CONTRACT REPORT

2002 AERIAL SURVEYS FOR HARBOR PORPOISE AND OTHER MARINE MAMMALS OFF OREGON, WASHINGTON AND BRITISH COLUMBIA

By
Todd Chandler
and
John Calambokidis

Cascadia Research
218½ W 4th Avenue
Olympia, Washington 98501

Prepared for

National Marine Mammal Laboratory
7600 Sand Point Way NW
Seattle, WA 98115

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EXECUTIVE SUMMARY

From 6 August to 12 September 2002, Cascadia Research conducted aerial surveys for harbor porpoise, *Phocoena phocoena* and other marine mammals under contract from the National Marine Mammal Laboratory. The surveys were flown over the coastal waters of Oregon, 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 this first year.

The survey area was divided into 11 strata (A-K) with each containing several modified sawtooth line-transect routes. Most (5) of the 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 Oregon, 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 111 hours were flown (not including ferry of the aircraft from Oxnard, California). Of these 42.6 hours were flown on-effort covering 4,010 nmi. A total of 86% of this (36.5 h and 3,434 nmi) were conducted in 'good' weather conditions. Surveys coverage was fairly complete in most of the 11 regions except northern Washington. Off northern Washington, permit conditions to avoid impacts on eagles and cormorants prevented flights early in the survey period and poor weather prevented most flights later in the survey period.

A total of 1,696 sightings of 4,765 animals were made both on and off effort. These represented 5 baleen whale species, 4 delphinid species, 2 porpoise species, 5 pinniped species, and 2 otters. Sightings of harbor porpoise (607 sightings of 935 animals) and harbor seals (806 sightings of 2,823 animals) together accounted for 83% of the sightings. Harbor porpoise were seen in all regions (536 sightings of 836 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 6 August to 12 September 2002, Cascadia Research conducted aerial surveys for harbor porpoise other marine mammals 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 Oregon, 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 this first year (2002).

The primary objectives of this study were to:

1. Conduct line-transect aerial surveys off Oregon, 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/September 2002 aerial surveys for marine mammals that occupy the waters of Oregon, 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 Oregon, Washington, and Southern British Columbia south of 49 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 together.

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 Strata or region (Figure 1). Unlike traditioinal 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 2 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 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. Surveys were generally limited to visibility conditions of a Beaufort sea state three or less and cloud cover ≤ 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 chair, 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 location was updated automatically by the computer each 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 trackline) could be determined. The center observer called out 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.

Coordinated Vessel Surveys

On three days (August 12, 20, and 22) aerial survey effort was flown in conjunction with shipboard surveys conducted by the National Marine Mammal Laboratory. These coordinated surveys took place in the eastern Strait of Juan de Fuca and the San Juan Islands. These proved good sighting conditions with large numbers of harbor porpoise seen.

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 time and position which proceeded and followed it. 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

Survey effort

A total of 111 hours were flown (not including ferry of the aircraft from Oxnard, California). Of these 42.6 hours were flown on-effort covering 4,010 nmi. A total of 86% of this (36.5 h and 3,434 nmi) were conducted in 'good' weather conditions between 6 August and 12 Sept 2002 (Table 2). Surveys were attempted only under favorable weather conditions (light winds and little cloud cover) 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 surveys coverage achieved was fairly complete in most of the 11 regions (Figure 2). Off northern Washington, permit conditions to avoid impacts on eagles and cormorants prevented flights early in the survey period and poor weather prevented most flights later in the survey period. Coverage of that area was therefore the most incomplete of all the regions surveyed. This region will be one of the areas targeted for coverage in 2003.

Sightings

A total of 1,696 sightings of 4,765 animals were made both on and off effort. These represented 5 baleen whale species, 4 delphinid species, 2 porpoise species, 5 pinniped species, and 2 otters. Sightings of harbor porpoise (607 sightings of 935 animals) and harbor seals (806 sightings of 2,823 animals) together accounted for 83% 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 a larger number of large whales in 2002 compared to past surveys. These included blue whales, fin whales, humpback whales, killer whales, minke whales, and gray whales (Table 2, Figure 6)). Sightings of blue and fin whales were made off southern Oregon in 2002. A large concentration of gray whales was seen repeatedly near Cape Blanco and Port Orford Reef. Killer whales were seen in the Strait of Juan de Fuca as well as one sighting off Oregon.

A total of 606 sightings of 934 harbor porpoise were made during the surveys, with 560 sightings of 867 animals made on-effort (Table 2). Group sizes of harbor porpoise ranged from one to seven with single animals occurring 57% of the time and paired animals in 35% of the sightings (Table 4). 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.

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

ACKNOWLEDGMENTS

Pat Obrien and Barry Hansen of Aspen Helicopters Inc., Oxnard CA, piloted the aircraft (Rick Throckmorton made contract and logistical arrangements). Steve Osmek, Tom Norris, Annie Douglas, Joe Evenson, and Steve Jeffries were observers on flights (Stephanie Norman and Jen Quan made themselves available if needed as alternates). Jim Cubbage, Cascadia Research Collective, developed the Data Acquisition System used on the surveys. Permits for aspects of the flights were provided by the Olympic Coast National Marine Sanctuary (Mary-Sue Brancato), U.S. Fish and Wildlife Service (Kevin Ryan), and National Park Service (Larry Nickey). John Ford, Department of Fisheries and Oceans assisted with arrangements for flights in Canada. Jeff Laake designed the survey transects and served as COTR for this study. Funding for these surveys was provided by the National Marine Mammal Laboratory of the Alaska Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington.

