

APPENDIX A

**AERIAL SURVEY FLIGHT CAPTIONS, SURVEY TRACKS, AND
SIGHTING SUMMARIES, 1987**



CONTENTS

| | Page |
|--|------|
| INTRODUCTION | A-1 |
| METHODS | A-7 |
| RESULTS | |
| Table A-1. Summary of daily flight effort and endangered whale abundance (WPUE) in the Alaskan Beaufort and eastern Chukchi Seas, 1987 | A-4 |
| Table A-2. Semi-monthly summary of all marine mammal sightings by species, 1987 | A-6 |
| Flight Captions, Survey Tracks and Sighting Summaries | A-8 |
| SEPTEMBER | |
| 1-15: Flights 1 to 11 | A-8 |
| 16-30: Flights 12 to 21 | A-30 |
| OCTOBER | |
| 1-15: Flights 22 to 30 | A-50 |
| 16-31: Flights 31 to 41 | A-68 |



INTRODUCTION

This appendix consists of flight tracks 1 through 41, depicting aerial surveys flown over the eastern Chukchi and Alaskan Beaufort Seas in September and October 1987. Each flight is represented by a survey track, with all marine mammal sightings plotted, and a caption describing the flight's objectives, survey conditions and sightings. Each symbol on the flight track/sighting charts represents one sighting of one or more animals. Additionally, summary information on bowhead and gray whale sightings is presented beneath the flight caption in the tabularized format:

| | | | |
|----------|--|-----------------|----------------|
| T#/C# | Total number of whales/total number of calves seen | | |
| LAT/LONG | Location (latitude N/longitude W) in degrees, minutes, and tenths of minutes | | |
| DIS | Perpendicular distance from the aircraft in meters (altitude x cotangent clinometer angle) | | |
| CUE | Sighting cue: | | |
| | BO = Body | MP = Mud Plumes | |
| | BW = Blow | DY = Display | |
| | SP = Splash | | |
| BEH | Behavior: | | |
| | SW = Swim | DY = Display | SH = Spyhop |
| | DI = Dive | MT = Mate | TS = Tail-Slap |
| | RE = Rest | FE = Feed | BR = Breach |
| | MI = Mill | CC = Cow-Calf | RL = Roll |
| | UB = Underwater Blow | DE = Dead | NA = None |
| HDG | Heading in magnetic degrees | | |
| ICE | Ice cover in percent | | |
| SS | Sea State (Beaufort scale) | | |
| DEPTH | Depth in meters | | |

Dashes (-) indicate data were not recorded.



A daily summary of flight effort and endangered whale WPUE (table A-1) and a semimonthly summary of all marine mammal sightings (table A-2) are provided as an overview of survey effort and sighting data for the 1987 field season. Species abbreviations used in flight track keys are listed in table A-2.

Eleven surveys (see *, table A-1) were conducted in part, or wholly, east of 154°W in the Alaskan Beaufort Sea. All data east of 154°W are summarized in Treacy (in prep.).

Table A-1. Summary of daily flight effort and endangered whale abundance (WPUE) in the Alaskan Beaufort and eastern Chukchi Seas, 1987.

| Date | Flt. No. | Sea | Transect Length (km) | Connect Length (km) | Search Length (km) | Total Length (km) | Time on Transect (hr:min) | Total Time (hr:min) | WPUE (whales/hr) |
|---------|----------|----------|----------------------|---------------------|--------------------|-------------------|---------------------------|---------------------|------------------|
| 1 Sept | 1 | Bering | 0 | 0 | 181 | 181 | 0:00 | 0:44 | - |
| | | Chukchi | 213 | 22 | 883 | 1118 | 0:50 | 4:25 | 4.08 (GW) |
| 2 Sept | 2 | Beaufort | 532 | 94 | 99 | 725 | 2:04 | 2:53 | - |
| 4 Sept | 3 | Chukchi | 913 | 76 | 231 | 1220 | 3:48 | 5:02 | 0.99 (GW) |
| 5 Sept | 4 | Chukchi | 484 | 68 | 214 | 766 | 1:56 | 3:10 | 1.89 (GW) |
| 6 Sept | 5* | Beaufort | 650 | 100 | 387 | 1137 | 2:31 | 4:21 | - |
| 7 Sept | 6 | Chukchi | 100 | 23 | 374 | 497 | 0:24 | 2:05 | 2.40 (GW) |
| | | Beaufort | 306 | 70 | 44 | 420 | 1:12 | 1:41 | - |
| 8 Sept | 7 | Chukchi | 316 | 50 | 616 | 982 | 1:15 | 3:52 | 0.52 (GW) |
| 9 Sept | 8 | Chukchi | 691 | 92 | 122 | 905 | 2:53 | 3:50 | 7.31 (GW) |
| 10 Sept | 9 | Chukchi | 150 | 16 | 440 | 606 | 0:34 | 2:26 | 1.23 (GW) |
| | | Beaufort | 90 | 0 | 168 | 258 | 0:19 | 1:03 | 0 |
| 12 Sept | 10 | Chukchi | 537 | 91 | 344 | 972 | 2:07 | 3:55 | 0.51 (GW) |
| | | Beaufort | 0 | 0 | 13 | 13 | 0:00 | 0:04 | 0 |
| 14 Sept | 11 | Beaufort | 482 | 63 | 102 | 647 | 1:51 | 2:35 | 0 |
| 18 Sept | 12 | Chukchi | 971 | 136 | 450 | 1557 | 3:51 | 6:11 | 0 |
| 19 Sept | 13 | Chukchi | 661 | 87 | 587 | 1335 | 2:37 | 5:34 | 0.72 (GW) |
| 21 Sept | 14 | Chukchi | 629 | 72 | 127 | 828 | 2:39 | 3:31 | 0.28 (BH) |
| | | Beaufort | 0 | 0 | 15 | 15 | 0:00 | 0:04 | 0.85 (GW) |
| 22 Sept | 15* | Beaufort | 546 | 113 | 225 | 884 | 2:14 | 3:37 | 0 |
| 25 Sept | 16 | Beaufort | 528 | 75 | 135 | 738 | 2:10 | 3:04 | 0 |
| 26 Sept | 17 | Beaufort | 101 | 18 | 121 | 240 | 0:25 | 0:57 | 0 |
| 27 Sept | 18 | Chukchi | 483 | 53 | 79 | 615 | 1:59 | 2:34 | 0.39 (GW) |
| | | Beaufort | 436 | 80 | 126 | 642 | 1:52 | 2:47 | 0.39 (CT) |
| 28 Sept | 19 | Chukchi | 1102 | 123 | 296 | 1521 | 4:18 | 5:58 | 0.36 (BH) |
| | | Beaufort | 0 | 0 | 27 | 27 | 0:00 | 0:11 | 0.17 (GW) |
| 29 Sept | 20 | Chukchi | 526 | 90 | 886 | 1502 | 2:12 | 6:22 | 1.57 (GW) |
| | | Beaufort | 0 | 0 | 25 | 25 | 0:00 | 0:07 | 0 |
| 30 Sept | 21* | Chukchi | 222 | 34 | 45 | 301 | 0:52 | 1:12 | 3.33 (GW) |
| | | Beaufort | 477 | 76 | 234 | 787 | 2:01 | 3:19 | 0.60 (BH) |

*Indicate surveys in which part or all of flight was conducted east of 154°W; all data east of 154°W is summarized in Treacy (in prep.).

Table A-1 (contd).

| Date | Flt. No. | Sea | Transect Length (km) | Connect Length (km) | Search Length (km) | Total Length (km) | Time on Transect (hr:min) | Total Time (hr:min) | WPUE (whales/hr) |
|----------------|----------|----------|----------------------|---------------------|--------------------|-------------------|---------------------------|---------------------|------------------|
| 1 Oct | 22 | Chukchi | 112 | 51 | 333 | 496 | 0:28 | 2:02 | 0.49 (GW) |
| | | Beaufort | 0 | 0 | 26 | 26 | 0:00 | 0:07 | 0 |
| 3 Oct | 23 | Beaufort | 663 | 82 | 185 | 930 | 2:49 | 3:58 | 0 |
| 5 Oct | 24* | Beaufort | 534 | 116 | 363 | 1013 | 2:10 | 4:22 | 0.46 (BH) |
| 6 Oct | 25* | Chukchi | 54 | 0 | 46 | 100 | 0:13 | 0:26 | 0 |
| | | Beaufort | 0 | 0 | 336 | 336 | 0:00 | 1:58 | 12.76 (BH) |
| 8 Oct | 26 | Chukchi | 945 | 68 | 159 | 1172 | 3:55 | 4:58 | 1.81 (GW) |
| | | Beaufort | 0 | 0 | 19 | 19 | 0:00 | 0:05 | 0 |
| 10 Oct | 27 | Beaufort | 439 | 76 | 127 | 642 | 1:46 | 2:40 | 0 |
| 11 Oct | 28 | Chukchi | 439 | 85 | 335 | 859 | 1:50 | 3:33 | 0 |
| | | Beaufort | 0 | 0 | 15 | 15 | | 0:04 | 0 |
| 12 Oct | 29 | Beaufort | 49 | 0 | 225 | 274 | 0:11 | 1:01 | 0 |
| 15 Oct | 30 | Chukchi | 247 | 12 | 189 | 448 | 0:58 | 1:47 | 5.06 (GW) |
| | | Beaufort | 0 | 0 | 20 | 20 | 0:00 | 0:07 | 0 |
| 16 Oct | 31 | Chukchi | 445 | 60 | 65 | 570 | 1:53 | 2:23 | 0.42 (BH) |
| | | | | | | | | | 2.93 (GW) |
| | | | | | | | | | 0.84 (CT) |
| | | Beaufort | 527 | 107 | 115 | 749 | 2:07 | 3:02 | 1.32 (BH) |
| 17 Oct | 32 | Chukchi | 342 | 53 | 104 | 499 | 1:17 | 2:04 | 0.49 (BH) |
| | | | | | | | | | 0.49 (CT) |
| | | Beaufort | 560 | 93 | 113 | 766 | 2:15 | 3:07 | 0 |
| 19 Oct | 33 | Chukchi | 0 | 0 | 126 | 126 | 0:00 | 0:28 | 0 |
| | | Beaufort | 50 | 0 | 260 | 310 | 0:13 | 1:16 | 0 |
| 20 Oct | 34 | Chukchi | 554 | 105 | 360 | 1019 | 2:20 | 4:19 | 0.46 (CT) |
| 21 Oct | 35 | Chukchi | 300 | 21 | 49 | 370 | 1:14 | 1:29 | 0 |
| | | Beaufort | 447 | 95 | 90 | 632 | 1:49 | 2:37 | 0 |
| 23 Oct | 36* | Beaufort | 625 | 120 | 134 | 879 | 2:33 | 3:36 | 0.28 (BH) |
| 25 Oct | 37* | Beaufort | 445 | 90 | 760 | 1295 | 1:52 | 5:12 | 0.19 (BH) |
| 28 Oct | 38* | Beaufort | 389 | 109 | 580 | 1078 | 1:31 | 4:18 | 0.23 (BH) |
| 29 Oct | 39* | Beaufort | 477 | 61 | 639 | 1177 | 2:02 | 4:42 | 0 |
| 30 Oct | 40* | Beaufort | 526 | 156 | 196 | 878 | 2:07 | 3:30 | 0.29 (BH) |
| 31 Oct | 41* | Beaufort | 339 | 113 | 406 | 858 | 1:21 | 3:18 | 0 |
| Total Bering | | | 0 | 0 | 181 | 181 | 0 | 0:44 | 0 |
| Total Chukchi | | | 11436 | 1488 | 7460 | 20384 | 46:32 | 83:36 | 0.04 (BH) |
| | | | | | | | | | 1.41 (GW) |
| Total Beaufort | | | 10218 | 1907 | 6330 | 18455 | 41:29 | 75:43 | 0.50 (BH) |
| TOTAL | | | 21654 | 3395 | 13971 | 39020 | 88:01 | 160:03 | |

Table A-2. Semimonthly summary of all marine mammal sightings* by species, 1987.

| Species | Abbr* | September | | October | | Total |
|--|-------|-----------|---------|---------|-------|---------|
| | | 1-15 | 16-30 | 1-15 | 16-31 | |
| Bowhead Whale (<u>Balaena mysticetus</u>) | BH | 0/0 | 4/4 | 17/27 | 10/10 | 31/41 |
| Gray Whale (<u>Eschrichtius robustus</u>) | GW | 28/69 | 12/23 | 8/19 | 5/7 | 53/118 |
| Belukha (<u>Delphinapterus leucas</u>) | BE | 20/147 | 18/67 | 5/13 | 7/45 | 50/272 |
| Unidentified Cetacean | CT | 0/0 | 1/1 | 0/0 | 5/5 | 6/6 |
| Walrus (<u>Odobenus rosmarus</u>) | WS | 39/1046 | 40/1149 | 1/30 | 0/0 | 80/2225 |
| Bearded Seal (<u>Erignathus barbatus</u>) | BS | 7/7 | 8/8 | 5/5 | 0/0 | 20/20 |
| Ringed Seal (<u>Phoca hispida</u>) | RS | 2/3 | 2/2 | 2/3 | 0/0 | 6/8 |
| Unidentified Pinniped | PN | 15/15 | 34/38 | 36/43 | 13/21 | 98/117 |
| Polar Bear (<u>Ursus maritimus</u>) | PR | 0/0 | 0/0 | 3/5 | 0/0 | 3/5 |

*The figures shown for each month represent the number of sightings/the number of individuals sighted during that period.

