

CONTRACT REPORT

**2003 AERIAL SURVEYS FOR HARBOR PORPOISE AND OTHER MARINE
MAMMALS OFF OREGON, WASHINGTON AND BRITISH COLUMBIA**

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EXECUTIVE SUMMARY

From 1 - 31 August 2003, Cascadia Research conducted aerial surveys for harbor porpoise, *Phocoena phocoena*, and other marine mammals under contract from the National Marine Mammal Laboratory. This was the second year that surveys were flown over the coastal waters of Washington and southern British Columbia and the inland waters of Washington (except Puget Sound) and southern British Columbia as part of a multi-year abundance estimate effort. This report summarizes the effort undertaken and sighting results of the second year.

The survey design was identical to the first year but included a smaller set of survey strata that did not include the Oregon and southern Washington outer coasts. As opposed to 11 regions or strata (A-K) as in 2002, there were 6 regions flown this year (F-K) with each containing several modified sawtooth line-transect routes. Two of the three coastal strata were further divided into inshore and offshore components with the offshore tracklines fewer in number. A high-wing twin-engine aircraft fitted with side bubble windows and a belly window was used with three experienced observers and a dedicated data recorder. A Data Acquisition System (DAS) interfaced with a GPS was used to streamline the data recording/entry process. Flights were conducted primarily on days with 'good' conditions (Beaufort sea state of 0-2, and cloud cover 50% or less). Sections flown in conditions worse than this were re-flown if possible.

The primary objectives of this study were to:

- 1) conduct line-transect aerial surveys off Washington and British Columbia to obtain data to estimate abundance of harbor porpoise.
- 2) obtain data on other species of marine mammals in these areas.
- 3) conduct aerial surveys in the eastern Strait of Juan de Fuca and the San Juan Islands concurrently with small boat transects in the same area.

A total of 74.5 hours were flown in the study area including transits to and from the various regions. Of these hours, 28.2 were flown on-effort covering 2,717 nmi. A total of 80% of this (22.5 h and 2,169 nmi) were conducted in 'good' weather conditions. Survey coverage was fairly complete in most of the six regions except northern Washington. Although heavily targeted this year due to missed effort last year, the northern Washington outer coast again proved hard to cover mostly due to fog and cloud cover but also high winds.

A total of 1,664 sightings of 4,166 animals were made both on and off effort. These represented 3 baleen whale species, 2 delphinid species, 2 porpoise species, 5 pinniped species, and 1 fissiped species. Sightings of harbor porpoise (499 sightings of 847 animals) and harbor seals (1048 sightings of 2,994 animals) together accounted for 92% of the sightings. Harbor porpoise were seen in all regions (422 sightings of 716 animals on-effort in 'good' weather). High concentrations of harbor porpoise were seen in the central Strait of Juan de Fuca (in conjunction with vessel surveys) and also in the northern San Juan Islands. Relatively low numbers of sightings were made in central and northern Strait of Georgia.

INTRODUCTION

From 1 to 30 August 2003, Cascadia Research conducted a second year of aerial surveys for harbor porpoise and other marine mammals as part of a 2-3 year effort under contract from the National Marine Mammal Laboratory. These surveys represent a continuation of surveys that have been conducted at 5-6 year intervals starting in the late 1980s (Calambokidis et al. 1992, 1993, 1997, Osmek et al. 1996, Laake et al. 1997a, 1997b, 1998). The surveys were flown over the coastal waters of central and northern Washington, southern British Columbia and the inland waters of Washington (except Puget Sound) and southern British Columbia as part of a multi-year abundance estimate effort. This report summarizes the effort undertaken and sighting results of this second year (2003).

The primary objectives of this study were to:

1. conduct line-transect aerial surveys off Washington and British Columbia to obtain data to estimate abundance of harbor porpoise.
2. obtain data on other species of marine mammals in these areas.
3. conduct aerial surveys in the eastern Strait of Juan de Fuca and the San Juan Islands concurrently with small boat transects in the same area.

We report the methods and preliminary results of August 2003 aerial surveys for marine mammals that occupy the waters of Washington and southern British Columbia. These data will now be used to estimate abundance of harbor porpoise and other species using line transect procedures (Buckland et al. 2001).

METHODS

Study Area

The study area includes the coastal waters of Washington and southern British Columbia between 47 and 50 degrees N latitude, from shore out to a depth of 200m and the inside waters of Washington (not Puget Sound) and southern British Columbia (Figure 1). This is the same area as flown in previous years, however, this is the first year that both inside and outside waters were flown during the same time period.

Survey Design and Procedures

Surveys were flown following a modified saw-tooth transect line design (Cooke 1985) and were intended to provide uniform coverage of each stratum or region (Figure 1). Unlike traditional saw-tooth transect lines, the lines we flew did not stop and start at the same point but were spaced slightly apart thereby requiring a short deadhead transit between lines. This survey design enables analysis of the data using four separate replicates instead of just two if each set of lines were connected.

Flights generally originated and ended at Olympia International Airport, Washington unless weather conditions or transit duration made it impractical. The flying direction of any given region varied from one survey to another depending on which direction would provide the best combination of visibility conditions for a particular time of day (*e.g.* to reduce sun glare).

Surveys were conducted using a high-wing (*Partenavia P-68*) twin-engine aircraft equipped with left and right side bubble windows and a belly window. This arrangement made it possible to observe marine mammals slightly ahead of, to the side, and beneath the aircraft. Three experienced harbor porpoise observers, located at left, center and right positions in the aircraft viewed the water for marine mammals while the aircraft flew at an altitude of 198 m (650 ft) and a speed of approximately 167 km/hr (90 kts). Observers rotated to a new position at the beginning of each flight if some track-lines were flown on effort during the previous flight. Surveys were generally limited to visibility conditions of a Beaufort sea state 3 or less and cloud cover $\leq 50\%$. When a transect line was aborted prematurely because of poor visibility conditions or because of airspace conflicts, these lines were flown again when the situation improved.

