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REPORT OF THE TWO AERIAL SURVEYS FOR MARINE MAMMALS IN CALIFORNIA COASTAL WATERS UTILIZING A NOAA DeHAVILLAND TWIN OTTER AIRCRAFT MARCH 9-APRIL 7, 1991 AND FEBRUARY 8-APRIL 6, 1992

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

NOAA Technical Memorandum NMFS

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James V. Carretta
and
Karin A. Forney

INTRODUCTION

This report presents the preliminary results of two aerial surveys conducted for marine mammals in the waters off the coast of California during 1991 and 1992. The objective of the surveys was to obtain winter abundance estimates for cetacean species commonly found in coastal California waters. The aerial surveys were designed to seasonally complement a ship-based survey conducted during the summer/fall of 1991 (Hill and Barlow 1992). The two aerial surveys were conducted in winter/spring, when average sea surface temperatures in California waters are coldest, whereas the ship survey was conducted during the warmest season. Estimates of abundance with statistical confidence limits for the 1991 aerial survey are presented in Forney and Barlow (1993). Summer abundance estimates for cetaceans in California waters based on a ship survey are presented in Barlow (1993). Estimates of abundance for pinnipeds were not calculated from the aerial survey data. These populations are monitored by ground counts or aerial photogrammetry counts at their breeding colonies (Lowry and Perryman 1992). However, sighting information for pinnipeds encountered during the two aerial surveys is included in this report.

Motivation for the study results from the incidental take of cetaceans in drift and set gillnets along the California coast, and the need to determine the impact of this mortality upon cetacean populations. For most of the common cetacean species in California waters, estimates of abundance were at least ten years old, and without statistical confidence limits (Dohl et al. 1980, 1983). Estimates of abundance with statistical confidence limits were available for common dolphins (Delphinus delphis); however, these estimates were based on survey data collected in the mid-1970's (Dohl et al. 1986). In order to determine the impact of gillnet fisheries on cetacean populations, current estimates of abundance for each species were needed.

The California gillnet fishery is divided into two main types, each targeting different species. Barlow et al. (in press) briefly review the two fishery types. In the drift gillnet fishery, shark and swordfish are the target species. Drift gillnets are used in offshore waters from the Mexican border to the Oregon border, and are usually fished 20 to 200 miles from the coast. The set gillnet fishery utilizes bottom gillnets and trammel nets to target halibut and angel shark. This fishery operates from the Mexican border north to about Bodega Bay. Set gillnets are fished in shallow water, usually less than 50 fathoms. Marine mammal species that have become entangled in gillnets or have shown evidence of entanglement include common dolphin (Delphinus delphis), Pacific white-sided dolphin (Lagenorhynchus obliquidens), bottlenose dolphin (Tursiops truncatus), northern right whale dolphin (Lissodelphis borealis), Risso's dolphin (Grampus griseus), Dall's porpoise (Phocoenoides dalli), harbor porpoise (Phocoena phocoena), short-finned pilot whale (Globicephala macrorhynchus), minke whale (Balaenoptera acutorostrata), gray whale (Eschrichtius robustus), Cuvier's beaked whale (Ziphius cavirostris), mesoplodont beaked whales (Mesoplodon spp.), sperm whale (Physeter macrocephalus), California sea lion (Zalophus californianus), harbor seal (Phoca vitulina), and elephant seal (Mirounga angustirostris).

Survey Objectives

1. The primary objective of the aerial surveys was to obtain winter abundance estimates for the common cetacean species in California waters. The surveys were also designed to seasonally complement a ship-based survey that was completed in summer/fall 1991 (Hill and Barlow 1992).

2. To establish a baseline for detecting seasonal and interannual changes in marine mammal abundance.

3. To collect distributional information on cetacean species in California waters.

4. To utilize photogrammetric techniques on common dolphins (Delphinus delphis) and other delphinid species to determine length and stock identity.

MATERIALS AND METHODS

Study Area

The study area (Figure 1) extends beyond the continental shelf edge of the California coast, to roughly the 3000-4000m depth contour. It was selected to encompass all of the known drift-net fishing area, based on effort data for California Department of Fish and Game (CDFG) blocks. In Central/Northern California (CNC), this extends from the coast to approximately 100 nmi perpendicular distance offshore. In the Southern California Bight (SCB), the study area is bounded by the U.S. / Mexico border in the south and extends out to approximately 150 nmi offshore (the edge of the CDFG blocks). It then follows a straight line northwestward to a point 100 nmi off of Pt. Conception, connecting with the CNC area. The transect lines were chosen without reference to oceanographic features or bottom topography. Generally, surveys were flown in a northeast or northwest direction to minimize glare, unless glare was eliminated by high cloud cover.

A total of 154 transects formed two approximately uniform, overlapping grids with lines spaced roughly 45-50 nmi apart and formed an overall grid with lines spaced approximately 22-25 nmi apart (Figure 1). The second grid was shifted from the first by 1/2 of a grid unit. Initially, the first grid was surveyed to provide coarse coverage of the entire California coast. Once this grid was nearly completed, the transects forming the second grid were flown to provide finer-scale coverage of the study area.

Scientific Personnel

1991 Survey

Dr. Jay Barlow	-NMFS/SWFSC	Principal Investigator/Observer
James Carretta	-NMFS/SWFSC	Marine Mammal Observer
Karin Forney	-NMFS/SWFSC	Principal Investigator & Survey Coordinator/Observer
Susan Kruse	-NMFS/SWFSC	Marine Mammal Observer
Carrie LeDuc	-NMFS/SWFSC	Marine Mammal Observer
Richard LeDuc	-NMFS/SWFSC	Marine Mammal Observer

Pilots

Lt. Tim O'Mara	-NOAA/AOC
Lt. Julie Vance	-NOAA/AOC
LCDR Pat Wehling	-NOAA/AOC
LCDR Mike White	-NOAA/AOC

1992 Survey

Dr. Jay Barlow	-NMFS/SWFSC	Principal Investigator/Observer
James Carretta	-NMFS/SWFSC	Survey Coordinator/Observer
Darlene Everhart	-NMFS/SWFSC	Marine Mammal Observer
Karin Forney	-NMFS/SWFSC	Principal Investigator/Observer
Susan Kruse	-NMFS/SWFSC	Marine Mammal Observer
Carrie LeDuc	-NMFS/SWFSC	Marine Mammal Observer
Mary Lycan	-NMFS/SWFSC	Marine Mammal Observer

Pilots

Lt. Tim O'Mara	-NOAA/AOC
Lt. Steve Nokutis	-NOAA/AOC
LCDR Mike White	-NOAA/AOC

Abbreviations:
- NOAA - National Oceanic and Atmospheric Administration
- AOC - Aircraft Operations Center (Miami)
- NMFS - National Marine Fisheries Service
- SWFSC- Southwest Fisheries Science Center

All marine mammal observers had prior experience with identifying marine mammals in the field, either from ship-board platforms, aerial platforms, or both. In addition, intensive training on species identification and group size estimation for aerial survey work was provided to all observers before the start of each survey.

Equipment

The aircraft utilized for the survey is a high-wing, twin engine turbo-prop DeHavilland Twin Otter, based out of the NOAA Aircraft Operations Center (AOC) in Miami. The plane has a capacity for 5 observers and two pilots, and has an approximate flight range of 7 hours. The aircraft is fitted with left and right side bubble windows just forward of the wings. The bubble windows provided observers with unobstructed viewing from the horizon (0° declination angle), to the trackline directly beneath the aircraft (90°), and approximately 10° of visual overlap directly below the aircraft. The bubble windows allowed observers to search ahead and behind the aircraft as well. The aircraft maintained an altitude of 700 ft (213 m) and airspeeds of 90-100 knots (167-185 km/hr) while surveying. A 45 cm diameter round viewing hole in the bottom of the aircraft was fitted with optical glass to allow a third semi-independent observer to monitor the trackline directly below the aircraft. The semi-independent observer was able to view an area from the trackline (90°) out to approximately 55° declination on each side of the aircraft. This window is hereafter referred to as the belly window.

The two side observers utilized Suunto[1] optical clinometers to measure the declination angle from the aircraft to animals sighted. The trackline directly below the aircraft is located at 90° declination; the horizon is at approximately zero degrees. Declination angles were used to calculate the perpendicular distance of sighted animals from the trackline. The relationship between the declination angle and perpendicular distance from the trackline is as follows:

$$d = h / \tan \theta$$

where θ=the declination angle from the aircraft to the marine mammal school, d=perpendicular distance of the marine mammals from the trackline , and h=survey altitude.

(Appendix 1 contains a table showing perpendicular distances from the trackline relative to declination angle.) Due to space limitation, the secondary observer utilized hatch marks on the belly window to measure declination angles to sightings. These hatch marks were calibrated using a clinometer prior to the surveys.

A Toshiba[1] T-1000 laptop computer was used to record all effort and sighting data. The computer was connected to the aircraft's navigation system via a 25 to 9 pin serial port connector to obtain continuous location data. During the 1991 survey, position data were collected from a Loran unit (Texas Instruments[1] 9100 Loran-C Airborne Navigator). In 1992, both a Loran and GPS (Trimble[1] Navigator 3000 Global Positioning System) were used.

An event-driven, Pascal program was used to record effort and sighting data. The program automatically obtained current position data every minute, and again when any survey events were recorded. These events included changes in altitude, airspeed, environmental conditions, observer positions, and sighting information. During a sighting, the program provided dynamic distance and bearing information to assist in the relocation of animals.

Aerial photogrammetry was used to obtain length data for cetaceans, and to distinguish stock differences in delphinids, specifically common dolphins (Delphinus delphis). Aerial photogrammetry was also used to verify species identifications. A 127 mm format, KA-45 military reconnaissance camera was mounted in the belly window of the plane. The camera mount was moveable so that it could be positioned away from the window during survey effort, to prevent obscuring the belly observer's view of the trackline. The camera has a 152 mm focal length lens, and a forward motion compensator to eliminate blurring by forward aircraft motion. Photographs were taken with Kodak[1] 3404 Plus-X black and white film, which was exposed through a Wratten 9 filter to increase contrast between subject and water. A second Toshiba[1] T-1000 laptop computer was linked to the aircraft's radar altimeter to obtain accurate and continuous altitude data during photographic operations. Photogrammetric methods are reviewed in Perryman and Lynn (1993).

A Realistic[1] voice-activated cassette recorder was linked to the aircraft headsets to record all conversation while surveying. The recorded conversational data documented all survey activity during the flights, but was only used as a backup to computer-recorded data.

Fluorescein dye markers were dropped from a PVC plastic chute located behind the plane's cockpit whenever a sighting was made. The dye markers were used as an aid in relocating marine mammals after an initial sighting was made.

Duty Stations

The aerial survey team consisted of five observers and two pilots. Five observers rotated through 4 duty stations and one rest position every 30 to 45 minutes. The four duty stations were: left bubble window, right bubble window, data recorder, and belly window observer. The left and right bubble windows were designated as "primary observer" stations, and the belly window observer was designated as a "secondary observer." The following is a description of the duty stations.

[1]-Reference to trade names does not imply endorsement by the NMFS.

Primary Observers

The left and right observers searched with unaided eye through bubble windows on each side of the aircraft. To increase sighting efficiency near the trackline, primary observers limited their search for marine mammals out to a declination angle of 12° (1004 m perpendicular distance from the trackline). When marine mammals were sighted, the observer waited until the animals were perpendicular to the aircraft, and then measured a declination angle to the center of the group. The pilots were then instructed to direct the aircraft towards the group, so that observers could make species identifications and school size estimates.

Secondary Observer

A third, semi-independent observer searched with unaided eye through a round, 45 cm diameter belly window located in the tail section of the aircraft. This observer had a clear view of the trackline directly below and slightly forward of the aircraft, and a view of the survey area out to approximately 55° declination angle (150 meters perpendicular distance) on each side of the trackline. The role of the secondary observer was to sight marine mammals near the trackline that were missed by primary observers. The secondary observer waited approximately 5-10 seconds to announce the presence of marine mammals when sighted, to ensure that they were well out of the view of the primary observers. These data were utilized to calculate the fraction of sightings missed by both observer teams. The fraction of sightings missed is discussed in Forney and Barlow (1993) for various species groups and school sizes.

Data Recorder

The data recorder entered all effort, environmental, and sighting data into the laptop computer. The data recorder updated environmental data (percent cloud cover, Beaufort state, percent sea-surface glare, etc.) each time a change in conditions occurred, and also recorded changes in effort data, such as transect number and observer positions. The environmental and effort parameters recorded during the surveys are summarized in Appendix 1. The recorder terminated effort when the aircraft diverted from the trackline, and made sure that observers were prepared to search before resuming effort. The data recorder also communicated the location of animals to the pilots during a sighting, and released fluorescein dye markers to aid in the relocation of the animals when a sighting was announced. The data recorder did not actively search for marine mammals, and any sightings that were made by the recorder were classified as "off-effort" sightings, if they were not detected by primary or secondary observers (see explanation of on and off-effort classifications in data collection procedures section).

Data Collection Procedures

Aerial surveys were conducted during Beaufort sea states 0-4. Survey effort was terminated when conditions reached Beaufort 5. A summary of Beaufort scale conditions is given in Appendix 1.

Sightings were recorded as either "on-effort" or "off-effort". "On-effort" sightings were those made by primary and secondary observers while the aircraft was flying along a predetermined transect line, and all three observers were actively searching for marine mammals. Sightings were categorized as "off-effort" in the following four cases: 1. Sightings made while the three observers were not actively searching along the transect line (i.e. when in transit) 2. Sightings made by the pilot, the recorder, or the resting observer, but missed by the primary and secondary observers. 3. Additional sightings made while circling to re-locate an on-effort sighting. 4. Sightings made beyond 12° declination angle (1004 m perpendicular distance). When a sighting was made, the observer who made the sighting announced the presence of marine mammals. The data recorder then released a fluorescein dye marker from the aircraft, terminated survey effort, and entered the sighting information into the laptop computer. The aircraft then circled back to the location of the marine mammals. The data entry procedures used during the survey are summarized in Appendix 1.

During the sighting, the aircraft typically made several passes over the group of animals. Observers made species identifications at this time, and took notes on the features they observed. After a consensus was reached on the identification of the species present, the aircraft circled widely around the sighting area so that observers could obtain school size estimates. Observers made three estimates, a best, high, and low estimate of the number of animals thought to be present. The observers entered their estimates into personal notebooks without discussing them, to avoid biasing or influencing each other. These estimates were entered into the data files at the end of the day by the survey coordinator.

Occasionally, it was not possible to identify marine mammals to species. In these instances, the animals were assigned a higher taxonomic identification (i.e. "unidentified dolphin" or "unidentified whale") if a positive identification could not be made. In some cases, the observer could narrow the identification down to one of two species, for example,"common dolphin" or "Pacific white-sided dolphin". In this case, the codes for both species were combined: (DDLO). The species codes utilized during both surveys are summarized in Table 1.

RESULTS

A total of 433 on-effort sightings were recorded during the two surveys in Beaufort sea states 0 through 4, accounting for a total of 19,410 animals, comprising 18 cetacean species, 4 pinniped species, one mustelid species, and one sea turtle species. Of these 433 sightings, 213 were cetacean sightings, totalling 19,061 animals. Of the 213 on-effort cetacean sightings, 177 were made by primary observers, and 36 by the secondary observer. A total of 40 off-effort sightings were recorded during the two surveys. Six species of cetaceans were photographed with the large format military reconnaissance camera mounted in the aircraft. Aerial photographs of

Grampus griseus, Delphinus delphis, Lagenorhynchus obliquidens, and Lissodelphis borealis will be analyzed by the SWFSC photogrammetry group along with additional photographs obtained during 1993 aerial surveys in progress. Length determinations will be used to clarify geographical stock identities of these species (Perryman and Lynn 1993). In addition to the above species, aerial photographs of Physeter macrocephalus and a single north Pacific right whale Eubalaena glacialis (Carretta and Lynn, in press) were obtained.

Although the 1992 survey occurred over a two-month period, and the 1991 survey was restricted to one month, the number of kilometers surveyed was greater in 1991 than 1992 due to poorer weather conditions in 1992. 7036 kilometers were flown in 1991, and 5882 km were flown in 1992. The distribution of survey coverage is shown in Figures 2-3, for 1991 and 1992, respectively. In 1991, survey coverage was concentrated in the inner SCB, and north of Cape Mendocino (40.5°N latitude), where two passes of the survey grid were completed. Between Pt. Conception and Cape Mendocino in 1991 survey coverage was fairly uniform, although some gaps in effort occurred west of Pt. Arena (39°N), and Pt. Conception. One pass of the survey grid was completed in this area. In 1992, most survey effort was concentrated south of Pt. Conception, with two passes of the survey grid completed in the most near-shore waters. Large gaps in effort occurred between San Francisco Bay north to Cape Mendocino in 1992. High winds and low fog caused gaps in survey coverage during both surveys, especially between 37°N and 40.5°N latitude. One pass of the survey grid was completed north of Cape Mendocino in 1992. Good survey coverage in the SCB for both surveys was a result of this area being in close proximity to the base of operation (San Diego) and relatively better weather conditions.

Table 2 lists the species sighted during both survey years, with the number of on-effort sightings in parentheses. The locations of all sightings (on and off effort) for all species are plotted in Figures 4-35. Tables 3A and 3B summarize sighting information for all on and off-effort sightings for all species encountered, including unidentified sightings, for 1991 and 1992, respectively. All sighting rates presented in this report refer to on-effort cetacean sightings only.

A total of 12,918 km were surveyed in Beaufort sea state conditions 0-4. Most survey effort was conducted during Beaufort 3 conditions (5740 km, 44.4% of all effort). In general, sighting rates declined with increasing Beaufort. The highest rate (2.35 sightings/100 km), occurred during Beaufort 2 conditions, and the lowest rate (1.14 sightings/100 km), during Beaufort 4 conditions. The average sighting rate for both years combined was 1.65 sightings/100 km. The sighting rate for the 1991 survey (1.81 sightings/100 km), was greater than the sighting rate for the 1992 survey (1.46 sightings/100 km), but the number of animals seen per 100 km was virtually the same for the two years (147.0 and 148.2, respectively). The mean group size for animals sighted (cetaceans only) was similar for both years (1991 = 73.8 animals/sighting, 1992 = 88.9 animals/sighting). The number of sightings, total number of animals seen, mean group size, kilometers surveyed, sightings/100 km, and animals/100 km, stratified by Beaufort sea state for both years, are summarized in Table 4.

The number of kilometers searched by each of the 8 observers varied from 2305 to 7914 km. Observer sighting rates varied from 0.27 to 0.87 sightings/100 km. Individual sighting rates varied relative to Beaufort, but data pooled for all 8 observers shows that sighting rates decreased with increasing Beaufort. Sighting rates pooled across 8 observers ranged from a high of 0.78 sightings/100 km in Beaufort 2, to a low of 0.38 sightings/100 km in Beaufort 4. The average sighting rate for individual observers for both years combined was 0.55 sightings/100 km. The number of sightings made, number of kilometers searched, and the rates of detecting cetacean schools for each of the 8 observers stratified by Beaufort, are summarized in Table 5. Numeric codes for observers have been used rather than initials in Table 5 to provide anonymity of individual results.

The effect of sea-surface glare and cloud cover on sighting rates was examined. Three glare and cloud categories were chosen to represent poor, fair, and good searching conditions across the three categories. The categories were divided so that each had a similar amount of effort. The effects of sea-surface glare and cloud cover were examined for primary and secondary observers separately.

Sea-Surface Glare

Primary observer sighting rates decreased with increasing sea-surface glare. The highest sighting rates (0.96 and 0.99 sightings/100 km) occurred in glare conditions of 0-35%, for right and left observers, respectively. Sighting rates decreased to 0.77 and 0.48 sightings/100 km in glare conditions of 40-65%, and 0.59 and 0.48 sightings/100 km in glare conditions of 70-100%, for right and left observers, respectively. For the secondary observer, sighting rates were highest in the poorest glare conditions. The secondary observer sighting rate for the 70-100% glare category was 0.39 sightings/100 km. This sighting rate was nearly double the rates found for glare conditions of 0-35% (0.24/100 km), and 40-65% (0.21/100 km). Table 6 summarizes the sighting rates and number of kilometers searched by primary and secondary observers, stratified by percent sea-surface glare and Beaufort sea state.

Cloud Cover

For primary observers, the lowest sighting rates were recorded during overcast conditions (cloud cover 65-100%). The rate of detecting cetacean schools in this category was 1.11 sightings/100 km. Sighting rates were highest in cloud cover of 15-60% (1.48/100 km), and similar in cloud cover of 0-10% (1.47/100 km). Secondary observer sighting rates were higher with increasing cloud cover. The highest rate (0.33/100 km) occurred in cloud cover of 65-100%, and the lowest rate (0.25/100 km) in cloud cover of 0-10%. Table 7 summarizes the sighting rates and number of kilometers searched for primary and secondary observers, stratified by percent cloud cover and Beaufort sea state. Cloud cover was not analyzed separately for right and left observers because cloud cover was scored once for all three observers searching simultaneously (see Appendix 1).

DISCUSSION

We compared the seasonal distribution of the most commonly sighted cetacean species during winter/spring 1991-1992 aerial surveys with those sighted during a summer/fall ship survey conducted in 1991 (Hill and Barlow 1992), and compared any observed seasonal differences with prior findings for each species. We also discuss the observed effects of cloud and glare on sighting rates.

Species Accounts

Dall's porpoise (Phocoenoides dalli) were the most commonly sighted cetacean (n=38) during the 1991-1992 aerial surveys, although the average group size for these sightings was only 3 animals. During the winter/spring aerial surveys, Dall's porpoise were distributed uniformly within the survey area, from the Channel Islands north to the California/Oregon border (Figure 13). Hill and Barlow (1992) reported 128 sightings of Dall's porpoise during a summer/fall ship survey. All sightings of Dall's porpoise during that study occurred north of Pt. Conception (34.5° N latitude), with no sightings being made near the Channel Islands. Dohl (1980) notes that Dall's porpoise is infrequently seen in the SCB during warm-water periods, and Leatherwood et al. (1972) state that during periods of cold-water intrusion, Dall's porpoise may be seen as far south as Bahia de Ballenas, Baja California, Mexico. Our seasonal findings seem to agree with prior data indicating a tendency of Dall's porpoise to avoid warm-water masses.

Northern right whale dolphins (Lissodelphis borealis) were sighted 31 times during 1991-1992 aerial surveys. Most of the sightings occurred over shelf waters in the inner SCB, near the Channel Islands, although sightings were recorded as far north as the California/Oregon border (Figure 10). Hill and Barlow (1992) did not record any Lissodelphis sightings in the inner SCB during the summer/fall, when shelf waters are warmer. All of their Lissodelphis sightings that occurred south of Pt. Conception were well west of the Channel Islands, approximately 100 nmi or more from shore. Lissodelphis also occurred north to Pt. Arena (39.5° N latitude), California during that study. Leatherwood and Walker (1979) and Dohl et al. (1980) reported that Lissodelphis was a seasonal visitor to the SCB, increasing in abundance during cool water (winter) periods, and declining in abundance during the summer/fall when water temperatures increased. Comparison of winter/spring aerial survey data with summer/fall ship survey data supports these prior findings.

Common dolphins (Delphinus delphis) were sighted 27 times during the two aerial surveys. All but two of these sightings occurred south of Pt. Conception (Figure 7). Hill and Barlow (1992) reported 182 sightings of Delphinus from a ship survey conducted in the summer/fall of 1991. They divided common dolphin sightings into short and long-beaked forms. Genetic and morphological evidence indicates that these two forms may represent different species (Heyning and Perrin 1991, Rosel 1992). The two forms are not distinguishable from an aircraft, although the use of aerial photogrammetry may be used to separate the two (Perryman and Lynn 1993). Delphinus sightings (short-beaked form) during the 1991 ship survey were distributed from the SCB north and westward to approximately 130° W longitude and 39° N latitude. The long-beaked form was found primarily south of Pt. Conception, with a cluster of sightings recorded near the islands of Santa Cruz, Santa Rosa, and San Miguel. The major difference in the distribution of common dolphin (within 100-150 nmi of the coast) between the two surveys is that they were primarily found south of Pt. Conception in winter/spring, and dispersed north and west with increasing water temperatures in the summer/fall. It should be noted that Barlow (1993) shows the distribution of common dolphin extending to the edge of his study area, approximately 300 nmi offshore, and north to 39.5° N latitude, while the 1991-1992 aerial survey study area only extended 100-150 nmi from shore. This complicates the detection of seasonal movements for this species. However, the apparent seasonal change in distribution (within 100-150 nmi of the coast) is in general agreement with the work of Dohl (1986), who found that Delphinus were more widely distributed in the SCB during warm water periods. Dohl also found that the abundance of Delphinus in the SCB increased seasonally, during warm-water periods. However, surveys conducted in 1991 (Forney and Barlow 1993, Barlow 1993) covering both the cold-water and warm-water periods respectively, showed that the abundance of common dolphins were very similar for the two oceanographic periods.

Gray whales (Eschrichtius robustus) were sighted 25 times during the two aerial surveys. Most sightings occurred near the coast or around the northern Channel Islands, with sightings being recorded as far north as Cape Mendocino (40.5° N latitude), California. The summer/fall 1991 ship survey recorded only two sightings, one near Pt. Reyes, the other near the California/Oregon border (42° N). The 1991 ship survey was conducted when most gray whales have already migrated north through California waters.

Pacific white-sided dolphins (Lagenorhynchus obliquidens) were sighted 21 times during aerial surveys. They were seen in the SCB, from 32° N latitude, north to approximately 41.5° N latitude. Approximately half of the sightings were recorded south of Pt. Conception (Figure 11). Hill and Barlow (1992) reported 18 sightings of white-sided dolphin, which were distributed from Pt. Conception north to Pt. Arena. Most sightings were found within 150 nmi of the coast in both surveys. Comparison of the distribution of white-sided dolphin between the two surveys shows that an apparent south to north shift occurred between the winter/spring and summer/fall periods. Leatherwood et al. (1984) stated that there may be evidence of seasonal fluctuation of Lagenorhynchus off of southern California, during November through April, when peak abundances were recorded. Dohl et al. (1980) found that Lagenorhynchus moved inshore and to the southern extreme of the SCB as waters cooled seasonally. Comparison of Lagenorhynchus distributions between the winter/spring aerial and summer/fall ship surveys support past findings that show

Lagenorhynchus moving north of the SCB during warm water periods.

Risso's dolphins (Grampus griseus) were sighted 20 times during the aerial surveys, and 32 times during the ship survey. During the aerial surveys, Grampus was found primarily around the Channel Islands in the SCB, and north within 30 nmi of the coast to about Pt. Reyes (Figure 8). Ship survey results also found Grampus abundant in the SCB, with additional sightings well offshore (200 nmi and beyond) and north to about Cape Mendocino. Both surveys showed similar distributions for this species within 150 nmi of the mainland. No apparent north/south or inshore/offshore shift in distribution was detected between the two surveys. This contrasts with Dohl et al. (1980), who found that Grampus increased in numbers and moved inshore with an increase in water temperature in the SCB. During periods of cooling, Grampus were found to move offshore and south in the SCB (Dohl et al. 1980).

Of special interest was a sighting of a rare north Pacific right whale (Eubalaena glacialis), which was sighted on 24 March 1992, southwest of San Clemente Island California (Figure 24). This whale was photographed with a large format military reconnaissance camera mounted in the belly window of the aircraft. This whale represented only the 12th reliable record of this species from California waters since the year 1900 (Carretta and Lynn, in press). Recent population estimates for right whales in the northeast Pacific range from "a few individuals" (Klinowska 1991), to the low hundreds (Berzin and Doroshenko 1982, Braham and Rice 1984).

Cloud and Glare Effects

The observed increase in secondary observer sighting rates with increasing glare and cloud conditions may be an artifact of the survey design. The secondary observer only announced sightings that were missed by the primary observers. It is apparent that higher glare and cloud conditions caused the primary observers to miss more sightings, which would, in turn, make more sightings "available" to the secondary observer. Barlow et al. (1988) and Forney et al. (1991) have shown that apparent densities of harbor porpoise significantly decreased with an increase in cloud cover. Sea-surface glare (from sun glare or due to clouds) may not have been as much of a handicap in detecting marine mammals for the secondary observer as for the primary observers, otherwise, one would expect a decline in sighting rates for the secondary observer with increasing cloud and glare levels. The secondary observer generally had a better view of the sea surface from the trackline out to 150 meters perpendicular distance than the primary observer. One reason for this is that the secondary observer always had a line of sight perpendicular to the sea surface, which reduces the apparent amount of glare relative to that experienced by the primary observers.

SUMMARY

We have presented cetacean and pinniped sighting data for two years of aerial surveys in California coastal waters. Overall sighting rates (primary and secondary observers pooled) for cetaceans decreased with increasing Beaufort. Sighting rates were variable among individual observers. Sighting rates for primary observers declined with increasing glare and cloud levels. Sighting rates for the secondary observer increased with an increase in cloud and glare levels. Seasonal distributions of the most commonly sighted cetacean species in California waters appears to have south/north and inshore/offshore components, which coincided with cold and warm water periods, respectively.

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LITERATURE CITED

Barlow, J., R. Baird, J. Heyning, K. Wynne, A. Manville, L. Lowry, D. Hanan, J. Sease, and V. Burkanov. (in press). A review of cetacean and pinniped mortality in coastal fisheries along the west coast of the U.S. and Canada and the east coast of the U.S.S.R. Report of the International Whaling Commission, Special Issue:

Barlow, J. 1993. The abundance of cetaceans in California waters estimated from ship surveys in summer/fall 1991. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center Administrative Report LJ-93-09. 39pp.

Barlow, J., C.W. Oliver, T.D. Jackson, and B.L. Taylor. 1988. Harbor porpoise, Phocoena phocoena, abundance estimation for California, Oregon, and Washington: II. Aerial surveys. Fishery Bulletin 86(3):433-444.