REFERENCES

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling. Oxford University Press, Oxford. 432pp.

Calambokidis, J., J.R. Evenson, J.C. Cubbage, P.J. Gearin, and S.D. Osmek. 1992. Harbor porpoise distribution and abundance estimate off Washington from aerial surveys in 1991. Report to the National Marine Mammal Laboratory, National Marine Fisheries Service, Seattle. 44pp.

Calambokidis, J., J.C. Cubbage, J.R. Evenson, S.D. Osmek, J.L. Laake, P.J. Gearin, B.J. Turnock, S.J. Jeffries, and R.F. Brown. 1993. Abundance estimates of harbor porpoise in Washington and Oregon waters. Report to the National Marine Mammal Laboratory, National Marine Fisheries Service, Seattle, Washington. 55pp.

Calambokidis, J., J.L. Laake, and S.D. Osmek. 1997. Aerial surveys for marine mammals in Washington and British Columbia inside waters. Final report to the National Marine Mammal Laboratory, Seattle, WA 98115.

Cooke, J.G. 1985 Notes on the estimation of whale density from line transects. Report of the International Whaling Commission 35:319-324

Laake, J.L., J. Calambokidis, S.D. Osmek, and D.J. Rugh. 1997a. Probability of detecting harbor porpoise from aerial surveys: Estimating g(0). Journal of Wildlife Management 61:63-75.

Laake, J., R.L. DeLong, J. Calambokidis and S. Osmek. 1997b. Abundance and distribution of marine mammals in Washington and British Columbia inside waters, 1996. Pages 67-73 in Marine Mammal Protection Act and Endangered Species Act Implementation Program 1996. AFSC Processed Report 97-10. National Marine Fisheries Service, Seattle, WA.

Laake, J., J. Calambokidis and S. Osmek. 1998. Survey report for the 1997 aerial surveys for harbor porpoise and other marine mammals of Oregon, Washington and British Columbia outside waters. Pages 77-97 in Marine Mammal Protection Act and Endangered Species Act Implementation Program 1997. AFSC Processed Report 98-10. National Marine Fisheries Service, Seattle, WA.

Osmek, S., J. Calambokidis, J. Laake, P. Gearin, R. DeLong, J. Scordino, S. Jeffries and R. Brown. 1996. Assessment of the status of harbor porpoise (*Phocoena phocoena*) in Washington and Oregon waters. U.S. Department of Commerce NOAA Technical Memorandum NMFS-AFSC-76.

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 proceeded 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 proceeded 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