The data recorder, who also navigated from the copilot's seat, entered survey information using a custom Data Acquisition System (DAS) on a laptop computer that was interfaced with a GPS navigational system. Visibility conditions, and altitude were recorded at the beginning of a transect line and when conditions changed. The date, time, and position were updated automatically by the computer every minute and when other data entries were made. When a marine mammal sighting was made, side observers used a clinometer to measure angle from the aircraft to the group of animals as they passed abeam of the aircraft so the perpendicular distance (distance from the survey track-line) could be determined. The center observer reported sighting angles from a clinometer-calibrated scale mounted at the bottom of the belly window. The species, group size, number of calves, and behavior were recorded along with the observer who made the sighting.

When a group was sighted from the center, the observer would delay for 2-3 seconds waiting for the side observers to register their sighting information with the recorder if they had any. This method of recording was used to avoid confusion when typically both observers would report the same sighting in unison. The center observer also told the recorder if they saw a sighting made by the side observer to provide information on the number of missed center sightings within the overlapping search area of 90-65 degrees.

No angles were recorded for pinniped sightings as this was found to interfere with sighting and recording harbor porpoise data. Initially, an attempt was made to determine if pinniped sightings were inside or outside of a predetermined strip (80 degrees R to 80 deg L) then later decided that it was too much to record and interfered with harbor porpoise data.

Coordinated Vessel Survey

An attempt was made to conduct vessel line transect surveys in conjunction with the aerial surveys in region J. Ideally these coordinated surveys were to occur close in time however, inclement weather prevented clean overlap. Observers from the National Marine Mammal Laboratory were on site attempting vessel surveys in the Strait of Juan de Fuca at various times from 12-29 August and in the San Juan Islands from 19-28 August. Aerial surveys in the eastern Straits of Juan de Fuca occurred from 7-10 August and in the San Juan Islands from 13-19 August. These flights were earlier than desired due to good weather in those regions and unsuitable weather elsewhere.

Data Editing and Preliminary Analysis

Error checks of the electronic data were conducted prior to analysis, both visually and using computer programs written to test for reasonable speed between one-minute position fixes, altitudes, clinometer angles, and species codes (Appendix Table 1). On several occasions it was found that the GPS failed to provide reliable positions for small portions of a flight (*e.g.*, position format error). In these instances, latitude and longitude were interpolated using the times and positions which preceded and followed the missing entry. In two instances, data were missing from on-effort harbor porpoise sightings. On one occasion, a sighting of a harbor porpoise was found to contain no angle and in another instance, no number of animals. Species codes included a designation for probable but not certain, as well as codes for unidentified species. Probable sightings were included in the data summaries for that species.

RESULTS AND DISCUSSION

Survey effort

A total of 74.5 hours were flown (Table 1). Of these 28.2 hours were flown on-effort covering 2,717 nmi. A total of 80% of this (22.5 h and 2,169 nmi) were conducted in 'good' weather conditions between 1-31 August, 2003 (Table 3). Surveys were attempted only under favorable weather conditions because past surveys had shown decreased sighting rates of harbor porpoise with increasing Beaufort sea state and cloud cover (Forney *et al.* 1991, Palka 1996, Calambokidis *et al.* 1992). Surveys were also terminated if Beaufort sea state steadily remained above a level 2 (7 knots).

The survey coverage achieved was fairly complete in most of the 6 regions (Figure 1). Although heavily targeted due to missed effort last year, coverage in regions G and H was the most incomplete of all regions. This was mainly due to high overcast early in the survey period and fog later in the survey but also unacceptable wind speeds. The proximity of airports with fuel to routes in survey strata G and H also limited coverage there.

Sightings

A total of 1,664 sightings of 4,166 animals were made both on and off effort (Table 4). These represented 3 baleen whale species, 2 delphinid species, 2 porpoise species, 4 pinniped species, and 1 fissiped species. Sightings of harbor porpoise (499 sightings of 847 animals) and harbor seals (1048 sightings of 2,994 animals) together accounted for 92% of the sightings. Sightings were made throughout the survey region although there were patterns in the distribution of many species (Figures 3-7).

We saw fewer total numbers of large whales and large whale species this year compared to 2002. This was likely due to less effort over outer coastal waters. Sightings of blue, fin, and humpback whales were made in 2002 over Oregon coastal waters, an area not covered this year. Killer whales were again seen in the Strait of Juan de Fuca.

A total of 499 sightings of 847 harbor porpoise were made during the surveys, with 422 sightings of 716 animals made on-effort in "good" weather (Table 4). Group sizes of harbor porpoise ranged from 1 to 12 individuals with single animals occurring 57% of the time and paired animals in 30% of the sightings (Table 5). High concentrations of harbor porpoise were seen in the central and eastern Strait of Juan de Fuca (in the area of coordinated vessel surveys) and also in the northern San Juan Islands. Relatively low numbers of sightings were made in central and northern Strait of Georgia.

Estimates of abundance of harbor porpoise and other marine mammals will be computed with line-transect analysis using the data from last years' effort and this survey. Results of these future analyses will be summarized in subsequent reports by the National Marine Mammal Laboratory and Cascadia Research.

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APPENDIX 1. DATA ACQUISITION SYSTEM (DAS) DATA FIELD COLUMNS

| Column | Description of data entry |
|---------|---|
| 1 | Event code |
| 3-7 | Begin waypoint number |
| 8-12 | End waypoint number |
| 13-14 | Month |
| 16-17 | Day |
| 19-20 | Year |
| 22-23 | Time (Hours) |
| 25-26 | Time (Minutes) |
| 28-29 | Time (Seconds) |
| 31-33 | Position (Latitude degrees) |
| 35-39 | Position (Latitude minutes) |
| 41-44 | Position (Longitude degrees) |
| 46-50 | Position (Longitude minutes) |
| 52-55 | Altitude |
| 57-60 | Sighting number |
| 57+ | Comment only (if no sighting data on line) |
| 61-63 | Species code |
| 65-67 | Angle to sighting |
| 67 | Side of center observer's sighting (L or R) |
| 69-72 | Group size |
| 75-77 | Minimum group size |
| 80-82 | Maximum group size |
| 84-85 | Number of calves or pups |
| 93-94 | Behavior code |
| 103-105 | Observer initials |
| 107-109 | Cloud cover |
| 112 | Beaufort scale |
| 114 | Glare left observer |

Event code (column 1): 1 digit code representing the reason for data entry. The different codes are as follows:

1 = left observer sighting

2 = center observer sighting

3 = right observer sighting

4 = sighting from data recorder or pilot

8 = altitude update

W = Weather

B = Begin line

E = End line

X = short break of a given trackline (usually due to a land crossing or species confirmation)

A = resighting of a previously sighted animal

R = Resume on-effort (back over water)

C = Comment

O = Observer update for left, center, right, data recorder, pilot positions

* = aircraft position captured by the DAS program (positions are recorded each minute even when observers were off-effort).