Berzin, A.A. and N.V. Doroshenko. 1982. Distribution and abundance of right whales in the North Pacific. Report of the International Whaling Commission 32:381-383.

Braham, H.W. and D.W. Rice. 1984. The Right Whale, Balaena glacialis. Marine Fisheries Review 46(4):38-44.

Carretta. J.V., and M.S. Lynn. (in press) Right whale (Eubalaena glacialis) sighting off San Clemente Island, California. Marine Mammal Science.

Dohl, T.P., K.S. Norris, R.C. Guess, J.D. Bryant and M.W. Honig. 1980. Cetacea of the Southern California Bight. Part II, Summary of marine mammal and seabird surveys of the Southern California Bight area, 1975-1978. Final Report to the Bureau of Land Management, NTIS Rep. No. PB81248189. 414 pp.

Dohl, T.P., R.C. Guess, M.L. Duman, and R.C. Helm. 1983. Cetaceans of central and northern California, 1980-1983: Status, abundance and distribution. OCS Study MMS 84-0045. Minerals and Management Service contract #14-12-0001-29090. 284pp.

Dohl, T.P., M.L. Bonnell, and R.G. Ford. 1986. Distribution and abundance of common dolphin (Delphinus delphis), in the southern California Bight: A quantitative assessment based upon aerial transect data. Fishery Bulletin 84:333-343.

Forney, K.A., D.A. Hanan, and J. Barlow. 1991. Detecting trends in harbor porpoise abundance from aerial surveys using analysis of covariance. Fishery Bulletin 89:367-377.

Forney, K.A. and J. Barlow. 1993. Preliminary winter abundance estimates for cetaceans along the California coast based on a 1991 aerial survey. Rep. Int. Whal. Commn. (in press).

Heyning, J.E. and W.F. Perrin. 1991. Re-examination of two forms of common dolphins (genus Delphinus) from the eastern North Pacific; evidence for two species. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center Administrative Report LJ-91-28, Southwest Fisheries Science Center, La Jolla, CA. 53 pp.

Hill, P.S. and J. Barlow. 1992. Report of a marine mammal survey of the California coast aboard the research vessel McArthur July 28-November 5, 1991. NOAA-TM-NMFS-SWFSC-169, 103pp.

Klinowska, M. 1991. Northern Right Whale. In: Dolphins, Porpoises, and Whales of the World: The IUCN Red Data Book. IUCN, Gland, Switzerland, and Cambridge, U.K. pp. 351-357.

Leatherwood, J.S., W.E. Evans and D.W. Rice. 1972. The whales, dolphins, and porpoises of the eastern North Pacific. Naval Undersea Center, San Diego, Calif. NUC TP 282.

Leatherwood, S., and W.A. Walker. 1979. The northern right whale dolphin _Lissodelphis borealis_ Peale in the eastern North Pacific. In Winn, H.E., and B.L. Olla (eds.), Behavior of Marine Mammals, p. 85-141. Plenum Press, New York-London.

Leatherwood, S., R.R. Reeves, A.E. Bowles, E.S. Stewart and K.R. Goodrich. 1984. Distribution, seasonal movements, and abundance of Pacific white-sided dolphins in the eastern north Pacific. Sci. Rep. Whales Res. Inst. 35:129-157.

Lowry, M.S. and W.L. Perryman. 1992. Aerial photographic census of California sea lion (_Zalophus californianus_) pups at San Miguel Island, California for 1987-1990, and San Nicolas Island, California for 1990. Administrative Report LJ-92-19, 19pp.

Perryman, W.L. and M.S. Lynn. 1993. Identification of geographic forms of common dolphins (_Delphinus delphis_) from aerial photogrammetry. Marine Mammal Science 9(2):119-137.

Rosel, P.E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. thesis presented to the University of California, San Diego. 191pp.

Table 1. Flowchart of species codes used during 1991-1992 aerial surveys for marine mammals. Generic species codes are also shown.

Phocoena phocoena	PP	UP
Phocoenoides dalli	PD	UP
Lagenorhynchus obliquidens	LO	WB, SD, UD, UW
Delphinus delphis	DD	WB, SD, UD, UW
Stenella coeruleoalba	SC	WB, SD, UD, UW
Lissodelphis borealis	LB	SD, UD, UW
Tursiops truncatus	TT	SD, UD, UW
Grampus griseus	GG	LD, UD, SW, UW
Pseudorca crassidens	PC	LD, UD, SW, UW
Globicephala macrorhynchus	GM	LD, UD, SW, UW
Orcinus orca	OO	LD, UD, SW, UW
Mesoplodon spp.	UM	SZ, ZU, SW, UW
Ziphius cavirostris	ZI	SZ, ZU, SW, UW
Berardius bairdii	BD	ZU, SW, UW
Kogia spp.	UK	SW, UW
Balaenoptera acutorostrata	BA	SW, UW
B. edeni	BE	LR, UB, LW, UW
B. borealis	BB	LR, UB, LW, UW
B. physalus	BP	LR, UB, LW, UW
B. musculus	BM	UB, LW, UW
Megaptera novaeangliae	MN	UB, LW, UW
Eschrichtius robustus	ER	UB, LW, UW
Eubalaena glacialis	EG	UB, LW, UW
Physeter macrocephalus	PM	LW, UW

UP	Unid. porpoise
WB	'Whitebelly' dolphin
SD	Small delphinid
UD	Unid. delphinid
LD	Large delphinid
SW	Small whale
SZ	Small ziphiid
ZU	Unid. ziphiid
UW	Unid. whale
LR	Fin/sei/Bryde's whale
UB	Unid. large baleen whale
LW	Unid. large whale

Zalophus californianus	ZC	UO, OT, PU
Eumetopias jubatus	EJ	UO, OT, PU
Arctocephalus townsendii	AT	UA, OT, PU
Callorhinus ursinus	CU	UA, OT, PU
Phoca vitulina	PV	US, PU
Mirounga angustirostris	MA	US, PU

UO	Unid. sea lion
OT	Unid. sea lion/fur seal
UA	Unid. fur seal
PU	Unid. pinniped
US	Unid. seal

OTHER CODES USED:

EL	*Enhydra lutris*	Sea otter
MM		unidentified marine mammal
DC	*Dermochelys coriacea*	Leatherback turtle
UT		unidentified turtle

Table 2. Species sighted during 1991-1992 aerial surveys. The number of on and off-effort sightings for each species are shown in parentheses.

# sightings (on/off)	Species Code	Cetaceans	
(27/1)	DD	Delphinus delphis	(Common dolphin)
(20/7)	GG	Grampus griseus	(Risso's dolphin)
(0/1)	GM	Globicephala macrorhynchus	(Short-finned pilot whale)
(31/2)	LB	Lissodelphis borealis	(Northern right whale dolphin)
(21/0)	LO	Lagenorhynchus obliquidens	(Pacific white-sided dolphin)
(2/0)	OO	Orcinus orca	(Killer whale)
(38/2)	PD	Phocoenoides dalli	(Dall's porpoise)
(18/1)	PP	Phocoena phocoena	(Harbor porpoise)
(8/1)	TT	Tursiops truncatus	(Bottlenose dolphin)
(3/1)	ZI	Ziphius cavirostris	(Cuvier's beaked whale)
(2/0)	UM	Mesoplodon sp.	(Mesoplodon beaked whale)
(3/1)	BA	Balaenoptera acutorostrata	(Minke whale)
(1/1)	BM	Balaenoptera musculus	(Blue whale)
(2/2)	BP	Balaenoptera physalus	(Fin whale)
(25/4)	ER	Eschrichtius robustus	(Gray whale)
(8/1)	MN	Megaptera novaeangliae	(Humpback whale)
(1/0)	EG	Eubalaena glacialis	(Northern Right whale)
(3/1)	PM	Physeter macrocephalus	(Sperm whale)
		*Pinnipeds	
(105/0)	ZC	Zalophus californianus	(California sea lion)
(6/0)	PV	Phoca vitulina	(Harbor seal)
(2/0)	MA	Mirounga angustirostris	(Northern elephant seal)
(20/0)	CU	Callorhinus ursinus	(Northern fur seal)

* Pinniped sightings were not recorded within 6 nmi of the mainland or islands

		Other species	
(3/0)	EL	Enhydra lutris	(sea otter)
(4/0)	DC	Dermochelys coriacea	(leatherback turtle)

	Unidentified sightings (codes used)	
(2/0)	MM	unid. marine mammal
(15/9)	SD,UD,DDLO,DDSC,SDPD,SDUP,LOPD,WB,WBPDTT	unid. dolphin
(9/6)	SW,SZUK,LR,LW,TTSZ,UB,UW	unid. whale
(2/0)	ZU,SZ	unid. ziphiid
(83/3)	UO,US,OT,PU	unid. pinnipeds

Table 3A. All cetacean and pinniped sightings (including off effort sightings) made during the 1991 aerial survey. Sightings are listed alphabetically by species code. Species present in the school are listed with their percent composition of the school to the right of each species. The sighting number and type, (P) primary, (S) secondary, or (O) off effort, are given for each sighting. The observer who made the sighting is also given. School size estimates represent the "best" estimate from individual observers.

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
1991:																			
BA	100							174	P	910328	1529.23	3548.73	12315.01	KF	1				
BA	50	MN	50					308	P	910407	1050.75	4157.80	12542.93	RL	2	2	2	2	
BA	100							278	P	910403	1344.72	3309.03	11755.37	SK	1	1	1		
CU	100							106	P	910322	1143.87	3700.59	12345.70	CL	3	2	2		
CU	100							320	P	910407	1453.30	4150.22	12515.81	RL	2				
CU	100							316	P	910407	1440.38	4138.26	12521.01	SK	1				
CU	100							107	P	910322	1158.63	3715.49	12339.52	KF	1				
CU	100							105	P	910322	1123.62	3649.64	12349.86	SK	5	7	5	5	
CU	100							327	P	910407	1557.57	4143.53	12522.31	KF	1				
CU	100							322	P	910407	1500.45	4155.60	12513.61	SK					
CU	100							328	S	910407	1558.15	4143.16	12520.92	CL	1				
DC	100							NA	S	910323	1243.05	3304.67	11925.89	KF	1				
DC	100							NA	S	910407	1416.13	4102.15	12531.71	JC	1				
DD	100							266	P	910403	1111.77	3243.66	11732.33	KF	1400	1150	950	900	1050
DD	100							262	P	910401	1718.92	3250.27	11759.59	CL	35	35	20		
DD	100							264	O	910401	1738.63	3242.89	11730.75	CL					
DD	100							166	P	910324	1235.95	3209.71	12010.66	SK	45	55	60	55	52
DD	98	TT	2					261	P	910401	1650.75	3256.77	11824.60	SK	2575				
DD	100							224	P	910331	1637.28	3410.67	12001.88	JC	2400	3100	2400	2200	
DD	100							37	P	910316	0906.00	3251.85	11730.97	JB	10	9	18	8	7
DD	100							62	P	910316	1503.00	3433.79	12049.32	KF	440	750	450	400	
DD	100							283	P	910404	1253.32	3356.88	11908.81	CL	350	450	320		
DD	100							45	P	910316	1048.67	3333.05	11911.72	JB	20	20	35	30	30
DD	100							38	P	910316	0938.98	3305.44	11725.19	CL	220	300	130	135	
DD	100							225	P	910331	1711.85	3407.61	11950.72	SK	700	1100	950	620	1100
DD	100							50	P	910316	1113.55	3337.76	11926.98	CL	12	9	9	9	
DD	100							138	P	910323	1132.50	3201.01	11950.36	KF	95	80	95		
DD	39	GG	10	LB	51			148	P	910323	1253.98	3322.20	11919.40	SK	185	165	132	163	
DDLO	4	LB	7	LO	89	ZC	<1	158	S	910324	1122.48	3136.24	11859.65	RL	133	250	92	165	
EL	100							197	S	910329	1736.98	3650.27	12153.84	KF	1				
EL	100							97	P	910322	0929.08	3544.81	12120.41	JB	1	1			
EL	100							98	S	910322	0929.67	3545.19	12121.73	KF	1				
ER	100							91	S	910319	1206.00	3736.87	12243.71	KF	2				
ER	100							282	P	910404	1233.72	3347.89	11830.12	KF	2				

Table 3A (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
ER	100							56	P	910316	1211.72	3401.74	12002.28	SK	1				
ER	100							151	P	910323	1413.75	3350.63	11908.00	JC	1	1			
ER	100							119	P	910322	1251.92	3826.46	12310.82	JC	1				
ER	100							311	P	910407	1338.33	4044.18	12422.74	SK	5				
ER	100							40	P	910316	1003.88	3315.05	11802.06	CL	6	6	6	6	6
ER	100							99	P	910322	0930.62	3545.75	12123.70	SK	1	1	1	1	
ER	100							44	S	910316	1043.13	3331.21	11904.28	KF	1	1			
ER	100							46	O	910316	1101.87	3334.27	11916.06	JB					
ER	100							57	P	910316	1211.93	3402.13	12002.06	SK	1	1	1		
ER	100							63	P	910316	1521.70	3443.83	12045.83	JB	10	10			
ER	100							67	O	910316	1533.13	3450.68	12044.53		16				
ER	100							66	S	910316	1527.07	3453.65	12041.38	KF	4				
ER	100							213	P	910330	1702.82	4105.98	12414.81	KF	1				
ER	100							221	O	910331	1611.40	3425.30	12040.85	SK	1	1			
ER	100							195	O	910329	1729.02	3637.25	12200.11	KF	4				
ER	100							81	P	910317	0953.22	3323.02	11819.40	JB	1	1			
ER	100							65	P	910316	1524.53	3448.91	12043.68	JC	1				
GG	100							241	P	910401	1241.43	3258.36	11858.41	CL	24	28	29	26	
GG	100							223	P	910331	1624.00	3413.47	12013.84	SK	85	30	45	45	
GG	77	TT	15	LB	4			260	P	910401	1630.02	3258.94	11831.51	SK	55	23	19		
GG	100							185	P	910329	1050.25	3345.22	12202.68	JC	8	9	7		
GG	100							259	P	910401	1616.72	3306.10	11900.17	CL	4				
GG	100							277	P	910403	1336.47	3301.98	11758.72	SK	8	10	9	9	
GG	10	LB	51	DD	39			148	P	910323	1253.98	3322.20	11919.40	SK	185	165	132	163	
GG	100							222	O	910331	1612.82	3423.22	12037.65	JC	10				
GG	97	LB	2	LO	1	ZC	<1	188	P	910329	1202.97	3526.95	12126.60	JC			60		
GG	100							85	O	910317	1033.27	3308.93	11735.08	JC	7				
GG	100							88	O	910317	1036.68	3303.21	11728.43	KF					
GG	100							87	O	910317	1036.45	3303.58	11728.91	JB					
GG	76	LB	24					52	P	910316	1124.58	3340.60	11941.75	SK		80	65	50	50
GG	100							83	O	910317	1021.38	3328.16	11758.03	JB	40				
GG	100							54	P	910316	1153.98	3348.01	12009.13	JC	11	8	12	11	11
GG	100							51	O	910316	1117.15	3337.48	11926.91	SK	15				
GG	100							55	O	910316	1158.38	3349.36	12008.56	KF	32	28	23	31	
LB	51	DD	39	GG	10			148	P	910323	1253.98	3322.20	11919.40	SK	185	165	132	163	
LB	100							229	P	910401	1129.32	3211.11	11916.46	RL	9	10	9		
LB	100							323	S	910407	1534.23	4149.07	12545.70	SK	2				
LB	100							248	P	910401	1309.18	3322.45	11849.76	KF	10	10			
LB	100							146	P	910323	1235.82	3259.25	11927.87	KF	3				
LB	24	GG	76					52	P	910316	1124.58	3340.60	11941.75	SK		80	65	50	50
LB	100							74	P	910317	0840.60	3236.95	11851.01	JC	2	2	2		
LB	100							238	S	910401	1222.17	3249.55	11901.96	SK	8	6	8		
LB	2	LO	1	ZC	<1	GG	97	188	P	910329	1202.97	3526.95	12126.60	JC			60		
LB	100							256	P	910401	1614.63	3307.30	11904.83	KF	6				

Table 3A (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
LB	100							76	O	910317	0856.35	3240.14	11858.13	JB	10				
LB	100							299	S	910405	1508.23	3213.76	11853.48	SK	3				
LB	7	LO	89	ZC	<1	DDLO	4	158	S	910324	1122.48	3136.24	11859.65	RL	133	250	.92	165	
LB	100							78	P	910317	0925.77	3236.46	11837.58	CL	10				
LB	100							103	P	910322	1110.62	3649.12	12350.26	JC	4	4	4		
LB	70	PD	30					201	P	910330	1017.77	3954.63	12542.31	JC	10				
LB	100							300	P	910405	1626.55	3344.02	11939.79	RL	13				
LB	100							192	P	910329	1626.77	3514.96	12230.37	JC	6	8			
LB	100							258	P	910401	1616.45	3306.28	11900.78	KF	7				
LB	100							240	P	910401	1234.55	3255.10	11859.71	JC	4	4			
LB	8	LO	92					331	P	910407	1614.47	4134.72	12442.46	KF	700	840	600	1640	770
LB	100							154	O	910323	1700.72	3210.62	11847.13	KF	7				
LB	100							257	P	910401	1615.80	3306.58	11902.23	CL	7	6			
LB	4	GG	77	TT	15			260	P	910401	1630.02	3258.94	11831.51	SK	55	23	19		
LO	89	ZC	<1	DDLO	4	LB	7	158	S	910324	1122.48	3136.24	11859.65	RL	133	250	92	165	
LO	46	ZC	54					230	P	910401	1142.43	3225.61	11910.67	RL	55	75		80	80
LO	100							93	P	910319	1249.60	3757.10	12402.52	CL	60		50	100	100
LO	92	LB	8					331	P	910407	1614.47	4134.72	12442.46	KF	700	840	600	1640	770
LO	83	ZC	17					231	P	910401	1158.18	3227.91	11909.65	RL	27	20	14		
LO	1	ZC	<1	GG	97	LB	2	188	P	910329	1202.97	3526.95	12126.60	JC			60		
LO	100							124	P	910322	1533.40	3702.36	12318.98	JC	1	1	1		
LO	100							164	S	910324	1220.00	3202.82	11944.35	KF	10	10	13		
LOPD	100							321	P	910407	1454.42	4151.96	12515.15	RL	2	2			
LR	100							152	P	910323	1640.40	3157.84	11851.04	JB	2				
LW	100							80	O	910317	0947.58	3315.49	11823.02	JB	1				
LW	100							104	P	910322	1117.67	3648.22	12350.91	SK	1				
LW	100							219	P	910331	1531.42	3452.49	12109.66	RL	1				
LW	100							53	O	910316	1126.55	3340.89	11941.41	KF	2				
LW	100							301	P	910407	0841.63	4022.90	12424.18	CL	1				
LW	100							329	O	910407	1600.92	4141.71	12514.51	JC	2				
LW	100							309	O	910407	1121.00	4133.22	12459.10	SK					
LW	100							120	O	910322	1321.40	3730.65	12230.34	KF	1	1			
MA	100							298	P	910405	1504.72	3212.54	11847.38	JC	1				
MM	100							41	S	910316	1009.53	3316.20	11806.27	SK	1				
MN	50	BA	50					308	P	910407	1050.75	4157.80	12542.93	RL	2	2	2	2	
MN	100							207	P	910330	1558.40	4130.87	12559.71	SK	1	1			
MN	100							123	P	910322	1516.68	3653.43	12247.44	JC	2				
MN	100							94	O	910319	1357.60	3851.35	12500.50	KF	2				
MN	100							108	P	910322	1158.95	3715.97	12339.41	KF	1	1	1	1	
MN	100							325	P	910407	1548.48	4146.73	12534.50	CL	2				
OO	100							189	P	910329	1443.83	3347.31	12011.33	RL	1	1	1		
OO	100							304	P	910407	1001.77	4120.20	12558.82	CL	1	1			
OT	100							177	P	910328	1610.62	3646.20	12253.00	SK	1				
OT	100							112	P	910322	1217.68	3737.52	12330.82	JB	1				

Table 3A (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
OT	100							332	S	910408	1207.03	3936.49	12424.43	KF	1				
OT	100							319	P	910407	1453.20	4150.04	12515.85	RL	2				
OT	100							110	P	910322	1212.33	3728.74	12334.44	JB	1				
OT	100							111	P	910322	1213.05	3729.86	12334.02	SK	1	1			
OT	100							306	P	910407	1024.57	4139.13	12551.15	KF	4				
OT	100							60	P	910316	1434.28	3340.35	12110.09	SK	1				
OT	100							303	S	910407	1000.92	4118.86	12559.42	SK	3				
OT	100							305	P	910407	1015.45	4135.53	12552.65	KF	1				
OT	100							101	S	910322	0947.20	3553.15	12155.94	KF	1				
PD	100							116	P	910322	1237.32	3809.35	12317.59	JC	6				
PD	100							215	P	910331	1436.22	3519.72	12258.75	SK	1				
PD	100							113	S	910322	1232.05	3800.82	12321.23	KF	1				
PD	100							210	P	910330	1649.22	4111.63	12440.43	KF	1				
PD	30	LB	70					201	P	910330	1017.77	3954.63	12542.31	JC	10				
PD	100							102	P	910322	1102.88	3636.53	12354.88	SK	5				
PD	100							209	P	910330	1639.48	4114.41	12452.29	KF	5				
PD	100							47	S	910316	1103.03	3334.90	11918.52	JB	1				
PD	100							96	S	910319	1431.15	3938.93	12440.16	RL	1				
PD	100							187	O	910329	1152.33	3510.28	12132.65	KF	2				
PD	100							132	S	910322	1647.40	3734.10	12429.98	KF	1				
PD	100							203	P	910330	1138.55	3954.00	12534.54	SK	5				
PD	100							318	P	910407	1446.38	4147.68	12516.87	RL	6	7			
PD	100							153	P	910323	1657.37	3210.23	11847.17	JB	3	3			
PD	100							312	P	910407	1350.25	4049.83	12443.91	JC	2				
PD	100							131	S	910322	1647.32	3733.95	12430.03	KF	1				
PD	100							72	P	910317	0811.80	3223.29	11758.16	KF	6	6			
PD	100							129	P	910322	1607.05	3707.32	12338.21	CL	1				
PD	100							272	P	910403	1141.50	3250.55	11800.96	RL	2				
PD	100							186	O	910329	1151.10	3508.73	12133.52	RL	4				
PD	100							130	P	910322	1616.98	3712.54	12357.53	KF	2	4			
PM	100							71	P	910316	1706.70	3253.68	11948.11	CL	2	2			
PP	100							126	P	910322	1542.45	3705.15	12328.83	JC	1	1	1	1	
PP	100							212	P	910330	1702.58	4106.07	12415.27	KF	2				
PP	100							211	P	910330	1658.73	4107.61	12423.65	KF	1				
PP	100							310	O	910407	1332.40	4047.88	12413.53	KF	1				
PP	100							214	P	910330	1703.12	4105.88	12414.17	KF	1				
PP	100							199	P	910329	1738.48	3652.59	12152.54	SK	1				
PP	100							198	P	910329	1737.68	3651.35	12153.14	SK	1				
PP	100							172	P	910328	0813.85	4022.92	12427.48	KF	1				
PP	100							173	P	910328	0814.65	4023.18	12429.06	KF	1				
PP	100							121	P	910322	1446.13	3639.26	12150.44	JB	1				
PP	100							181	P	910328	1648.97	3740.47	12231.80	JC	1				
PP	100							122	P	910322	1446.43	3639.44	12151.02	JB	1	1			
PP	100							179	P	910328	1646.72	3736.21	12232.96	JC	1				

Table 3A (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
PP	100							180	P	910328	1647.02	3736.77	12232.83	JC	1				
PU	100							175	P	910328	1543.15	3603.09	12309.89	KF	2				
PU	100							242	P	910401	1249.43	3258.41	11858.27	KF	1				
PU	100							314	P	910407	1413.92	4101.10	12527.05	CL	2				
PU	100							247	S	910401	1306.97	3318.72	11850.82	CL	1				
PU	100							236	P	910401	1217.28	3241.42	11904.82	CL	1				
PU	100							317	P	910407	1442.68	4141.94	12519.43	SK	2				
PU	100							176	S	910328	1608.98	3643.63	12254.25	KF	1				
PU	100							255	P	910401	1614.15	3307.53	11905.92	KF	3				
PU	100							157	P	910324	1110.70	3116.93	11907.23	JC	1				
PU	100							270	S	910403	1136.75	3248.23	11752.67	CL	1				
PU	100							275	P	910403	1322.32	3239.55	11806.87	CL	3				
PU	100							273	P	910403	1243.15	3140.52	11827.95	JC	1				
PU	100							302	S	910407	0926.95	4045.10	12556.36	KF	1				
PU	100							156	P	910323	1715.78	3224.34	11842.26	KF	1				
PU	100							252	P	910401	1335.03	3331.41	11846.03	SK	1				
PU	100							134	P	910322	1704.23	3756.67	12419.69	CL	1				
PU	100							168	P	910324	1405.95	3330.93	12015.03	KF	1				
PU	100							61	P	910316	1457.73	3423.88	12052.93	CL	1	1			
PU	100							250	P	910401	1334.40	3330.31	11846.50	JC	1				
PU	100							274	S	910403	1310.70	3220.96	11813.44	JC	1				
PU	100							326	O	910407	1554.15	4145.76	12530.55	KF	2				
PU	100							182	P	910329	1031.00	3326.29	12152.37	JC	1				
PU	100							193	P	910329	1643.65	3535.76	12222.96	KF	1				
PU	100							216	S	910331	1530.68	3452.86	12111.07	CL	1				
PU	100							217	P	910331	1531.02	3452.68	12110.44	KF	1				
PU	100							39	P	910316	0947.08	3306.15	11726.80	KF	1				
PU	100							330	S	910407	1604.05	4140.34	12507.08	CL	1				
PU	100							336	O	910408	1310.07	4051.88	12440.33	KF	1				
PU	100							335	P	910408	1249.55	4018.62	12453.21	KF	1				
PU	100							202	P	910330	1039.17	3959.68	12603.46	KF	4				
PU	100							334	P	910408	1230.83	3949.56	12504.33	JC	2				
PU	100							227	P	910401	1121.75	3158.80	11921.20	CL	1				
PV	100							218	P	910331	1531.42	3452.49	12109.66	KF	1				
PV	100							145	P	910323	1233.15	3254.96	11929.46	CL	1				
PV	100							237	P	910401	1221.65	3248.64	11902.27	CL	1				
SD	100							150	P	910323	1401.65	3338.31	11912.92	CL	1				
SD	100							58	O	910316	1343.02	3415.08	12004.84	KF					
SD	100							171	P	910327	0922.28	3836.19	12335.73	JC	12	6			
SDPD	100							136	O	910322	1109.52	3132.29	12002.23	KF	8				
SDPD	100							142	P	910323	1151.55	3206.05	11947.09	SK					
SDUP	100							127	P	910322	1555.58	3705.32	12329.94	JC	2				
SZ	100							167	P	910324	1319.08	3222.40	12041.06	JC	1	1	1	1	1
SZUK	100							137	P	910323	1123.75	3154.71	11952.73	KF	1				

Table 3A (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
TT	100							82	P	910317	0956.97	3329.41	11817.88	JB	50				
TT	2	DD	98					261	P	910401	1650.75	3256.77	11824.60	SK	2575				
TT	100							220	P	910331	1548.75	3446.53	12043.79	KF	1	1			
TT	100							267	P	910403	1124.80	3243.78	11735.53	KF	20	15	20	17	
TT	15	LB	4	GG	77			260	P	910401	1630.02	3258.94	11831.51	SK	55	23	19		
TT	100							90	O	910317	1050.35	3247.17	11716.77	JB					
TTSZ	100							75	S	910317	0847.58	3239.63	11858.22	JC	1				
UB	100							95	P	910319	1411.50	3911.46	12451.43	JC	1				
UD	100							42	O	910316	1032.27	3325.63	11842.13	JC					
UD	100							263	O	910401	1726.32	3249.12	11754.88	JC					
UD	100							178	O	910328	1627.08	3703.24	12246.34	KF	12				
UD	100							89	O	910317	1040.42	3255.71	11723.09	JB					
UM	100							307	P	910407	1038.75	4144.76	12548.87	RL	2	2	2		
UM	100							133	P	910322	1653.03	3744.54	12425.79	SK	1	1			
UO	100							128	P	910322	1606.78	3707.19	12337.82	KF	1				
UO	100							114	S	910322	1233.97	3803.86	12319.82	KF	1				
UO	100							115	P	910322	1235.85	3806.94	12318.49	CL	1				
UO	100							315	P	910407	1424.87	4113.45	12530.85	CL	1				
UO	100							92	S	910319	1237.90	3753.24	12347.58	SK	1				
UO	100							68	O	910316	1616.50	3322.46	12116.56	KF	1				
UO	100							77	P	910317	0904.58	3243.08	11910.61	JB	1				
UO	100							206	P	910330	1557.23	4131.44	12602.50	JC	1				
US	100							165	P	910324	1232.78	3208.11	12004.43	SK	1				
US	100							253	P	910401	1335.40	3332.06	11845.77	JC	1				
US	100							109	P	910322	1208.35	3721.91	12337.09	SK	1				
US	100							163	P	910324	1207.20	3155.54	11919.26	KF	1				
WB	100							204	P	910330	1146.08	3958.25	12533.18	JC					
WB	100							84	O	910317	1031.10	3312.43	11739.37	JB					
WB	100							86	O	910317	1034.72	3306.64	11732.30	JB					
WB	100							191	P	910329	1509.52	3357.13	12045.68	RL	1				
WB	100							194	S	910329	1712.57	3620.16	12204.96	KF	1				
WB	100							200	O	910330	0948.48	3936.86	12431.84	CL					
WBPDTT	100							155	S	910323	1706.25	3216.94	11844.93	CL	2				
ZC	100							232	P	910401	1211.83	3232.31	11908.38	CL	1				
ZC	100							233	S	910401	1214.03	3235.96	11906.92	SK	1				
ZC	100							235	P	910401	1215.00	3237.52	11906.21	JC	1				
ZC	100							239	P	910401	1234.28	3254.71	11859.85	JC	1				
ZC	100							234	P	910401	1214.62	3236.92	11906.48	JC	1				
ZC	100							73	P	910317	0820.55	3226.03	11807.83	KF	1				
ZC	100							190	S	910329	1506.22	3355.49	12039.85	CL	1				
ZC	100							333	S	910408	1218.35	3941.43	12444.96	SK	1				
ZC	<1	GG	97	LB	2	LO	1	188	P	910329	1202.97	3526.95	12126.60	JC			60		
ZC	100							244	P	910401	1302.93	3311.82	11853.43	RL	1				
ZC	54	LO	46					230	P	910401	1142.43	3225.61	11910.67	RL	55	75		80	80

Table 3A (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
ZC	100							228	P	910401	1124.67	3203.54	11919.34	CL	1				
ZC	17	LO	83					231	P	910401	1158.18	3227.91	11909.65	RL	27	20	14		
ZC	100							313	S	910407	1354.20	4050.89	12447.49	RL	1				
ZC	100							159	S	910324	1156.98	3150.26	11859.62	JC	1				
ZC	<1	DDLO	4	LB	7	LO	89	158	S	910324	1122.48	3136.24	11859.65	RL	133	250	92	165	
ZC	100							268	P	910403	1131.03	3245.50	11742.05	KF	1				
ZC	100							160	P	910324	1157.17	3150.49	11859.90	CL	1				
ZC	100							162	P	910324	1158.20	3151.12	11901.83	KF	1				
ZC	100							271	P	910403	1137.60	3248.64	11754.11	KF	1				
ZC	100							276	S	910403	1331.57	3254.13	11801.56	KF	1				
ZC	100							269	P	910403	1135.55	3247.77	11750.47	RL	2				
ZC	100							245	P	910401	1304.27	3314.15	11852.49	KF	1				
ZC	100							59	P	910316	1425.63	3324.18	12115.63	SK	1				
ZC	100							265	P	910403	1108.28	3241.62	11725.59	KF	1				
ZC	100							251	P	910401	1334.80	3331.12	11846.17	JC	1				
ZC	100							249	P	910401	1332.18	3326.72	11848.14	RL	1				
ZC	100							70	S	910316	1650.08	3303.34	12019.65	JB	1				
ZC	100							69	P	910316	1640.52	3310.93	12035.79	CL	1				
ZC	100							149	S	910323	1321.95	3333.72	11914.91	KF	1				
ZC	100							246	P	910401	1305.38	3316.04	11851.74	RL	1				
ZI	100							208	P	910330	1602.92	4129.61	12553.62	JC	5				
ZI	100							143	P	910323	1215.82	3232.22	11938.07	CL	1	1			
ZI	100							324	O	910407	1537.72	4149.14	12545.10	JC	2	2	2		
ZU	100							205	P	910330	1243.92	4056.70	12510.26	RL	2	2			

Table 3B. All cetacean and pinniped sightings (including off effort sightings) made during the 1992 aerial survey. Sightings are listed alphabetically by species code. Species present in the school are listed with their percent composition of the school to the right of each species. The sightings number and type, (P) primary, (S) secondary, or (O) off effort, are given for each sighting. The observer who made the sighting is also given. School size estimates represent the "best" estimate from individual observers.