**Abbreviations are those used in flight track legends.

D = Dead

METHODS

Maps were prepared using a series of computer programs consisting of BASIC subroutines implemented on a Hewlett-Packard (HP 85) microcomputer connected to an HP 7470A printer/plotter. The coastlines for each map, digitized on an HP 9111A graphics tablet, were formatted to examine the principal study areas (i.e., the eastern Chukchi Sea and the western Alaskan Beaufort Sea). As a result, a comparison of flight tracks for a given study area can be made on a visual basis over the period of the field season to evaluate ongoing patterns of the animal distribution and aircraft coverage. Each map shows the flight track as a line drawn through position updates recorded on the aircraft computer system. Each animal sighting is marked with a species symbol on the flight track plot. Additional information on survey conditions and sightings provided by the computer log is summarized in the flight captions.

FLIGHT CAPTIONS, SURVEY TRACKS, AND SIGHTINGS SUMMARY

Flight 1: 1 September 1987

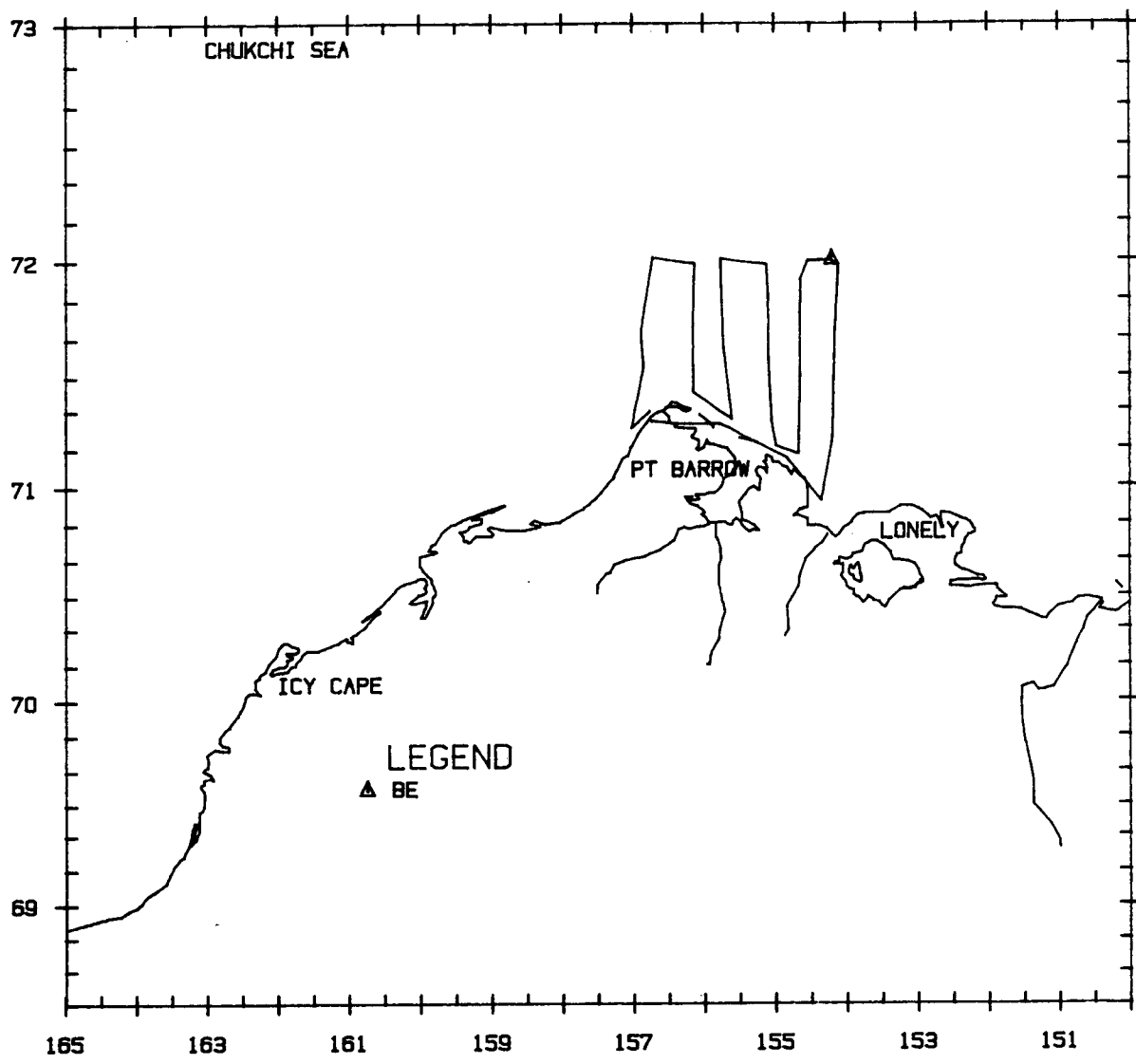
Flight was a coastal search survey from Nome to Barrow with a transect survey of the southern two legs in block 22. Weather was overcast with areas of patchy fog. Visibility ranged from less than 1 km to unlimited. Sea state ranged from Beaufort 01 to 04 and averaged 02; there was no ice. Eighteen gray whales, including one cow-calf pair, and walrus were seen.

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 15/0 | 68°17.7' | 166°44.0' | 357 | BO | FE | - | 0 | B1 | 18 |
| 1/0 | 68°16.7' | 166°38.0' | - | BO | SW | - | 0 | B1 | 18 |
| 2/1 | 68°18.7' | 166°29.7' | - | BO | SW | 230 | 0 | B1 | 18 |

Flight 2: 2 September 1987

Flight was a transect survey of block 12. Weather was overcast with unlimited visibility. There was no ice except along the northernmost border of the block, where cover was 10 to 15 percent broken floe. Sea state varied from Beaufort 01 to 02 in areas with ice, and 02 to 03 in ice-free areas. One belukha was seen.

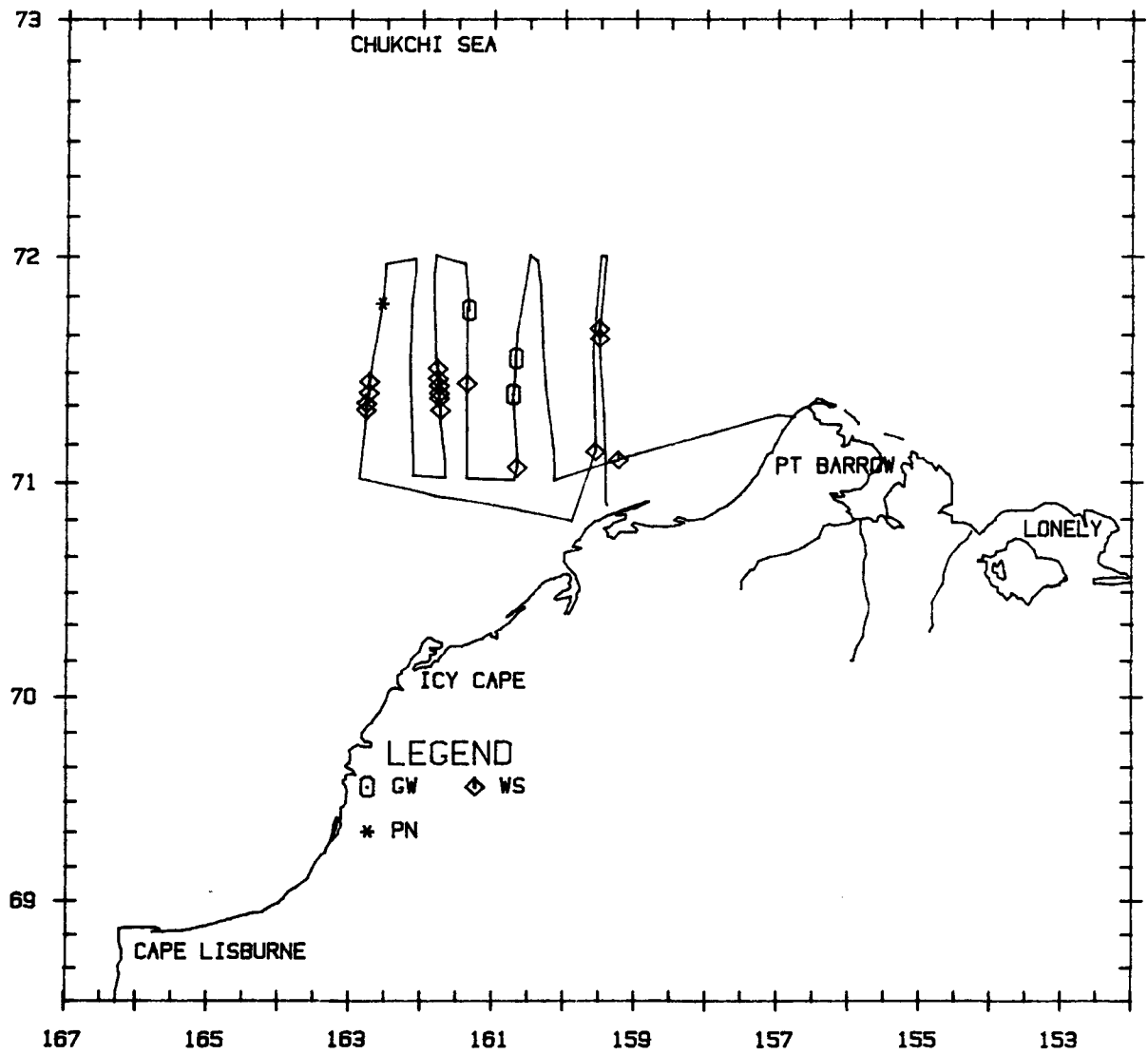


Flight 3: 4 September 1987

Flight was a transect survey block of 14 and the westernmost two lines in block 13. Weather was low overcast and visibility ranged from unacceptable to unlimited. Ice cover was 20 to 95 percent, and 20 to 50 percent in the northern half of blocks 14 and 13 respectively. Sea state ranged from Beaufort 00 to 03. Gray whales, walrus, and an unidentified pinniped were seen.

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 2/0 | 71°34.0' | 160°41.3' | - | MP | FE | - | 10 | B1 | 49 |
| 1/0 | 71°23.1' | 160°43.8' | - | MP | DI | - | 5 | B1 | 49 |
| 2/0 | 71°46.6' | 161°21.3' | - | MP | DI | - | 1 | B2 | 33 |

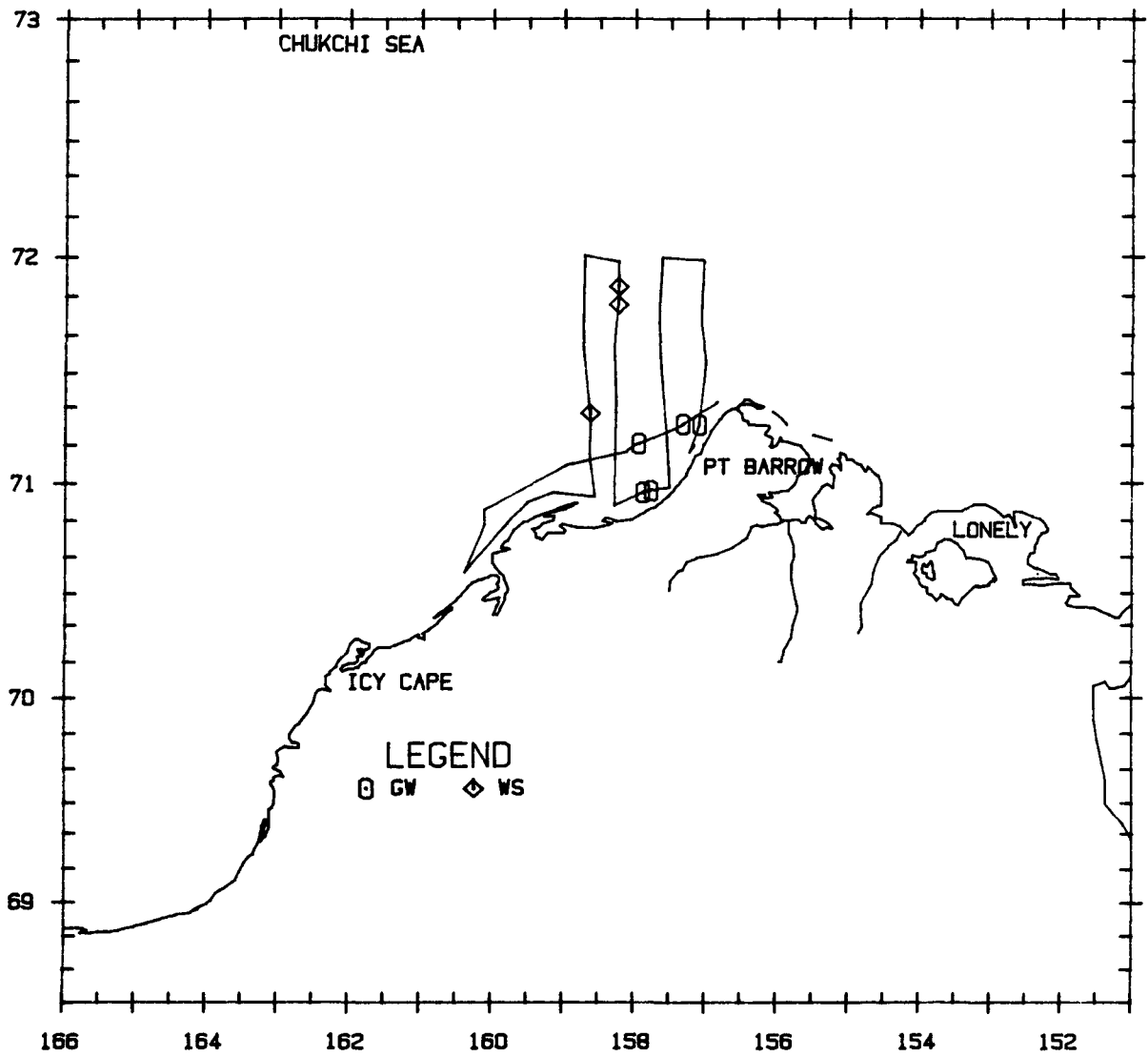


Flight 4: 5 September 1987

Flight was a transect survey of the eastern two-thirds of block 13. Weather was mostly cloudy with unlimited visibility, although fog and snow squalls limited visibility in nearshore areas. There was open water in the southern half of the block, with 10 to 25 percent broken floe cover in the northern half. Sea state varied from Beaufort 01 to 03. Gray whales and walrus were seen.