Begin waypoint (columns 3-7): Alpha-numeric code representing the region (letters) and waypoint number at the beginning of the transect line (see attached waypoint table for details).

End waypoint (columns 8-12): Alpha-numeric code representing the region (letters) and waypoint number at the end of the transect line (see attached waypoint table for details).

Month (columns 13-14): Numeric value representing month (e.g. 12 for December).

Day (columns 16-17): Numeric value representing the day of the month.

Year (columns 19-20): Numeric value representing the year (e.g. 96 for 1996).

Time (Hours) (columns 22-23): Numeric value representing the hour (e.g. 13 for the thirteenth hour of the day - Pacific Daylight Savings Time).

Time (Minutes) (columns 25-26): Numeric value representing minutes (e.g. 10 for the tenth minute of the hour).

Time (Seconds) (columns 28-29): Numeric value representing seconds (e.g. 10 for the tenth second of the minute.)

Position (Latitude degrees) (columns 31-33): Numeric value representing the latitude (e.g. N48 for 48 degrees north; "I" indicates that the position was interpolated based on the time and latitude of the position that preceded and followed it).

Position (Latitude minutes) (columns 35-39): Numeric value representing the minutes latitude (60 minutes equals one degree).

Position (Longitude degrees) (columns 41-44): Numeric value representing the degrees longitude (e.g. W123 for 123 degrees west; "I" indicates that the position was interpolated based on the time and longitude of the position that preceded and followed it).

Position (Longitude minutes) (columns 46-50): Numeric value representing the minutes longitude (60 minutes equals one degree).

Altitude (columns 52-55): Numeric value representing the altitude of the survey aircraft at time of event.

Sighting number (columns 57-60): Numeric code given for the sighting number. DAS numbered the sightings sequentially beginning each time the DAS program was loaded. Skips in the sighting numbers represent that a sighting was removed from the data file.

Species code (columns 61-62): Code representing the species sighted:

1 = Harbor Porpoise
2 = Harbor Seal
BA = Minke Whale
EJ = Northern Sea Lion
EL = Sea Otter
ER = Gray Whale
GG = Risso's Dolphin
LB = Northern Right Whale Dolphin
LBT = Leatherback Turtle
LO = Pacific White-Sided Dolphin
MA = Elephant Seal
OO = Killer Whale
PD = Dall's Porpoise
TS = Shark (Most Likely Thresher Or Blue)
UP = Unidentified Pinniped
UO = Unidentified Otariid
UW = Unidentified Whale
ZC = California Sea Lion

Angle to sighting (columns 65 - 67): Numeric value representing the clinometer reading in degrees to animal as it passes abeam of the aircraft (90 degrees = trackline). Angles for the belly observer was estimated from a premarked grid positioned above the viewing port.

Side of aircraft (column 67): Left (L) or right (R) side of the aircraft (for center observer sightings)

Group size (columns 69-72): Numeric value representing the number of animals seen for the specific sighting (number includes all calves or pups in group).

Calves/Pups (column 84-85): Number of calves or pups if seen

Behavior code (column 94): Number: 3 = stationary, 6 = hauled pinniped, 15 = cetacean pectoral fin slap, 32 = alteration of normal activities, 33 = quick dive

Observer initials (columns 103-105): 2 digit code for the using the first letters from the observers first and last name.

Cloud cover (columns 107-109): Numeric code representing percent of cloud cover (e.g. 25 for 25% cloud cover).

Beaufort wind scale (column 111-112): Representing the Beaufort wind scale (1 = Beaufort 1).

Glare: Numeric code representing surface glare conditions.

1 = no glare problems

2 = some glare – affects search

3 = severe glare - scorched eyeballs

Left observer (column 114)

Center observer (column 116)

Right observer (column 118)

Visual quality: Numeric code of overall impression of ability to see animals

1 = Excellent

2 = Good

3 = Fair

4 = Poor

5 = Unacceptable

Left observer (column 120)

Center observer (column 122)

Right observer (column 124)

Comment for sighting: (columns 126+): Comment about sighting or flight.

Center saw: Letter code (Y or N) indicating whether the center observer saw the side observer's last sighting. No code indicates the center did not see the sighting.

TABLES AND FIGURES

Tables

1. Log of flights and hours
2. Status of individual routes showing dates flown and lines missed
3. Summary of nmi and hours on-effort in good and poor weather by region
4. Summary of sightings by species and on and off effort
5. Summary of group sizes for sightings on-effort in good weather

Figures

1. Survey effort flown showing good and poor weather segments
2. Sighting locations of harbor porpoise by weather condition
3. Sighting locations of Dall's porpoise by weather condition
4. Sighting locations of large whales
5. Sighting locations of delphinids
6. Sighting locations of pinnipeds

Table 1. Summary of flight times and hours flown during 2003 survey.