Figures

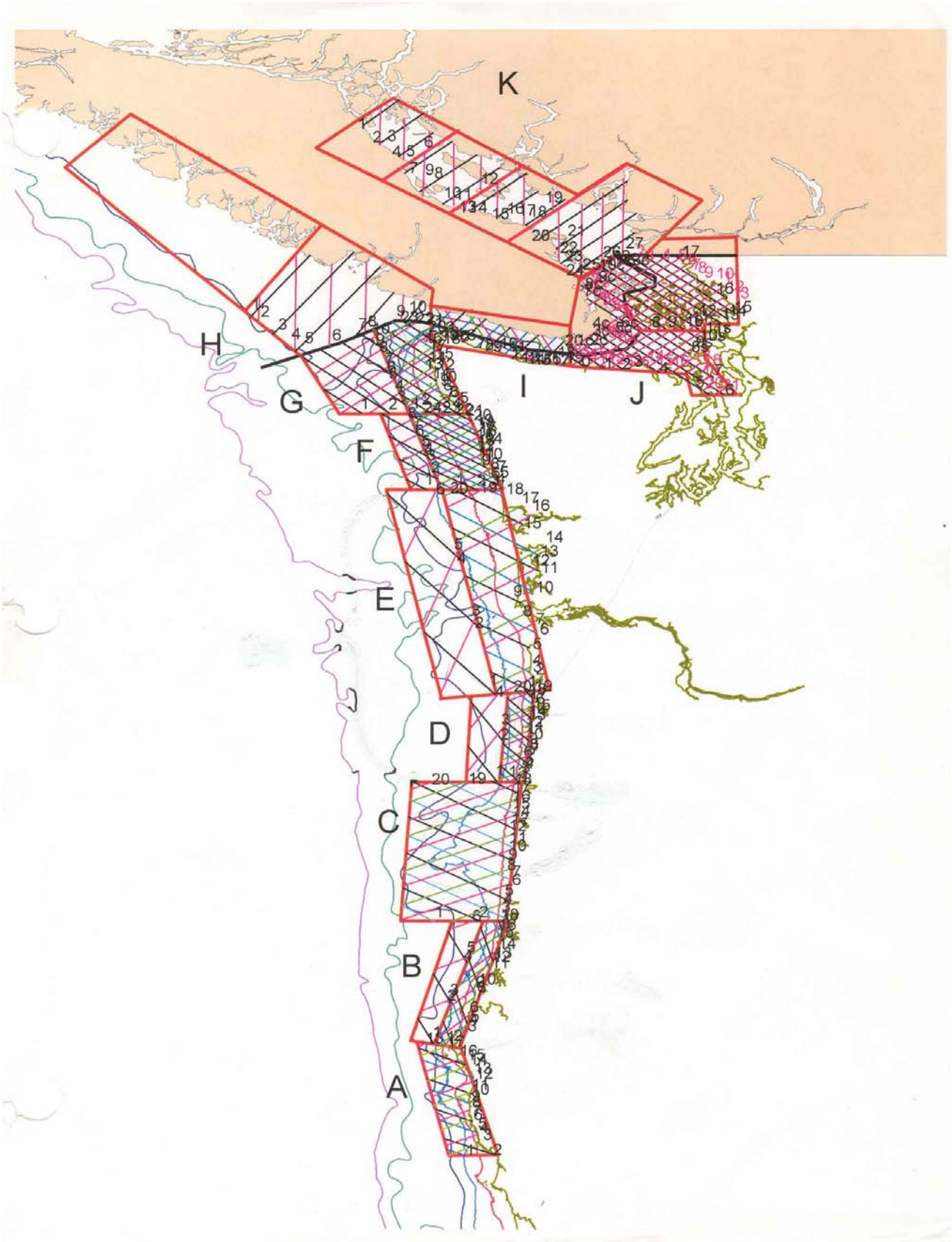

Figure 1. Study regions and planned survey lines for 2002 effort.

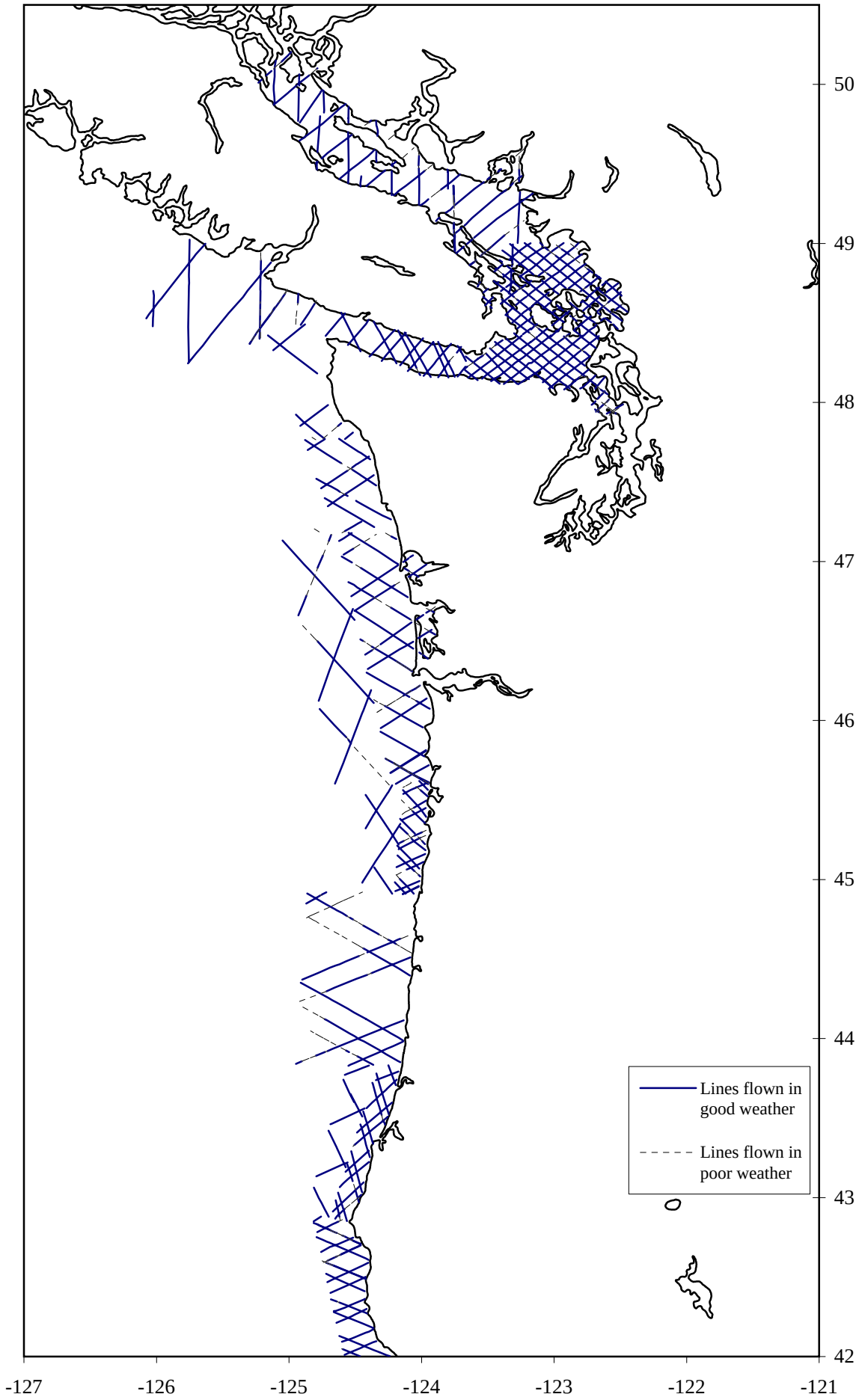

Figure 2. Transect lines completed in 2002 in good weather (Beaufort 0-2, Cloud cover <51%) and in poor weather