Gray Whales

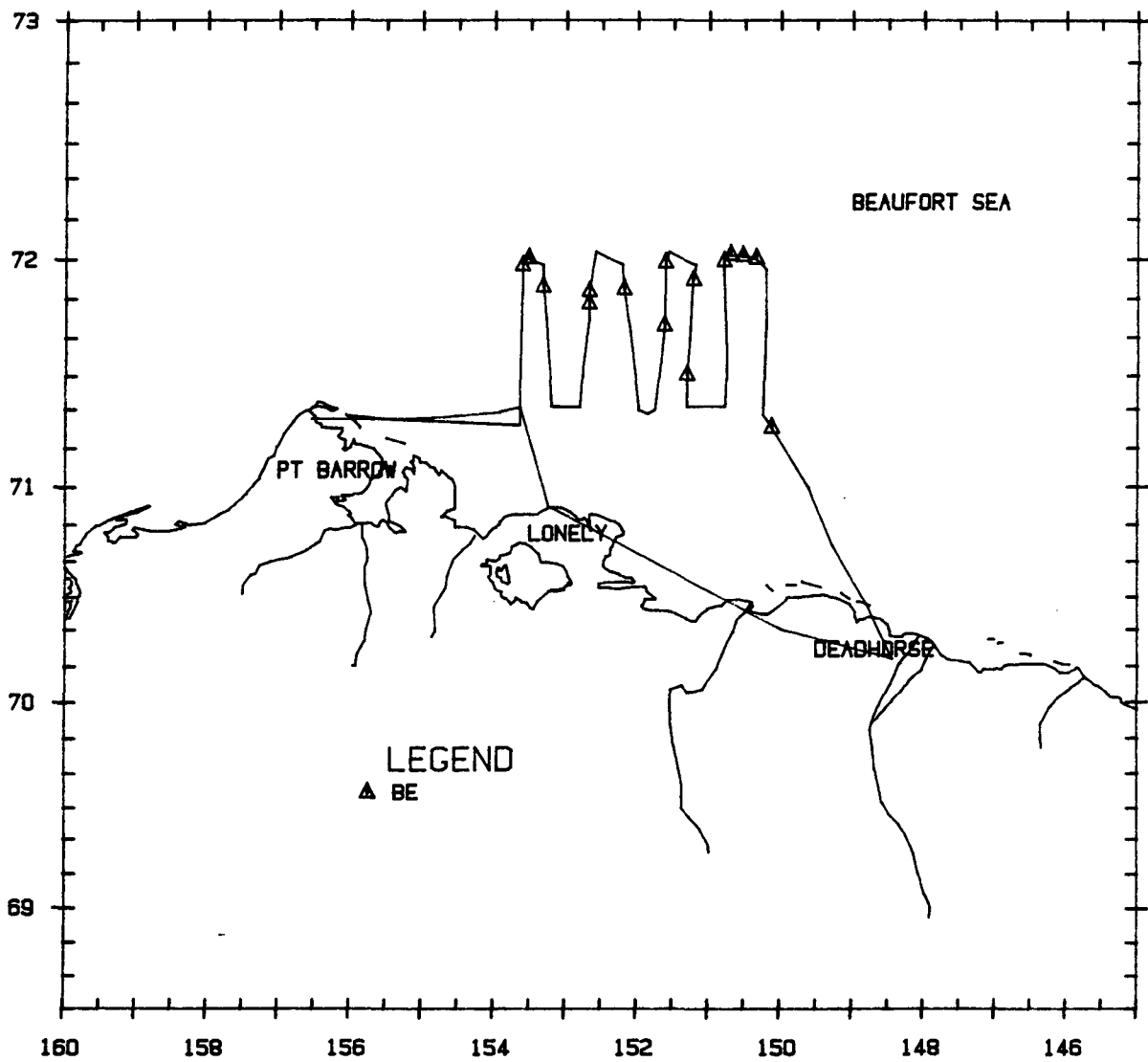
| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°15.5' | 157°05.3' | 546 | MP | FE | - | 0 | B2 | 35 |
| 2/0 | 70°58.2' | 157°46.5' | - | MP | FE | - | 0 | B2 | 18 |
| 1/0 | 70°57.7' | 157°53.3' | - | MP | FE | - | 0 | B2 | 18 |
| 1/0 | 71°10.6' | 157°56.7' | 517 | MP | FE | - | 0 | B4 | 42 |
| 1/0 | 71°15.7' | 157°19.3' | - | MP | FE | - | 0 | B4 | 35 |



Flight 5: 6 September 1987*

Flight was a transect survey of block 11. Weather was high overcast and visibility was unlimited. Ice cover in the northern one-third of the block ranged from 10 to 50 percent. Sea state ranged from Beaufort 00 to 02. Belukhas were the only marine mammals seen.

*Data east of 154°W presented in Treacy (in prep.).

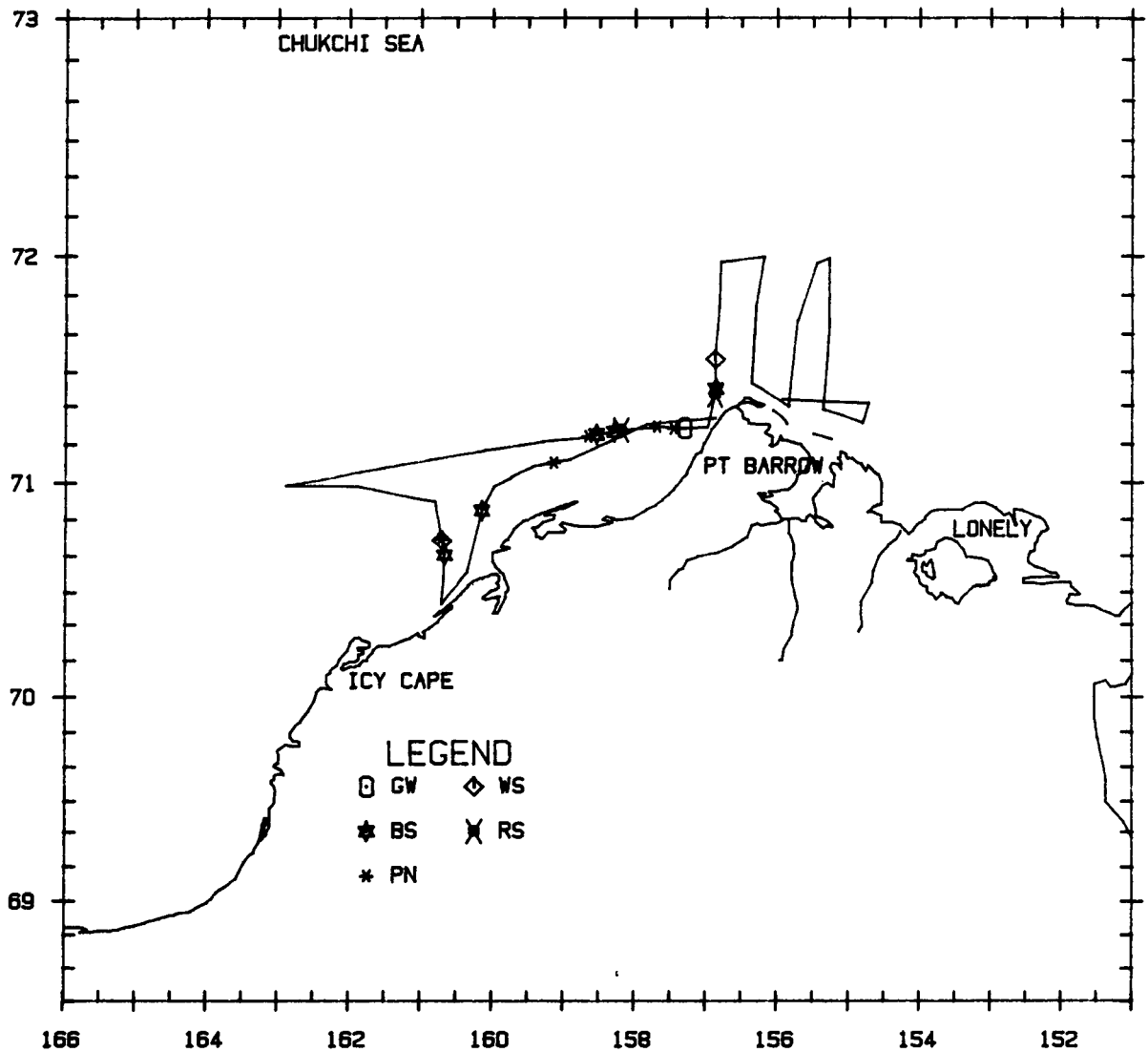


Flight 6: 7 September 1987

Flight was an attempted survey of block 17 which was aborted due to low fog, and a transect survey of the western two-thirds of block 12. Weather in block 12 was mostly overcast with unlimited visibility, although low-lying fog reduced visibility to less than 1 kilometer in the northern part of the block. There was open water from shore to 71°45'N, and 10 to 30 percent broken floe ice north of there. Sea state was Beaufort 01 to 02. Gray whales, walrus, bearded seals, ringed seals, and unidentified pinnipeds were seen.

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 5/0 | 71°14.3' | 157°17.9' | 587 | MP | FE | - | 0 | B2 | 18 |