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
1992:																			
BA	100							0	O	920329	1628.00	3353.00	11915.00	KF	1				
BM	67	BP	33					157	O	920227	1117.10	3228.02	11806.60	SK	3	3	3		
BM	100							197	P	920315	1125.25	3429.48	12147.10	JB	1	1	1	1	1
BP	100							69	S	920218	1552.62	3357.05	11905.47	CL	1	1	1	1	1
BP	33	BM	67					157	O	920227	1117.10	3228.02	11806.60	SK	3	3	3		
BP	100							58	O	920218	1153.03	3340.49	11938.51	KF	2	2	2	2	2
BP	5	ZC	17	LB	78			176	S	920305	1426.73	3307.90	11925.62	CL	60	57	27	42	47
CU	100							94	P	920224	1301.73	3758.70	12408.70	SK	4				
CU	100							93	P	920224	1301.02	3758.10	12406.30	SK	1				
CU	100							92	P	920224	1253.72	3754.40	12352.10	SK	1				
CU	100							90	P	920224	1238.02	3750.80	12337.90	DE	1				
CU	100							95	P	920224	1307.72	3800.90	12419.30	DE	1				
CU	100							123	P	920225	1544.62	4128.00	12546.70	SK	1				
CU	100							100	P	920224	1347.97	3822.50	12511.20	SK	1				
CU	100							110	P	920225	1041.22	4139.10	12551.10	SK	4				
CU	100							111	P	920225	1043.67	4144.90	12548.70	SK	1				
CU	100							119	P	920225	1517.73	4133.70	12508.10	CL	1				
CU	100							97	P	920224	1319.23	3807.40	12437.00	JC	1				
CU	100							91	P	920224	1244.82	3752.00	12343.20	SK	1	1			
DC	100							NA	S	920315	1240.10	3546.80	12126.34	JC	1				
DC	100							NA	S	920324	1252.39	3230.88	11909.20	JC	1				
DD	95	DDSC	5					26	P	920217	1055.32	3130.04	11902.50	KF	35	40	45	90	
DD	>99	MN	<1					229	P	920324	1640.52	3252.78	11805.47	DE	2901	900	2200		
DD	100							248	P	920329	1133.83	3238.67	11807.69	KF	475	450	500		
DD	>99	ZC	<1					51	S	920218	1127.33	3335.44	11919.02	ML	25	50	32	40	
DD	100							261	P	920329	1605.27	3409.97	11957.76	KF	35	25	35	35	
DD	100							65	P	920218	1253.58	3417.11	11955.84	ML	145				
DD	100							225	P	920324	1241.63	3229.20	11909.68	JB	1500	600	1100		
DD	100							216	P	920324	1124.42	3218.17	11900.29	DE	1500	550	800	1100	700
DD	100							63	S	920218	1238.42	3404.56	12001.38	KF	5	4	3	5	
DD	100							158	S	920304	1132.85	3231.97	11825.16	CL	400	600	950	400	550
DD	100							32	P	920217	1257.43	3221.59	11843.79	SK	12	15			
DD	100							207	P	920318	0956.70	3446.70	12042.26	ML	200	145	125		
DD	27	LO	69	ZC	2			30	P	920217	1223.10	3209.33	11847.80	SK	113	34	40	43	55
DDSC	5	DD	95					26	P	920217	1055.32	3130.04	11902.50	KF	35	40	45	90	
EG	100							214	P	920324	1053.63	3213.92	11841.90	DE	1	1	1		
ER	100							71	P	920219	1121.52	3242.37	11733.97	JC	5	5			

Table 3B (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
ER	100							79	P	920223	1230.27	3738.40	12252.90	DE	1				
ER	100							62	P	920218	1229.52	3350.47	12007.33	KF	2				
ER	100							77	P	920223	1153.68	3721.70	12238.60	CL	3	3	3	3	
ER	100							68	P	920218	1546.37	3349.60	11908.72	DE	1	1	1	1	1
ER	100							201	P	920315	1234.22	3546.36	12124.10	DE	18	18			
ER	100							170	P	920304	1531.42	3442.25	12045.59	SK	15	14			
ER	100							155	P	920227	1327.70	3632.80	12201.20	CL	2	2			
ER	100							181	P	920305	1500.90	3337.39	11913.84	ML	16	14	15	18	
ER	100							52	P	920218	1138.70	3335.96	11920.61	CL	4	4	4		
GG	100							250	P	920329	1207.58	3309.50	11755.98	DE	5	7			
GG	99	WB	1					73	P	920223	0845.75	3641.97	12201.81	SK	360	275	150	290	
GG	20	LO	80					153	P	920227	1258.33	3617.90	12206.50	SK	670	595	735	600	760
GG	100							82	P	920223	1246.02	3744.00	12311.40	CL	40				
GG	100							159	P	920304	1205.47	3239.08	11852.27	DE	7	7	7		
GG	100							21	P	920214	1611.78	3318.53	11811.26	SK	10	9	10	10	10
GG	100							40	P	920218	1035.83	3313.64	11745.00	JC	8	8	8	8	8
GG	81	TT	19					39	P	920218	1013.32	3309.67	11731.86	DE	40	45	35	35	37
GG	99	TT	1					24	P	920214	1629.57	3312.08	11744.06	KF	180	135	142		125
GG	100							22	P	920214	1621.92	3313.88	11752.58	KF	10	9	11	10	11
GM	100							181A	O	920309	1111.85	3234.36	11912.77	JC	4				
LB	20	ZC	3	LO	77			150	P	920227	1230.45	3553.60	12215.60	DE	382	180	250		
LB	100							37	P	920217	1406.37	3301.67	11828.12	KF	4				
LB	8	LO	92					106	P	920225	0944.73	4050.90	12611.50	JC	50	90	75	64	
LB	100							28	P	920217	1140.22	3145.40	11856.65	KF	13	12	15		
LB	42	LO	58					223	P	920324	1150.07	3223.34	11923.94	JC	550	240	600		
LB	78	BP	5	ZC	17			176	S	920305	1426.73	3307.90	11925.62	CL	60	57	27	42	47
LB	100							38	P	920217	1407.85	3304.20	11827.14	DE	5				
LB	1	PU	<1	LO	99			76	S	920223	1119.60	3709.00	12243.70	JC	600	560	1500	356	
LB	100							59	P	920218	1205.05	3341.91	11945.68	KF	9	7	8		
LO	100							193	P	920314	1246.87	3303.35	12021.47	CL	2				
LO	80	GG	20					153	P	920227	1258.33	3617.90	12206.50	SK	670	595	735	600	760
LO	93	ZC	7					33	S	920217	1313.63	3235.11	11838.54	ML	34	37	15		
LO	100							192	P	920314	1222.85	3302.83	12019.36	ML	25	30	38		
LO	92	LB	8					106	P	920225	0944.73	4050.90	12611.50	JC	50	90	75	64	
LO	100							185	P	920314	1002.23	3306.38	12025.36	JB	10	9	9	9	
LO	100							187	P	920314	1019.55	3303.29	12026.29	JB	25	11			
LO	99	LB	1	PU	<1			76	S	920223	1119.60	3709.00	12243.70	JC	600	560	1500	356	
LO	77	LB	20	ZC	3			150	P	920227	1230.45	3553.60	12215.60	DE	382	180	250		
LO	58	LB	42					223	P	920324	1150.07	3223.34	11923.94	JC	550	240	600		
LO	69	ZC	2	DD	27			30	P	920217	1223.10	3209.33	11847.80	SK	113	34	40	43	55
LO	100							83	P	920223	1312.22	3800.80	12322.70	ML	50	110	70		
LO	52	ZC	48					35	P	920217	1344.15	3240.82	11836.42	KF	20	4	2		

Table 3B (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
MA	100							115	P	920225	1213.50	4145.78	12449.92	DE	1				
MM	100							75	P	920223	0910.90	3643.15	12206.72	SK					
MN	<1	DD	>99					229	P	920324	1640.52	3252.78	11805.47	DE	2901	900	2200		
MN	100							108	P	920225	1030.68	4130.00	12555.00	SK	2	2			
MN	100							121	P	920225	1525.02	4130.20	12555.70	CL	3	3			
OT	100							112	S	920225	1045.95	4148.90	12545.70	CL	1				
OT	100							175	P	920305	1409.25	3247.10	11932.77	SK	1				
OT	100							167	P	920304	1508.70	3417.20	12055.80	SK	1				
OT	100							184	P	920313	1638.50	3241.22	11900.65	JB	1				
OT	100							144	P	920227	1129.72	3429.29	12240.56	ML	1				
OT	100							143	S	920227	1129.43	3428.95	12240.02	CL	1				
OT	100							145	P	920227	1131.78	3431.72	12244.38	JC	1				
OT	100							103	P	920224	1421.23	3836.20	12505.80	CL	2				
PD	100							130	S	920226	1115.27	3945.90	12435.80	SK	4	4	5		
PD	100							124	P	920225	1610.75	4115.30	12455.10	JC	3				
PD	100							117	S	920225	1438.53	4156.70	12438.20	JC	1				
PD	100							154	P	920227	1319.37	3626.30	12203.20	CL	5	4			
PD	100							105	P	920225	0928.95	4043.60	12549.90	SK	4	4			
PD	100							89	S	920224	1232.35	3750.20	12337.00	ML	6				
PD	100							212	S	920318	1219.80	3644.84	12253.16	DE	1				
PD	100							221	P	920324	1143.70	3221.99	11917.08	JC	6				
PD	100							23	S	920214	1627.77	3312.52	11747.71	JC	2				
PD	100							66	S	920218	1312.13	3420.26	11954.40	KF	6	6			
PD	100							203	P	920315	1254.37	3553.87	12154.05	DE	1				
PD	100							199	S	920315	1214.80	3518.57	12129.61	JB	2				
PD	100							142	P	920227	1114.00	3421.40	12217.40	ML	6	7			
PD	100							107	P	920225	1004.55	4057.20	12608.60	JC	1				
PD	100							98	P	920224	1324.62	3810.10	12449.70	JC	2				
PD	100							34	P	920217	1336.50	3237.51	11837.58	KF	7	9	8		
PD	100							178	P	920305	1451.53	3329.47	11916.93	JC	2	2	2		
PM	100							198	S	920315	1159.75	3508.71	12133.12	JB	1				
PM	100							139	P	920227	1040.60	3405.80	12119.60	DE	7				
PM	100							137	P	920227	0954.87	3403.50	12111.20	JC	22	22	25	18	
PP	100							213	O	920318	1348.82	3607.40	12249.29	CL	13				
PP	100							78	S	920223	1214.07	3741.70	12229.40	SK	1				
PP	100							85	P	920223	1336.48	3823.50	12313.90	JC	1				
PP	100							127	P	920225	1637.02	4104.00	12411.10	CL	3				
PP	100							131	S	920226	1133.73	4022.00	12422.00	SK	1				
PP	100							116	P	920225	1428.25	4150.00	12413.00	CL	1				
PU	100							86	P	920223	1337.75	3825.80	12313.10	JC	1				
PU	100							113	S	920225	1143.15	4051.93	12511.74	SK	1				
PU	<1	LO	99	LB	1			76	S	920223	1119.60	3709.00	12243.70	JC	600	560	1500	356	
PU	100							169	P	920304	1525.27	3432.27	12049.79	SK	1				
PU	100							166	P	920304	1426.02	3312.92	12119.08	SK	1				

Table 3B (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
PU	100							172	S	920305	1336.38	3151.53	11954.40	JC	1				
PU	100							162	P	920304	1245.42	3246.28	11938.56	JC	1				
PU	100							247	P	920329	1124.37	3222.48	11813.64	KF	1				
PU	100							164	P	920304	1300.55	3248.40	12004.93	CL	1				
PU	100							122	S	920225	1542.67	4129.00	12551.40	ML	1				
PU	100							146	P	920227	1132.33	3432.37	12245.40	ML	1				
PU	100							215	P	920324	1120.52	3216.31	11852.46	DE	1				
PU	100							194	P	920315	1020.52	3319.22	12118.47	JB	1				
PU	100							96	P	920224	1311.88	3801.80	12422.50	JC	1				
PU	100							174	P	920305	1405.10	3239.28	11935.71	SK	1				
PU	100							180	P	920305	1459.23	3334.41	11914.91	ML	1				
PU	100							114	P	920225	1153.83	4111.00	12504.00	JC	1				
PU	100							29	P	920217	1221.55	3209.44	11847.92	SK	1				
PU	100							226	P	920324	1255.03	3234.93	11907.53	JB	1				
PV	100							57	P	920218	1145.85	3338.95	11933.95	JC	1				
PV	100							129	P	920226	1110.13	3947.29	12434.88	DE	1				
PV	100							118	P	920225	1442.88	4159.20	12447.90	ML	1				
SDUP	100							204	S	920315	1309.57	3557.85	12211.79	CL	6				
SW	100							81	P	920223	1237.88	3742.30	12304.90	CL	1				
SW	100							67	P	920218	1536.65	3342.79	11911.41	DE	1				
TT	1	GG	99					24	P	920214	1629.57	3312.08	11744.06	KF	180	135	142		125
TT	19	GG	81					39	P	920218	1013.32	3309.67	11731.86	DE	40	45	35	35	37
TT	100							227	P	920324	1335.77	3344.73	11841.13	CL	10	7			
US	100							125	P	920225	1628.63	4106.80	12422.00	CL	1				
US	100							104	S	920224	1502.53	3858.50	12456.30	CL	1				
US	100							109	P	920225	1040.33	4139.10	12551.10	SK	1				
US	100							165	P	920304	1422.73	3307.27	12121.41	CL	1				
US	100							249	S	920329	1151.03	3241.40	11806.62	KF	1				
UW	100							80	O	920223	1236.25	3740.00	12300.00	C	1				
WB	1	GG	99					73	P	920223	0845.75	3641.97	12201.81	SK	360	275	150	290	
WB	100							102	S	920224	1405.38	3830.00	12508.00	JC	11				
WB	100							168	P	920304	1514.38	3426.49	12052.03	SK	8				
ZC	100							260	P	920329	1604.60	3410.35	11959.16	JC	1				
ZC	100							55	P	920218	1142.22	3337.72	11927.04	JC	1				
ZC	100							54	P	920218	1141.90	3337.55	11926.49	JC	1				
ZC	100							217	S	920324	1139.25	3220.21	11907.70	DE	1				
ZC	100							258	P	920329	1601.08	3412.22	12006.46	KF	1				
ZC	100							259	P	920329	1603.23	3411.09	12001.98	KF	1				
ZC	2	DD	27	LO	69			30	P	920217	1223.10	3209.33	11847.80	SK	113	34	40	43	55
ZC	100							210	P	920318	1033.65	3454.82	12116.58	ML	1				
ZC	100							206	P	920316	0954.78	3409.29	11932.15	JC	1				
ZC	100							205	P	920315	1657.43	3502.57	12148.22	ML	1				
ZC	<1	DD	>99					51	S	920218	1127.33	3335.44	11919.02	ML	25	50	32	40	
ZC	100							208	P	920318	1023.85	3449.93	12057.31	DE	1				

Table 3B (continued).

SP1	%	SP2	%	SP3	%	SP4	%	SI#	TYP	DATE	TIME	LATITUDE	LONGITUDE	OBS	BEST ESTIMATES 1	2	3	4	5
ZC	100							218	P	920324	1139.38	3220.28	11907.97	JC	2				
ZC	100							209	S	920318	1029.33	3452.96	12108.04	JC	1				
ZC	100							211	S	920318	1036.78	3456.06	12122.56	JC	1				
ZC	100							246	P	920329	1104.10	3150.54	11824.98	DE	1				
ZC	100							255	P	920329	1553.62	3416.19	12022.69	KF	1				
ZC	100							224	P	920324	1241.37	3228.71	11909.85	CL	1				
ZC	100							254	P	920329	1551.68	3417.07	12026.71	KF	2				
ZC	100							253	P	920329	1306.05	3354.43	11855.85	CL	1				
ZC	100							251	P	920329	1258.97	3351.53	11842.86	CL	1				
ZC	100							70	P	920219	1059.02	3230.50	11820.42	JC	1				
ZC	100							56	P	920218	1142.45	3337.87	11927.50	JC	1				
ZC	100							61	P	920218	1229.45	3350.31	12007.38	KF	1				
ZC	100							220	P	920324	1142.28	3221.47	11914.14	JC	1				
ZC	100							64	S	920218	1247.62	3407.33	12000.02	KF	1				
ZC	100							257	P	920329	1600.32	3412.61	12008.07	KF	1				
ZC	100							222	P	920324	1148.27	3222.56	11913.81	JC	1				
ZC	100							256	S	920329	1555.92	3414.98	12017.70	ML	1				
ZC	100							230	P	920325	0948.07	3307.19	11900.51	ML	1				
ZC	100							219	P	920324	1139.87	3220.49	11908.95	JC	1				
ZC	100							189	P	920314	1206.47	3255.78	11951.46	JB	1				
ZC	100							43	P	920218	1119.83	3334.22	11914.23	KF	1				
ZC	100							41	P	920218	1117.22	3333.06	11909.34	ML	1				
ZC	100							152	P	920227	1252.55	3612.80	12208.20	SK	1				
ZC	100							151	P	920227	1251.35	3604.03	12211.73	SK	1				
ZC	100							160	P	920304	1223.05	3243.12	11911.28	SK	1				
ZC	100							161	P	920304	1242.02	3246.17	11932.44	JC	1				
ZC	100							44	P	920218	1120.08	3334.32	11914.72	ML	1				
ZC	100							36	S	920217	1354.33	3243.18	11835.56	JC	1				
ZC	100							163	S	920304	1258.35	3248.33	12001.07	SK	1				
ZC	3	LO	77	LB	20			150	P	920227	1230.45	3553.60	12215.60	DE	382	180	250		
ZC	100							42	P	920218	1118.63	3333.68	11911.93	ML	1				
ZC	100							138	P	920227	1038.47	3405.40	12115.70	CL	5				
ZC	100							133	P	920227	0939.88	3356.20	12041.00	SK	1				
ZC	100							136	P	920227	0949.30	3400.50	12057.30	SK	1				
ZC	100							135	P	920227	0942.25	3357.30	12045.30	SK	2				
ZC	100							132	P	920227	0933.63	3351.90	12026.20	SK	1				
ZC	100							140	P	920227	1053.45	3413.30	12138.60	CL	1				
ZC	100							148	P	920227	1221.87	3552.55	12216.00	SK	2				
ZC	100							147	P	920227	1137.65	3438.50	12244.70	JC	1				
ZC	100							141	P	920227	1055.90	3412.90	12144.60	CL	1				
ZC	48	LO	52					35	P	920217	1344.15	3240.82	11836.42	KF	20	4	2		
ZC	17	LB	78	BP	5			176	S	920305	1426.73	3307.90	11925.62	CL	60	57	27	42	47
ZC	100							196	P	920315	1107.77	3402.35	12157.14	CL	1				
ZC	100							195	P	920315	1043.68	3328.60	12156.74	JC	1				

Table 3B (continued).

ZC	100			47	P	920218	1125.63	3334.50	11915.97	CL	1		
ZC	100			191	P	920314	1208.02	3256.51	11954.61	DE	1		
ZC	100			48	P	920218	1125.92	3334.77	11916.44	JC	1		
ZC	100			49	P	920218	1126.97	3335.32	11918.34	CL	1		
ZC	100			202	P	920315	1250.83	3552.12	12147.11	DE	1		
ZC	7	LO	93	33	S	920217	1313.63	3235.11	11838.54	ML	34	37	'15
ZC	100			200	P	920315	1222.80	3527.54	12126.29	CL	1		
ZC	100			50	P	920218	1127.18	3335.39	11918.72	JC	1		
ZC	100			190	P	920314	1207.63	3256.34	11953.86	JB	1		
ZC	100			60	P	920218	1216.77	3344.13	11953.81	KF	18		
ZC	100			179	P	920305	1457.83	3331.92	11915.97	JC	6		
ZC	100			45	P	920218	1120.20	3334.38	11915.01	KF	6		
ZC	100			177	P	920305	1450.90	3328.33	11917.32	ML	1		
ZC	100			182	S	920313	1630.90	3237.56	11847.34	JC	1		
ZC	100			183	P	920313	1634.63	3239.30	11853.74	JB	1		
ZC	100			188	P	920314	1118.82	3217.23	12030.72	JB	1		
ZC	100			46	P	920218	1123.35	3334.73	11915.46	CL	5		
ZC	100			134	P	920227	0940.87	3356.28	12041.71	JC	1		
ZI	100			99	S	920224	1328.63	3811.00	12458.10	DE	2		

Table 4. Number and percent of kilometers surveyed, sightings, sightings/100 km, total # animals seen, mean group size, and animals/100 km, stratified by Beaufort sea state for 1991-1992 aerial surveys. Data include on-effort cetacean sightings made by primary and secondary observers.

	Beaufort 0&1	2	3	4	ALL
Kilometers surveyed					
1991	357 (5.1%)	1,164 (16.5%)	3,317 (47.1%)	2,198 (31.2%)	7,036 (100.0%)
1992	484 (8.2%)	1,224 (20.8%)	2,423 (41.2%)	1,749 (29.7%)	5,882 (100.0%)
ALL	842 (6.5%)	2,388 (18.5%)	5,740 (44.4%)	3,947 (30.6%)	12,918 (100.0%)
# Sightings					
1991	6	38	55	28	127
1992	10	18	41	17	86
ALL	16	56	96	45	213
Sightings/100 km					
1991	1.68	3.27	1.66	1.27	1.81
1992	2.07	1.47	1.69	0.97	1.46
ALL	1.90	2.35	1.67	1.14	1.65
Total # animals seen					
1991	419	1,608	7,623	692	10,342
1992	2,743	2,873	2,393	710	8,719
ALL	3,162	4,481	10,016	1,402	19,061
Animals/100 km					
1991	117.1	138.1	229.8	31.5	147.0
1992	565.7	234.7	98.7	40.6	148.2
ALL	375.2	187.6	174.5	35.5	147.5
Mean group size					
1991	46.5	41.2	124.9	22.3	73.8
1992	211.0	136.8	52.0	39.4	88.9
ALL	143.7	74.6	93.6	28.6	80.0

Table 5. Individual number of sightings, kilometers surveyed, and rates of detecting cetacean schools, stratified by Beaufort sea state, for all observers during 1991-1992 aerial surveys. Only on-effort cetacean sighting data are shown. Sightings made by both primary and secondary observers are included.

	BEAUFORT				
OBSERVER	0&1	2	3	4	ALL
# sightings					
01	4	8	12	9	33
02	3	2	6	4	15
03	0	6	8	2	16
04	1	18	12	12	43
05	1	10	24	10	45
06	1	2	6	0	9
07	1	3	9	2	15
08	5	7	19	6	37
ALL	16	56	96	45	213
Kilometers surveyed					
01	571	1,351	3,281	2,235	7,439
02	393	792	1,367	1,200	3,752
03	290	517	1,100	398	2,305
04	447	1,604	3,296	2,567	7,914
05	352	762	2,589	1,448	5,151
06	206	595	1,510	1,054	3,364
07	97	350	1,232	1,122	2,801
08	171	1,195	2,845	1,818	6,028
Sightings/100 km					
01	0.70	0.59	0.37	0.40	0.44
02	0.76	0.25	0.44	0.33	0.40
03	0.00	1.16	0.73	0.50	0.69
04	0.22	1.25	0.36	0.47	0.54
05	0.28	1.44	0.93	0.69	0.87
06	0.49	0.34	0.40	0.00	0.27
07	1.03	1.14	0.73	0.18	0.54
08	2.92	0.59	0.67	0.33	0.61
Avg.	0.63	0.78	0.56	0.38	0.55

Table 6. Sighting rates and number of kilometers searched by primary and secondary observers, stratified by percent glare and Beaufort sea state for 1991-1992 aerial surveys. The number of kilometers searched for each category are shown in parentheses. Glare values were recorded to the nearest 5%. * Kilometer total (38,754) is three times the actual number of transect miles surveyed (12,918), because glare is scored seperately for each of the three observers.

# Sightings/100 km **(# km searched)**	Beaufort 0&1	2	3	4	ALL
Right observer					
Glare %					
0-35	0.64 (472)	1.66 (1,023)	0.77 (1,689)	0.74 (1,081)	0.96 (4,265)
40-65	0.45 (221)	1.51 (731)	0.57 (2,115)	0.73 (1,374)	0.77 (4,441)
70-100	0.67 (149)	0.47 (634)	0.77 (1,937)	0.40 (1,493)	0.59 (4,212)
ALL	0.59 (842)	1.30 (2,388)	0.70 (5,740)	0.61 (3,948)	0.77 (12,918)
Left observer					
Glare %					
0-35	1.32 (379)	0.95 (951)	0.91 (1,214)	1.06 (377)	0.99 (2,921)
40-65	0.99 (304)	0.56 (720)	0.59 (2,030)	0.16 (1,292)	0.48 (4,347)
70-100	0.63 (159)	0.98 (717)	0.56 (2,496)	0.22 (2,278)	0.48 (5,650)
ALL	1.07 (842)	0.84 (2,388)	0.65 (5,740)	0.28 (3,948)	0.60 (12,918)
Secondary observer					
Glare %					
0-35	0.16 (616)	0.17 (1,200)	0.27 (1,468)	0.37 (823)	0.24 (4,108)
40-65	0.00 (111)	0.14 (731)	0.27 (2,240)	0.18 (1,666)	0.21 (4,748)
70-100	0.87 (115)	0.44 (457)	0.44 (2,032)	0.27 (1,458)	0.39 (4,062)
ALL	0.24 (842)	0.21 (2,388)	0.33 (5,740)	0.25 (3,948)	0.28 (12,918)
All observers combined					
Glare %					
0-35	0.61 (1,467)	0.88 (3,174)	0.64 (4,371)	0.66 (2,281)	0.71 (11,294)
40-65	0.63 (636)	0.73 (2,183)	0.47 (6,385)	0.35 (4,332)	0.48 (13,356)
70-100	0.71 (424)	0.66 (1,807)	0.59 (6,465)	0.29 (5,229)	0.49 (13,924)
ALL	0.63 (2,528)	0.78 (7,164)	0.56 (17,221)	0.38 (11,842)	0.55 (38,754)*

Table 7. Sighting rates and number of kilometers searched by primary and secondary observers, stratified by percent cloud cover and Beaufort sea state for 1991-1992 aerial surveys. The number of kilometers searched for each category are shown in parentheses. Cloud cover values were recorded to the nearest 5%. The number of kilometers surveyed for each of the three observers are equal for each cloud category, because cloud cover is scored once for all three observers searching simultaneously.