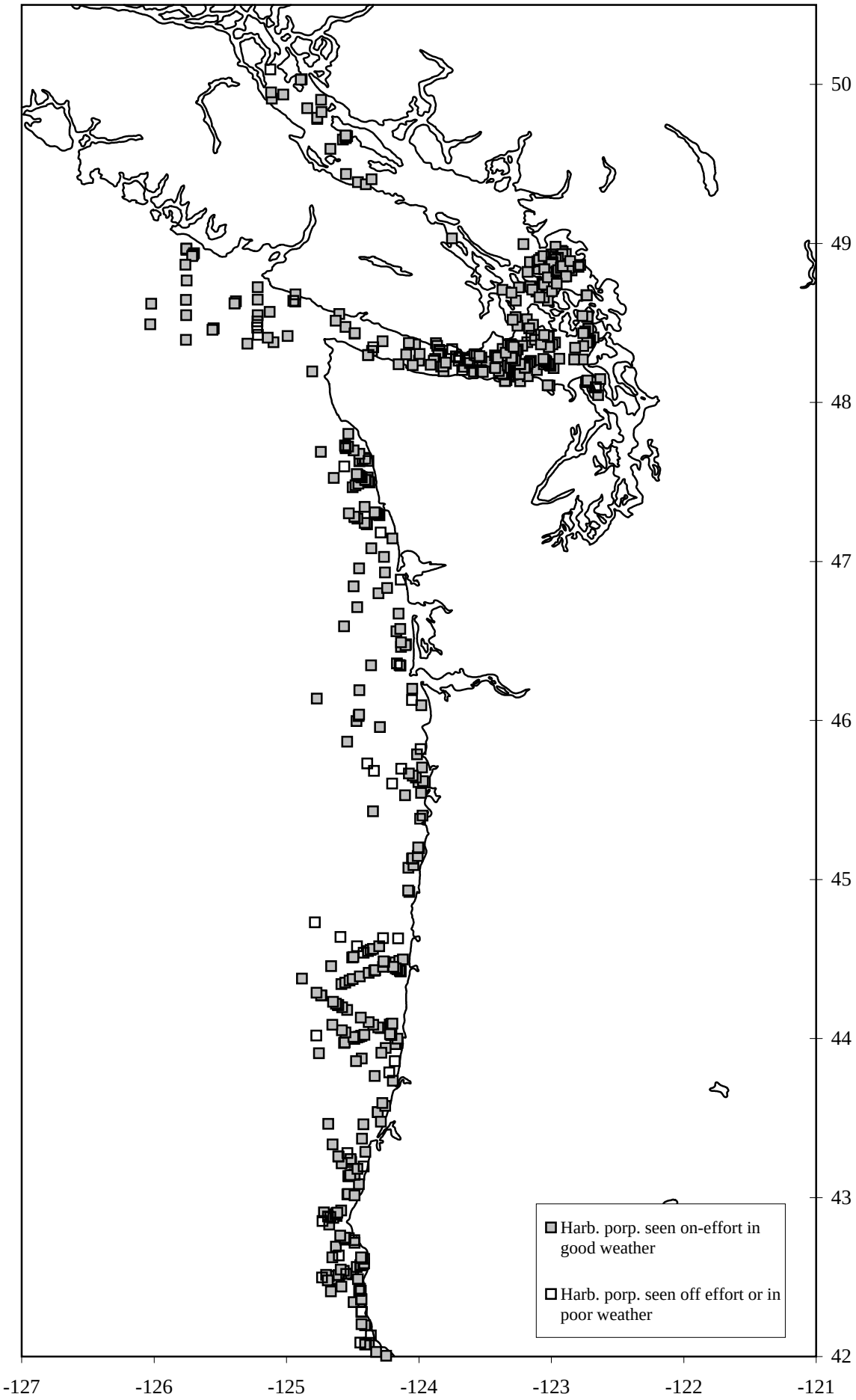

Figure 3. Locations of harbor porpoise sightings in 2002 aerial surveys.