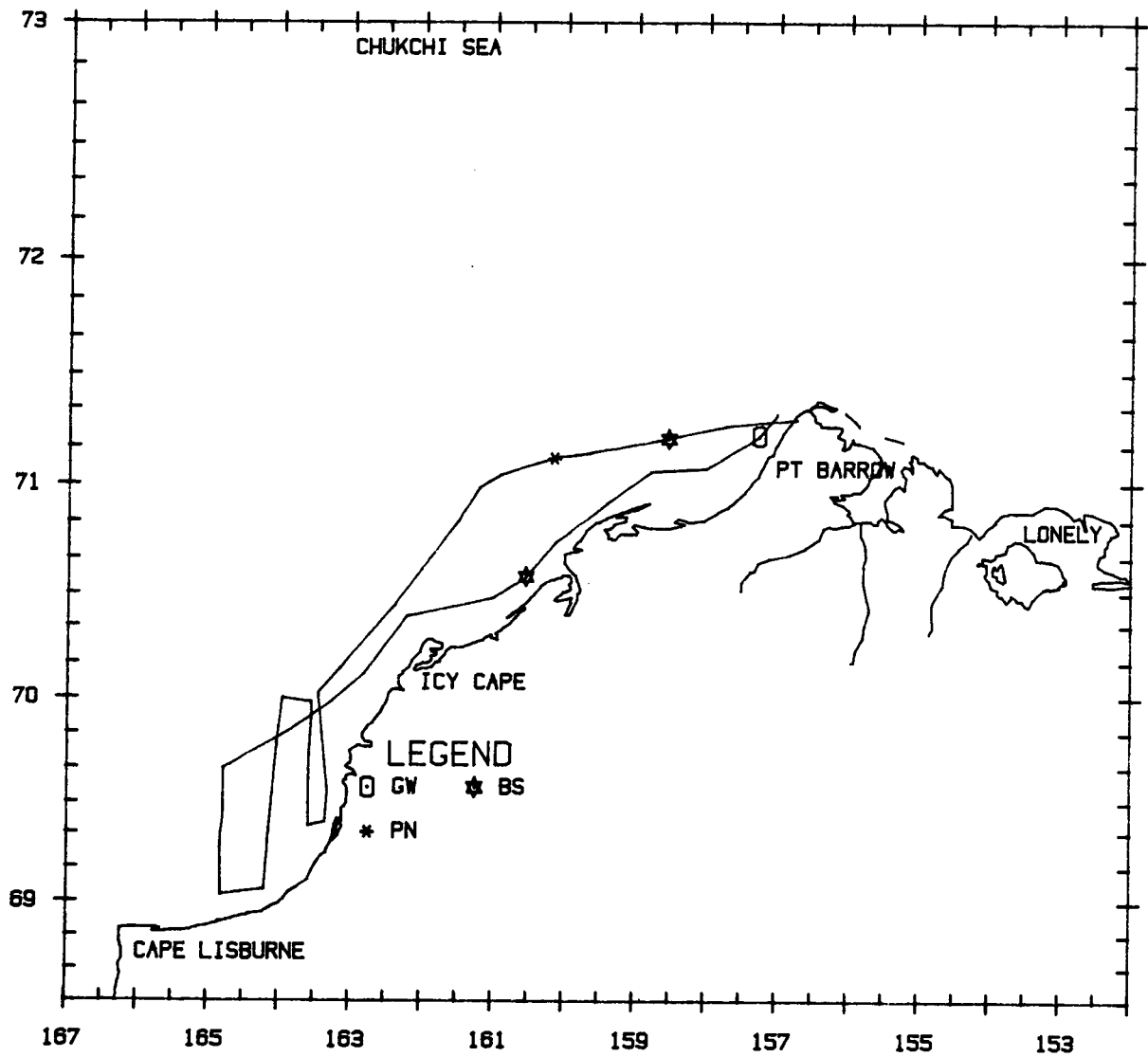


Flight 7: 8 September 1987

Flight was a transect survey of the eastern half of block 20, with a search survey to and from the block. Weather was low overcast and visibility ranged from less than 1 to 10 km. Sea state ranged from Beaufort 01 to 04. Gray whales, bearded seals, and an unidentified pinniped were seen.

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 2/0 | 71°13.0' | 157°16.0' | - | BO | FE | - | 0 | B3 | 18 |

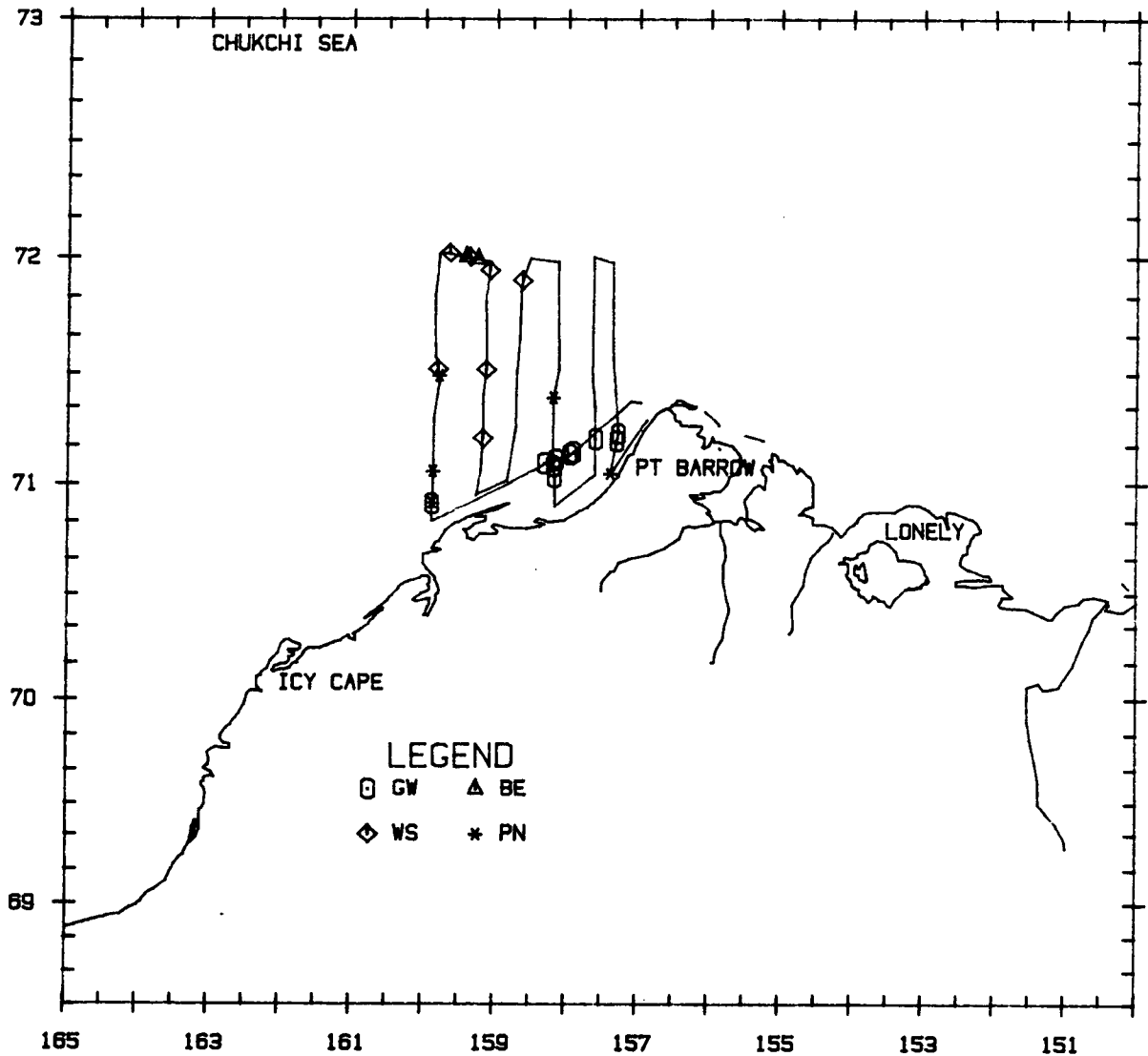


Flight 8: 9 September 1987

Flight was a transect survey of block 13. Weather was overcast with unlimited visibility. There was no ice in the southern half of the block, with 10 to 30 percent broken floe ice in the northern half. Sea state varied from Beaufort 01 to 02 in areas with ice, and 02 to 03 in open water. Gray whales, belukhas, walruses, and unidentified pinnipeds were seen.

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 71°11.3' | 157°18.3' | 526 | MP | FE | - | 0 | B3 | 18 |
| 1/0 | 71°13.2' | 157°17.1' | 868 | MP | FE | - | 0 | B3 | 18 |
| 2/0 | 71°11.8' | 157°36.4' | 627 | MP | FE | - | 0 | B3 | 38 |
| 3/0 | 71°02.0' | 158°11.0' | 526 | MP | FE | - | 0 | B3 | 20 |
| 4/0 | 71°04.9' | 158°12.0' | 898 | MP | FE | - | 0 | B3 | 20 |
| 1/0 | 70°54.8' | 159°53.5' | 3146 | BW | SW | 180 | 1 | B2 | 26 |
| 5/0 | 71°05.6' | 158°19.1' | - | MP | FE | - | 0 | B2 | 20 |
| 5/0 | 71°06.5' | 158°09.2' | 509 | MP | FE | - | 0 | B2 | 20 |
| 4/0 | 71°07.8' | 157°57.7' | - | MP | FE | - | 0 | B2 | 22 |
| 2/0 | 71°08.4' | 157°54.7' | - | MP | FE | - | 0 | B2 | 22 |

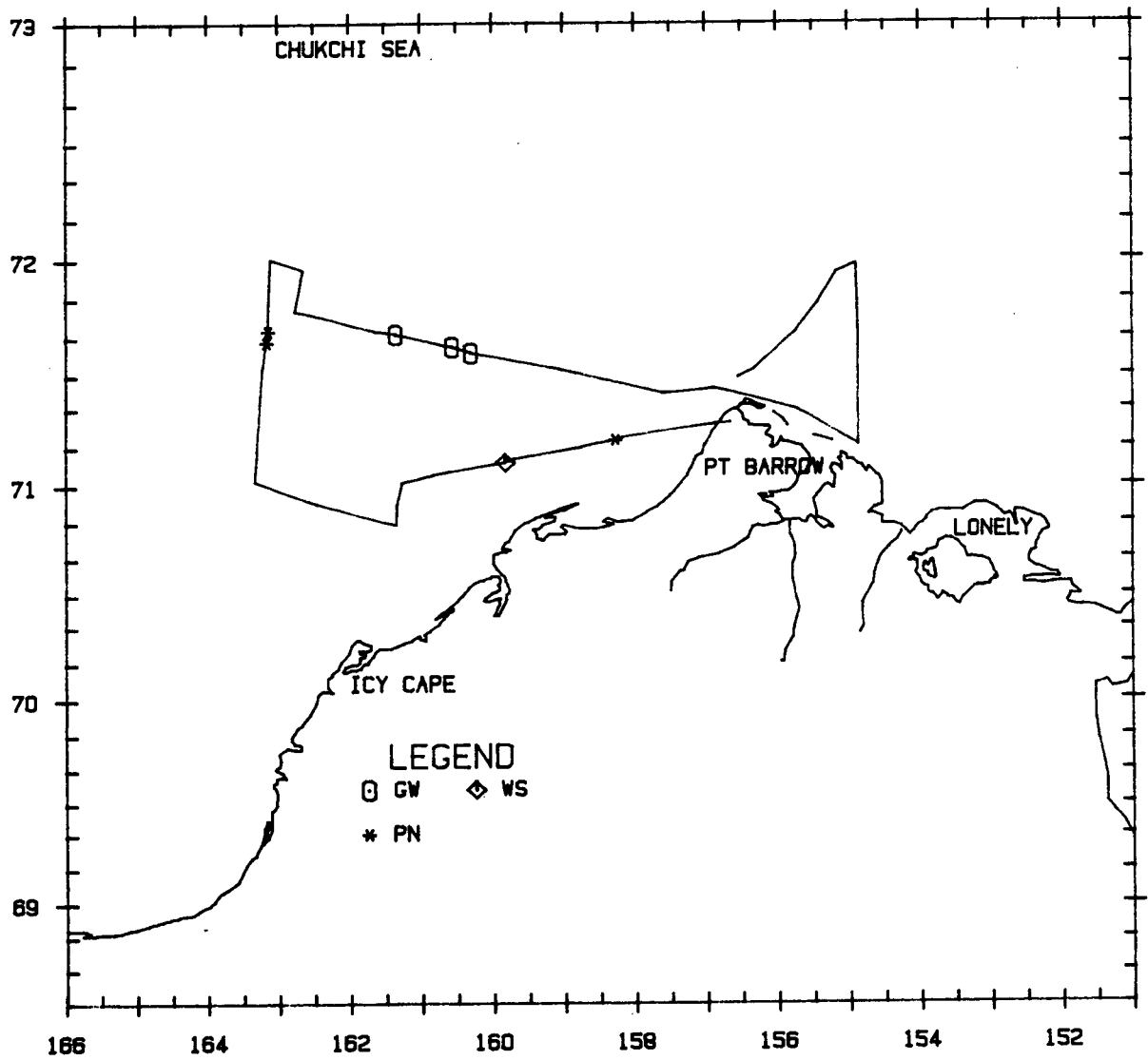


Flight 9: 10 September 1987

Flight was a partial transect survey of blocks 17, 15, 14, and 12. Transect surveys in all blocks were aborted due to low ceilings and high sea states. Ice cover in block 14 ranged from 10 to 60 percent; all other blocks were essentially ice-free. Sea state ranged from Beaufort 02 to 06. Gray whales, walruses, and unidentified pinnipeds were seen.