| Date | Take Off | Landing | Hours | Billed Hours | Description |
|--------|----------|---------|-------|--------------|--|
| 3-Aug | 1243 | 1328 | 0.75 | | Transit Olympia to Port Angeles - refuel |
| 3-Aug | 1354 | 1704 | 3.17 | 4.28 | Fly 3/4 of Route 29 (25% beau 3) |
| 4-Aug | 828 | 1034 | 2.10 | | Aborted route 28 |
| 4-Aug | 1237 | 1654 | 4.28 | | Fly Route 28 and southerly 3 lines of 27 |
| 4-Aug | 1725 | 1823 | 0.96 | 7.97 | Transit Bellingham to Olympia |
| 6-Aug | 1328 | 1722 | 3.90 | 4.10 | Oly to Route 17 (skip south 3 lines due to fog) |
| 7-Aug | 823 | 1220 | 3.95 | | Oly to Route 17 (skip south 3 lines due to fog) |
| 7-Aug | 1354 | 1753 | 3.98 | 8.33 | Port Angeles to Route 27 (excellent cond.) |
| 10-Aug | 1218 | 1658 | 4.67 | 4.85 | Fly Route 31 (good conditions) |
| 12-Aug | 1301 | 1500 | 1.98 | 2.13 | Attempt Route 18 - Abort due to beau f 3 |
| 13-Aug | 915 | 1157 | 2.70 | | Fly 1/2 Route 32 (@ 50% beau 3) - abort |
| 13-Aug | 1425 | 1525 | 1.00 | 4.10 | Attempt Route 25 - no effort beaufort 4 |
| 14-Aug | 826 | 1111 | 2.75 | | Fly Route 33 (excellent conditions) |
| 14-Aug | 1302 | 1706 | 4.07 | 7.10 | Fly Route 25 (good - skipped lines 17 and 20) |
| 17-Aug | 1239 | 1548 | 3.15 | | Fly Route 35 (good to excellent) |
| 17-Aug | 1649 | 1934 | 2.75 | 6.18 | Fly Route34 (fair to good) skip lines 7, 8 |
| 19-Aug | 1140 | 1455 | 3.25 | 3.50 | Finish Route 34, nearly finish route 25, part of 26 |
| 20-Aug | 1309 | 1445 | 1.60 | 1.87 | Aborted route 19 (fly first two lines) |
| 22-Aug | 1247 | 1632 | 3.75 | | Finish Route19 (good to fair), Fly route 20 (fair) |
| 22-Aug | 1706 | 1728 | 0.37 | 4.28 | Transit Hoquiam to Oly |
| 23-Aug | 1025 | 1500 | 4.58 | | Route 18 and eastern 4 lines of 24 |
| 23-Aug | 1619 | 1703 | 0.73 | 5.52 | Transit P.A. to Oly |
| 26-Aug | 1237 | 1643 | 4.10 | | Complete Route 23 |
| 26-Aug | 1723 | 1804 | 0.69 | 5.10 | Transit P.A. to Oly |
| 28-Aug | 828 | 1030 | 2.03 | | Finish Route 32 (50% beau 3) |
| 28-Aug | 1259 | 1414 | 1.25 | | Finish Route25, 26 |
| 28-Aug | 1526 | 1736 | 2.17 | 5.93 | Refly lines from above with non-active military area |
| 30-Aug | 835 | 1132 | 2.95 | 4.00 | Transit to Strait of Georgia fly 3 lines in route 29 |
| 30-Aug | 1518 | 1612 | 0.90 | | Transit PA to Oly |
| | | | 74.53 | 79.24 | Hours flown |
| | | | | 6.00 | Ferry hours (Oxnard to Olympia) |
| | | | | 10.76 | Hours added to reach daily minimum |
| | | | | 96.00 | Total hours |

Table 2. Status of individual routes showing dates flown and missed lines for 2003 survey.

| Routes | Date Completed | Description (quality) | Did not finish |
|---------------|-----------------------|--|-----------------------|
| 17 | 6-Aug | 75% complete (good) | lines 5, 2, 12 |
| 18 | 21&23 Aug | Complete (good to excellent) | |
| 19 | 20&22-Aug | Complete 22-Aug (good to fair conditions) | |
| 20 | 22-Aug | Fly all but northern 2 lines (fair conditions) | lines 16, 19 |
| 21 | | | entire route |
| 22 | | | entire route |
| 23 | 27-Aug | Complete entire route (fair to excellent) | |
| 24 | 24-Aug | fly 4 eastern lines | lines 1-5 |
| 25 | 14-19-28 Aug | flown in three parts (excellent -fair) | |
| 26 | 14-19-28 Aug | flown in three parts (excellent -fair) | |
| 27 | 4-Aug & 7-Aug | Complete (excellent) | |
| 28 | 4-Aug | Complete (excellent) | |
| 29 | 3&30 -Aug | 5/8 complete (30% beau. 3) | |
| 30 | 7-Aug | Complete (excellent) | |
| 31 | 10-Aug | Complete (good) | |
| 32 | 13&28-Aug | Fly 4 southern lines (50% beau 3) | |
| 33 | 14-Aug | Complete (excellent) | |
| 34 | 17-19-Aug | Complete in two parts (good to fair) | |
| 35 | 17-Aug | Complete (good to excellent) | |

Table 3. Summary of effort by region and date. Good weather is Beaufort of 2 or less and cloud cover of 50% or less.

| Reg | Good weather | | Poor weather | | Total | |
|---------------|---------------------|--------------------|---------------------|--------------------|-----------------|--------------------|
| | Time (h) | Dist. (nmi) | Time (h) | Dist. (nmi) | Time (h) | Dist. (nmi) |
| Region | | | | | | |
| F | 2.28 | 215 | 0.96 | 93 | 3.24 | 309 |
| G | 2.29 | 217 | 0.98 | 93 | 3.27 | 310 |
| GF | 1.52 | 153 | 0.18 | 18 | 1.70 | 171 |
| H | 0.67 | 64 | 0.15 | 14 | 0.81 | 78 |
| I | 2.78 | 272 | 0.70 | 67 | 3.48 | 339 |
| J | 8.05 | 766 | 1.83 | 177 | 9.88 | 943 |
| K | 4.94 | 482 | 0.86 | 85 | 5.80 | 567 |
| Date | | | | | | |
| 3-Aug | 0.93 | 90 | 0.37 | 36 | 1.29 | 126 |
| 4-Aug | 2.19 | 214 | 0.34 | 35 | 2.54 | 249 |
| 6-Aug | 1.10 | 106 | 0.58 | 56 | 1.68 | 162 |
| 7-Aug | 3.13 | 300 | 0.22 | 21 | 3.35 | 320 |
| 10-Aug | 1.50 | 145 | 0.70 | 68 | 2.19 | 213 |
| 12-Aug | 0.25 | 24 | 0.30 | 28 | 0.55 | 52 |
| 13-Aug | 0.53 | 51 | 0.64 | 62 | 1.17 | 112 |
| 14-Aug | 2.65 | 256 | 0.32 | 32 | 2.97 | 288 |
| 17-Aug | 2.36 | 218 | 0.17 | 16 | 2.53 | 234 |
| 19-Aug | 0.80 | 76 | 0.16 | 14 | 0.95 | 90 |
| 20-Aug | 0.28 | 27 | 0.14 | 14 | 0.42 | 40 |
| 22-Aug | 1.49 | 142 | 0.61 | 61 | 2.10 | 203 |
| 23-Aug | 2.09 | 197 | 0.49 | 45 | 2.58 | 241 |
| 26-Aug | 1.52 | 153 | 0.34 | 32 | 1.86 | 186 |
| 28-Aug | 0.80 | 81 | 0.28 | 28 | 1.08 | 109 |
| 30-Aug | 0.92 | 90 | | | 0.92 | 90 |
| Total | 22.53 | 2169 | 5.65 | 547 | 28.18 | 2717 |