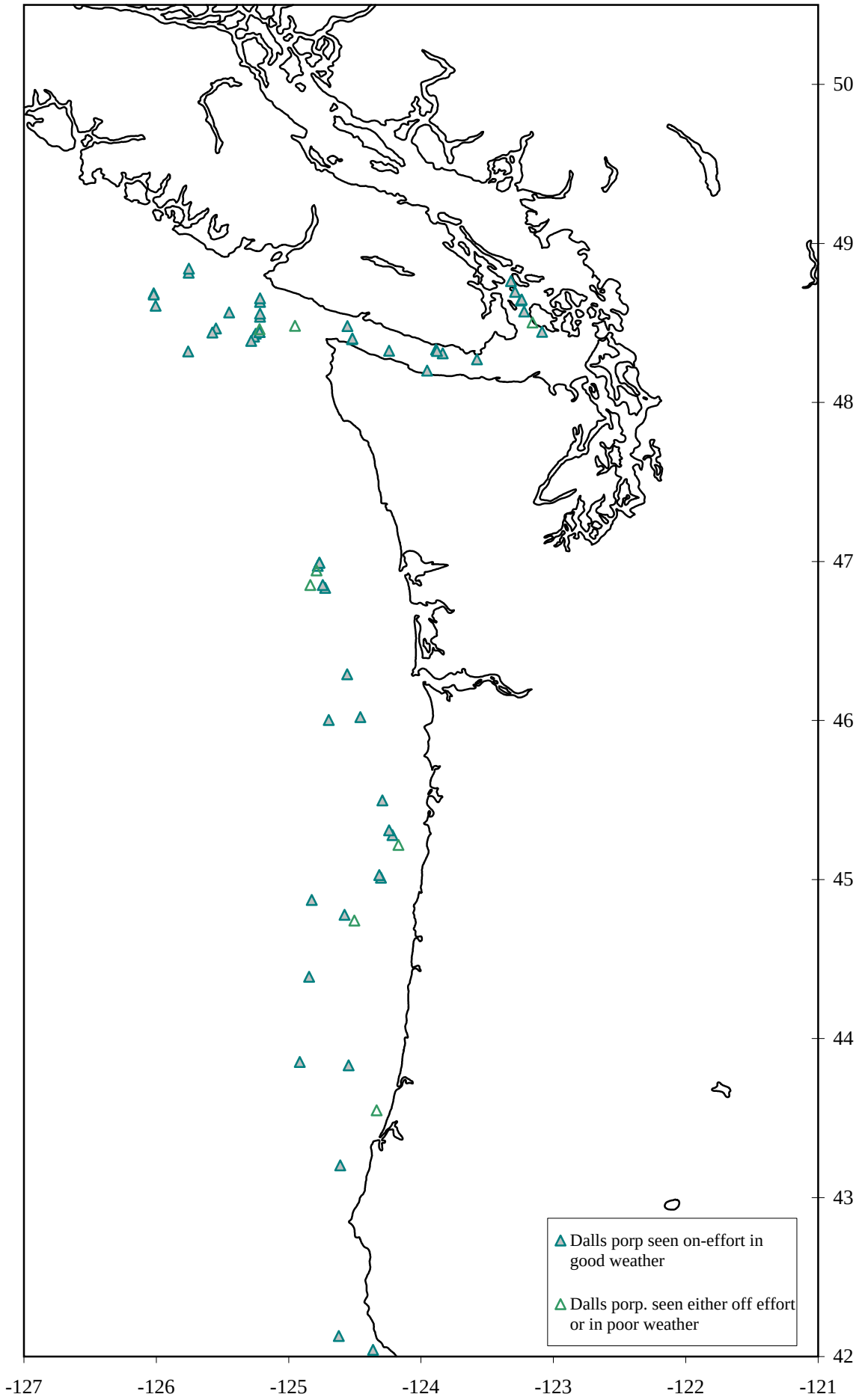

Figure 4. Dall's porpoise locations during 2002 surveys.

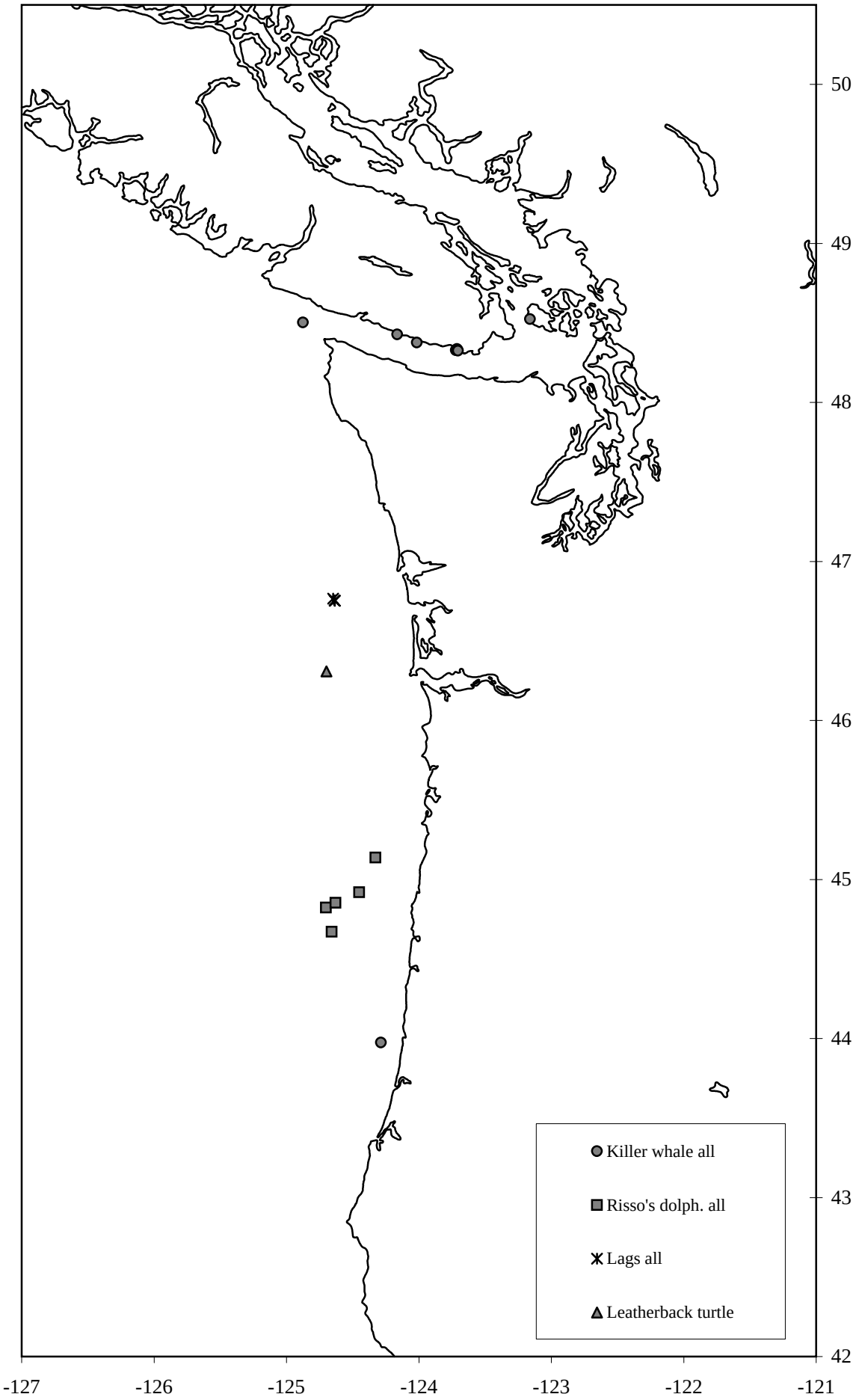

Figure 5. Sightings of delphinids and leatherback turtle in 2002 surveys (all effort and weather).