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°40.9' | 161°21.5' | 457 | MP | FE | - | 30 | B2 | 38 |
| 1/0 | 71°37.5' | 160°34.3' | 412 | MP | FE | - | 40 | B2 | 49 |
| 1/0 | 71°35.9' | 160°18.6' | 442 | BO | FE | - | 40 | B2 | 51 |

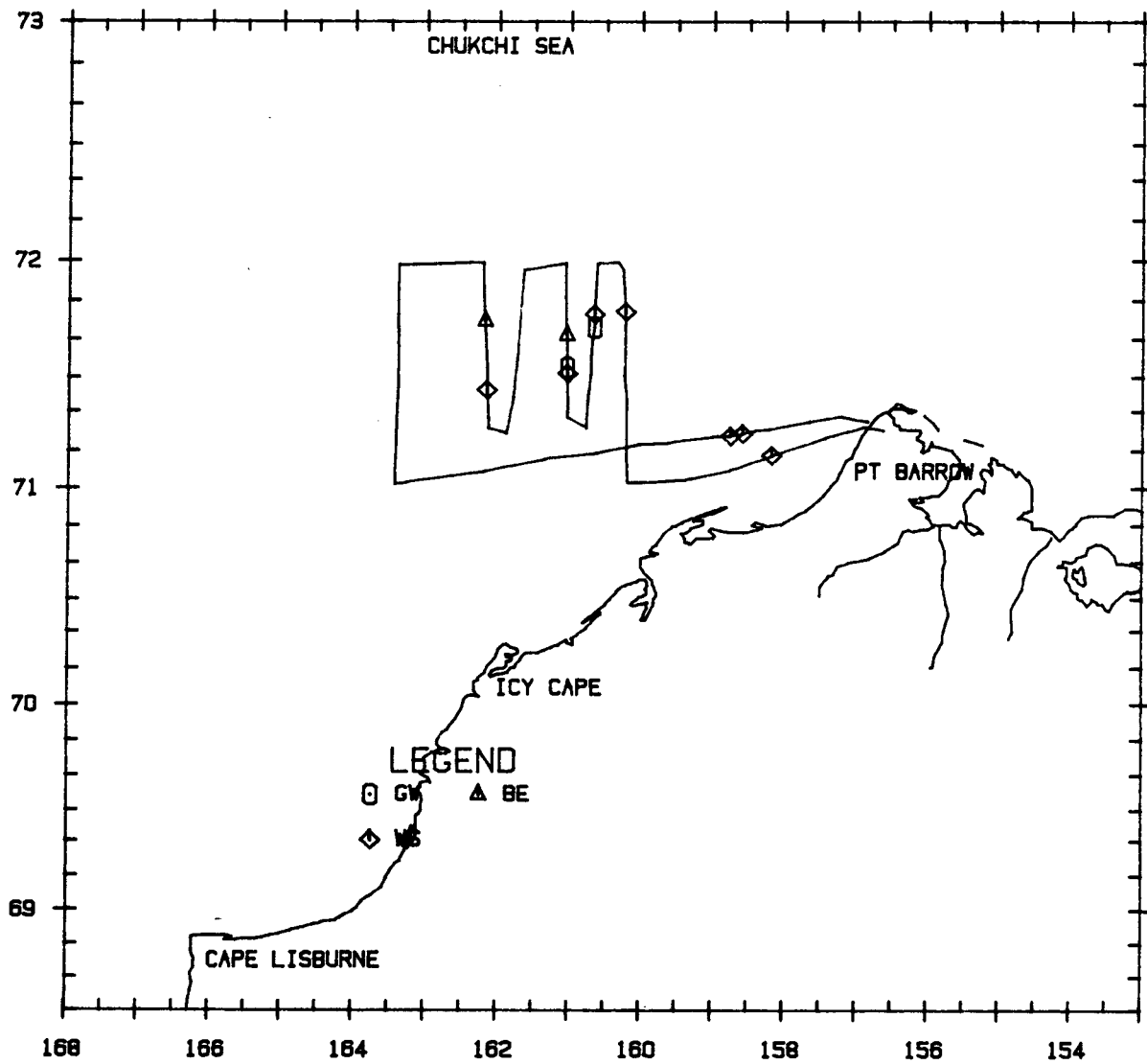


Flight 10: 12 September 1987

Flight was a transect survey of block 14 and the easternmost line in block 15. Weather was overcast with intermittent snow squalls and fog. Visibility varied from less than 1 km to unlimited. Ice cover was 20 percent in the northernmost areas, with open water in all other areas. High winds kept the sea state high, with Beaufort 03 in the ice and 04 to 05 in open water. Gray whales, belukhas, and walrus were seen.

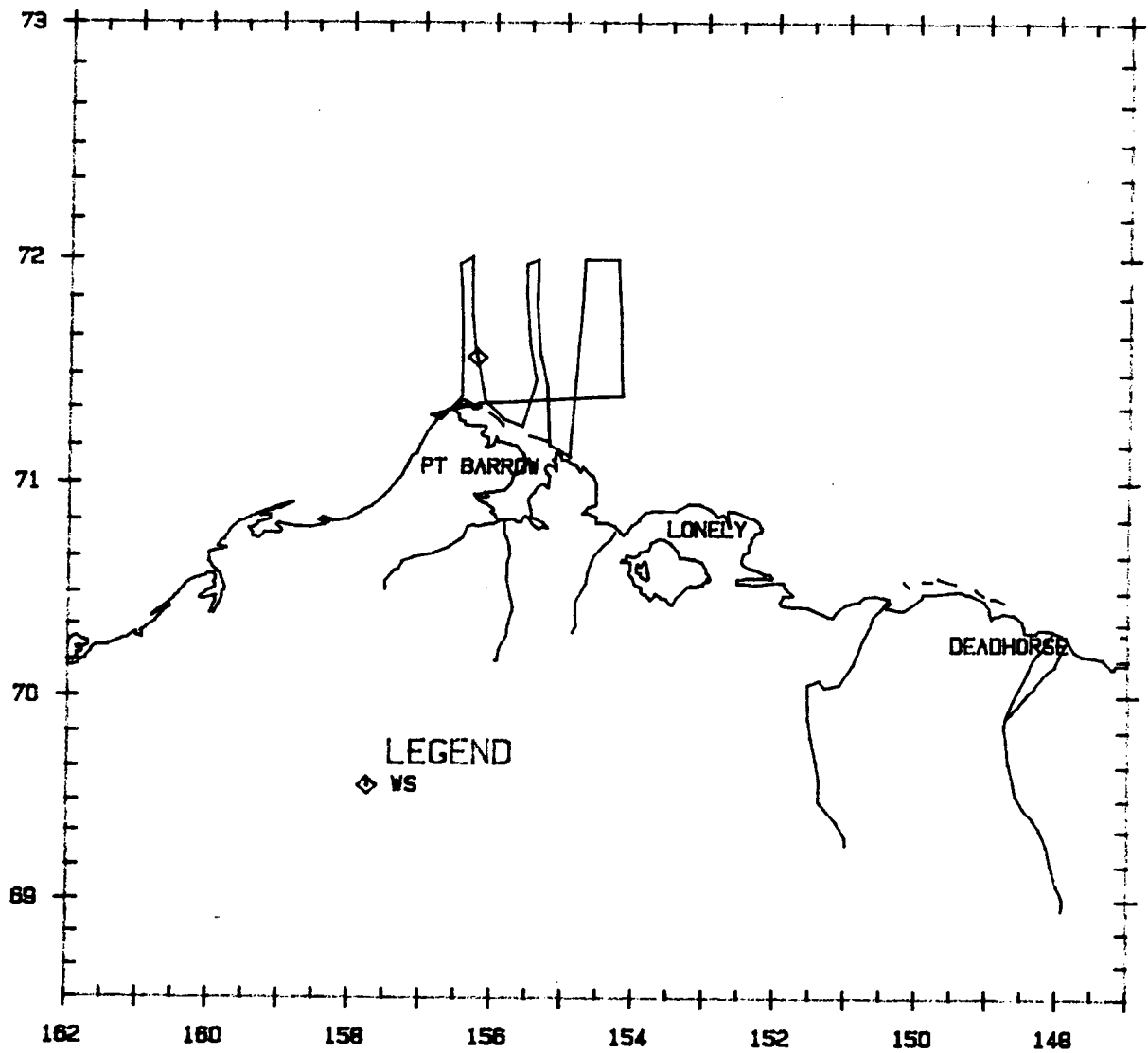
Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°32.6' | 161°02.6' | 566 | MP | FE | - | 55 | B1 | 42 |
| 1/0 | 71°43.0' | 160°39.8' | 474 | MP | FE | - | 60 | B1 | 42 |



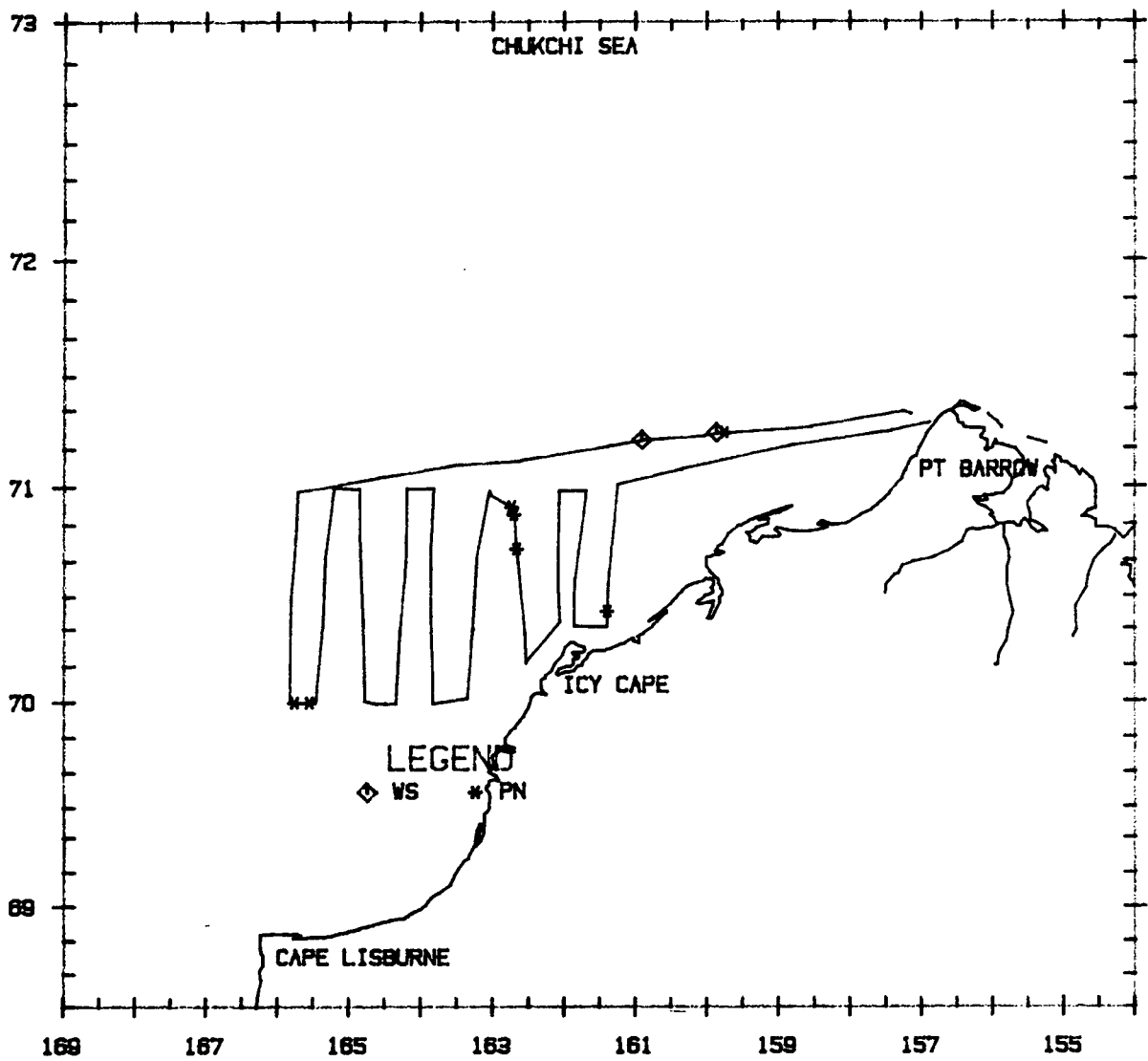
Flight 11: 14 September 1987

Flight was a transect survey of block 12. Weather was overcast with areas of patchy fog. Visibility ranged from less than 1 km to unlimited. Ice cover along the northern border of the block was 1 to 10 percent. Sea state ranged from Beaufort 02 to 05, but averaged 03. Walrus were the only marine mammals seen.



Flight 12: 18 September 1987

Flight was a transect survey of the western two-thirds of block 17 and all of block 18. Weather was mostly clear with high overcast and visibility was unlimited. Sea state was Beaufort 02, and there was no ice. Walruses and unidentified pinnipeds were seen.