# Sightings/100 km (# km searched)			**Beaufort**		
	0&1	**2**	**3**	**4**	**ALL**
Primary observers					
Cloud %					
0-10	1.25 (399)	2.43 (1,483)	1.26 (2,381)	1.02 (1,660)	1.47 (5,923)
15-60	2.91 (275)	2.21 (453)	1.67 (1,374)	0.67 (1,199)	1.48 (3,301)
65-100	0.59 (169)	1.10 (453)	1.26 (1,985)	0.83 (1,089)	1.11 (3,695)
ALL	1.66 (842)	2.14 (2,388)	1.36 (5,740)	0.86 (3,948)	1.37 (12,918)
Secondary observer					
Cloud %					
0-10	0.25 (399)	0.27 (1,483)	0.25 (2,381)	0.24 (1,660)	0.25 (5,923)
15-60	0.00 (275)	0.00 (453)	0.36 (1,374)	0.33 (1,199)	0.27 (3,301)
65-100	0.59 (169)	0.22 (453)	0.40 (1,985)	0.18 (1,089)	0.33 (3,695)
ALL	0.24 (842)	0.21 (2,388)	0.33 (5,740)	0.25 (3,948)	0.28 (12,918)
All observers combined					
Cloud %					
0-10	1.50 (399)	2.70 (1,483)	1.51 (2,381)	1.27 (1,660)	1.72 (5,923)
15-60	2.91 (275)	2.21 (453)	2.04 (1,374)	1.01 (1,199)	1.76 (3,301)
65-100	1.18 (169)	1.33 (453)	1.66 (1,985)	1.01 (1,089)	1.43 (3,695)
ALL	1.90 (842)	2.35 (2,388)	1.69 (5,740)	1.12 (3,948)	1.65 (12,918)

Figure 1. Study area with two overlapping transect grids. The solid lines represent Grid 1, the dotted lines Grid 2.

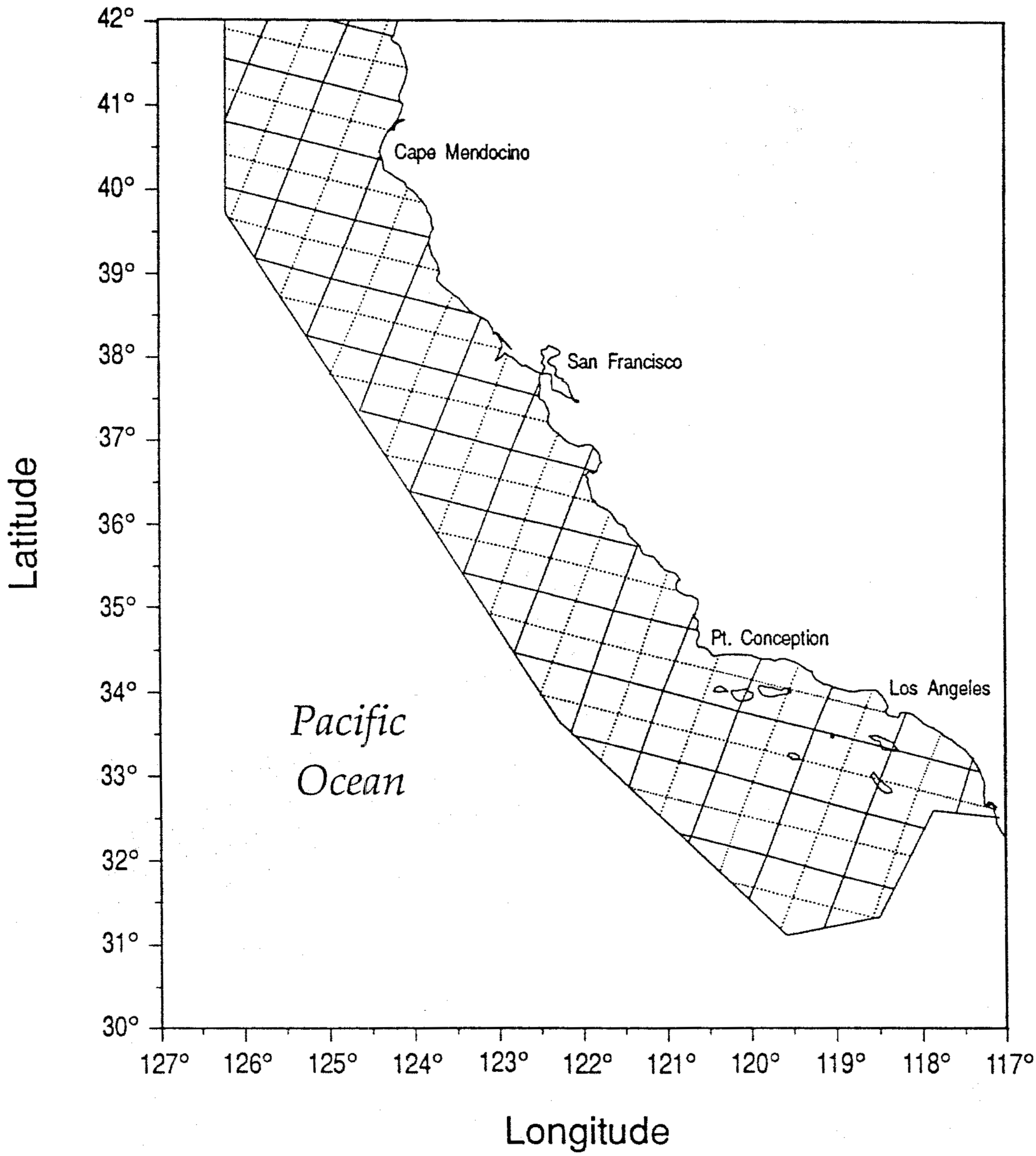


Figure 2. Completed transects (solid lines) for 1991 and a posteriori geographic strata (separated by dotted lines) used in analysis by Forney and Barlow (1993).

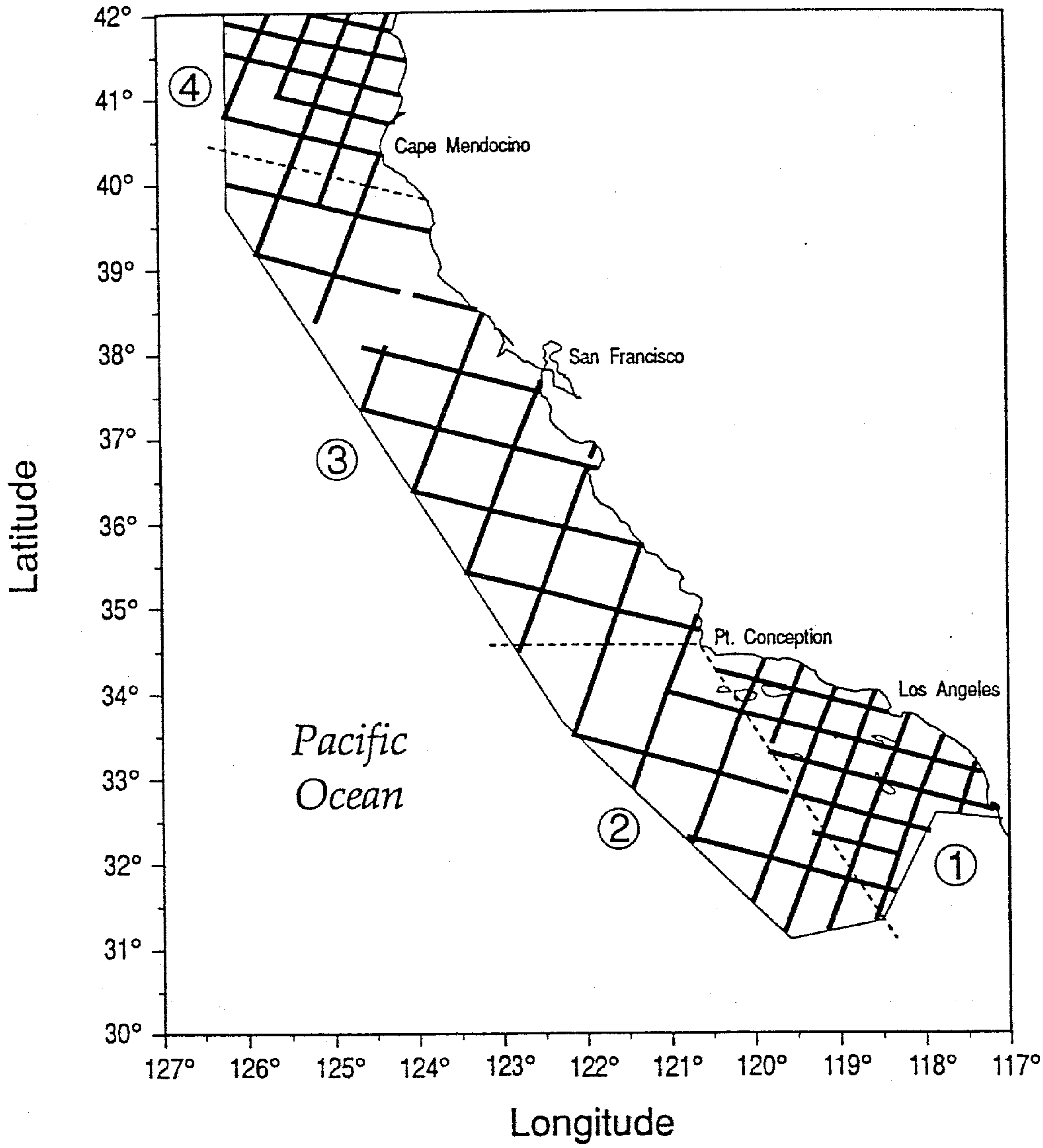


Figure 3. Completed transects (solid lines) for 1992 and a posteriori geographic strata (separated by dotted lines) used in analysis by Forney and Barlow (1993).

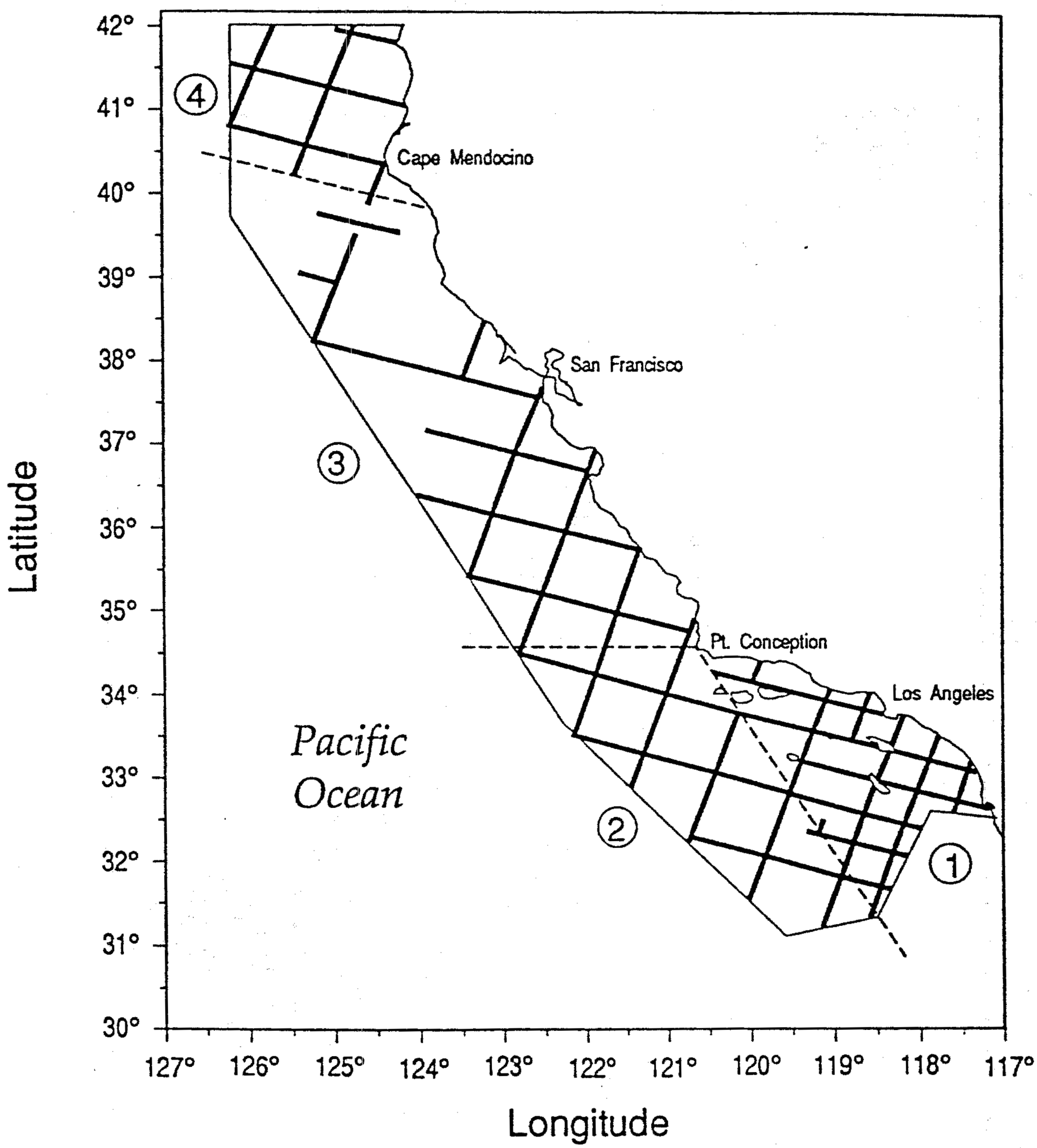


Figure 4. All marine mammal sightings made during 1991 aerial survey. On and off-effort sightings are included.

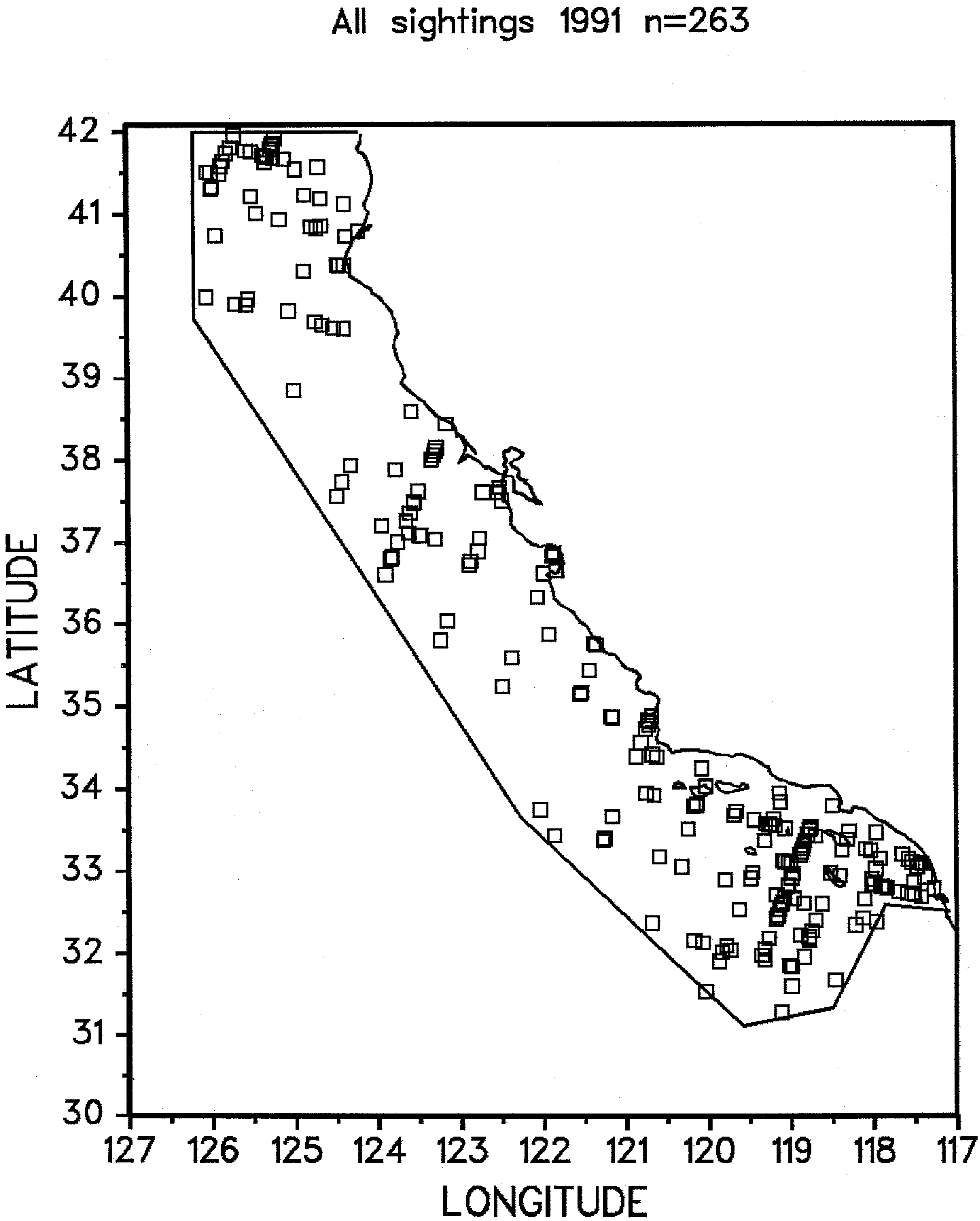


Figure 5. All marine mammal sightings made during 1992 survey. On and off-effort sightings are included.

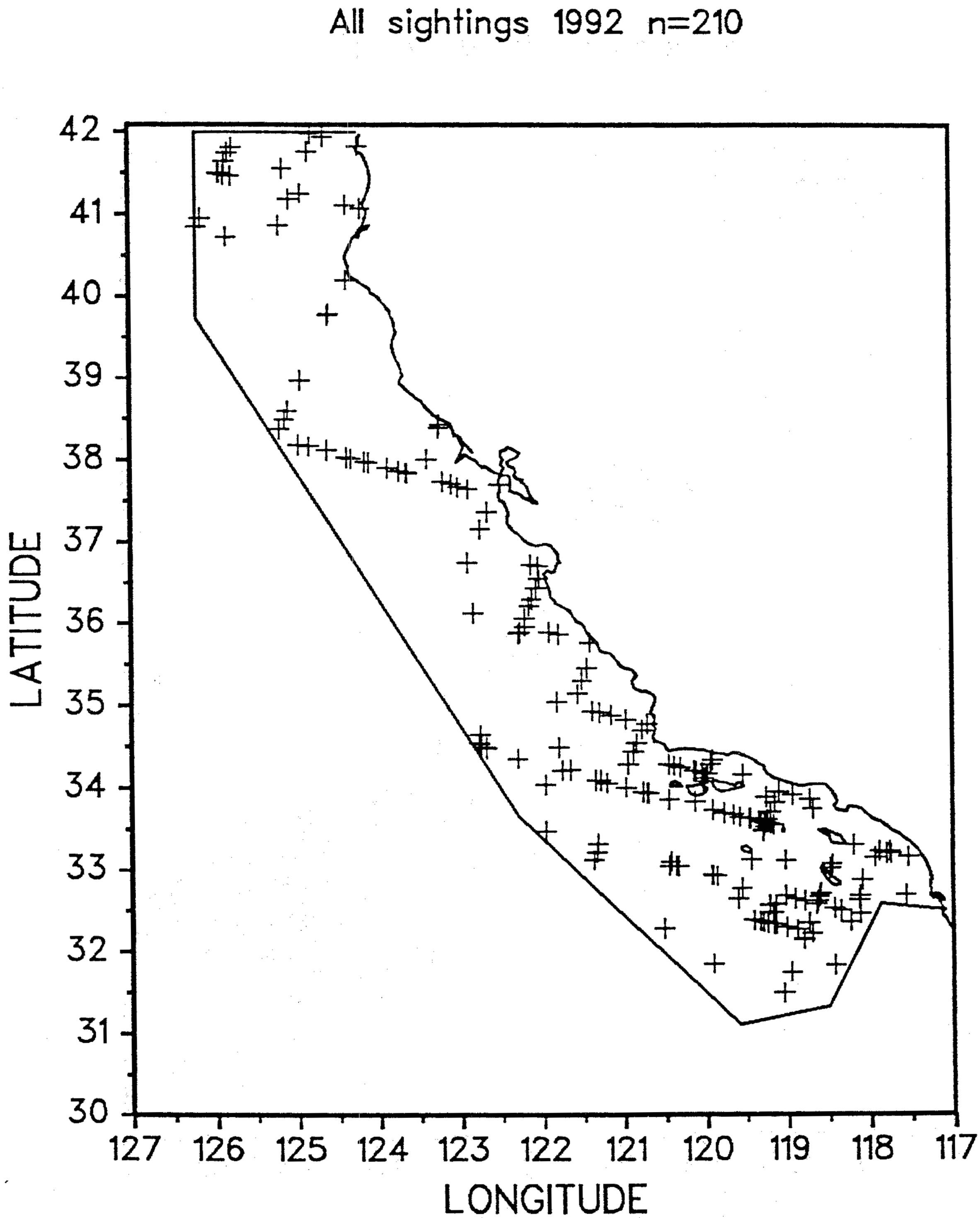


Figure 6. All marine mammal sightings made during 1991-1992 surveys. On and off-effort sightings are included. Square symbols represent 1991 sightings; plus signs 1992 sightings.

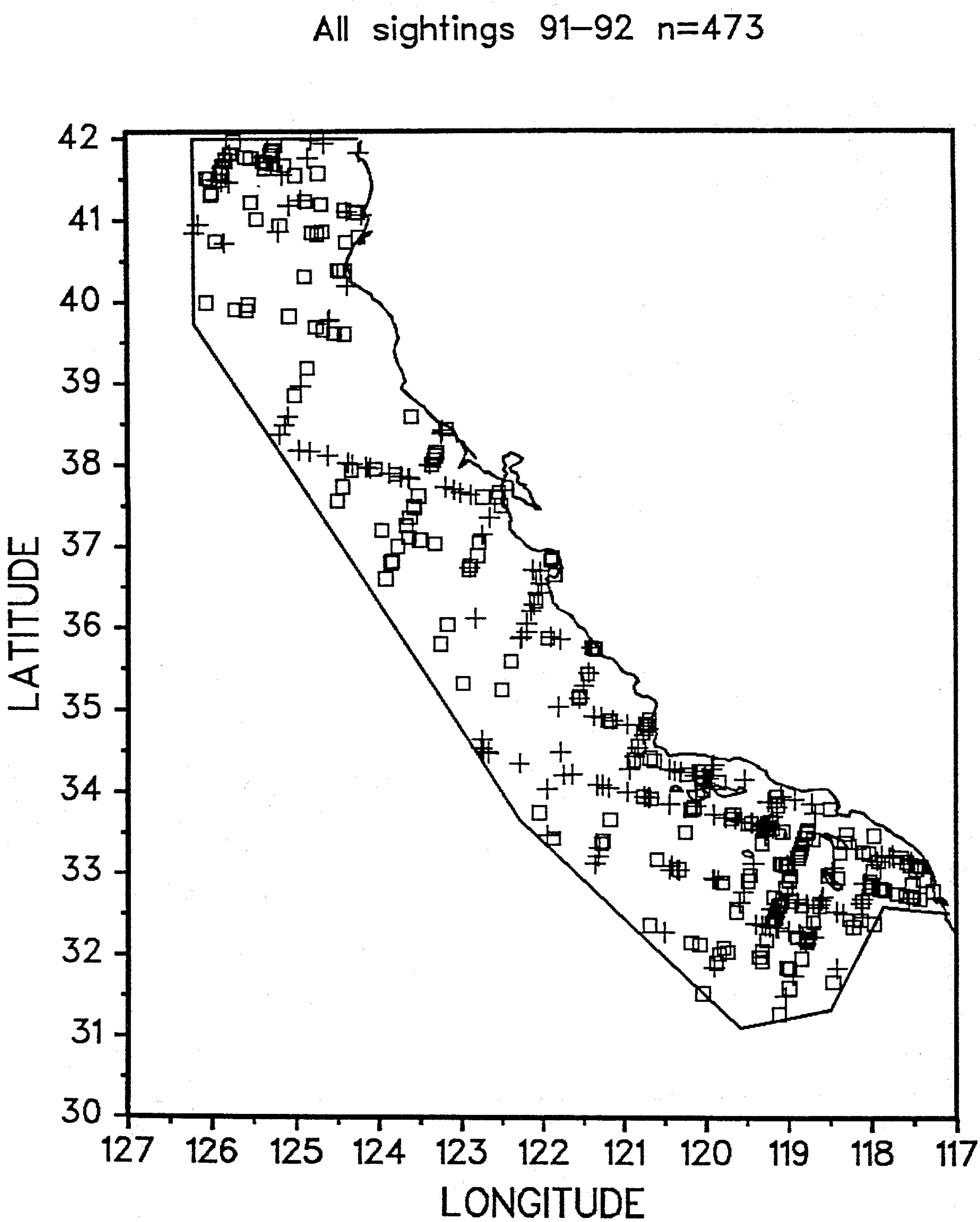


Figure 7. Common dolphin sightings during 1991 and 1992 aerial surveys for marine mammals.

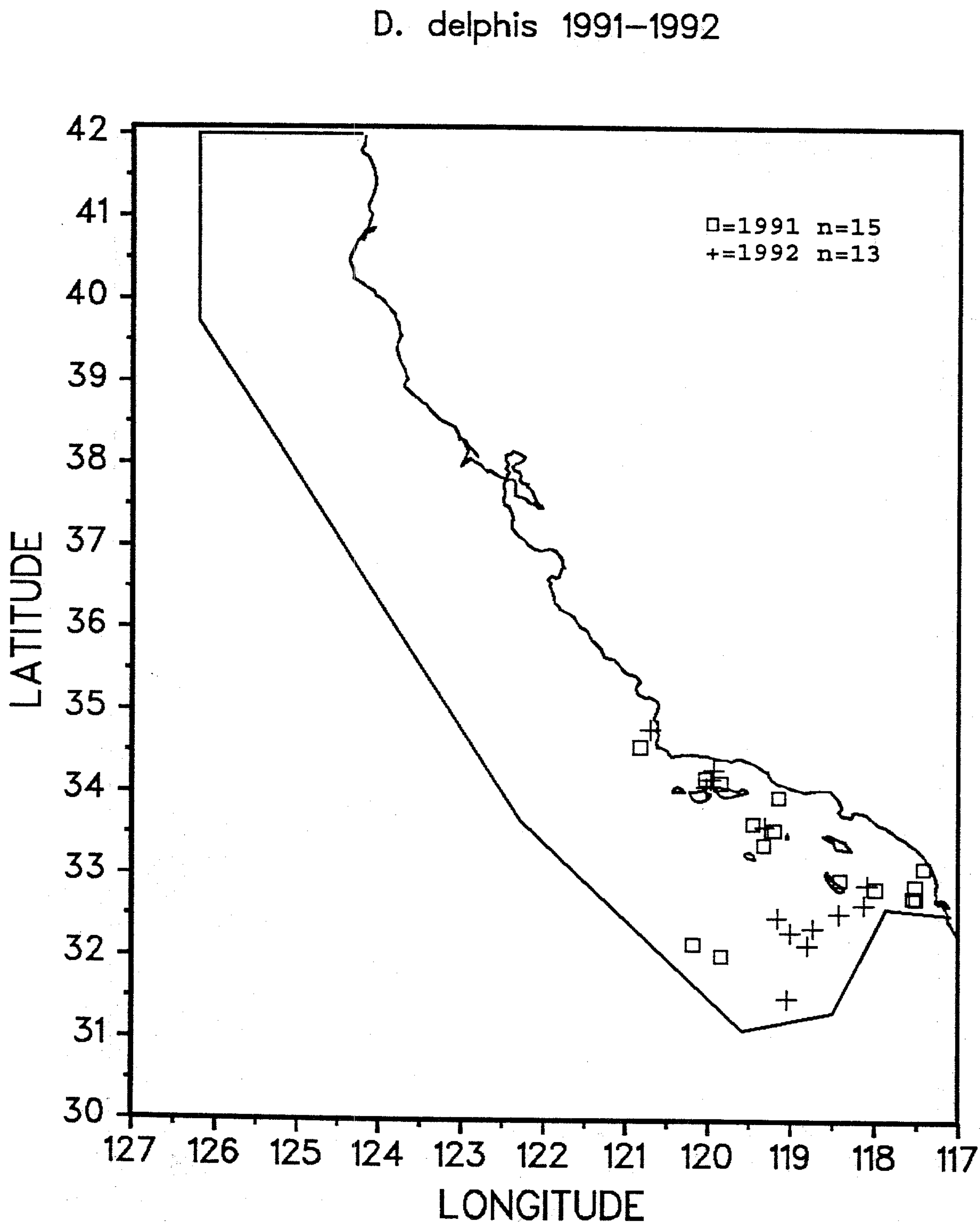


Figure 8. Risso's dolphin sightings during 1991 and 1992 aerial surveys for marine mammals.