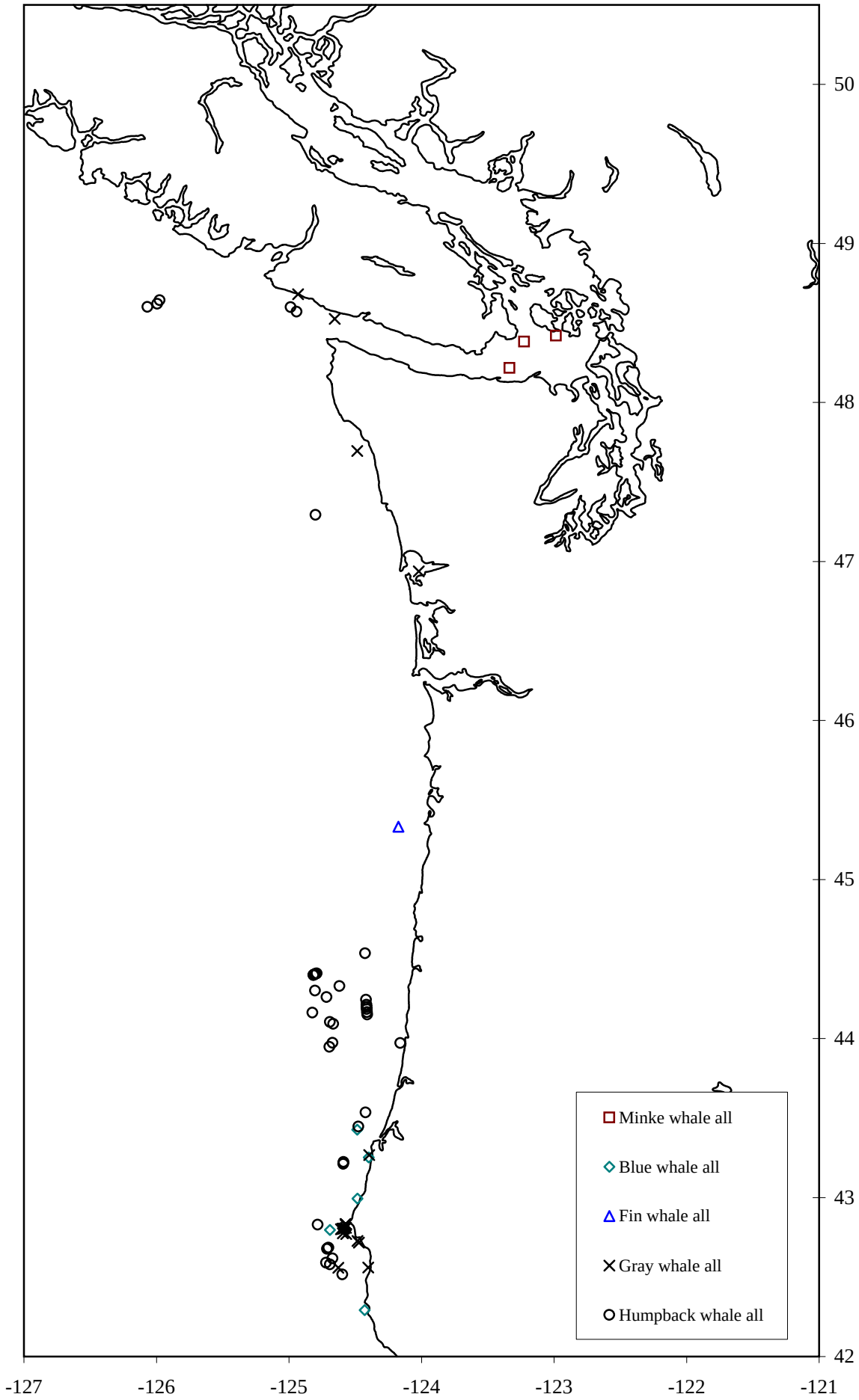

Figure 6. Sighting locations of baleen whales during 2002 surveys (all effort and weather).