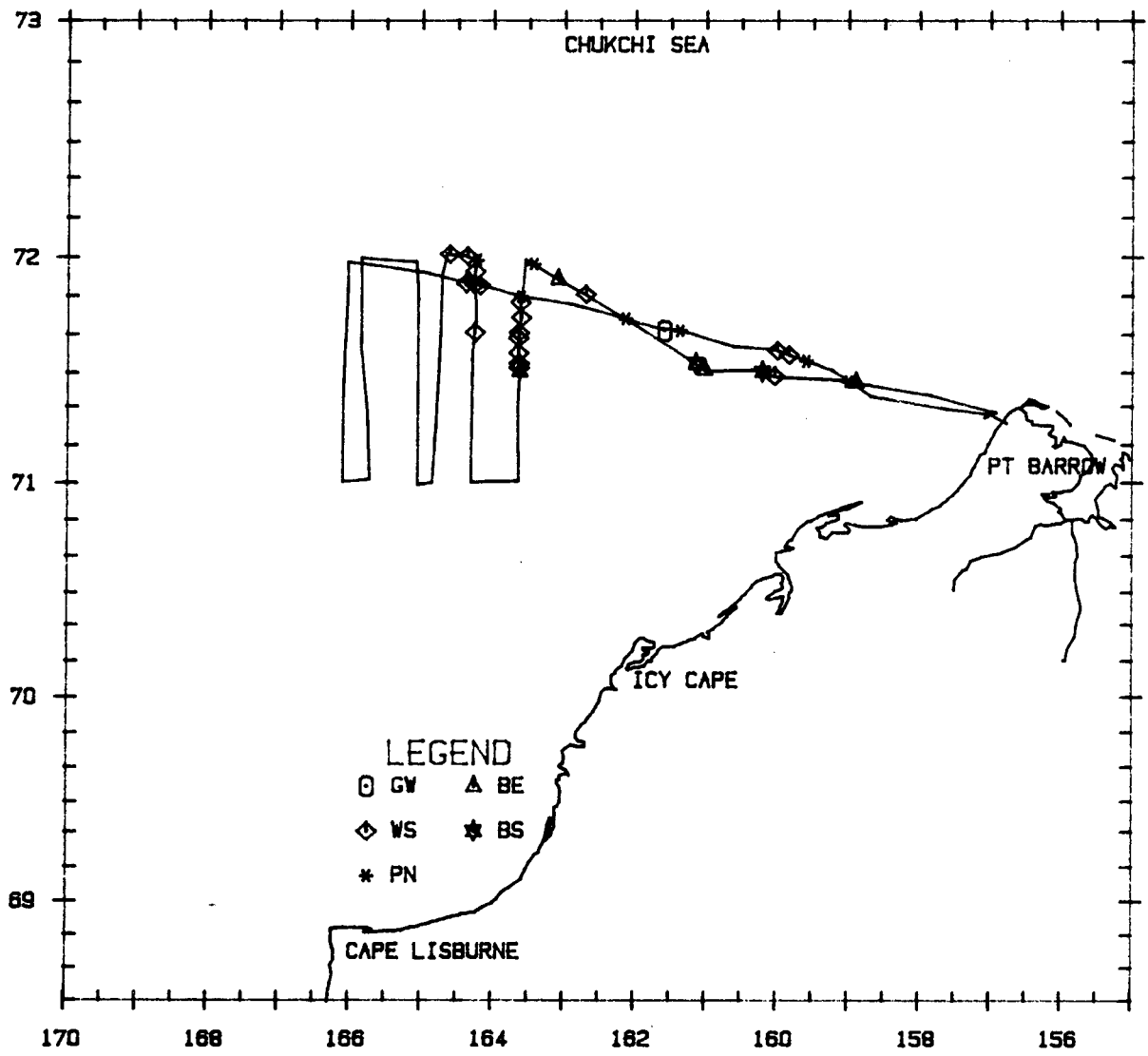


Flight 13: 19 September 1987

Flight was a transect survey of block 15 and the easternmost line in block 16. Weather was clear and visibility unlimited. There was open water throughout most of the block, with 90 to 95 percent broken floe in the northeastern corner. Sea state was Beaufort 02 to 03 in open water areas and 01 in ice. Gray whales, belugas, walrus, bearded seals, and unidentified pinnipeds were seen.

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 4/0 | 71°41.2' | 161°35.4' | - | BW | FE | - | 90 | B0 | 39 |



Flight 14: 21 September 1987

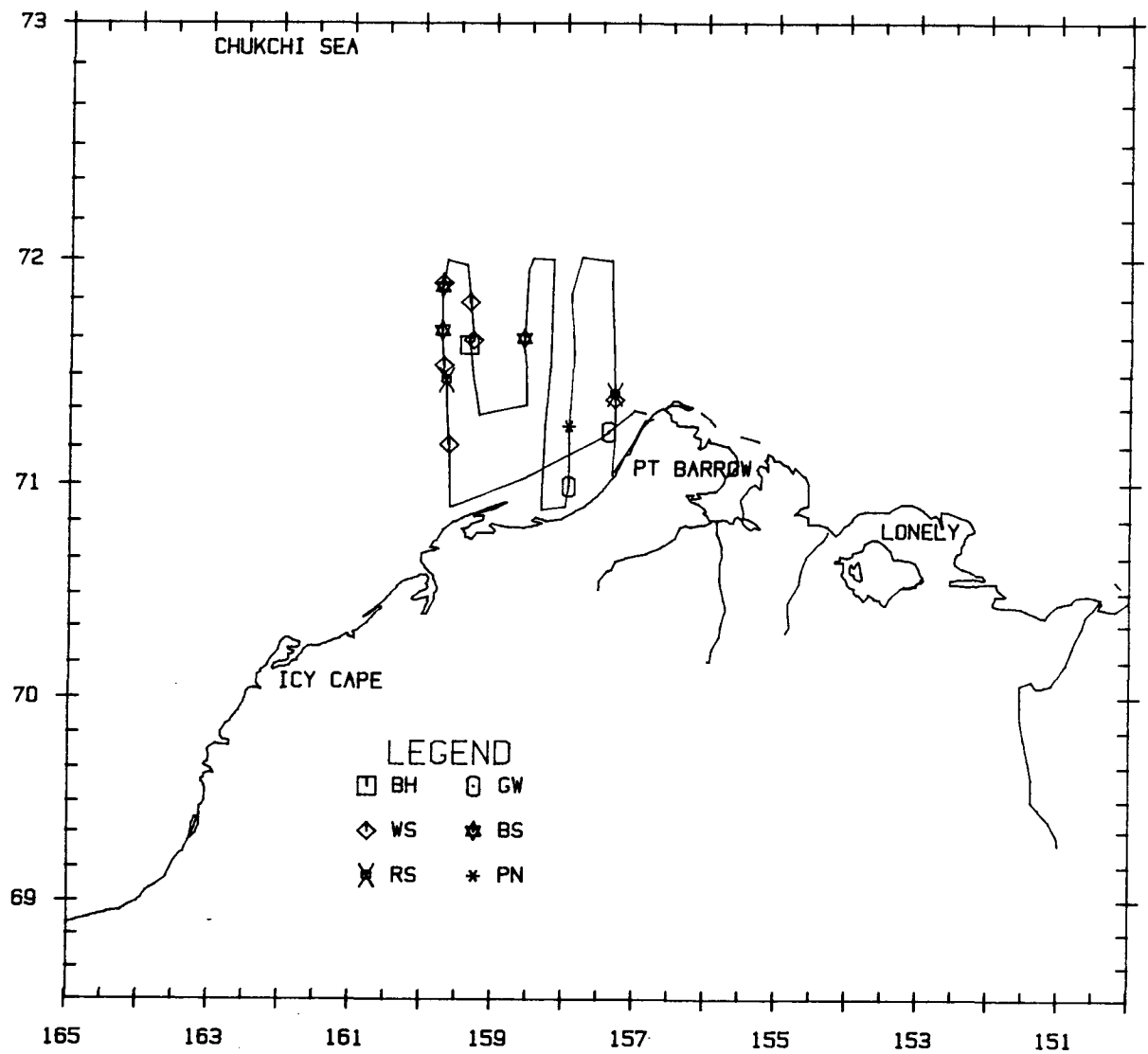
Flight was a transect survey of block 13. Weather was overcast with some areas of fog and low ceilings. Visibility ranged from unlimited to less than 1 km. There was 50 to 95 percent broken floe and new grease ice in the northwest corner, 5 to 30 percent broken floe ice in the northeast corner and open water in the southern half of the block. Sea state varied from Beaufort 01 to 02 in areas with ice, and 02 to 03 in open water. One bowhead, gray whales, walruses, bearded seals, ringed seals, and an unidentified pinniped were seen.

Bowhead Whale

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°37.9' | 159°21.7' | 524 | BO | SW | 150 | 75 | B1 | 51 |

Gray Whales

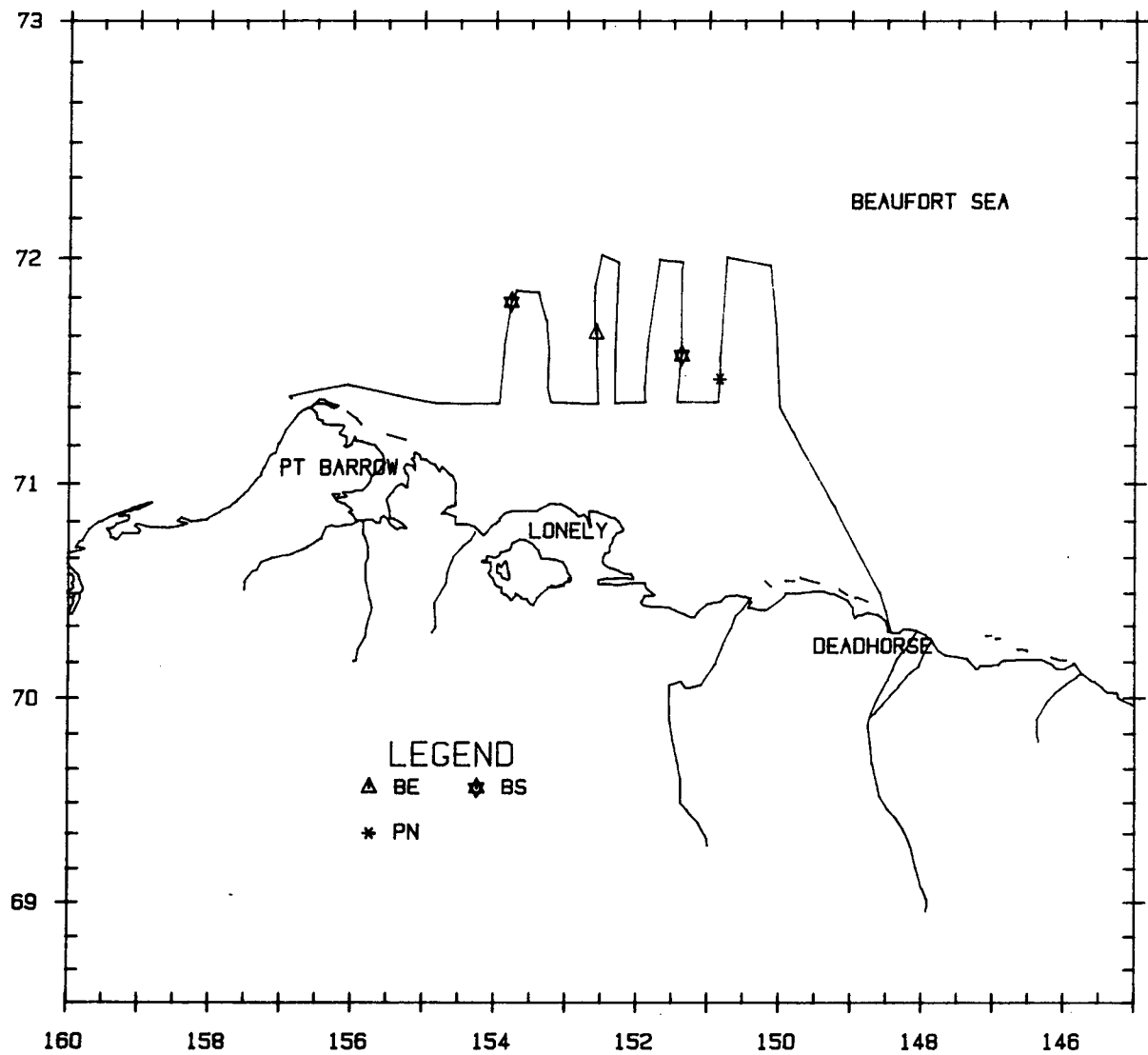
| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 2/0 | 70°59.3' | 157°56.6' | 202 | MP | FE | - | 0 | B2 | 18 |
| 1/0 | 71°13.8' | 157°22.8' | 297 | BO | FE | - | 0 | B2 | 38 |



