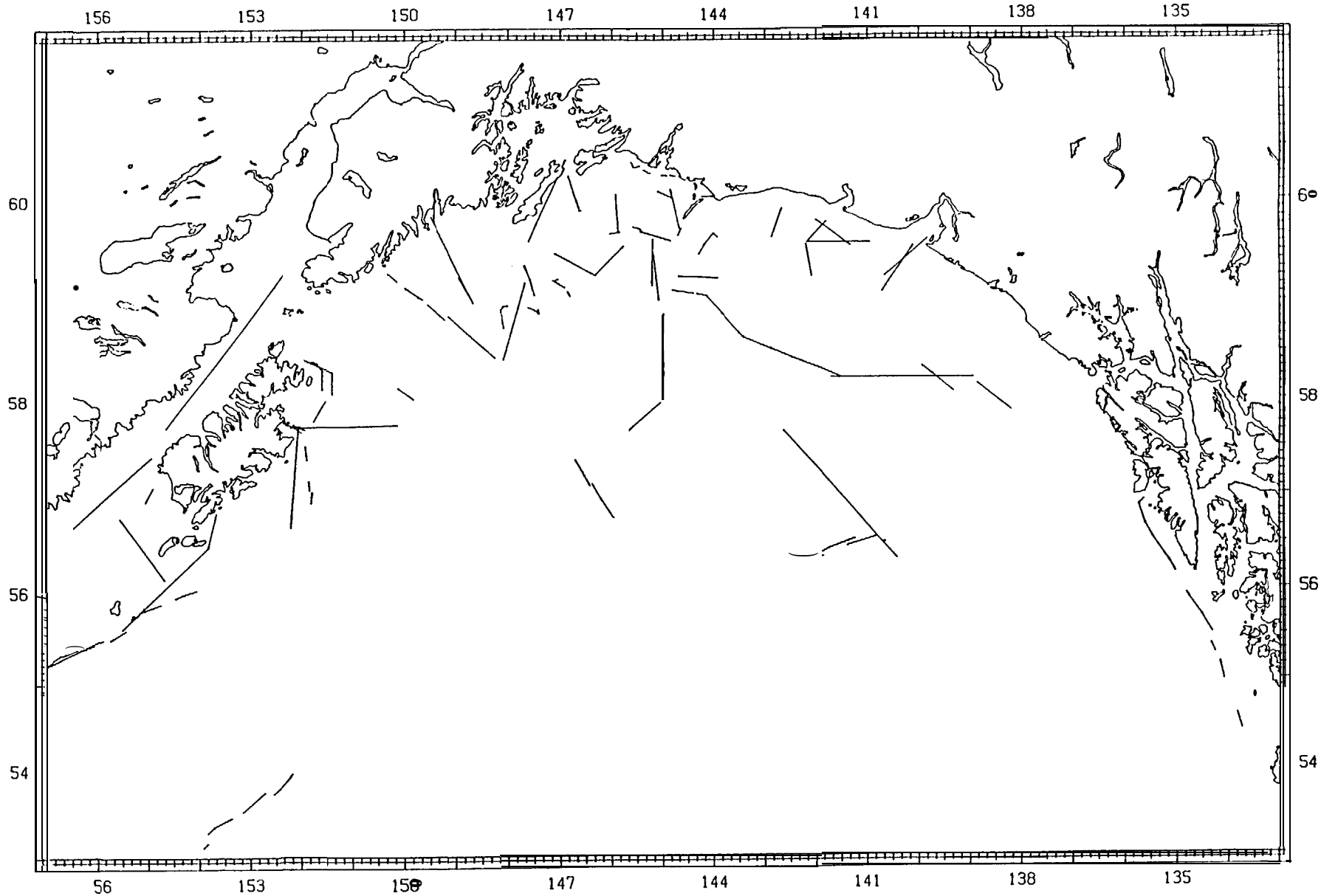
Appendix B Figure 1.–Winter (January-March) ship effort tracks, 1958-80.



Appendix B **Figure 2.**--Spring (April-June) ship effort tracks, 1958-80.



Appendix ≅ Figure 3.–Summer (July-September) ship effort tracks, 1958-80



Appendix B **Figure** 4.–Autumn (October-December) ship effort tracks, 1958-80.