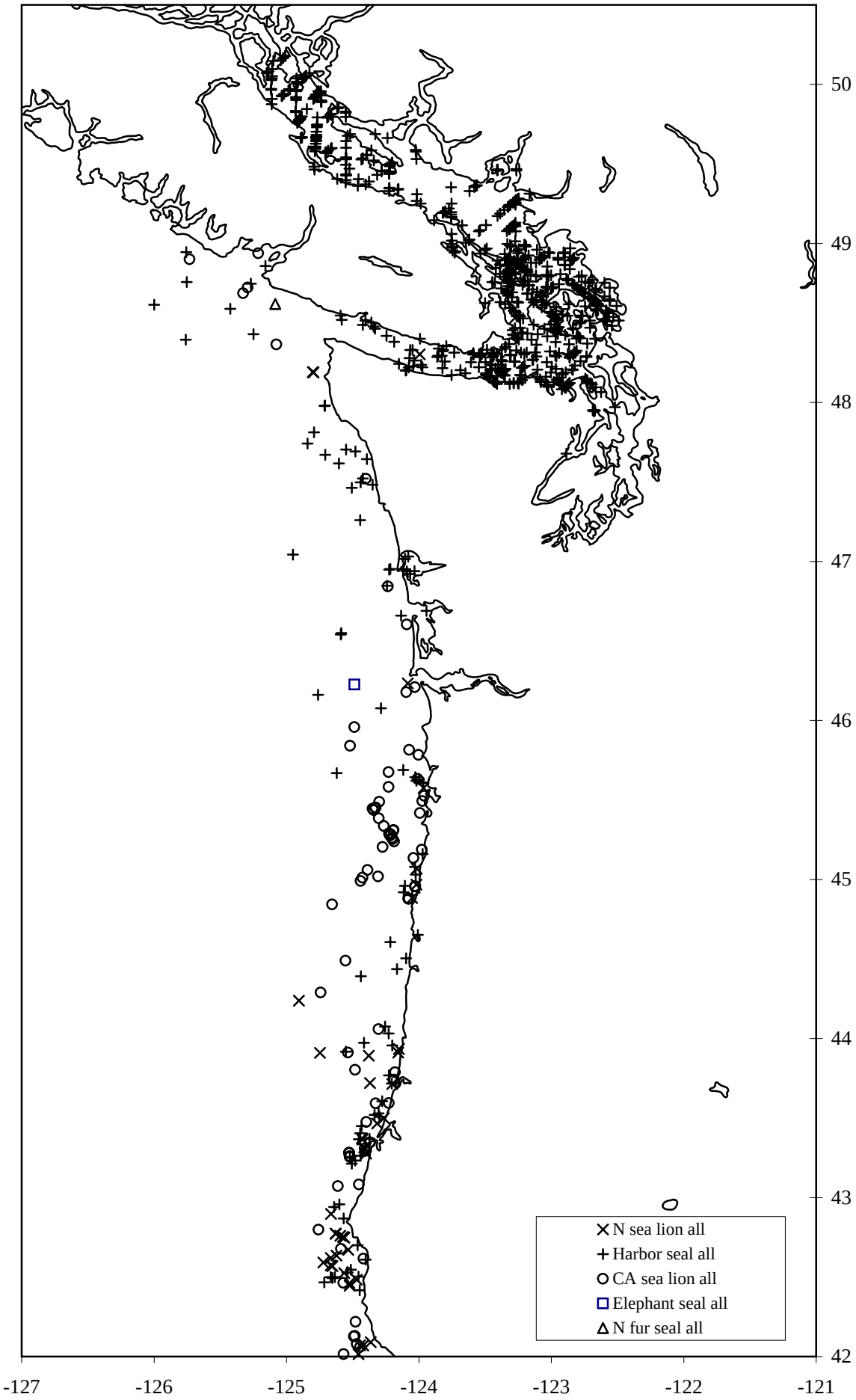

Figure 7. Sighting locations of pinnipeds during 2002 surveys (all effort and weather).

Table 1. Summary of flight times and hours during 2002 surveys.

Date	Take-off	Land	Hours	Description
5-Aug			6.60	Ferry Oxnard to Olympia
6-Aug	1020	1110	0.83	Transit to Seaside
6-Aug	1304	1702	3.96	Survey Route 13 in good conditions
7-Aug	0830	0936	1.10	Transit to P.A.
7-Aug	1036	1153	1.20	Transit to Strait of Georgia and back to P.A.
7-Aug	1341	1630	2.82	Start surveying route 24, abort 3.5 lines, transit back to Oly
8-Aug	0906	1347	4.68	Survey Route 10 and 15 in good conditions
8-Aug	1452	1630	1.63	Check conditions at route 14, transit back to Oly
9-Aug	0806	0848	0.70	Check conditions at route 14, set down in Astoria
9-Aug	1422	1501	0.65	Transit Astoria to Oly
12-Aug	0837	1241	4.06	Transit Oly to Strait of Juan de Fuca, complete survey 30
12-Aug	1416	1803	3.78	Complete Route 31
13-Aug	0825	0934	1.15	Transit P.A. to Southern Strait of Georgia to Friday Hbr.
13-Aug	1018	1345	3.45	Complete Route 33 (central San Juans)
13-Aug	1525	1919	3.90	Complete Routes 25 and 26
14-Aug	0843	0937	0.90	Transit back to Olympia
15-Aug	1049	1136	0.78	Transit to Astoria/wait for fog to clear
15-Aug	1312	1334	0.37	Astoria to Astoria (check on cloud cover - abort)
16-Aug	1159	1423	2.40	Survey Route 11 in 75% good conditions
16-Aug	1515	1607	0.87	Try and fly Route 14 - abort (beau. 3)
16-Aug	1641	1720	0.65	Astoria to Olympia (no hotels in Astoria)
20-Aug	1031	1149	1.30	Olympia to Friday Harbor (wait out cloud cover)
20-Aug	1227	1330	1.05	Abort route 29
21-Aug	0848	0916	0.83	Bellingham to Friday Harbor (wait out cloud cover)
21-Aug	1319	1811	5.55	Fly Routes 34 and 35
22-Aug	0838	1155	3.29	Fly Route 32
22-Aug	1359	1822	4.38	Fly Route 27
24-Aug	1008	1111	1.05	Transit Oly to Bellingham to refuel before Flying Route 28
24-Aug	1159	1553	3.90	Survey route 28 in 75-80 percent good conditions
24-Aug	1644	2006	3.28	Survey route 29 (complete 3/4 before getting too dark)
24-Aug	2008	2038	0.50	Drop Joe E off in Redmond - Transit back to Oly
26-Aug	1035	1117	0.70	Transit to Hoquiam - Wait out fog
26-Aug	1245	1829	5.73	Survey Route 19 and 3/4 of 24
27-Aug	0831	1024	1.88	Transit to Route 14 - abort
27-Aug	1050	1253	2.05	Transit to Route 22- abort
3-Sep	0910	1323	4.22	Complete Route 12 and 16
3-Sep	1431	1833	4.03	Complete Route 14
4-Sep	0741	1114	3.55	Transit From Oly / Complete 75% Route 5 (fog)
4-Sep	1216	1537	3.35	Complete 85% Route 3
5-Sep	0753	1018	2.42	Transit from Oly / Abort route 9 due to fog/wind
5-Sep	1050	1403	3.22	Complete 60% Route 4 / Finish Route 5
6-Sep	1433	1805	3.53	Fly Route 7 complete 98% (still need to do line 17)
7-Sep	0833	1312	4.65	Fly Route 1 and 2
7-Sep	1352	1701	3.15	Finish Route 4 and Fly Route 8 (last 1.7 lines beau. 3 and 4)
8-Sep	0823	0940	1.29	Transit Newport to Olympia
12-Sep	1001	1013	0.20	Aborted flight due to smoke in cabin
12-Sep	1055	1256	2.01	Transit from Oly to Rt 21 and back
16-Sep			6.69	Transit back to Oxnard
Total hours on site			110.99	
Total ferry hours (start and e			13.29	
Total hours flown			124.28	
			5.00	Additional billed hours to reach 3h/d minimum