Table 4. Summary of sightings both on and off effort in 2003 surveys.

| Species | Off effort | | On effort | | | | Total | |
|------------------------------|------------|------------|--------------|------------|--------------|-------------|-------------|-------------|
| | Sight. | No. | Poor weather | | Good weather | | Sight. | No. |
| | | | Sight. | No. | Sight. | No. | | |
| Baleen whales | | | | | | | | |
| Minke whale | 2 | 2 | | | | | 2 | 2 |
| Gray whale | 2 | 3 | | | 2 | 2 | 4 | 5 |
| Humpback whale | 3 | 4 | 1 | 1 | 7 | 13 | 11 | 18 |
| Unidentified whale | | | | | 1 | 1 | 1 | 1 |
| Delphinids | | | | | | | | |
| Pacific white-sided dolphins | 4 | 40 | | | | | 4 | 40 |
| Killer whale | 2 | 67 | | | 3 | 39 | 5 | 106 |
| Porpoise | | | | | | | | |
| Dall's porpoise | 5 | 17 | 6 | 10 | 23 | 51 | 34 | 78 |
| Harbor porpoise | 35 | 67 | 42 | 64 | 422 | 716 | 499 | 847 |
| Pinnipeds | | | | | | | | |
| Harbor seal | 9 | 184 | 70 | 188 | 969 | 2622 | 1048 | 2994 |
| California sea lion | | | 2 | 2 | 6 | 6 | 8 | 8 |
| Northern fur seal | | | | | | | | |
| Northern sea lion | 7 | 14 | 7 | 7 | 26 | 37 | 40 | 58 |
| Unidentified pinniped | | | | | 5 | 5 | 5 | 5 |
| Otters and turtles | | | | | | | | |
| Sea otter | | | | | 3 | 4 | 3 | 4 |
| Total | 69 | 398 | 128 | 272 | 1467 | 3496 | 1664 | 4166 |

Table 5. Summary of group sizes of sightings including those off-effort except as noted.

| Species | Group size | | | | | | | | | | | All | |
|------------------------------|-------------|------------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|----------|-----|-------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10-99 | >99 | | |
| Baleen whales | | | | | | | | | | | | | |
| Minke whale | 2 | | | | | | | | | | | | 2 |
| Gray whale | 3 | 1 | | | | | | | | | | | 4 |
| Humpback whale | 4 | 7 | | | | | | | | | | | 11 |
| Unidentified whale | 1 | | | | | | | | | | | | 1 |
| Delphinids | | | | | | | | | | | | | |
| Pacific white-sided dolphins | | | | 1 | | | 1 | | | | 2 | | 4 |
| Killer whale | | | | 1 | | | 1 | | | | 3 | | 5 |
| Porpoise | | | | | | | | | | | | | |
| Dall's porpoise | 10 | 13 | 8 | | 1 | 1 | 1 | | | | | | 34 |
| Harbor porpoise | 286 | 147 | 37 | 14 | 7 | 5 | | | | | 3 | | 499 |
| On-effort Good weather only | 237 | 128 | 35 | 9 | 7 | 4 | | | | | 2 | | 422 |
| Pinnipeds | | | | | | | | | | | | | |
| Harbor seal | 888 | 79 | 19 | 10 | 3 | 3 | 1 | 1 | 2 | 39 | 3 | | 1048 |
| California sea lion | 8 | | | | | | | | | | | | 8 |
| Northern sea lion | 29 | 6 | 4 | | 1 | | | | | | | | 40 |
| Unidentified pinniped | 5 | | | | | | | | | | | | 5 |
| Otters and turtles | | | | | | | | | | | | | |
| Sea otter | 2 | 1 | | | | | | | | | | | 3 |
| River otter | 1 | | | | | | | | | | | | 1 |
| Leatherback turtle | 1 | | | | | | | | | | | | 1 |
| Total | 1240 | 254 | 68 | 26 | 12 | 9 | 4 | 1 | 2 | 47 | 3 | | 1666 |