Flight 15: 22 September 1987*

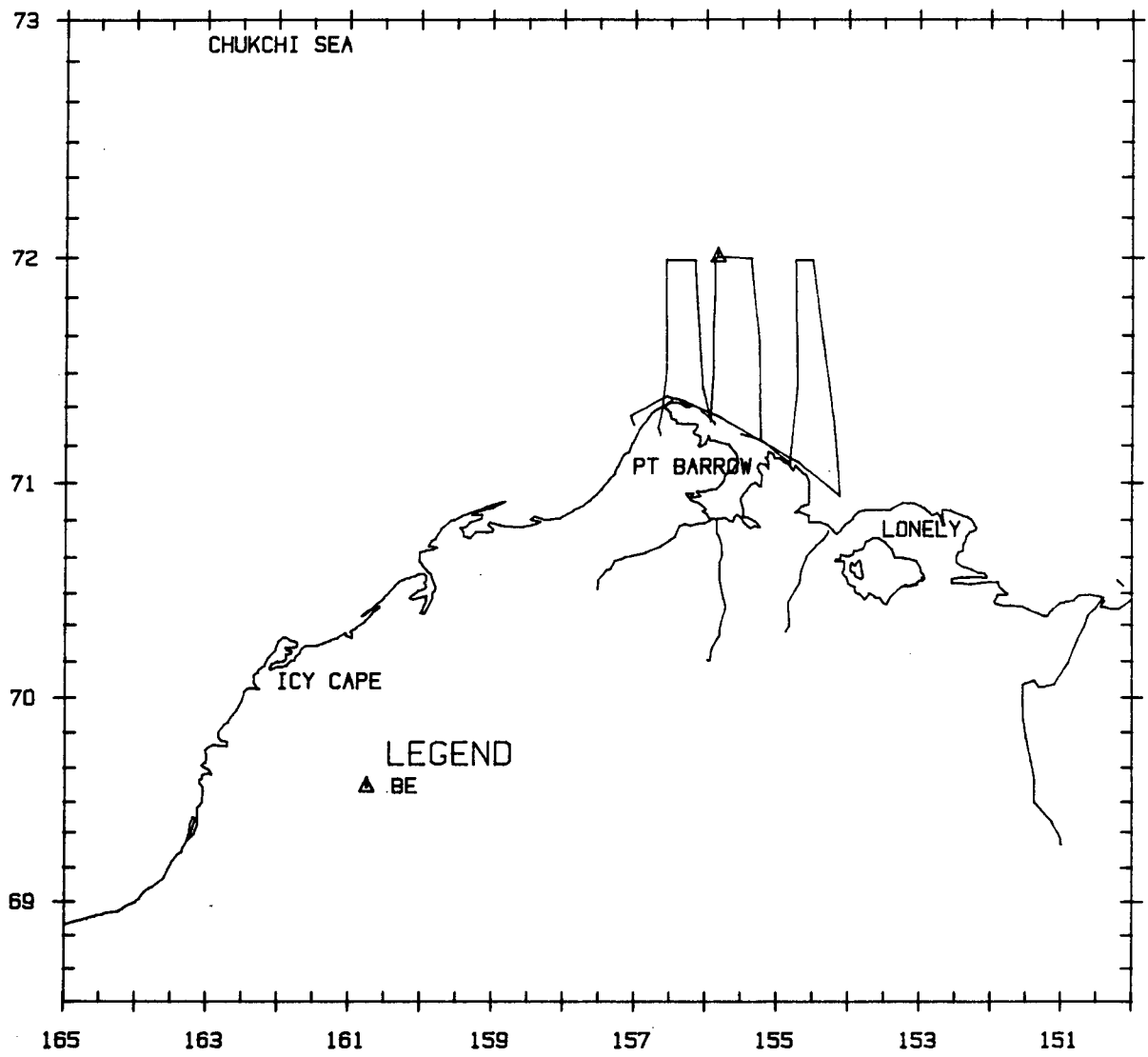
Flight was a transect survey of block 11. Weather was overcast with some fog and low ceilings in the northern portion of the block. Visibility ranged from 3 km to unlimited. Ice cover was 75 percent broken floe/new grease in the northeastern quarter, 25 to 50 percent broken floe in the northwestern quarter, and open in the southern half of the block. Sea state ranged from Beaufort 01 to 02 in areas with ice, and 02 to 03 in open water. One belukha, bearded seals, and an unidentified pinniped were seen.

*Data east of 154°W presented in Treacy (in prep.).



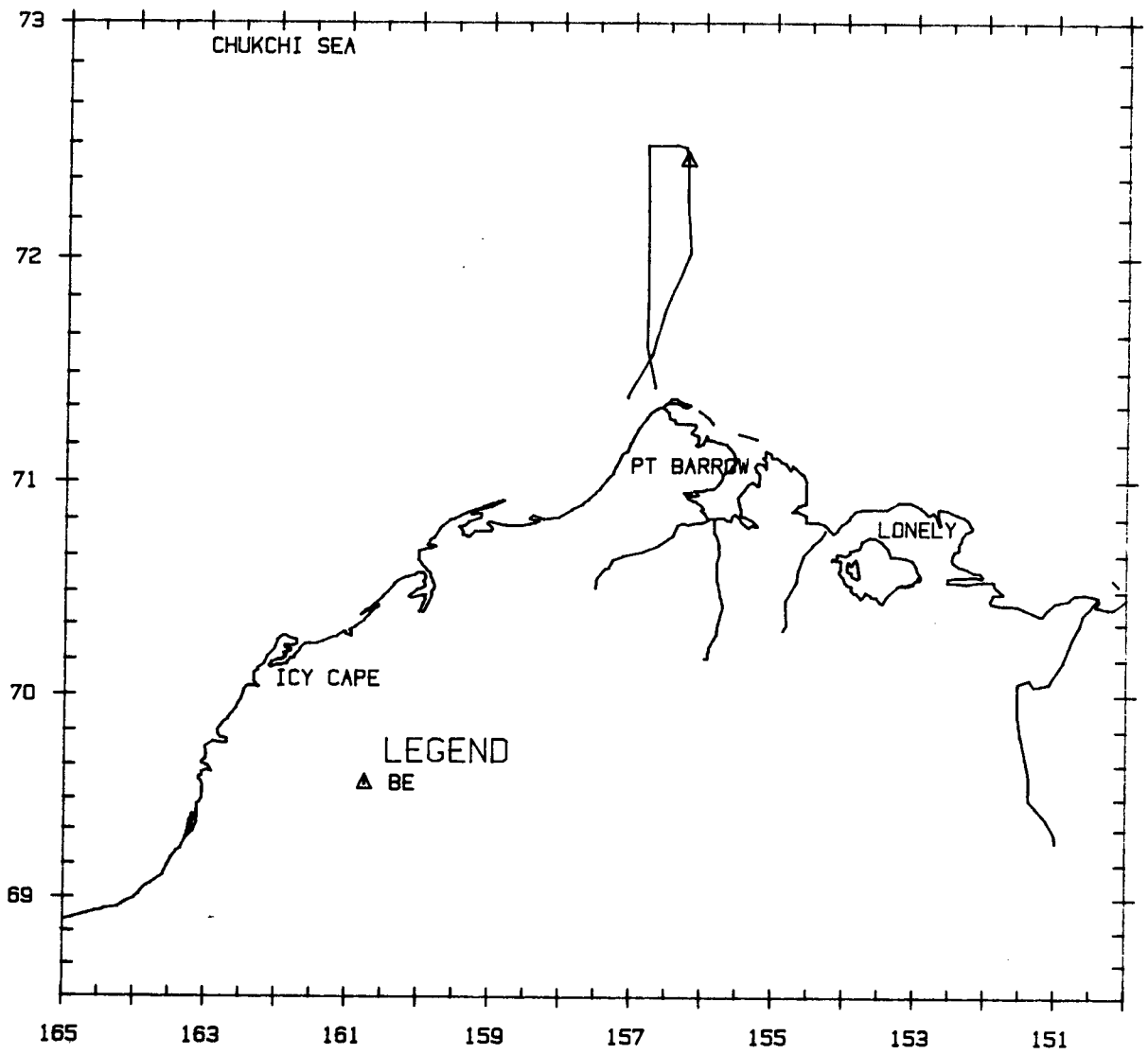
Flight 16: 25 September 1987

Flight was a transect survey of block 12. Weather was low overcast with patches of fog. Visibility ranged from less than 1 to 10 km. Ice cover along the northern border of the block was 5 percent, but the rest of the block was ice free. Sea state was Beaufort 03 to 04. Belukhas were the only marine mammals seen.



Flight 17: 26 September 1987

Flight was an aborted transect survey of block 12-N. Weather was overcast with low ceilings and fog. Visibility ranged from unacceptable to five km. There was 30 to 50 percent broken floe ice north of 72°N, with open water south of there. Sea state was Beaufort 03 to 04 in the ice and 05 in open water. Belukhas were the only marine mammals seen.



Flight 18: 27 September 1987

Flight was a transect survey of the eastern two-thirds of block 13 and the southern one-third of blocks 12-N and 13-N. The weather in blocks 12-N and 13-N was mostly low-lying fog, causing transect lines to be truncated. Weather in block 13 was partly cloudy with unlimited visibility. Ice cover in the northern blocks was 5 to 10 percent broken floe north to about 72°20'N, and 85 to 99 percent grease ice north of there. There was no ice in block 13. Sea state in open water areas ranged from Beaufort 02 to 04, and was 00 to 01 in heavy-ice areas. One bowhead, one gray whale, and one unidentified cetacean, whose blow was seen at a distance, were seen. Belukhas, walrus, and unidentified pinnipeds were also seen.

Bowhead Whale

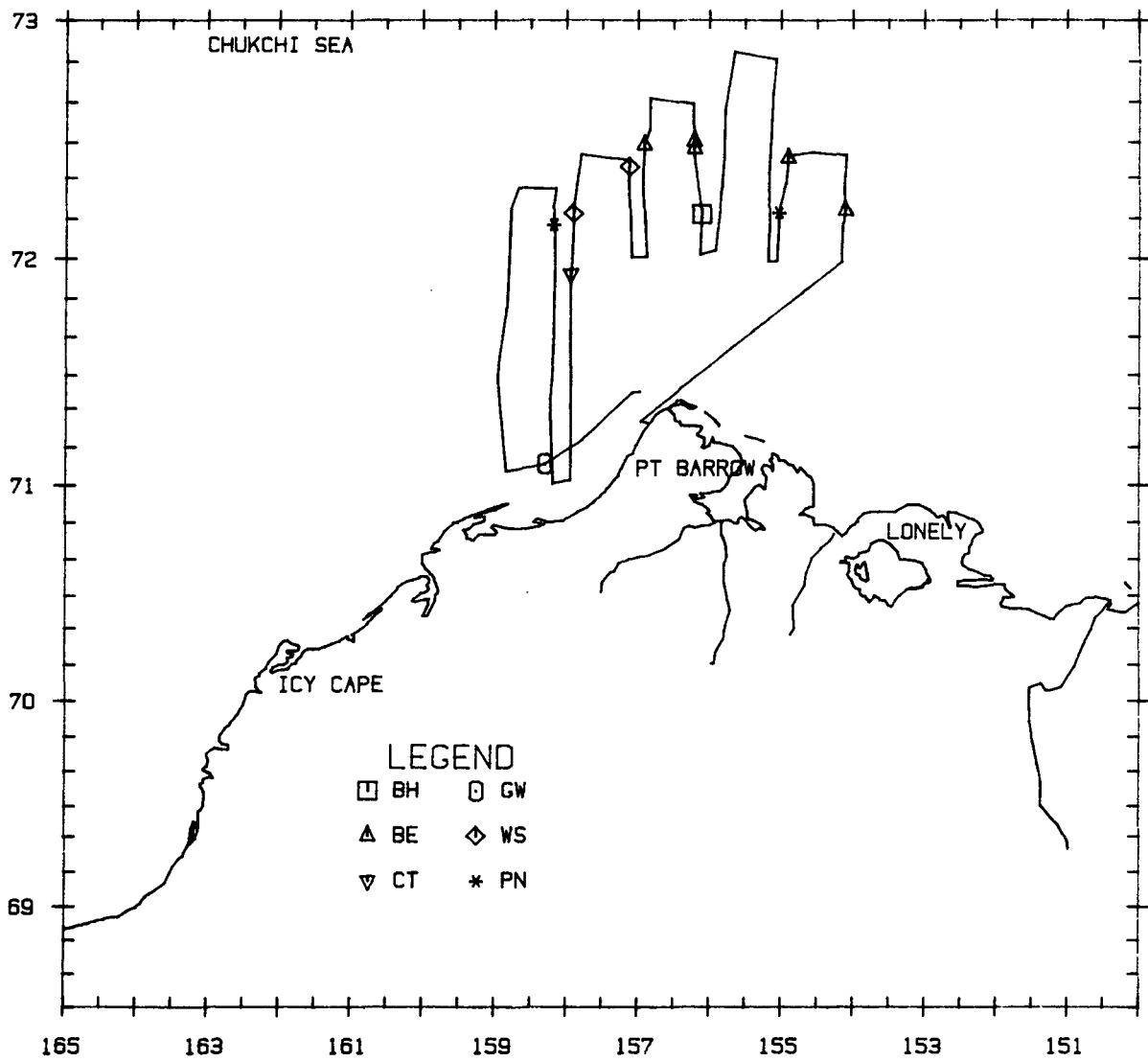
| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 72°11.0' | 156°06.8' | 299 | BO | SW | 150 | 10 | B1 | 165 |

Gray Whale

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°05.6' | 158°18.3' | - | BO | SW | 90 | 0 | B3 | 20 |

Unidentified Cetacean

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 71°56.1' | 157°56.9' | 1173 | BW | SW | - | 0 | B3 | 71 |