Table 2. Summary of nmi and hours on-effort in good and bad weather in 2002.

	Poor weather		Good weather		All on-effort	
Date	**nmi**	**hrs**	**nmi**	**hrs**	**nmi**	**hrs**
6-Aug	23.2	0.2	184.0	1.9	207.2	2.2
7-Aug	38.4	0.4	20.9	0.2	59.3	0.6
8-Aug	41.3	0.5	171.7	1.9	213.0	2.3
12-Aug	37.8	0.4	389.2	4.0	427.0	4.4
13-Aug	27.4	0.3	318.9	3.4	346.3	3.7
16-Aug	49.0	0.5	79.0	0.8	128.0	1.4
20-Aug	7.9	0.1	12.3	0.1	20.2	0.2
21-Aug	33.6	0.4	242.1	2.6	275.7	2.9
22-Aug	12.2	0.1	285.2	3.0	297.4	3.1
24-Aug	55.3	0.6	246.8	2.6	302.1	3.2
26-Aug	9.1	0.1	314.6	3.4	323.7	3.5
27-Aug	25.2	0.3	64.5	0.7	89.7	1.0
3-Sep	63.4	0.7	316.5	3.4	380.0	4.1
4-Sep			166.2	1.8	166.2	1.8
5-Sep	29.7	0.3	109.7	1.2	139.4	1.5
6-Sep	28.0	0.3	158.6	1.7	186.6	2.0
7-Sep	91.4	1.0	347.6	3.8	439.0	4.7
12-Sep	3.4	0.0	6.3	0.1	9.7	0.1
All days	576.3	6.1	3,434.0	36.5	4,010.3	42.6

Table 3. Summary of sightings both on and off effort in 2002 surveys.

	Off effort		On effort				Total	
			Poor weather		Good weather			
Species	**Sight.**	**No.**	**Sight.**	**No.**	**Sight.**	**No.**	**Sight.**	**No.**
Baleen whales								
Minke whale	1	1			1	1	2	2
Blue whale	3	3			2	3	5	6
Fin whale					2	4	2	4
Gray whle	15	18			3	3	18	21
Humpback whale	14	29	6	11	20	59	40	99
Unidentified whale	1	3	1	2	1	1	3	6
Delphinids								
Risso's dolphin			4	98	1	130	5	228
Northern right whale dolphins					3	107	3	107
Killer whale	3	66			6	32	9	98
Porpoise								
Dall's porpoise	4	13	5	12	55	118	64	143
Harbor porpoise	46	67	25	32	536	836	607	935
Pinnipeds								
Harbor seal	23	572	51	62	732	2189	806	2823
California sea lion	3	4	5	6	72	165	80	175
Northern fur seal					1	1	1	1
Northern sea lion	8	13	6	13	30	83	44	109
Elephant seal					1	1	1	1
Unidentfiied otariid					1	1	1	1
Undidentified pinniped					2	2	2	2
Otters and turtles								
Sea otter					1	2	1	2
River otter					1	1	1	1
Leatherback turtle					1	1	1	1
Total	121	789	103	236	1472	3740	1696	4765

Table 4. Summary of group sizes of sightings on-effort in good weather.

	Group size											
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10-99**	**>99**	**All**
Baleen whales												
Minke whale	1											1
Blue whale	1	1										2
Fin whale	1		1									2
Gray whle	3											3
Humpback whale	11	7		1						1		20
Unidentified whale	1											1
Delphinids												
Risso's dolphin											1	1
Northern right whale dolphins		1			1						1	3
Killer whale	3	1	1							1		6
Porpoise												
Dall's porpoise	22	20	7	1	2	1	1	1				55
Harbor porpoise	300	191	34	7	1	2	1					536
Pinnipeds												
Harbor seal	652	45	7	3	2	1	2			17	3	732
California sea lion	52	6	2	1	4	3				4		72
Northern fur seal	1											1
Northern sea lion	21	2	2	2	1				1	1		30
Elephant seal	1											1
Unidentfiied otariid	1											1
Undidentified porpoise	2											2
Otters and turtles												
Sea otter		1										1
River otter	1											1
Leatherback turtle	1											1
Total	1075	275	54	15	11	7	4	1	1	24	5	1472