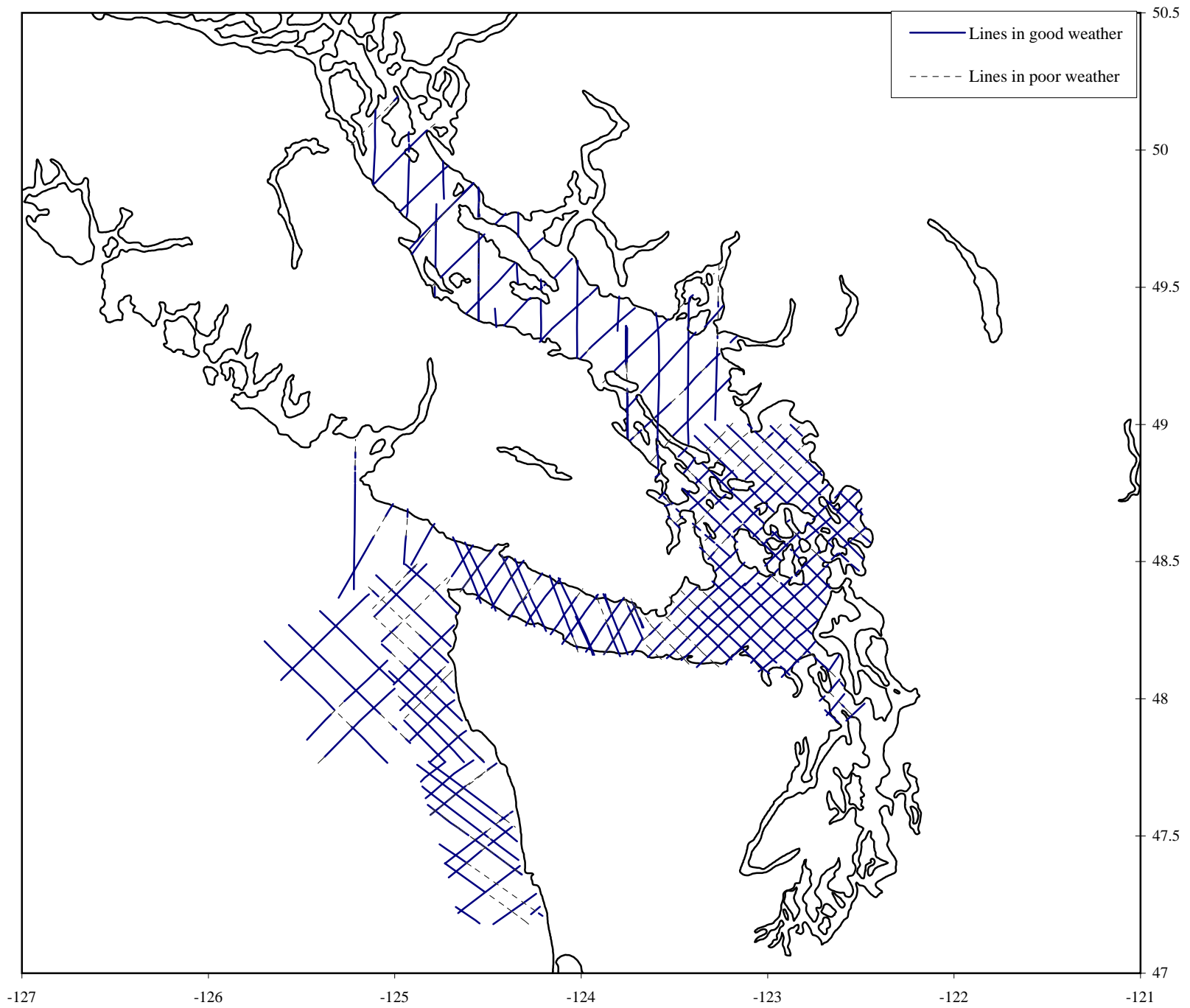


Figure 1. Survey effort flow in 2003 showing good and poor weather segments.

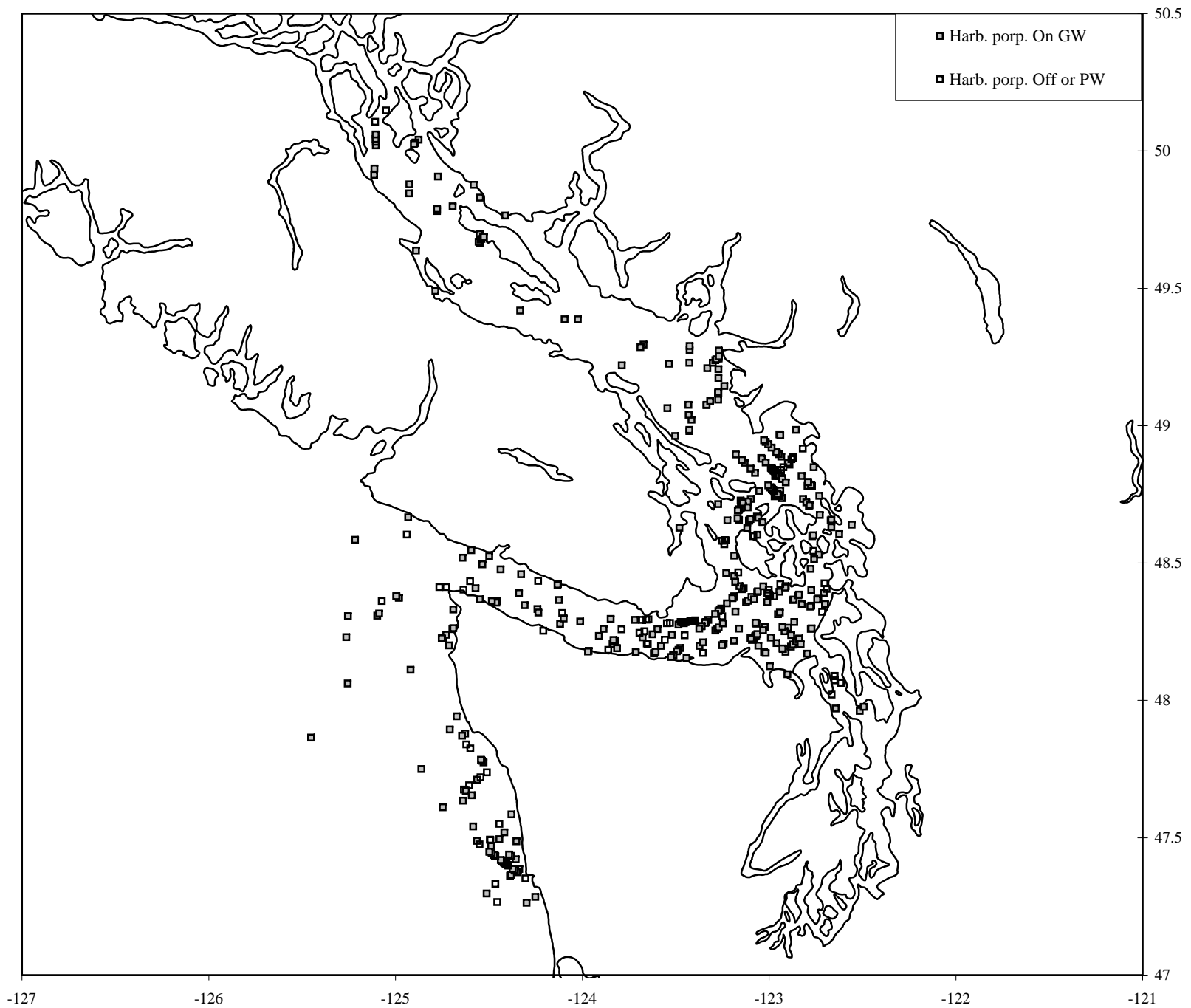


Figure 2. Map showing harbor porpoise sightings by effort type during 2003 survey.