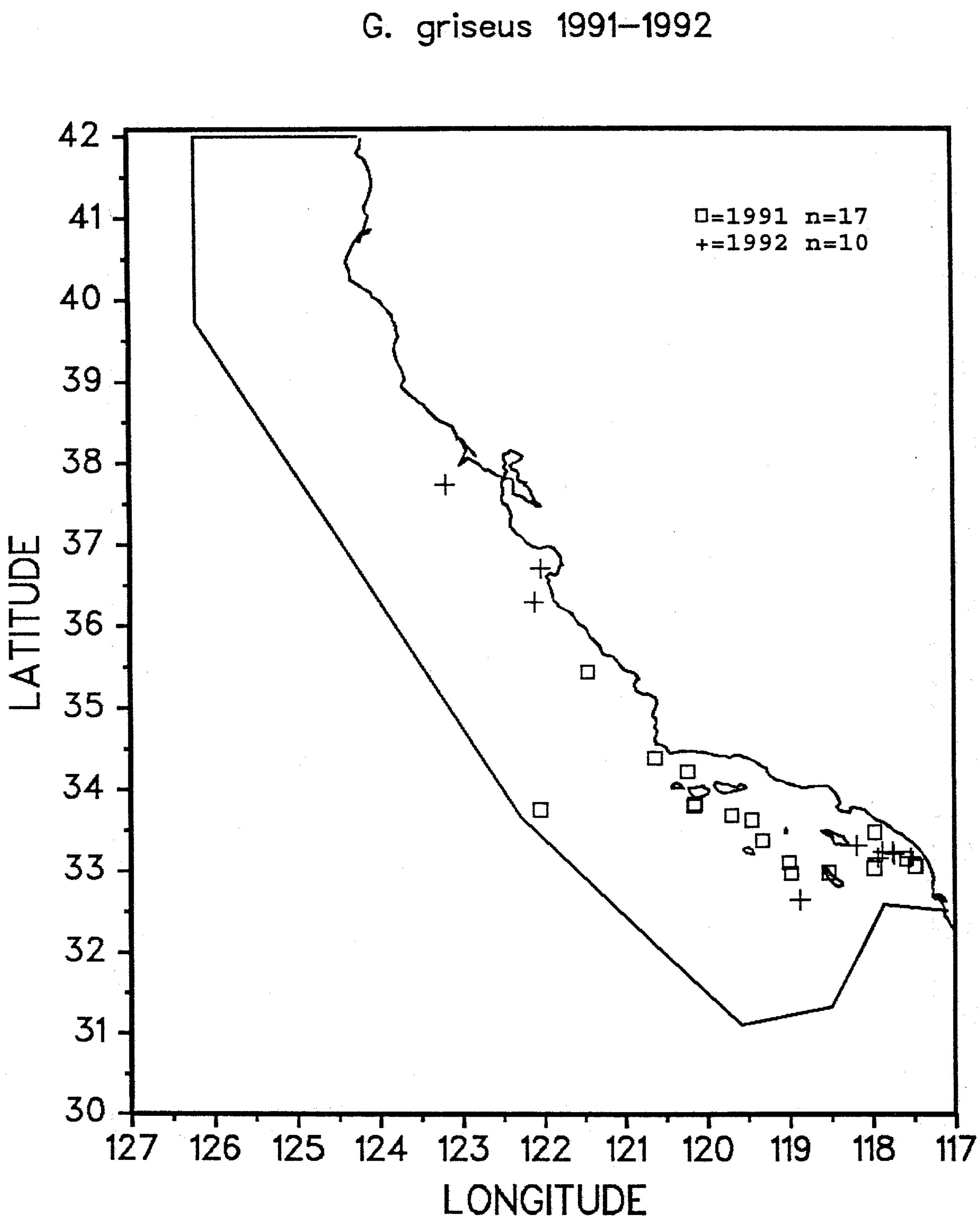


Figure 9. Pilot whale sightings during 1991 and 1992 aerial surveys for marine mammals.

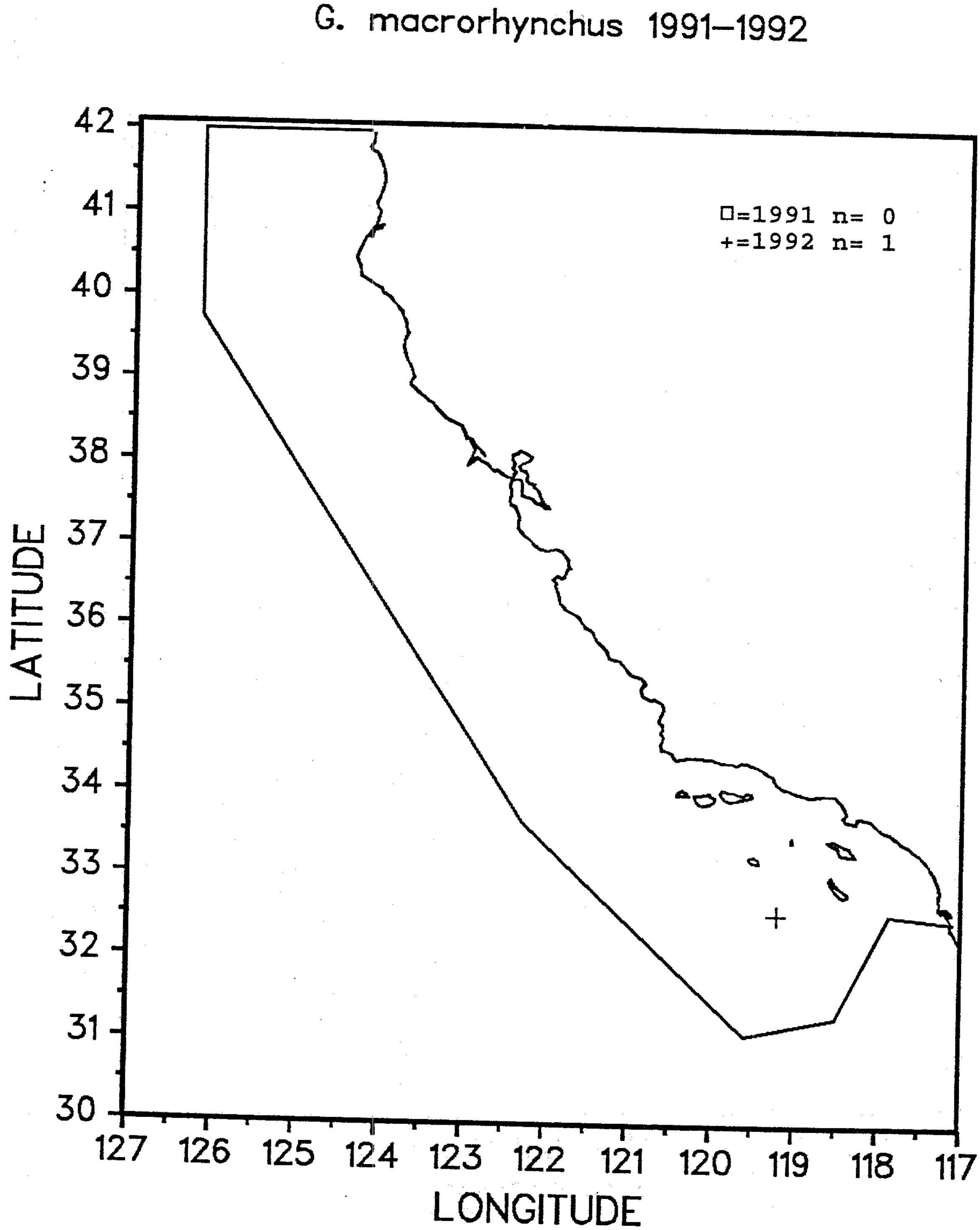


Figure 10. Northern right whale dolphin sightings during 1991 and 1992 aerial surveys for marine mammals.

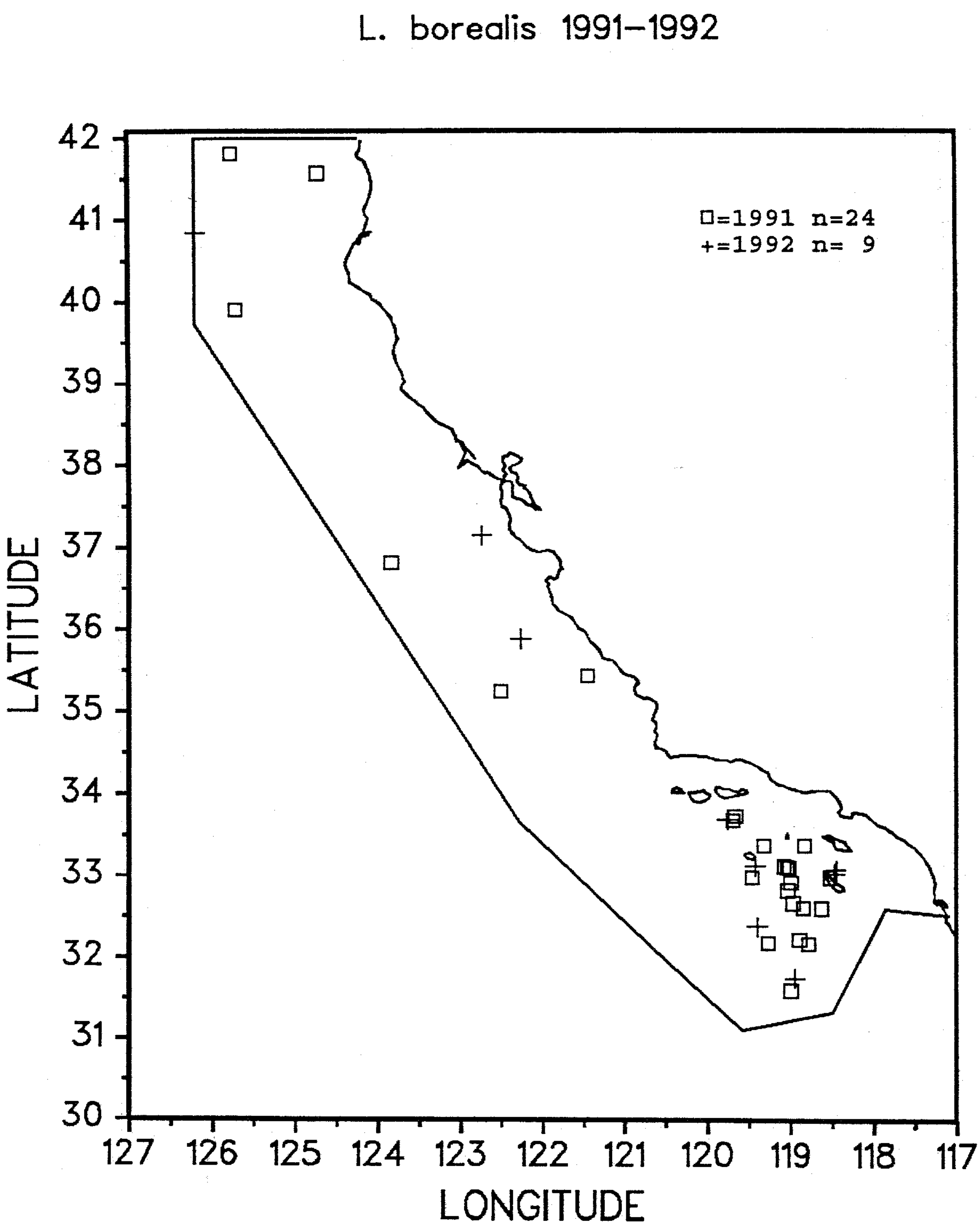


Figure 11. Pacific white-sided dolphin sightings during 1991 and 1992 aerial surveys for marine mammals.

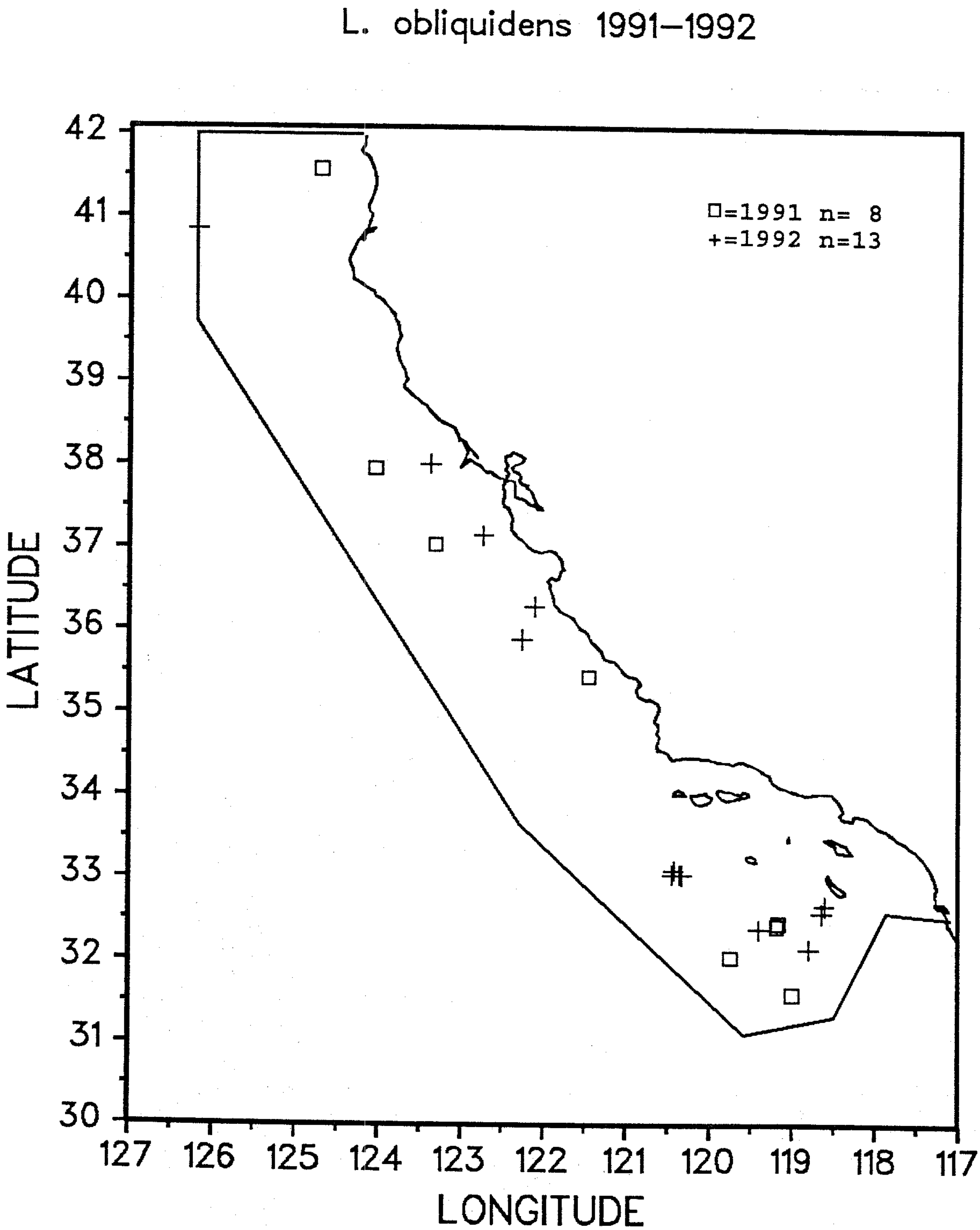


Figure 12. Killer whale sightings during 1991 and 1992 aerial surveys for marine mammals.

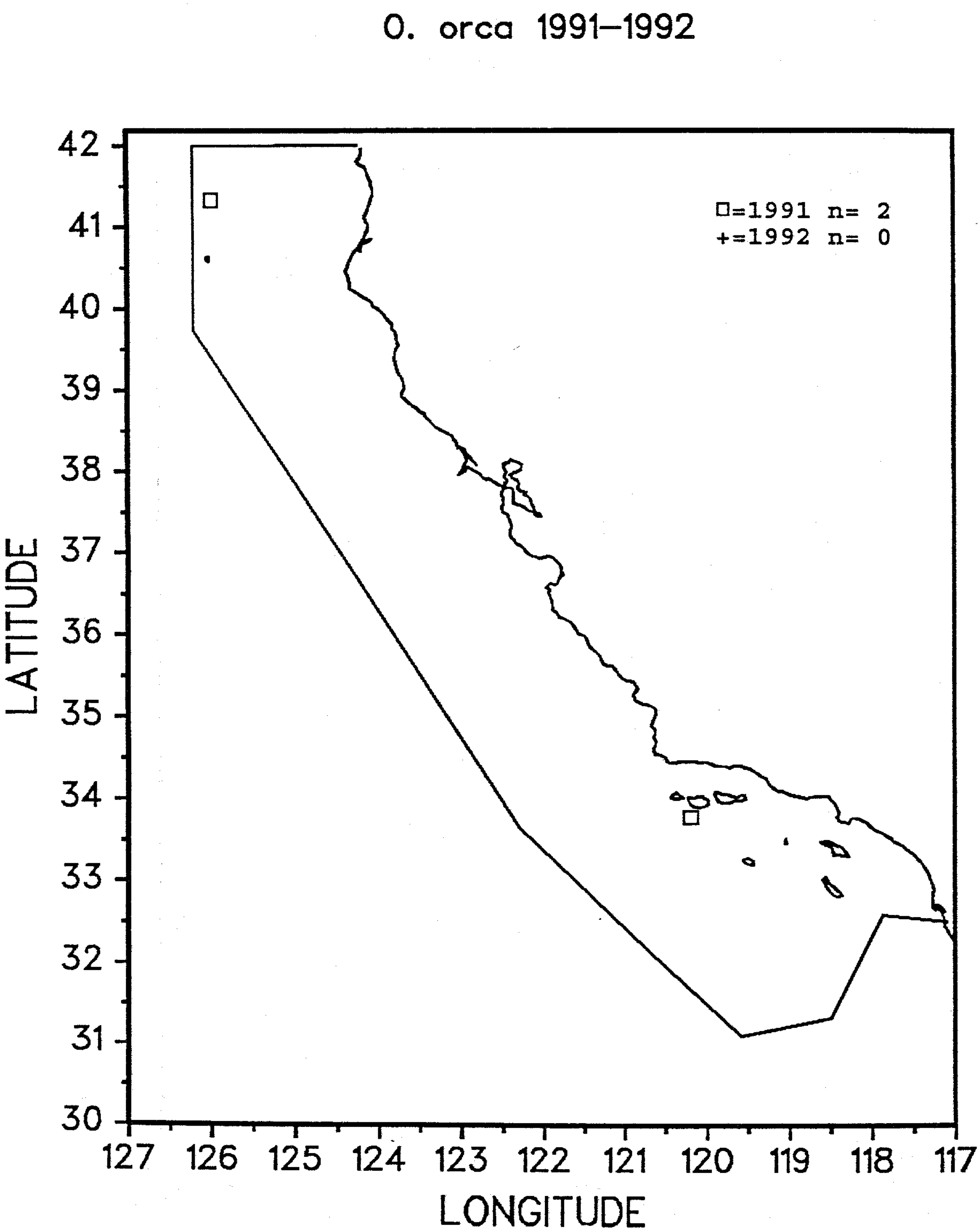


Figure 13. Dall's porpoise sightings during 1991 and 1992 aerial surveys for marine mammals.

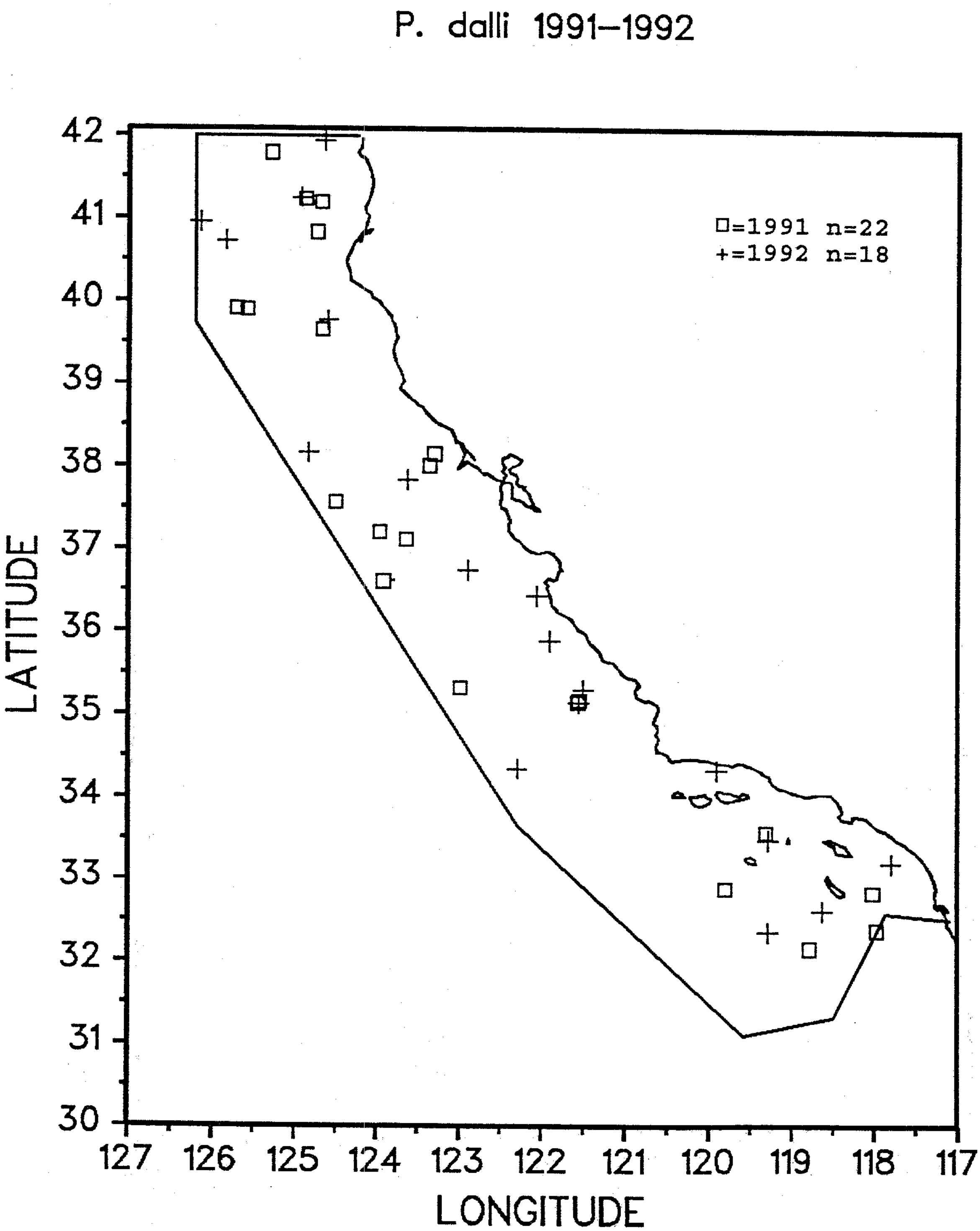


Figure 14. Harbor porpoise sightings during 1991 and 1992 aerial surveys for marine mammals.

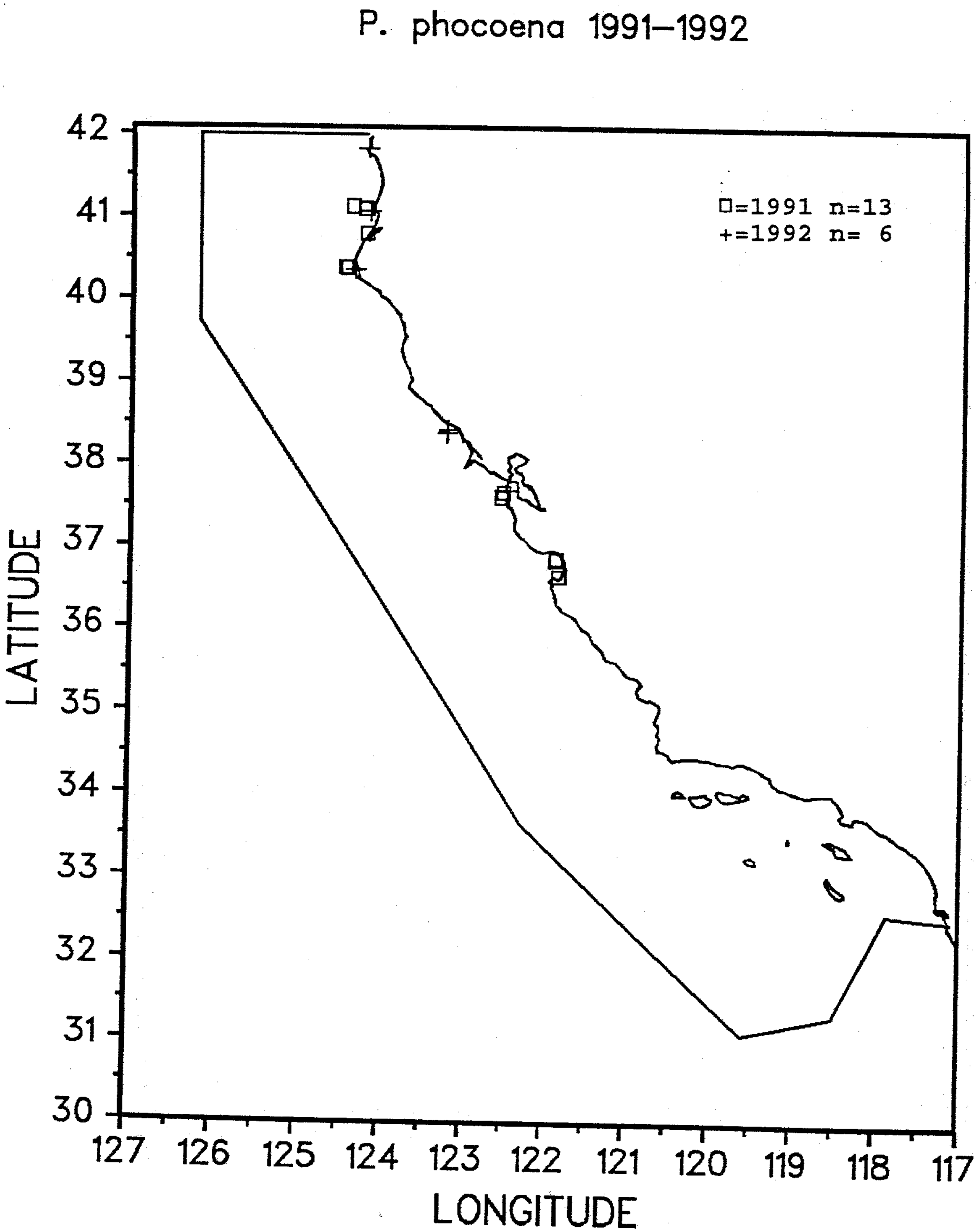


Figure 15. Bottlenose dolphin sightings during 1991 and 1992 aerial surveys for marine mammals.

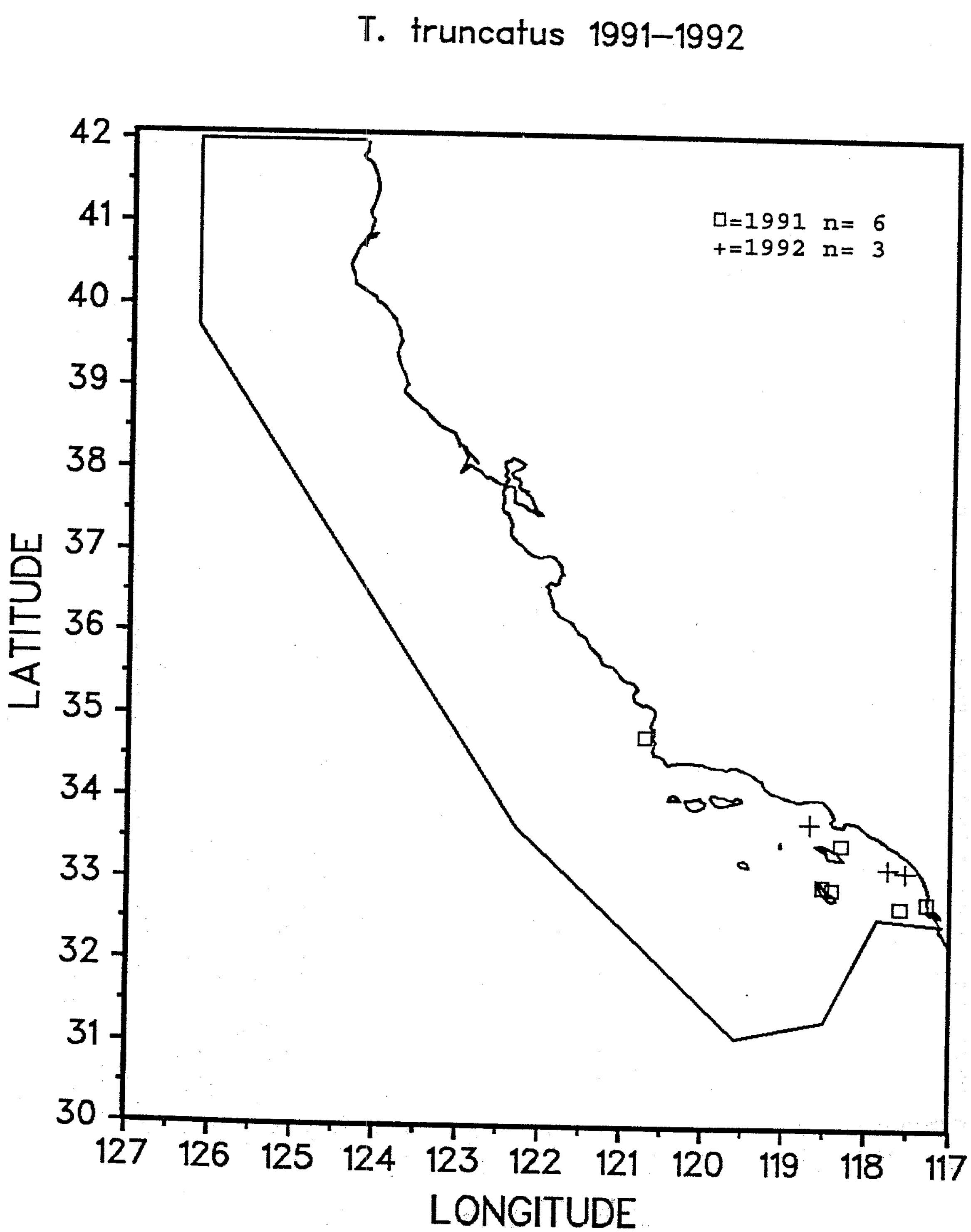


Figure 16. Cuvier's beaked whale sightings during 1991 and 1992 aerial surveys for marine mammals.