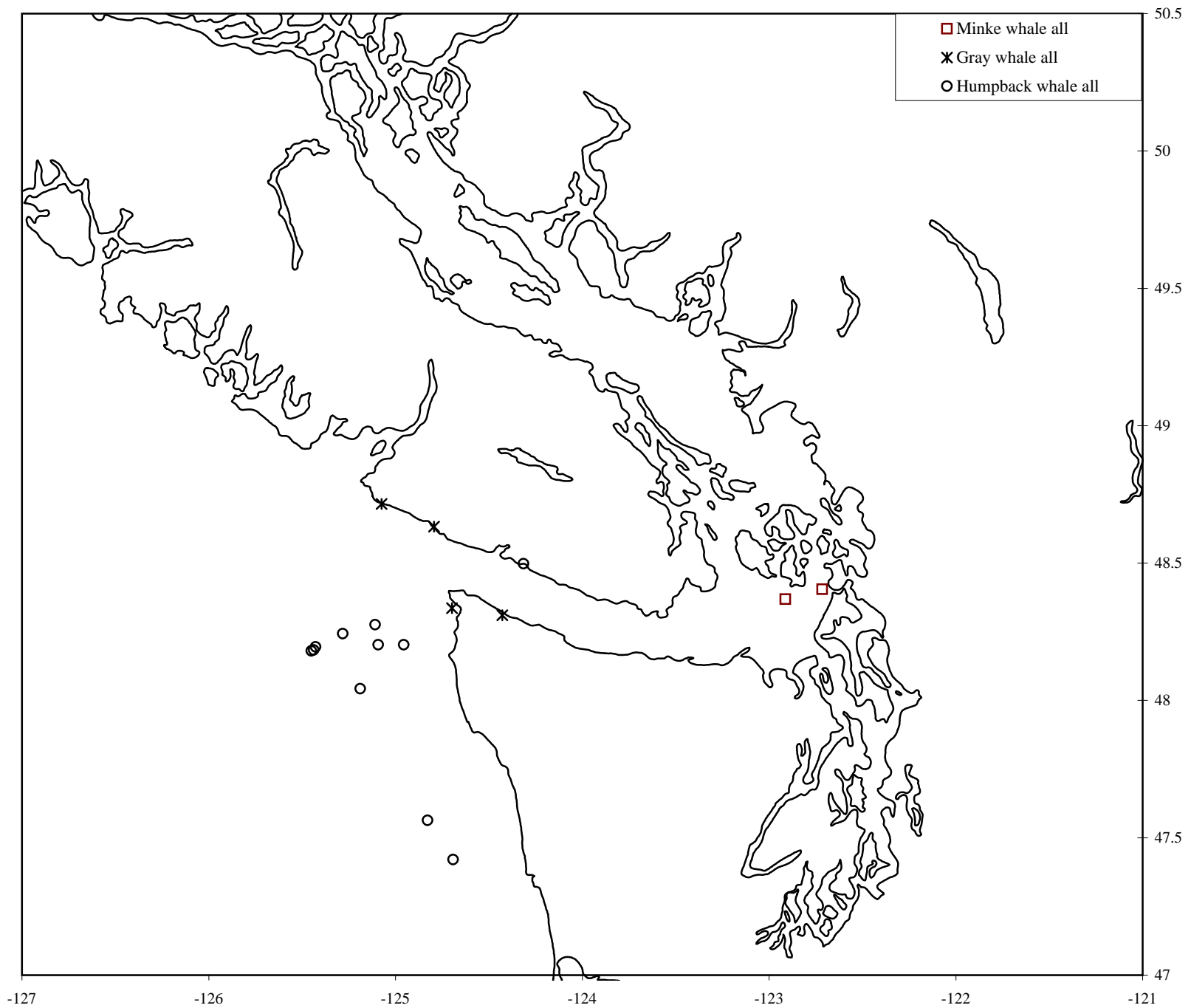


Figure 4. Map showing sightings of large whales during 2003 survey.