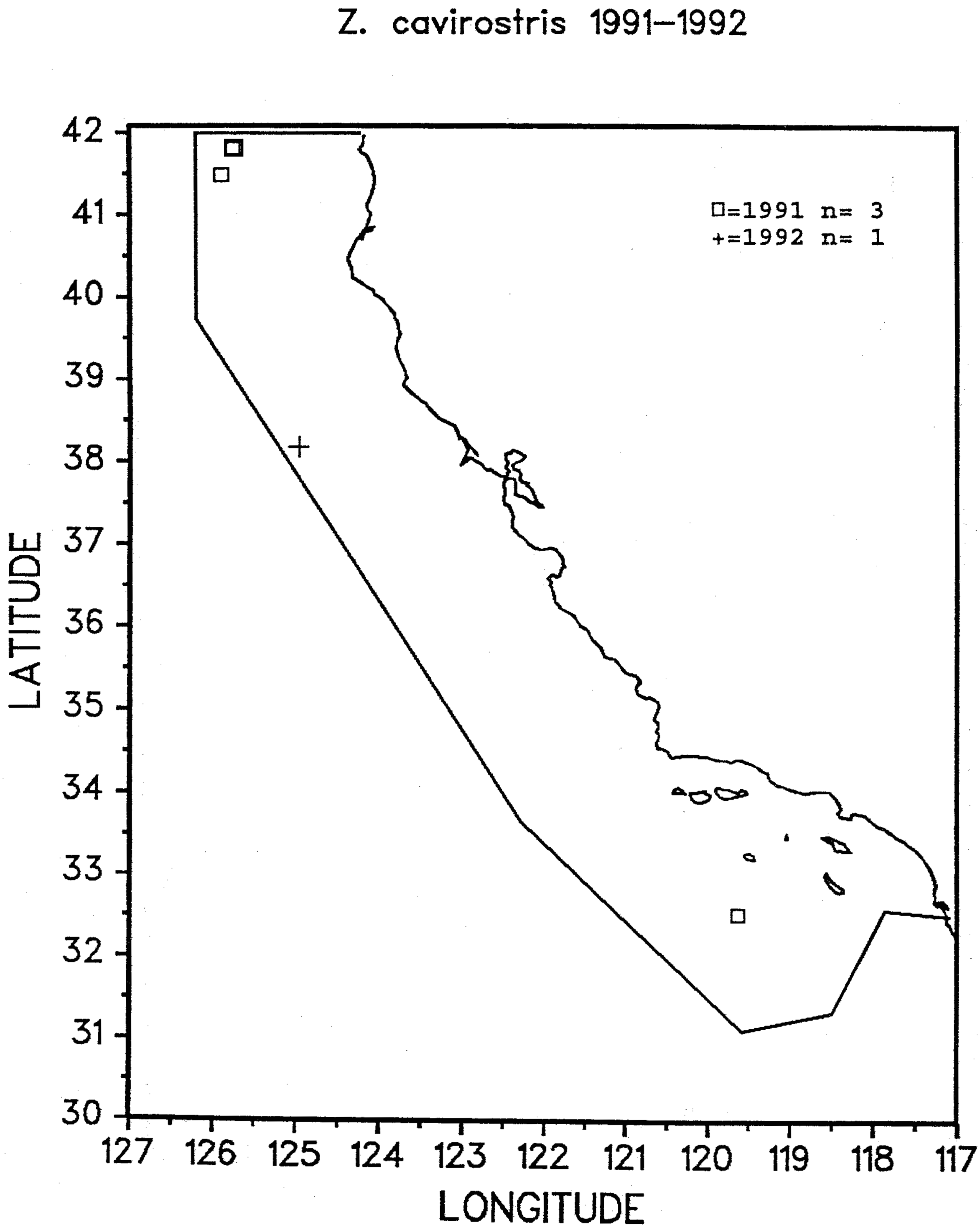


Figure 17. Unidentified ziphiid sightings during 1991 and 1992 aerial surveys for marine mammals.

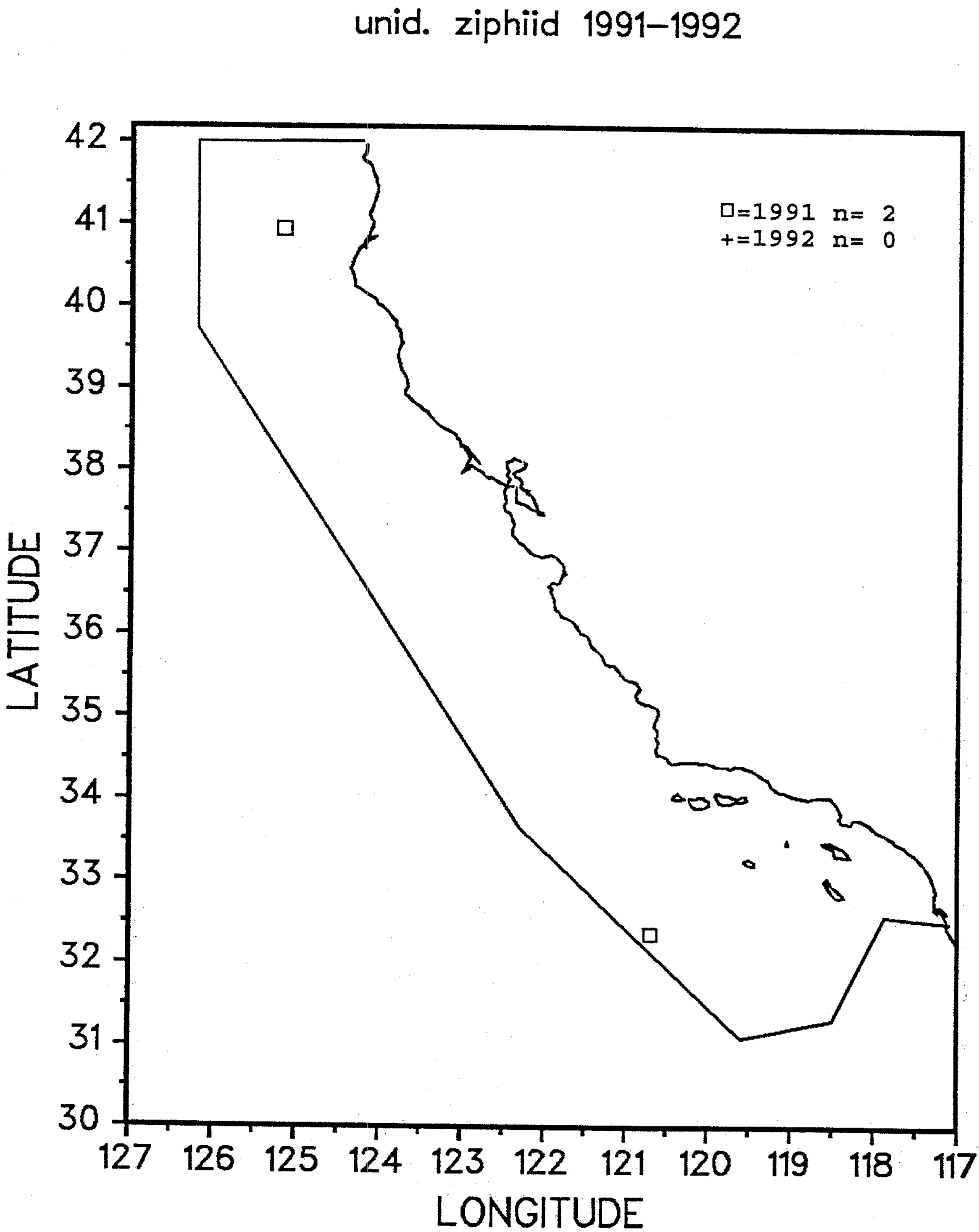


Figure 18. Unidentified Mesoplodon beaked whale sightings during 1991 and 1992 aerial surveys for marine mammals.

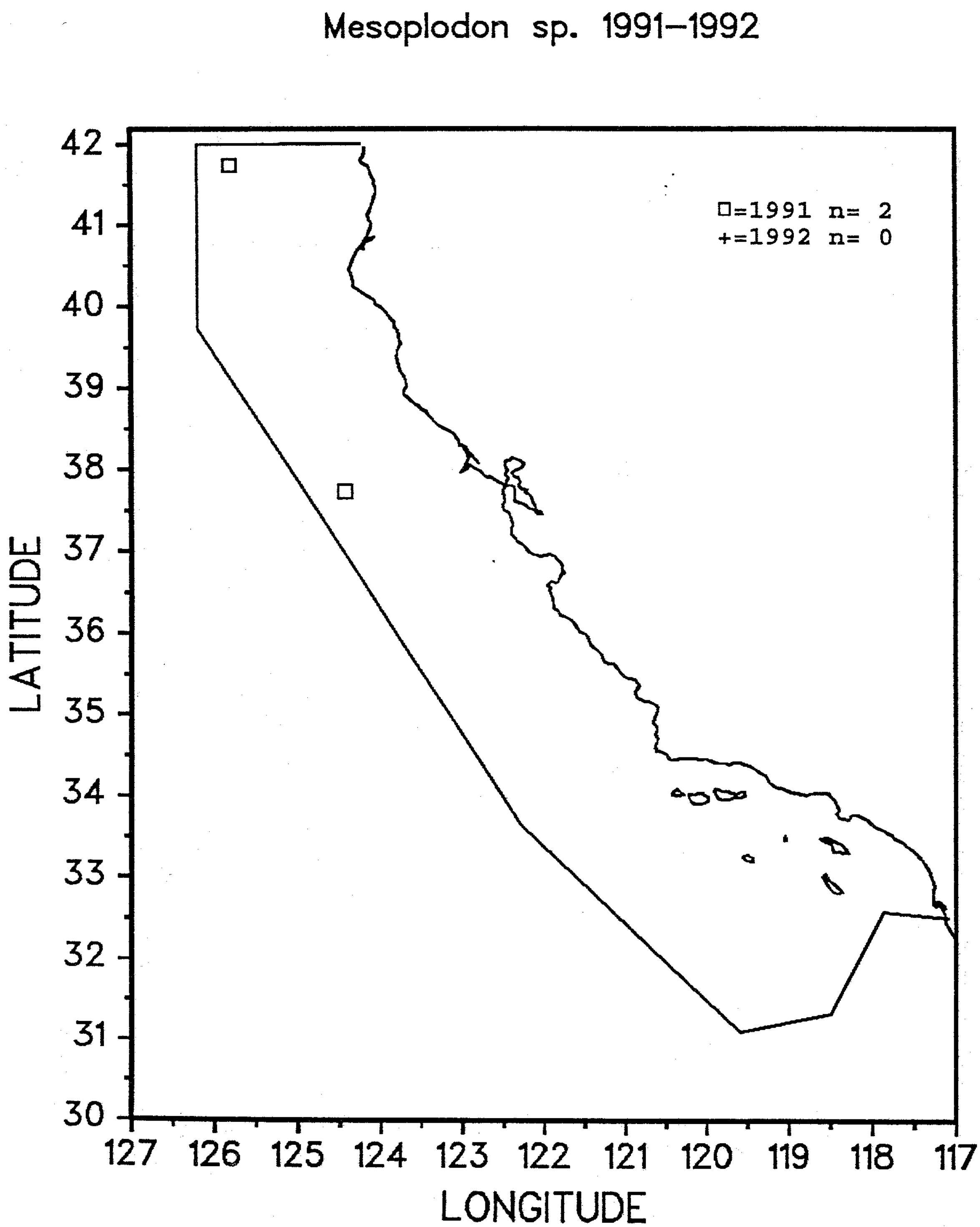


Figure 19. Minke whale sightings during 1991 and 1992 aerial surveys for marine mammals.

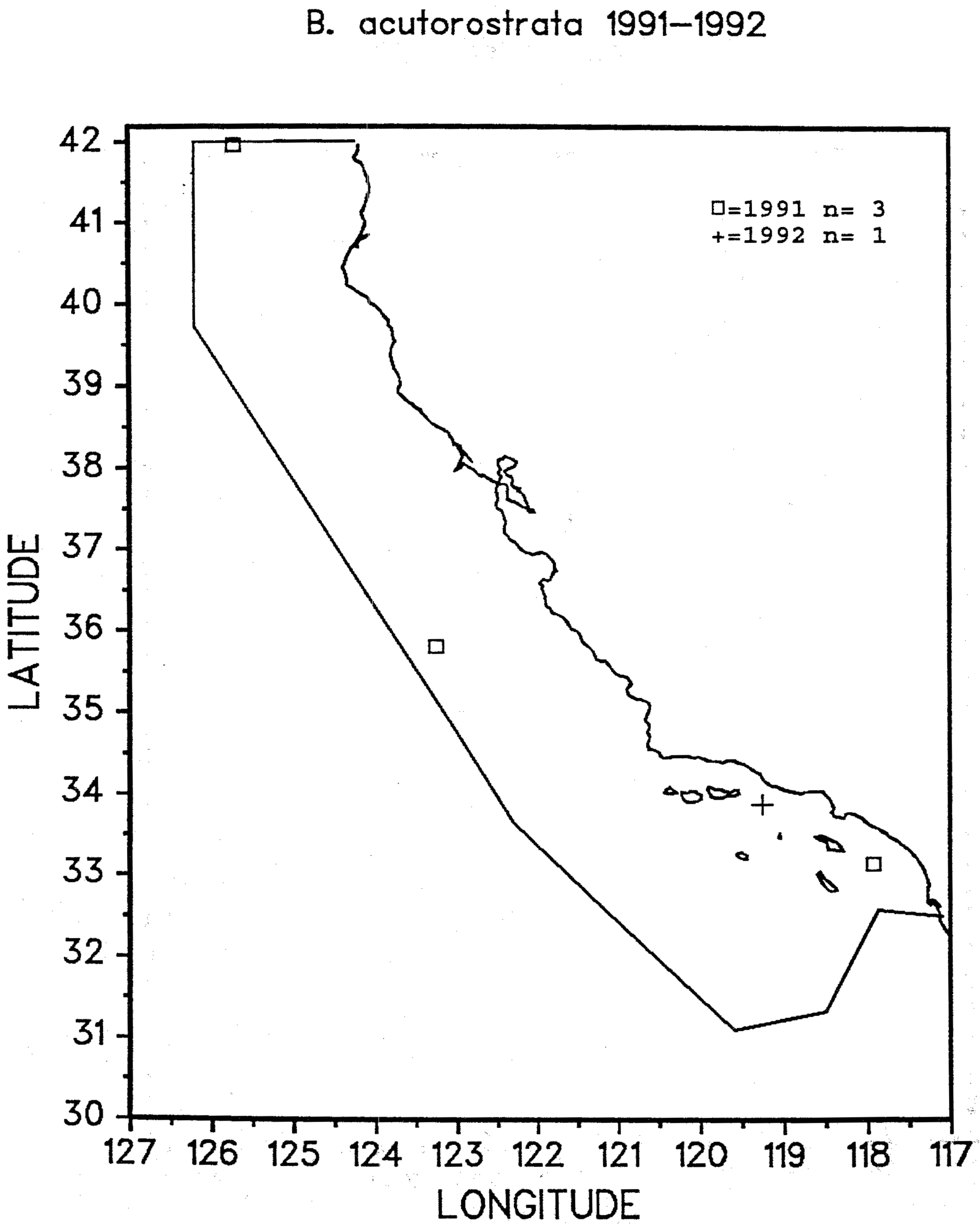


Figure 20. Blue whale sightings during 1991 and 1992 aerial surveys for marine mammals.

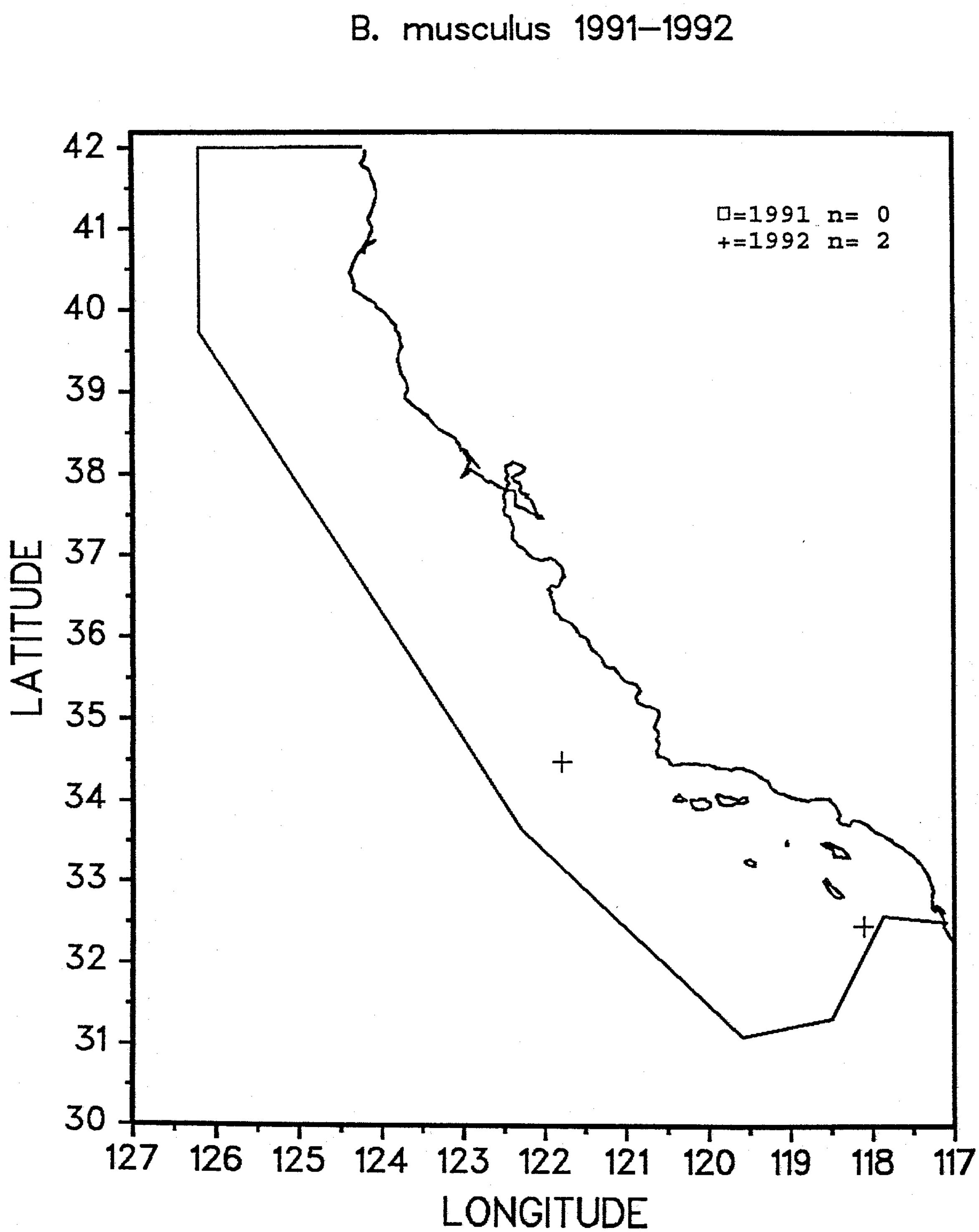


Figure 21. Fin whale sightings during 1991 and 1992 aerial surveys for marine mammals.

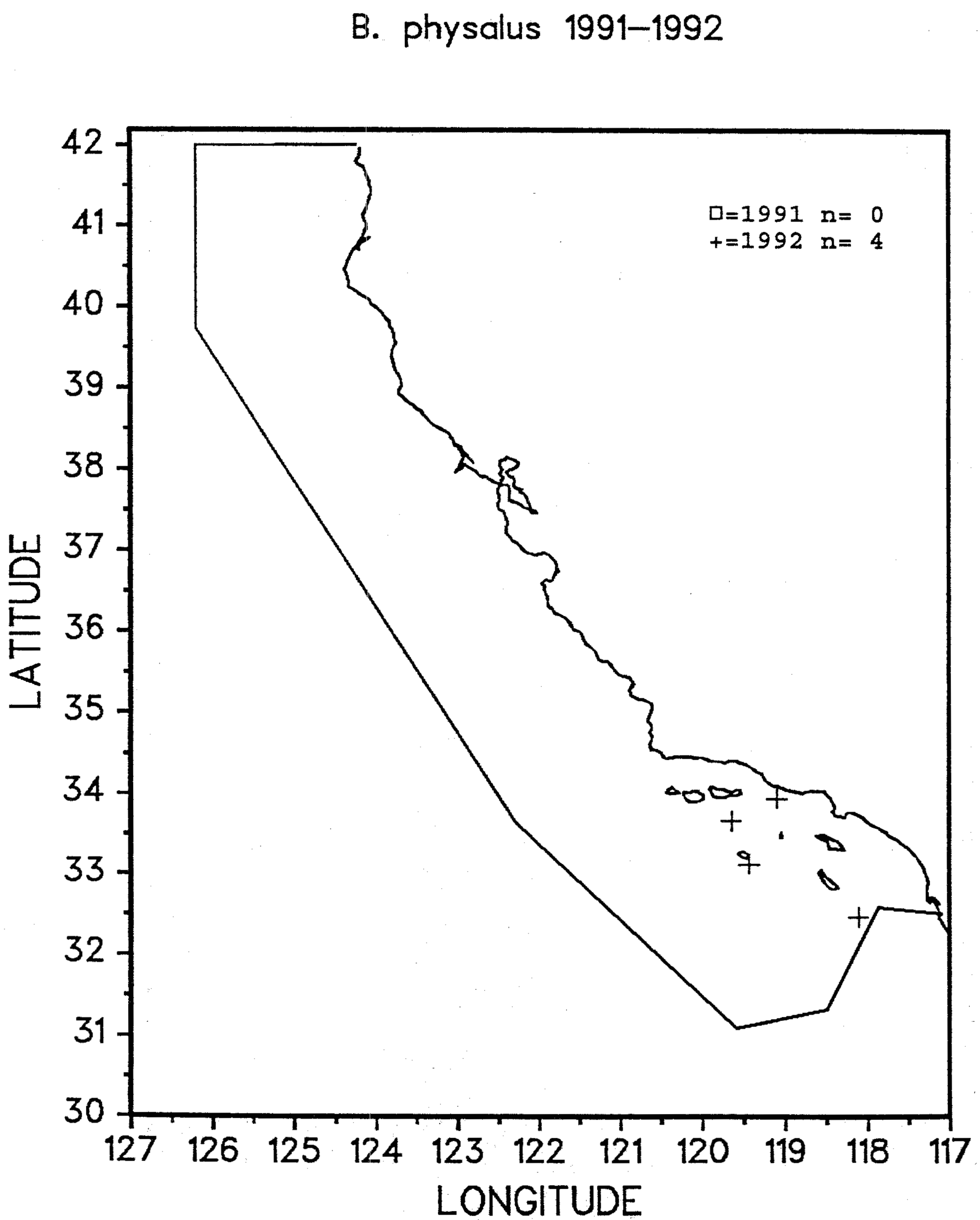


Figure 22. Gray whale sightings during 1991 and 1992 aerial surveys for marine mammals.

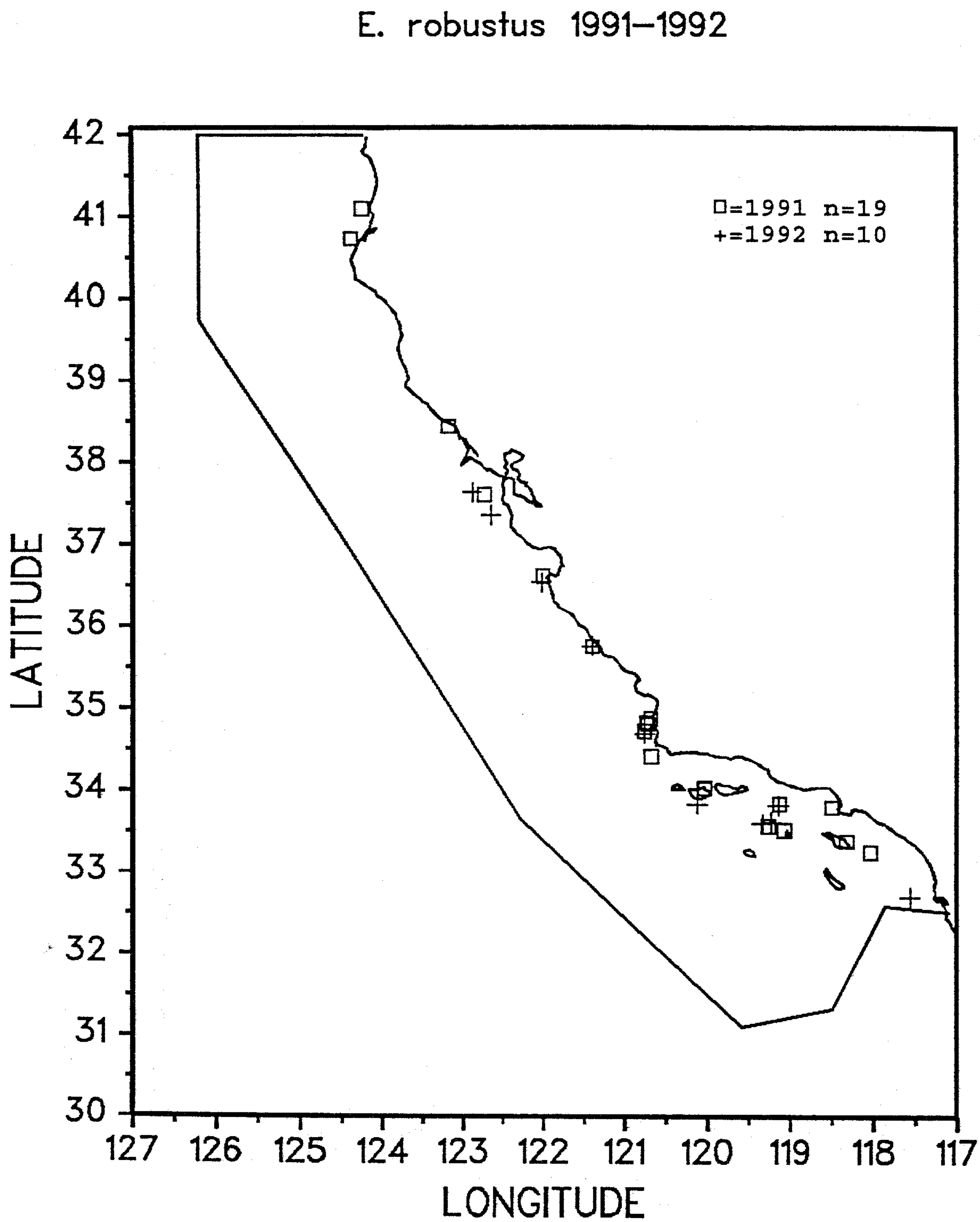


Figure 23. Humpback whale sightings during 1991 and 1992 aerial surveys for marine mammals.

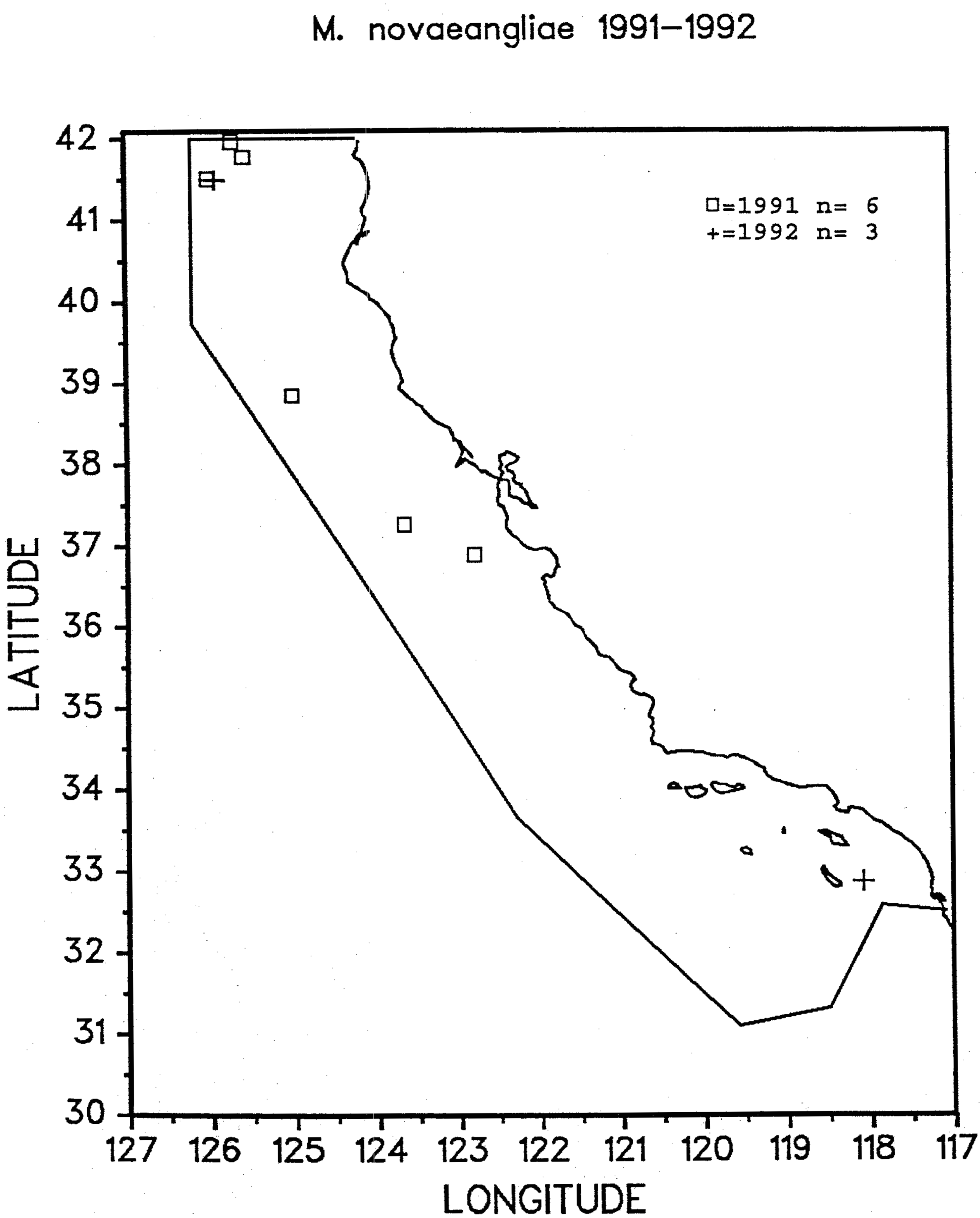


Figure 24. Right whale sightings during 1991 and 1992 aerial surveys for marine mammals.

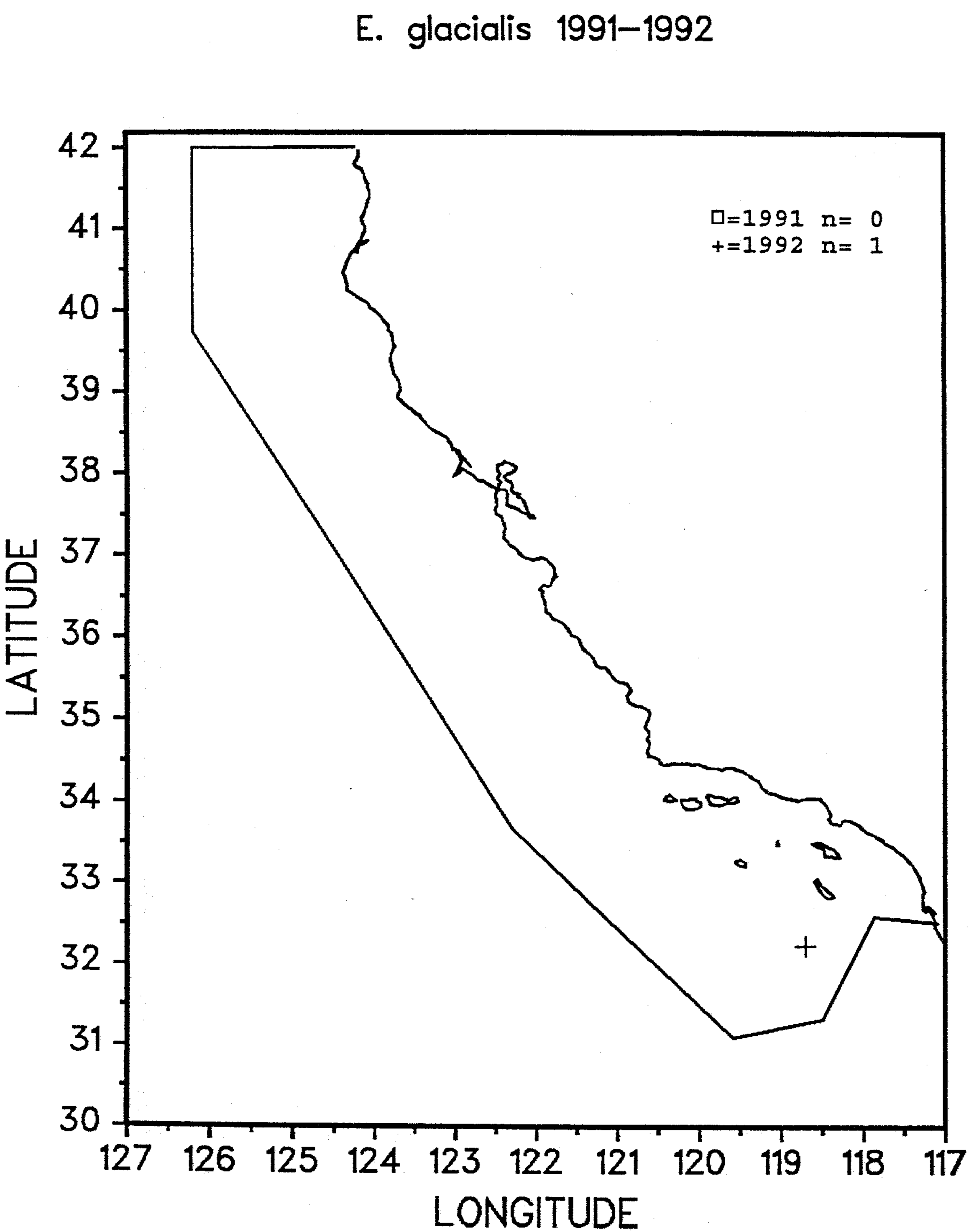


Figure 25. Sperm whale sightings during 1991 and 1992 aerial surveys for marine mammals.

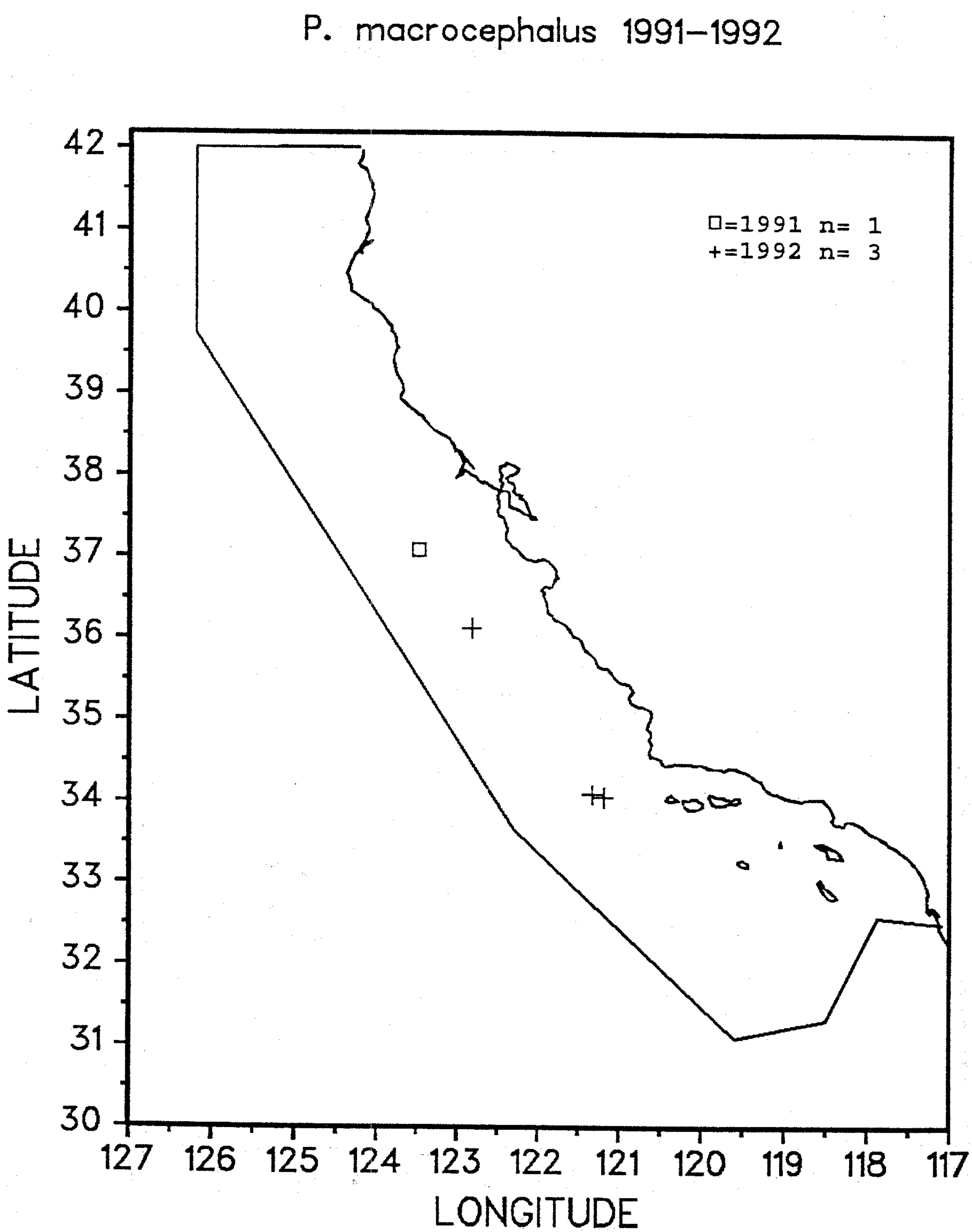


Figure 26. California sea lion sightings during 1991 and 1992 aerial surveys for marine mammals.

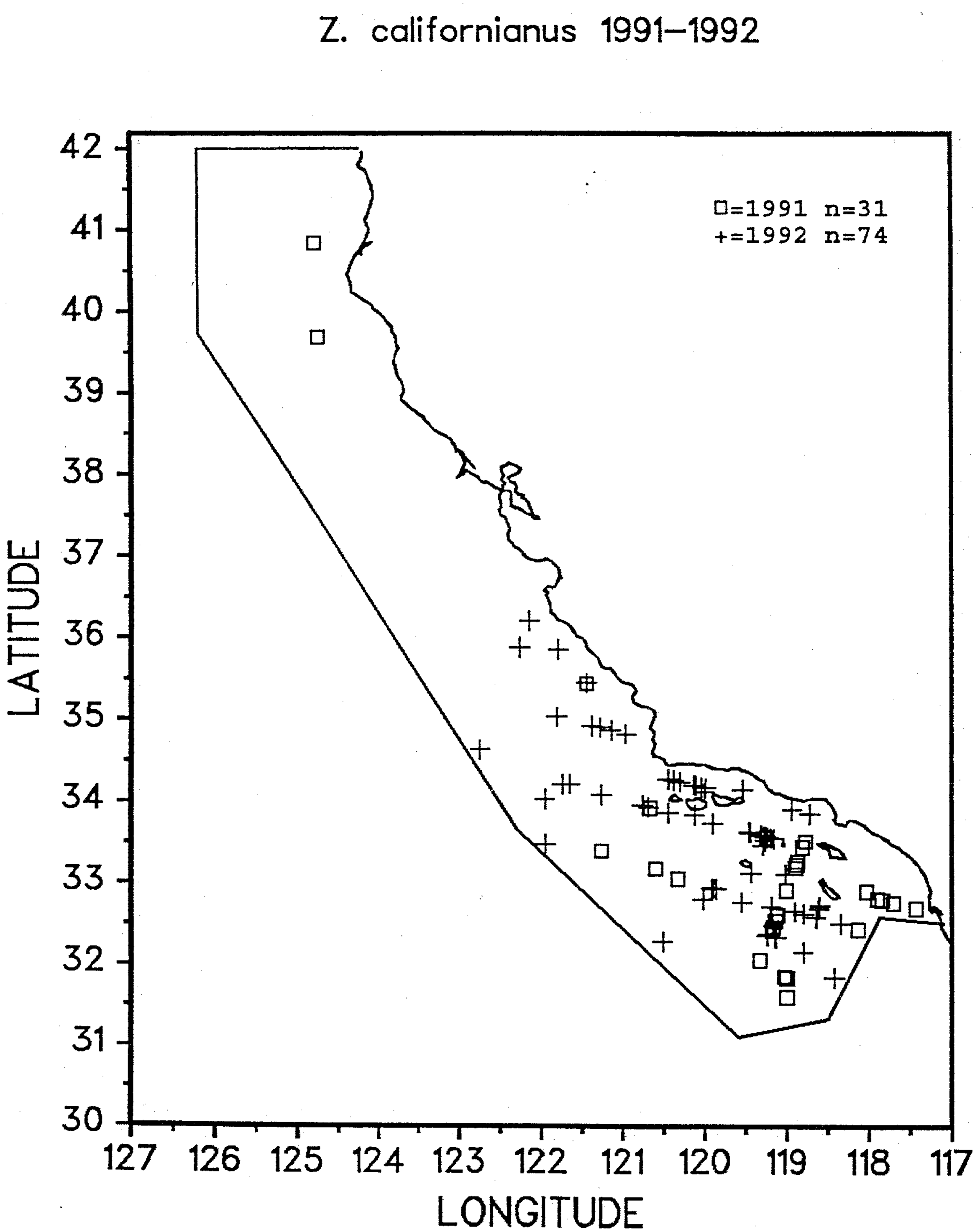


Figure 27. Harbor seal sightings during 1991 and 1992 aerial surveys for marine mammals.

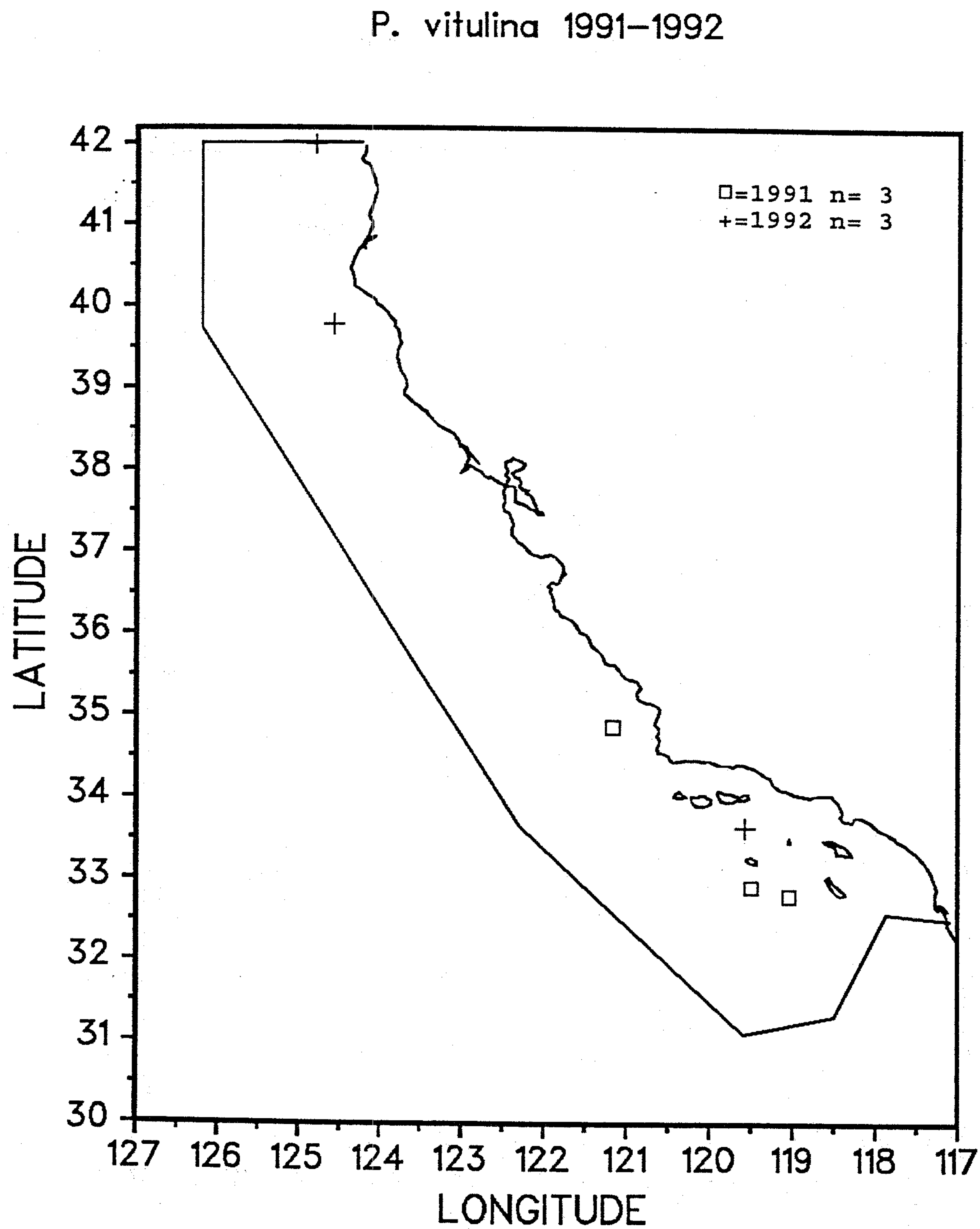


Figure 28. Northern elephant seal sightings during 1991 and 1992 aerial surveys for marine mammals.

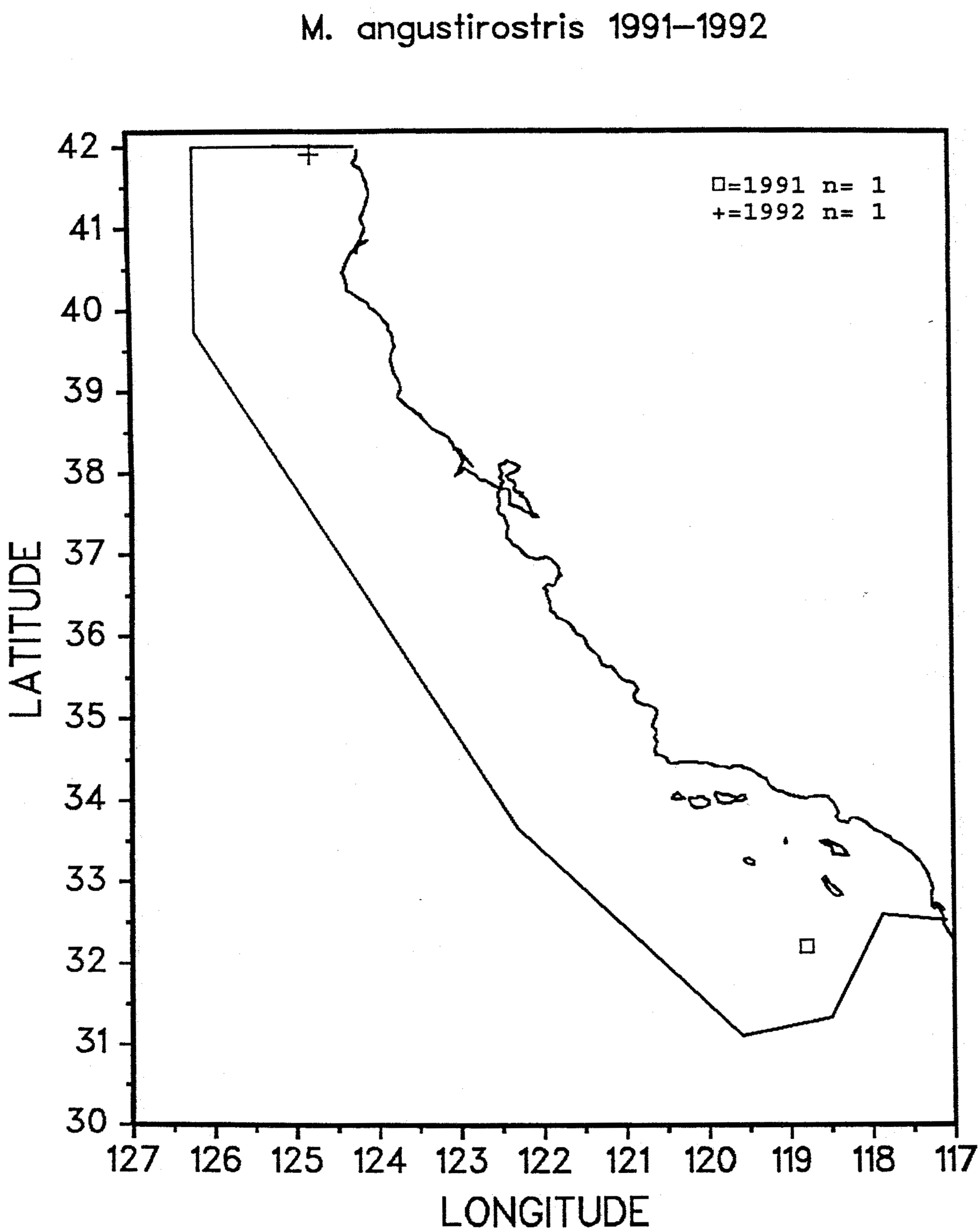


Figure 29. Northern fur seal sightings during 1991 and 1992 aerial surveys for marine mammals.

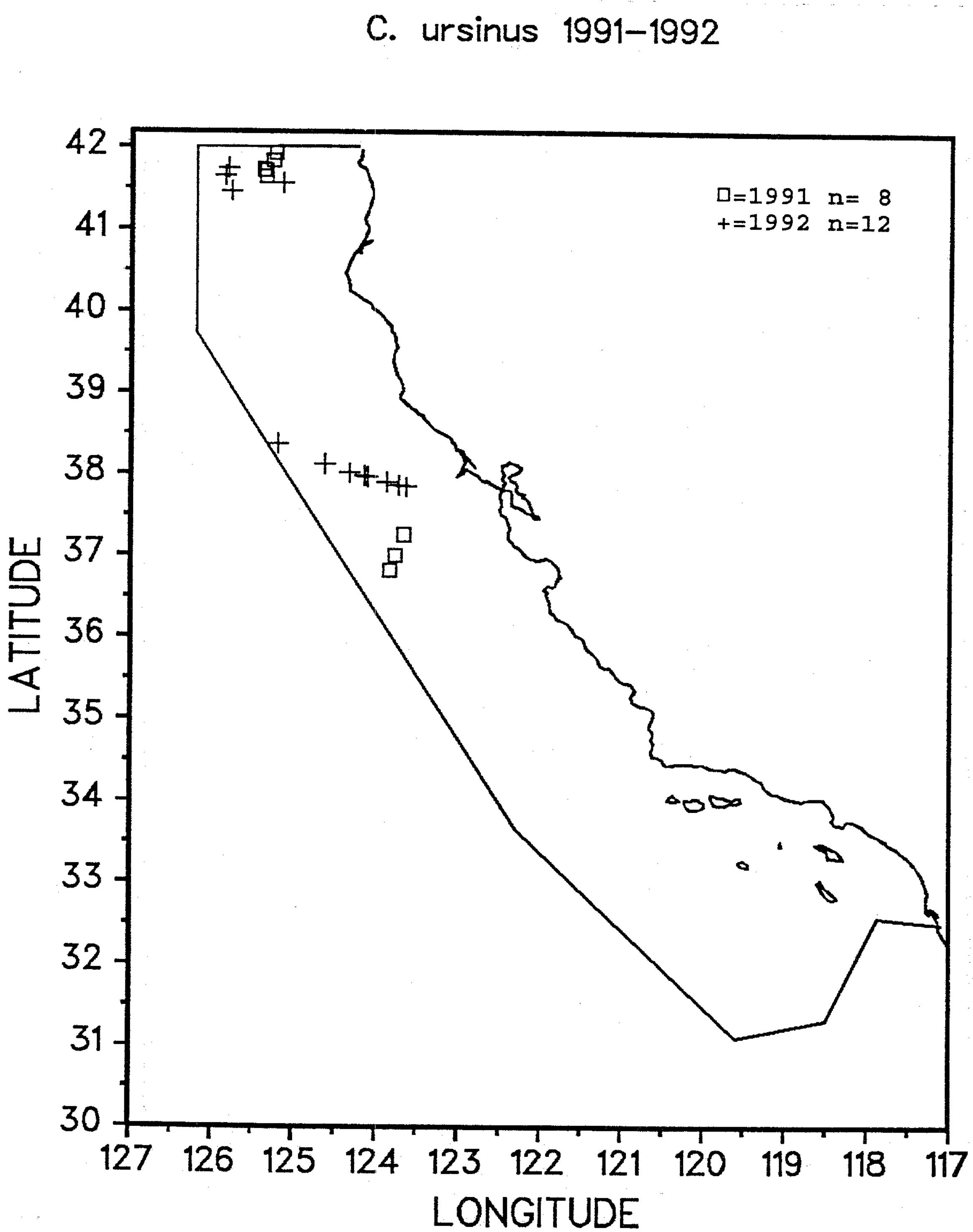


Figure 30. Sea otter sightings during 1991 and 1992 aerial surveys for marine mammals.

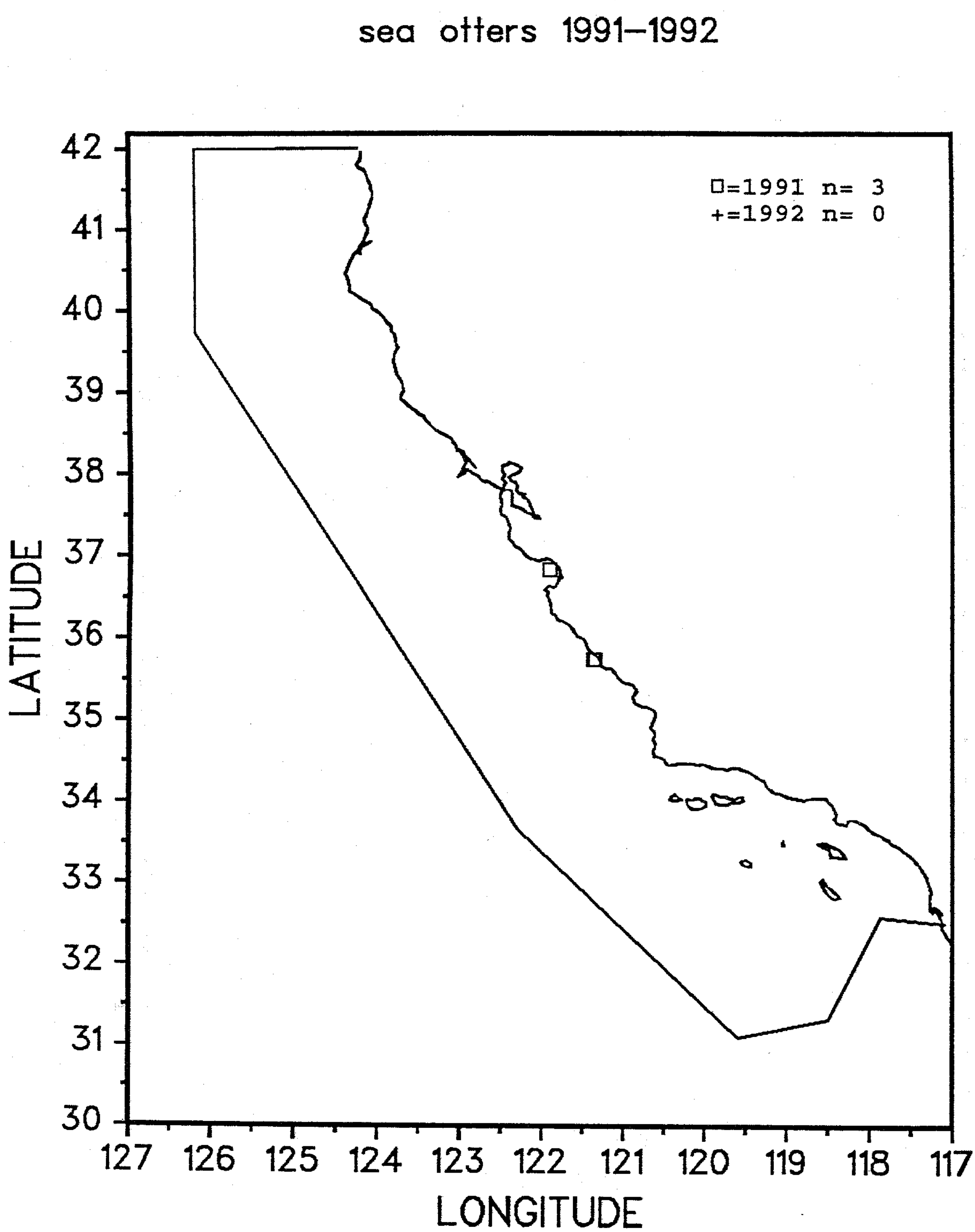


Figure 31. Unidentified pinniped sightings during 1991 and 1992 aerial surveys for marine mammals.

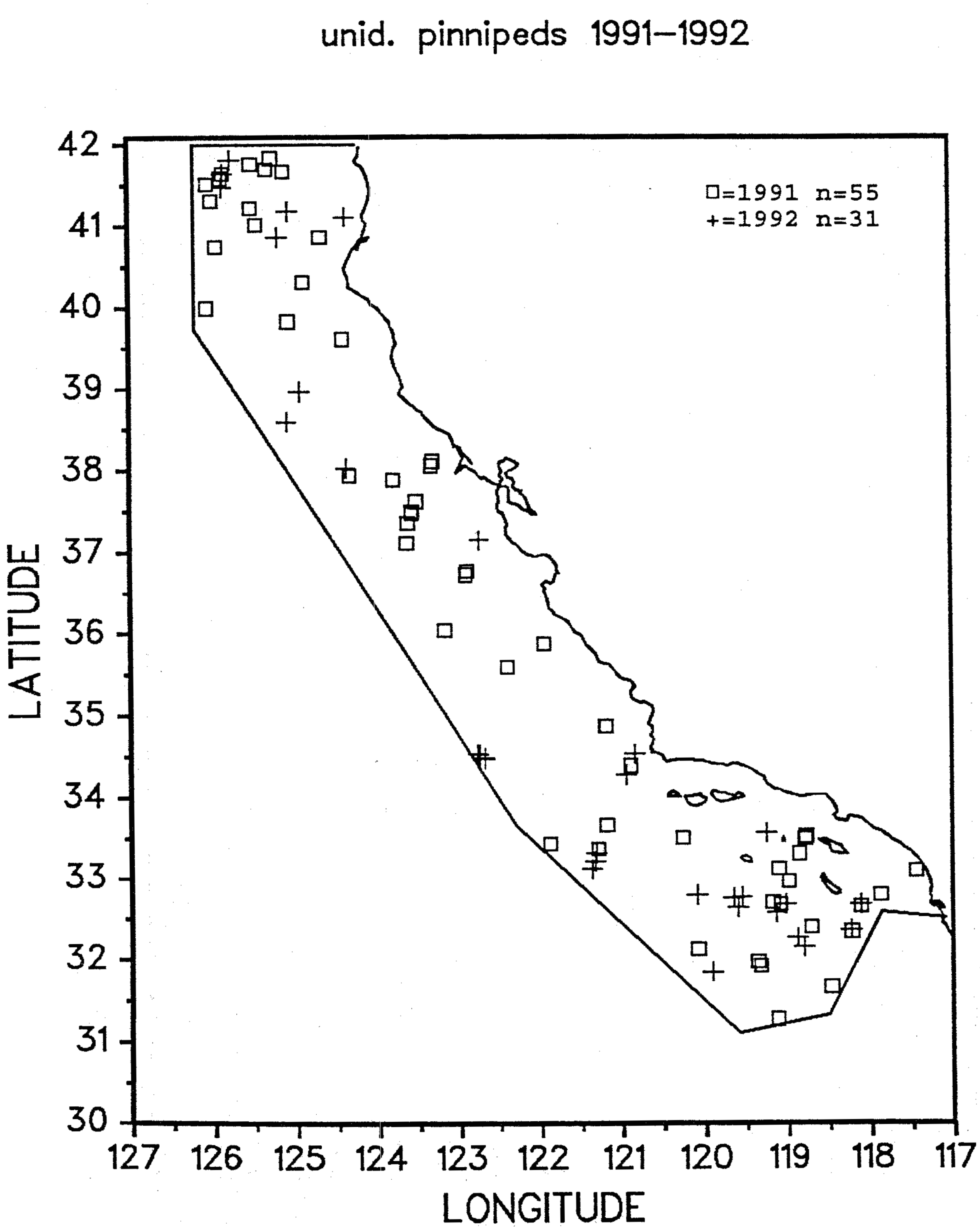


Figure 32. Unidentified dolphin sightings during 1991 and 1992 aerial surveys for marine mammals.