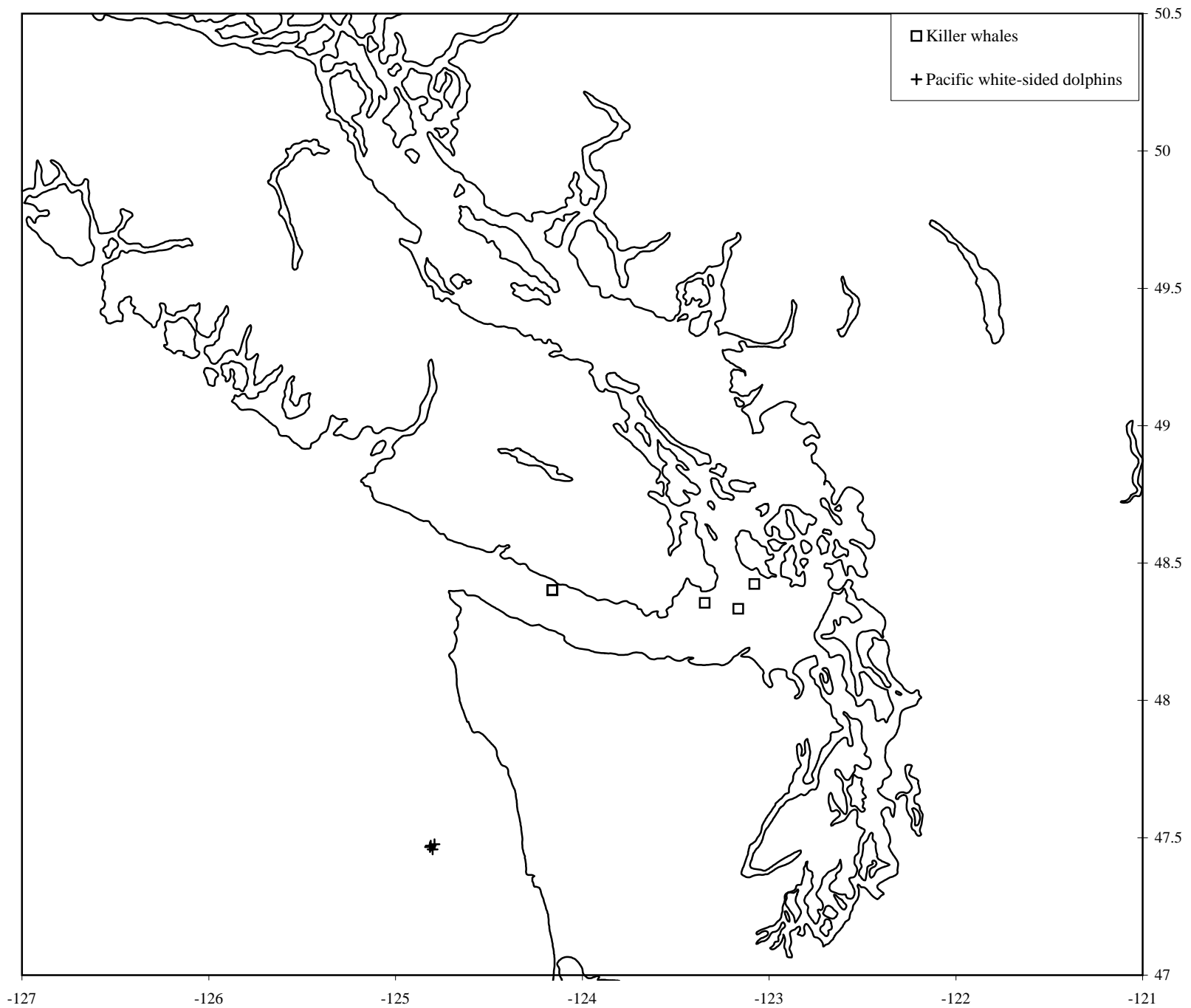


Figure 5. Map showing all delphinid sightings during 2003 survey.

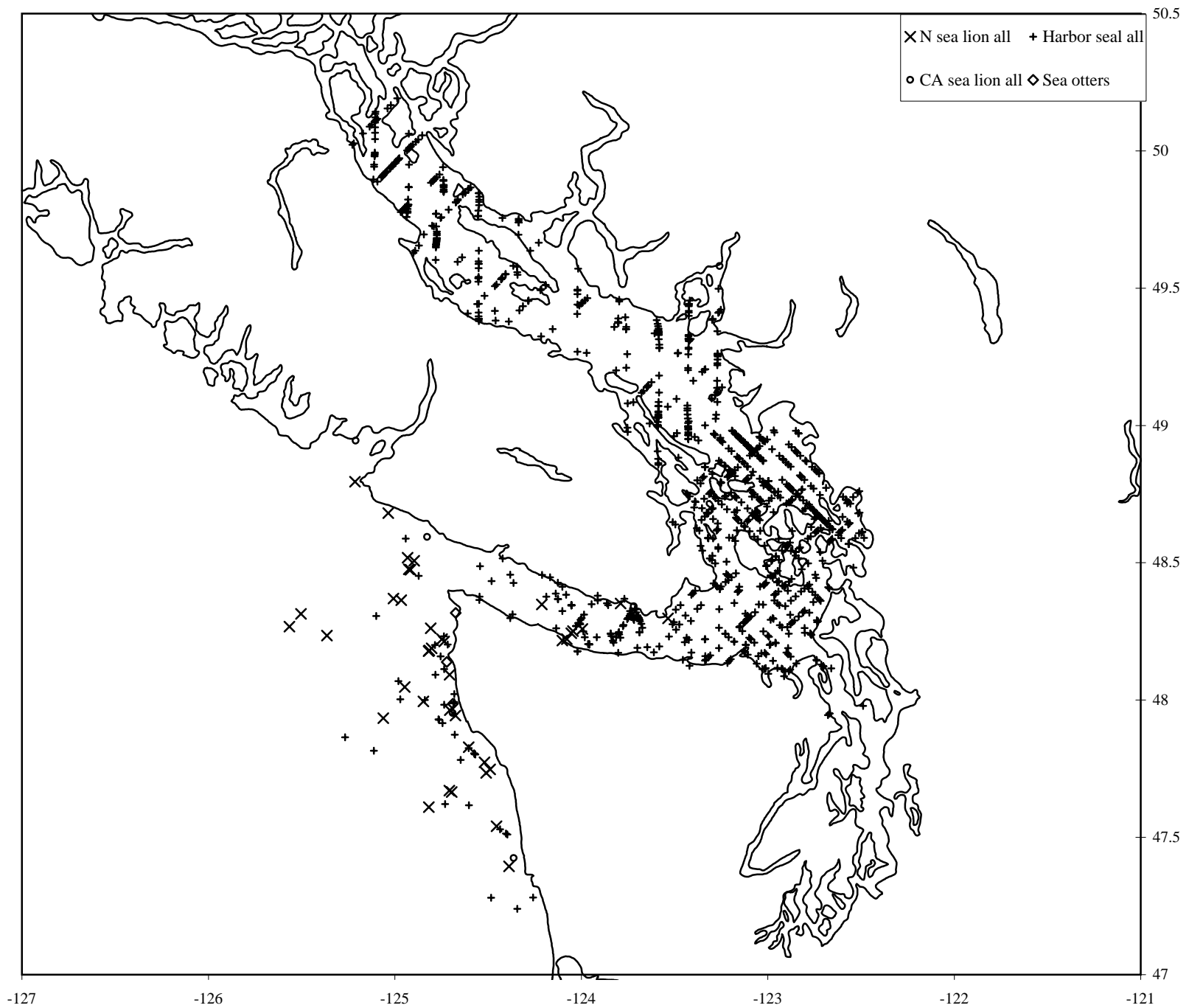


Figure 6. Map showing all pinniped sightings during 2003 survey.