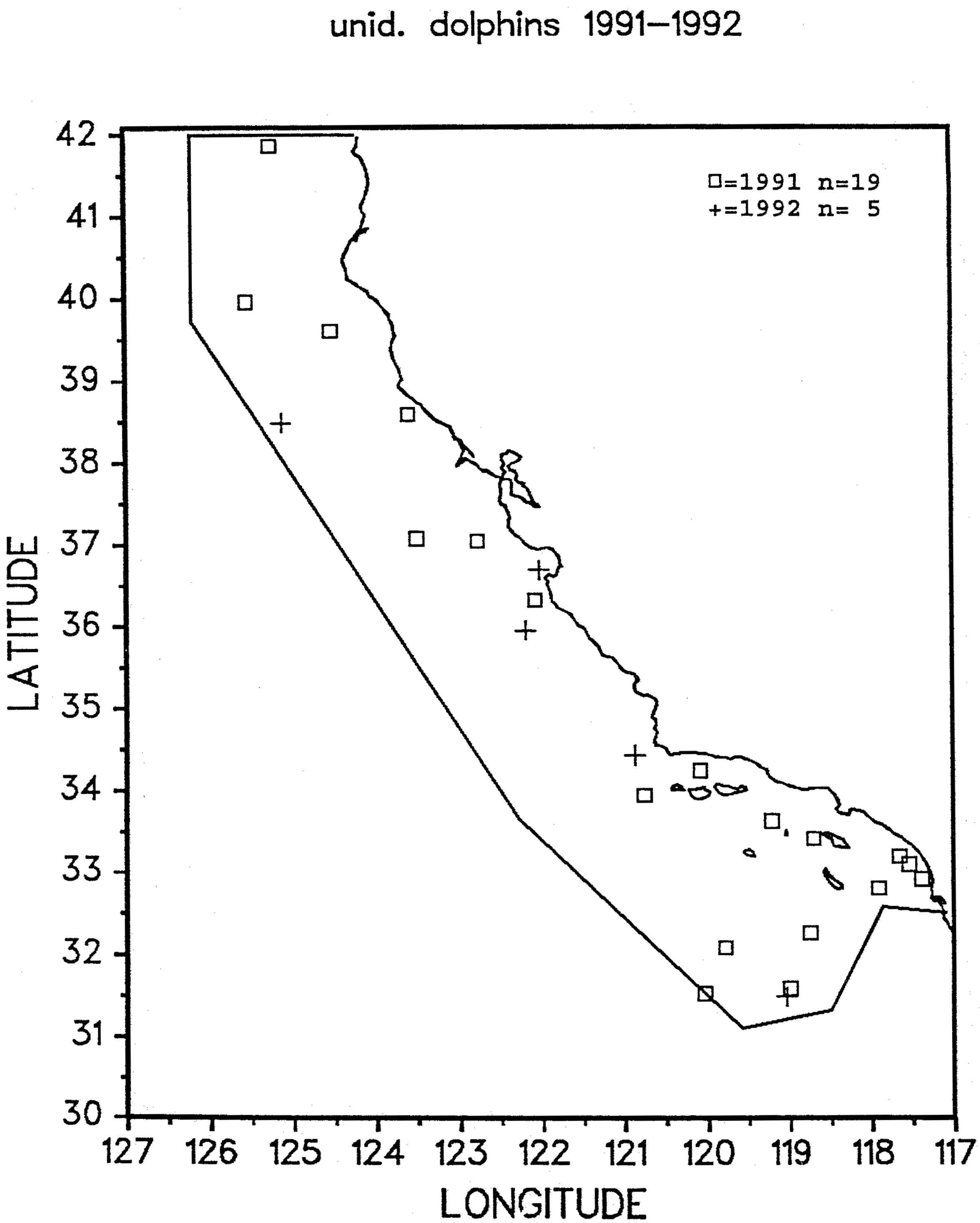


Figure 33. Unidentified whale sightings during 1991 and 1992 aerial surveys for marine mammals.

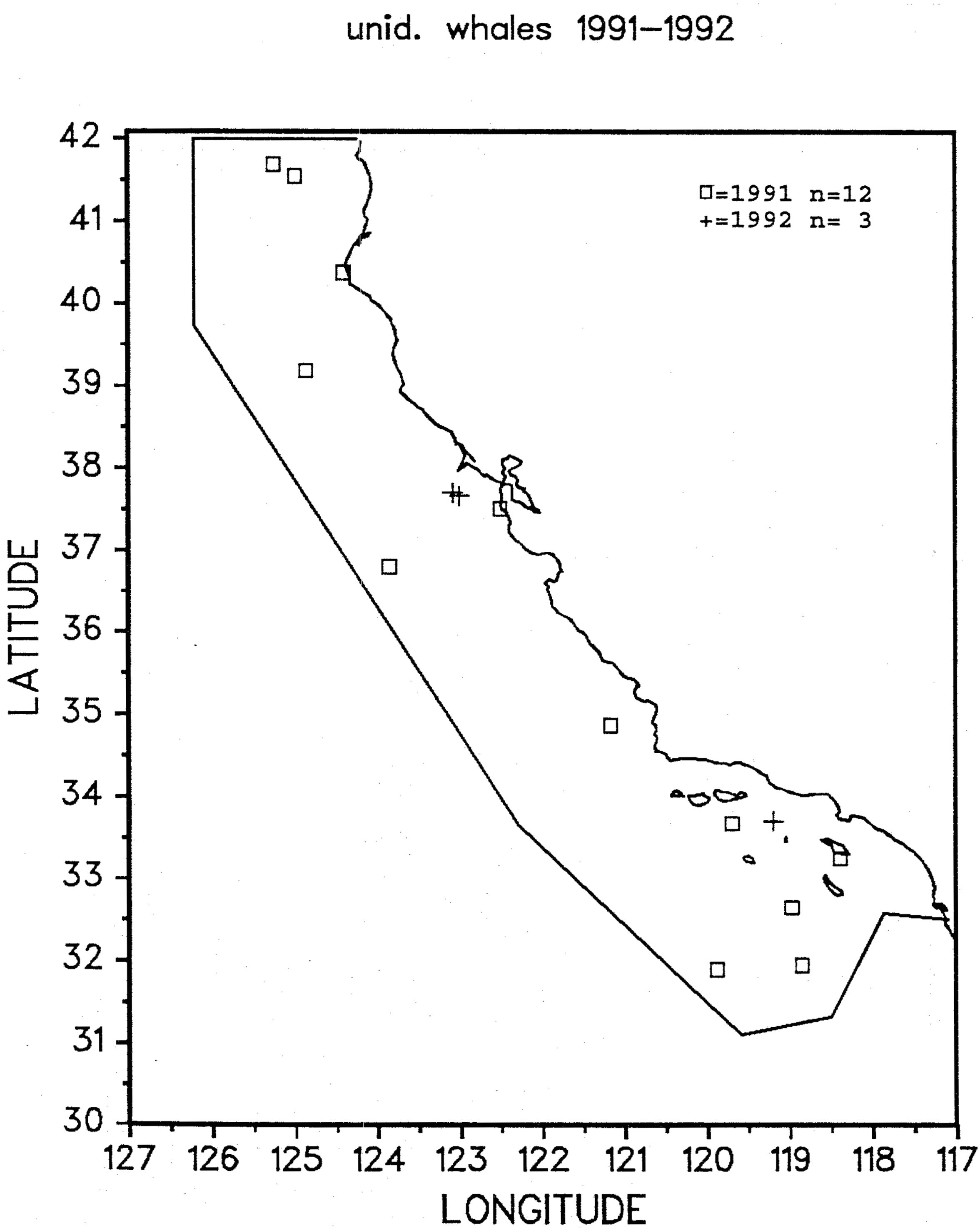


Figure 34. Unidentified marine mammal sightings during 1991 and 1992 aerial surveys for marine mammals.

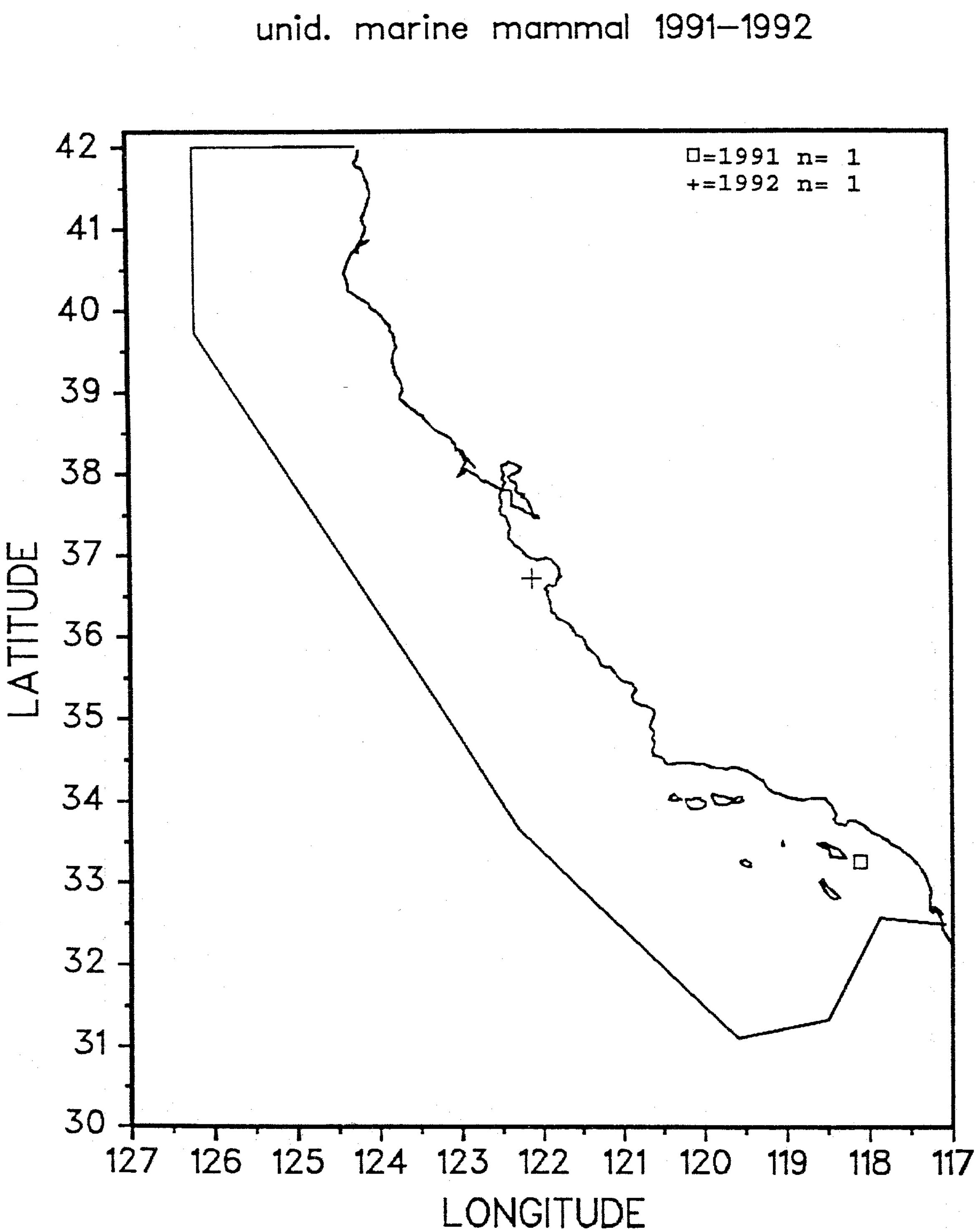
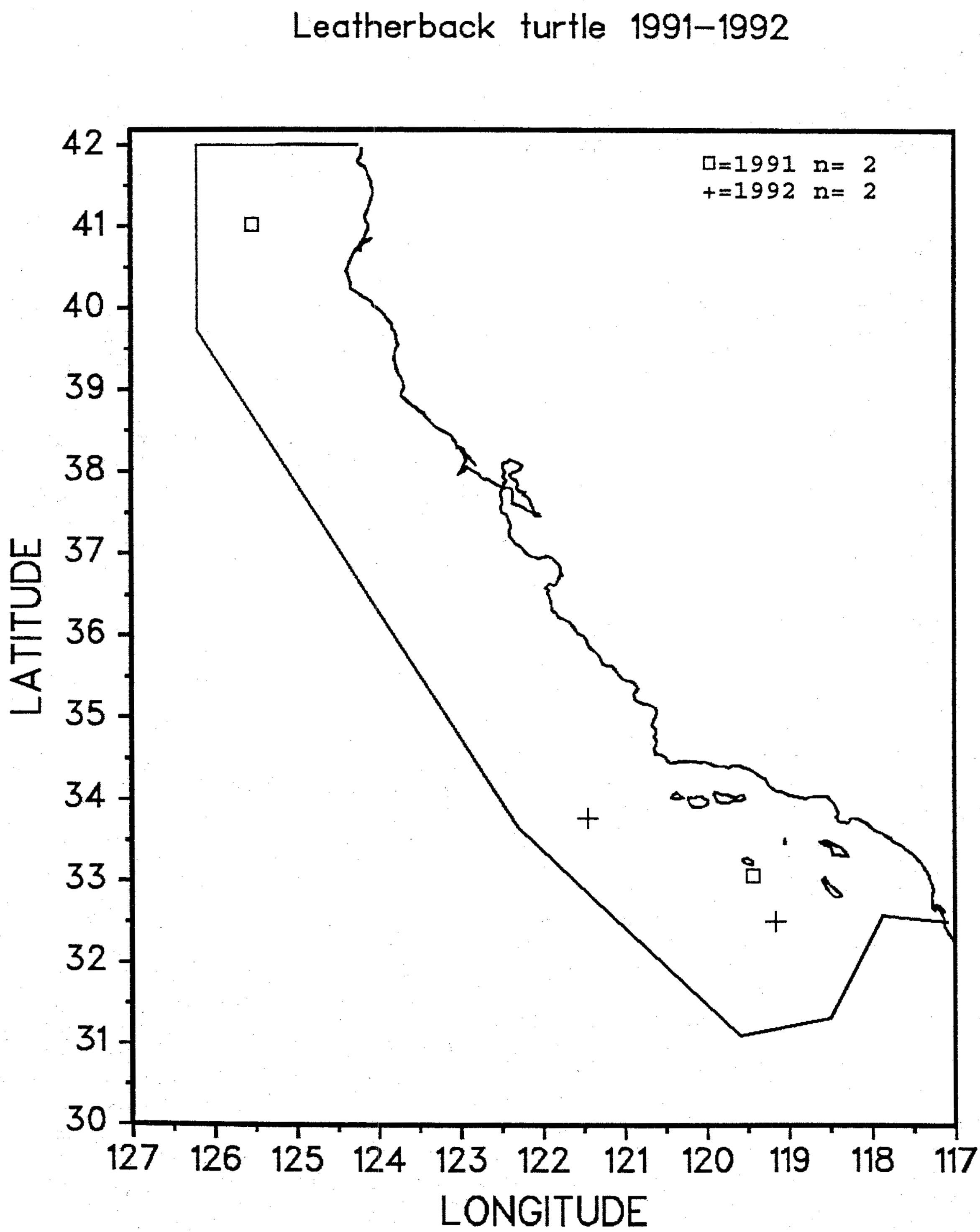


Figure 35. Leatherback turtle sightings during 1991 and 1992 aerial surveys for marine mammals.



APPENDIX 1.

DATA ENTRY INSTRUCTIONS FOR AERIAL SURVEYS FOR MARINE MAMMALS

INTRODUCTION

This will be the second field season of aerial surveys for marine mammals in which sighting and effort data will be recorded on a Toshiba laptop computer. Use of the laptop computer allows for increased accuracy in data collection, the capability of rapid data editing, and a quick transition time between data collection and analysis.

The data entry program (called **SURVEY3**) is a new and improved version of programs used on prior aerial surveys. It is an event-driven program, similar to the **CRUISE** program that was used on board the NOAA-ship McArthur during the **1991 CAMMS** marine mammal cruise (Hill and Barlow 1992 NOAA-TM-NMFS-SWFSC-169, 103pp.).

GENERAL FEATURES

The basic feature of the program is that it is event-driven. You press a function key to indicate an event. Each function key has a specific assignment (eg. F2 for a sighting, F5 to toggle effort on-or-off, etc.). When you press a function key, the computer notes the time and latitude/longitude of the aircraft at the moment you pressed the key. You will not have to write down time or position (for the latter, the computer is plugged into a GPS or LORAN navigation unit). The first event you enter will be noted in the event buffer in the upper left part of the computer screen. You can continue to press other event buttons while the computer is waiting for you to respond with information on the first event. These subsequent events will stack-up in the buffer and wait for your response. There is never any rush. The time and position of the buffered events has already been recorded.

RECORDER'S RESPONSIBILITY

It is the recorder's responsibility to enter and update all sighting, effort, and weather information. Observers will verbally provide the recorder with sighting, weather, and viewing condition information while we are surveying. However, if you are the recorder, and you notice for example, a change in the Beaufort sea state, speak up and get the consensus of the observers who may have not noticed the change in Beaufort.

At times the recorder may feel overwhelmed with a lot of information all at once, especially when three observers are trying to give you weather/viewing condition information, and another observer(s) may have a sighting. In the past, observers have been good about giving the recorder the needed information in a coherent and orderly manner. The event buffer in the upper left corner of the screen stores which function keys you hit, in the order in which they were hit, and records the position and time for each. There is no need to hurry out of one event window when given other information. You can for example, **(and should)** hit the F2 sighting button while you are in the weather window entering data if someone has a sighting. The event-driven system, automatically records the position and time where the sighting was made, and allows you to finish entering your weather data. Once you escape out of the weather window, the sighting window will appear, ready to receive the sighting information.

ERROR CORRECTION FEATURES

Most errors that are made in entering data can be easily corrected. If you make an error that cannot be corrected immediately, or you are unsure if you entered information correctly, it is best to document the problem using a comment statement (F10). If you make a mistake and pressed the wrong event button, you can cancel it by pressing the UNDO button (F1). When you are entering information, into an event window, you can navigate within the window using the ENTER or arrow keys. You can continue to make changes, going from one data element to the next, until you get it perfect. If you entered a wrong value and already pressed the ESC to save it, you can go backwards to make corrections using the left and right arrow keys. These will allow you to go back in the buffer, and retrieve the event window where you want to make changes. Record a comment (F10), concerning any changes you make. Each of the event buttons and error-recovery functions are documented in more detail below.

If you missed something or incorrectly entered data during the mayhem, use the arrow keys, which allow you to move around the event buffer, and reenter the window in which you need to fix data. You can only go back as far as the event code at the left edge of the buffer allows. If you try to go too far back in time, you will get a message that reads: **WARNING - Cannot Edit earlier records. Please document correction using comments.** Most corrections that you make while surveying will not require going back through that many events, but if this happens, utilize the F10 comment button to enter information. If you find yourself going back in time in the event buffer and someone has a sighting, hit the F2 SIGHT button, and then the ESC key once to get you back to real time. A sighting window will immediately appear, ready to receive information. If you did not finish editing the window that you had been in previously, you can go back to it with the arrow keys after the sighting.

SIGHTING RELOCATION FEATURES

This program has a feature that locks onto the location of the last on-effort sighting, and gives a bearing and distance back to that location once you have hit the sight button. Often, we will resight the same animals several times while circling to get estimates, photographs and/or identifications. Because of the movements of the animals, the original sighting position is often inaccurate after several minutes of circling over the area where the animals were originally sighted. The Shift-F2 button allows you to get an updated bearing and distance to the school each time you relocate them while circling. This makes relocation of animals progressively easier (theoretically) with each pass. Use this key to help the pilots relocate the animals after they have been sighted again after the initial sighting. Enter the current sighting number and angle where the animals were most recently seen.

MAP FEATURES

The **SURVEY3** program also has two map features that assist in: 1. relocating lost animals, and 2. showing you graphically where you are, where you've been, and where you're going. The maps are utilized with the SHIFT-F3 keystroke. You are given two map options to choose from. The first is a map of the entire CA. coast, and study area, which shows all survey effort that has been completed to date. The second option is a local map that shows all lines flown (on or off effort) within a 1 degree square around the current position. This map is useful when you are trying to relocate a sighting. It enables you to see where the plane has circled relative to the original sighting position. This map feature was utilized by the pilots last year, and proved very effective in relocating lost sightings.

GENERAL COMMANDS:

SURVEY3 — Type this at the DOS prompt to start program.

ESC — Hit this key when done entering information in an event window.

CTRL-D — Key sequence to end program.

FUNCTION KEYS:

F1 UNDO — This key allows you to do two things. You can delete an entire event window, or undo all changes in the window since you first entered information within a window. For example, if you want to update observer position information (F6), but instead hit weather (F9), you can hit F1 to erase the undesired event window. The **"W"** character in the buffer symbolizing weather will be replaced by a pound **(#)** sign. Another use for F1 UNDO is if you want to undo an accidental change of data in a window. For example, if you are updating values for glare, and you enter a value where there really was no change, hitting F1 will change all values in the window to their original value.

F2 SIGHT — Hit this key as soon as we are perpendicular to the animals, or when the secondary (belly) observer calls out a sighting. You will then record the following:

Observer: Observer who initially made the sighting. If more than one observer call the same sighting, whoever called sighting first is recorded.

Angle: Declination angle measured to the center of the sighted group. Sightings made to the left of the trackline are recorded as negative, those to the right are positive.

Primary?:	Enter Y if sighting was made by a primary (side) observer, or N if it was made by the secondary (belly) observer. Enter O if an off effort observer made the sighting.
Species1:	Enter 2-letter code identifying species.
Species2: & Species3:	If applicable, enter codes for other sighted species in group.

F3 BEG.TR. Hit this key at the beginning of a new transect. Refer to the attached figures containing Transects 1-76 for Grid 1, and Transects 101-178 for Grid 2. The F3 key will also automatically prompt you for glare (F7), weather (F9), altitude & speed (F8) and observer positions (F1).

F4 END TR. Hit this key when the transect ends. If we are immediately starting a new transect, hit F3 immediately afterwards.

F5 EFFORT This key is a toggle key that you hit whenever we begin or end effort while on a transect. Note, the large block letters in the lower left corner of the screen that read either **OFF** or **ON**. When the F5 key is hit, **OFF** will change to **ON**, and vice versa when struck again. This indicates whether we are on or off effort at the time. It should read **ON** while we are surveying. This **ON/OFF** message is also interactive with the begin transect (F3), and end transect (F4) keys. When you begin a transect (F3), the effort message will read **ON**. When you end a transect (F4), it will read **OFF**.

F6 OBSERVER POSITION This key when hit will ask you to enter the two letter code designating observers in their respective positions. If there is no one in the position, type off. The rear left and rear right positions are normally unoccupied (off). Observers initials are: (many more will be added as we go).

Jay Barlow	JB	Rick LeDuc	RL
Jim Carretta	JC	Mary Lycan	ML
Darlene Everhart	DE	Sue Kruse	SK
Karin Forney	KF	Carrie LeDuc	CL

Generally, 1st and last name initials will be used, unless there is a conflict.

F7 %GLARE Ask observers for their percent glare and record them in the respective fields, to the nearest 5%. If no observer is in that position, record OFF. Glare is defined as percentage of viewing area obscured by sun glare, cloud glare, or even glare from window reflections.

F8 ALTITUDE SPEED — We will normally be surveying at 700 feet and 100 knots. You should verify this periodically with the pilots.

F9 WEATHER — Record weather conditions whenever they change, and at the start of a transect. They are coded as:

HazeKelp:
- H=haze below plane.
- K=kelp obscuring surface of water.
- N=neither haze or kelp present.

%Overcast: Record (to the nearest 5%) this as a percentage of cloud cover between the viewing area and the sun (i.e., on the "sun side" of the plane.). Whoever has the best view of the sun can make this call. Don't give the overcast estimate more than a glance, otherwise you may miss animals below!

Beaufort:

0 Sea smooth and mirror-like.
Wind range: 0-1 knots.

1 Scale-like ripples, no foam crests.
Wind range: 1-3 knots.

2 Small, short wavelets; crests have glassy appearance and do not break.
Wind range: 4-6 knots.

3 Large wavelets; some crests begin to break; foam of glassy appearance; occasional white foam crests.
Wind range: 7-10 knots.

4 Small waves, becoming longer; fairly frequent white foam crests.
Wind range: 11-16 knots.

5 Moderate waves, taking a more pronounced form, many white foam crests; there may be some spray.
Wind range: 17-21 knots.

Water Color:
- L=light blue
- D=dark blue
- G=greenish blue
- R=red tide

The belly observer usually has the best view to evaluate water color.

F10 COMMENT — Record additional comments on behavior of animals sighted, or other items of interest. Also comment when mistakes were made in the data entry, and say how they should be corrected later. Data corrections that can be done right away should be done utilizing the F1 UNDO key if possible. Try to make each line of what you type a separate comment.

The maximum allowable length for a single comment is two lines on the screen. If possible, keep the length of comments **less than one line** - this helps later when data is edited.

SHIFTED FUNCTION KEYS:

F2 SPECIES SIGHTING — The Shift-F2 keystroke allows you to get an updated bearing and distance to the school when you relocate the animals while circling. Enter the current sighting number and angle where the animals where most recently seen. When you escape out of this window, another window appears near the top-center of the screen that says: **Last On-Eff. Sighting.** It gives you the position where the animals were last seen, along with a distance and bearing back to that position.

F3 MAP — Use this feature to call up a map of:

1. The entire California coast with all survey effort mapped.

2. All lines flown (on or off effort) within a 1 degree area around the current position. This local map is also useful in relocating lost animals. The map shows you where we have circled in relation to where the animals were first sighted.

F4 TURTLE — If a turtle is sighted, enter the two-letter observer code, declination angle, two-letter species code, and # of turtles. Also include the direction (in clock units) in relation to the plane that the turtle was travelling. For example, if the turtle was headed to the right of the trackline, record this as a 3. Also record any associated objects: J=jellyfish, F=floating objects, R=red tide. In the comments record the approximate size of the turtle, whether or not a tail was visible (which would indicate that it was a male), and any other item of interest or biological significance.

F5 NEW SIGHT # — The sighting numbers on the aerial survey are cumulative. The first sighting number of the day should be one greater than the last sighting number of the previous day. If for some reason, the program that keeps the sighting numbers tallied fails, the first sight number of that day would read as # 1. You can use this keystroke to update the correct sighting number for the **Survey3** program.

Declination angles and perpendicular distances from the trackline

Declination angle (°)	Perpendicular distance (meters)
90	0.0
85	19.0
80	38.5
75	57.0
70	78.5
65	99.3
60	123.0
55	149.0
50	179.0
45	213.0
40	254.0
35	304.0
30	369.0
25	457.0
20	585.0
15	795.0
12	1004.0

Southwest Fisheries Science Center, NMFS
Coastal Cetacean Surveys

Key to aerial survey raw data format

Columns	Entry
1-3	Line #
4	Entry type code
5	blank
6-11	Time, format: HHMMSS
12	blank
13-18	Date, format: MMDDYY
19	blank
20-28	Latitude, format: NDD:MM.MM
29	blank
30-39	Longitude, format: WDD:MM.MM
40	blank
41-end	entered data

Key to entry type codes:

* = position and time update (taken every minute)
T = Transect start, automatically followed by V,P,A,W.
V = Viewing conditions for all 3 observer positions. Recorded as percentage of viewing area obscured by glare.
P = Observer positions (order: left front, belly, right front, recorder).

A = Altitude and speed information.
W = Weather information:

H/K/N	Haze or kelp presence
0-100	% cloud cover
0-5	Beaufort sea state
G/L/D/R	Water color (green, light blue, dark blue, red tide)

O = End of transect
E = Ending effort on transect (i.e. to circle, transit, ...).
R = Resuming effort.
S = Sighting information:
- Sighting #
- Observer initials
- Declination angle (left side recorded as negative, right, positive)
- Primary sighting? (Y/N/O) (Note: Belly observer sightings are secondary, because only sightings missed by primary (side) observers may be called by this observer). "O" stands for off effort sightings.
- 1-3 fields with IDs for species in sightings

1-6 Individual observer estimates of school size and species proportions. Order: Best, High, Low, SP1 %, SP2%, SP3%
C = Comments - can be entered in any format to add information, point out errors in previous entries, etc.

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