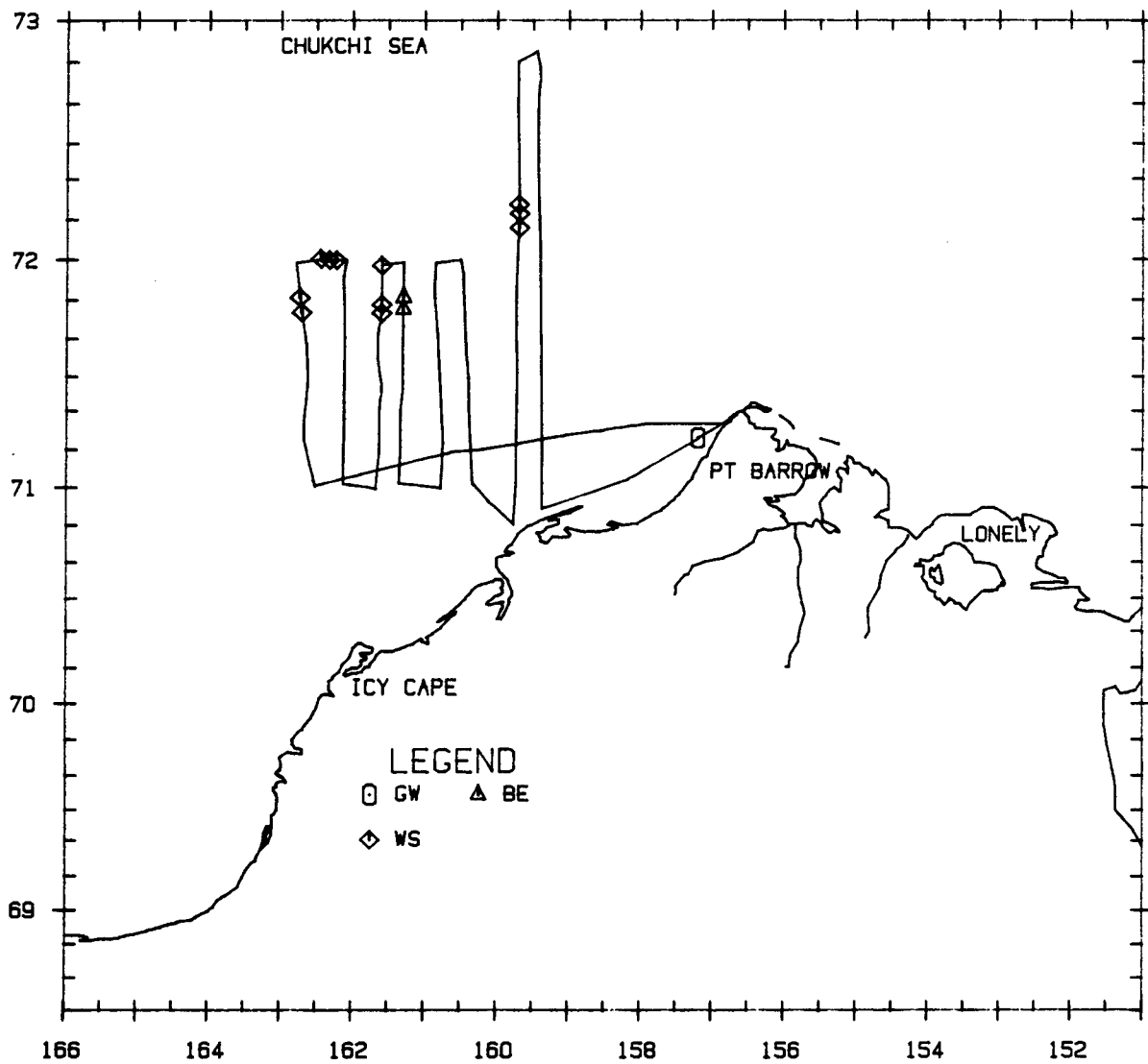


Flight 19: 28 September 1987

Flight was a transect survey of block 14 and the western one-third of blocks 13 and 13-N. Weather was partly cloudy with areas of overcast and patchy fog. Visibility ranged from unacceptable to unlimited. The northern one-quarter of block 14 and nearly all of block 13 N was covered by 20 to 100 percent new grease ice; all other areas were ice-free. Sea state ranged from Beaufort 00 to 03, but was 01 in most areas. One gray whale, belukhas, and walrus were seen.

Gray Whale

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°13.0' | 157°12.0' | - | BO | SW | 30 | 0 | B2 | 18 |

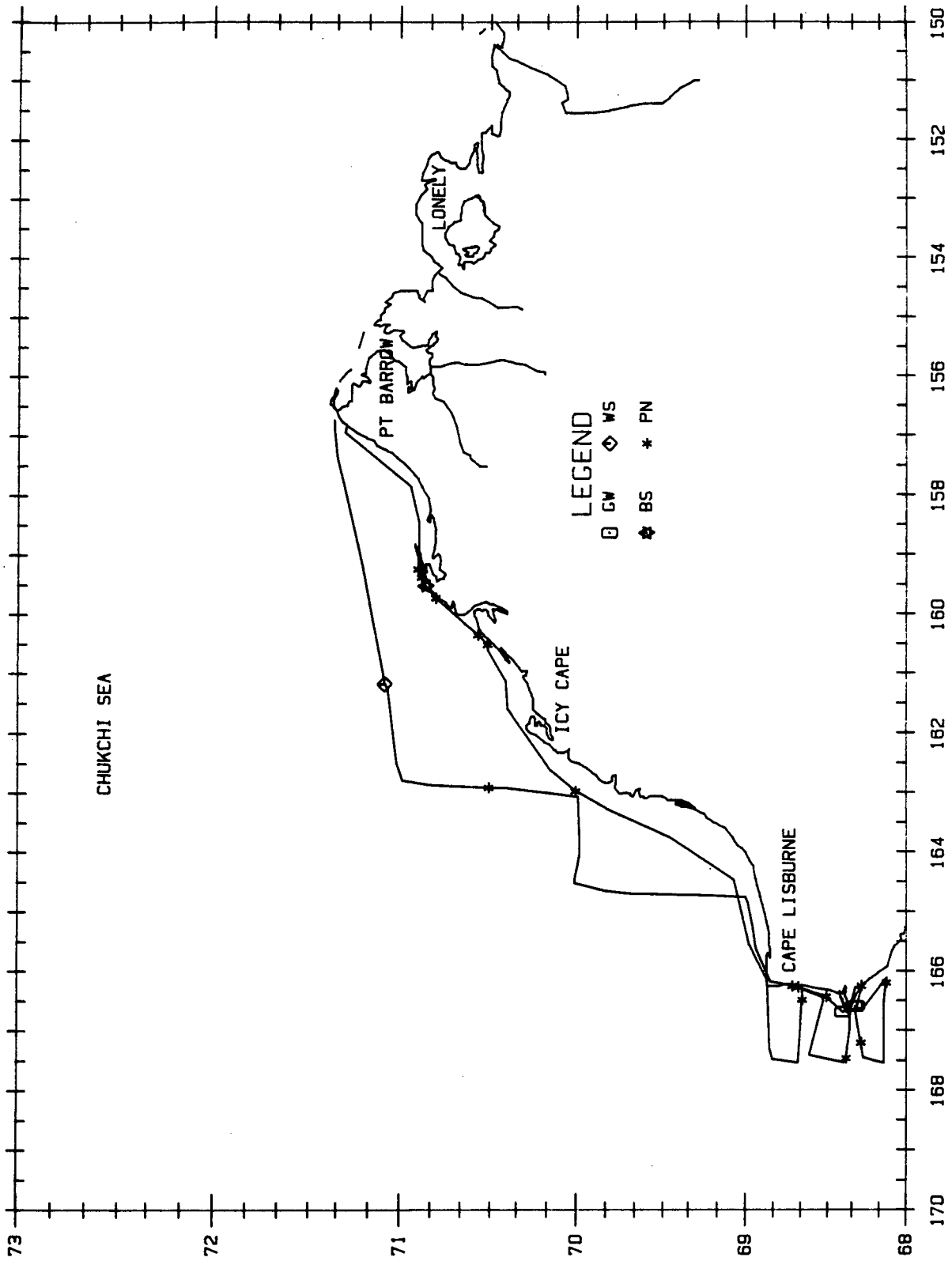


Flight 20: 29 September 1987

Flight was a transect survey of the eastern half of block 22, and one transect leg each in blocks 20 and 17. Weather was overcast with some areas of fog. Visibility was generally unlimited, but in foggy areas was reduced to unacceptable. Sea state was Beaufort 01 to 02. Gray whales, a walrus, a bearded seal, and unidentified pinnipeds were seen.

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 68°18.1' | 166°33.8' | 710 | BO | SW | 270 | 0 | B2 | 18 |
| 6/0 | 68°18.7' | 166°34.0' | - | MP | FE | - | 0 | B2 | 18 |
| 3/0 | 68°23.1' | 166°39.6' | - | MP | FE | - | 0 | B2 | 18 |



Flight 21: 30 September 1987*

Flight was a transect survey of block 12 and the eastern one-third of block 13, after a transect survey of block 11 was aborted due to fog. Weather varied from overcast with unlimited visibility in the southern portions of the survey area, to low ceilings with patchy fog and reduced visibility in the northern part. There was 5 to 10 percent broken floe ice north of 71°40'N and all other areas were ice-free. Sea state varied from Beaufort 02 to 03. Bowheads, gray whales, belukhas, and an unidentified pinniped were seen.

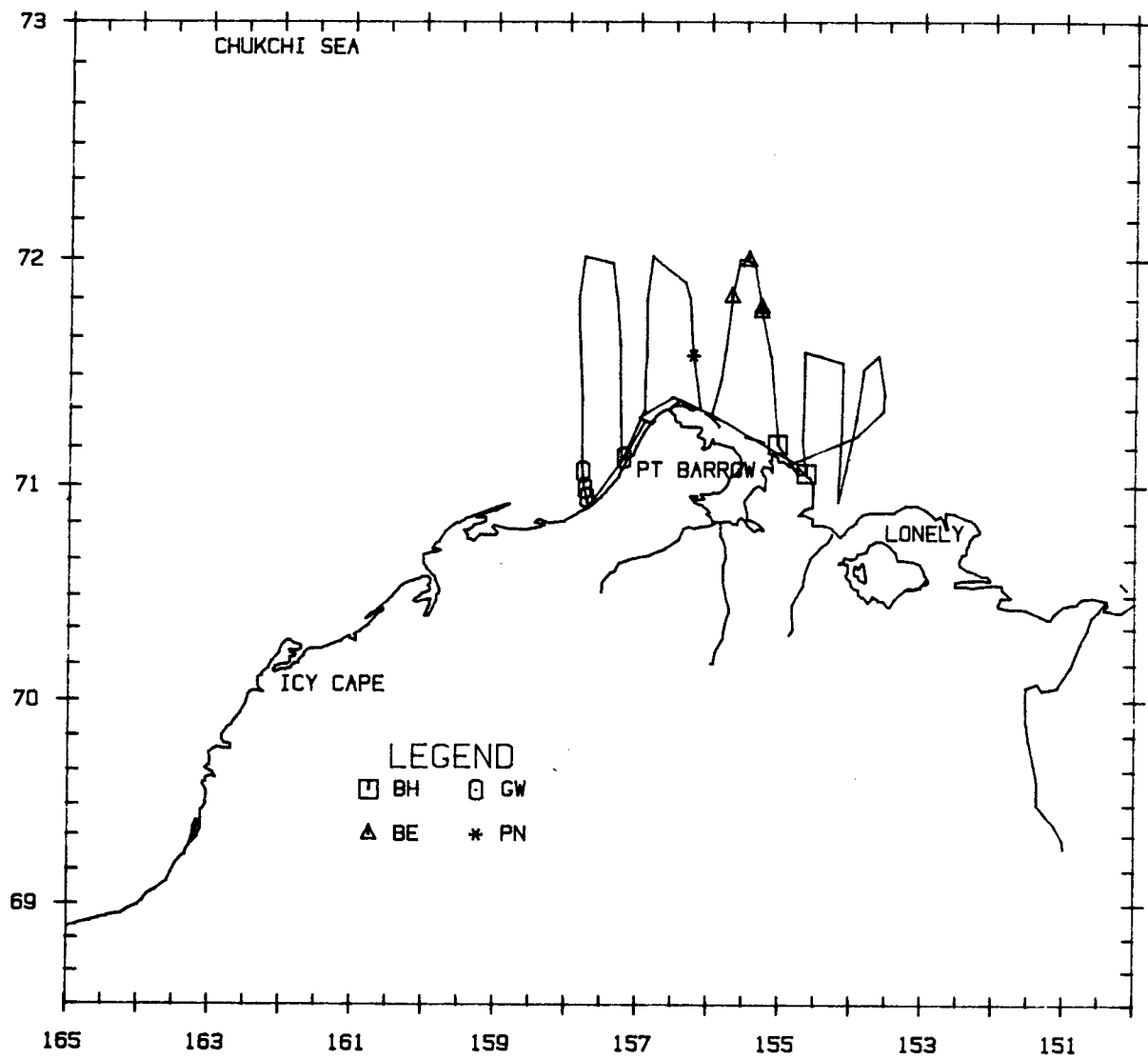
Bowhead Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 71°06.0' | 154°38.5' | 432 | BO | SW | 330 | 0 | B3 | 5 |
| 1/0 | 71°12.0' | 155°02.8' | 1195 | BO | SW | 260 | 0 | B6 | 7 |

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°07.4' | 157°12.8' | 231 | MP | FE | - | 0 | B2 | 18 |
| 1/0 | 71°03.8' | 157°47.3' | 157 | MP | FE | - | 0 | B3 | 27 |
| 1/0 | 70°59.3' | 157°45.8' | 771 | MP | FE | - | 0 | B3 | 18 |
| 1/0 | 70°56.8' | 157°44.1' | 295 | MP | FE | - | 0 | B3 | 18 |

*Data east of 154°W presented in Treacy (in prep.).

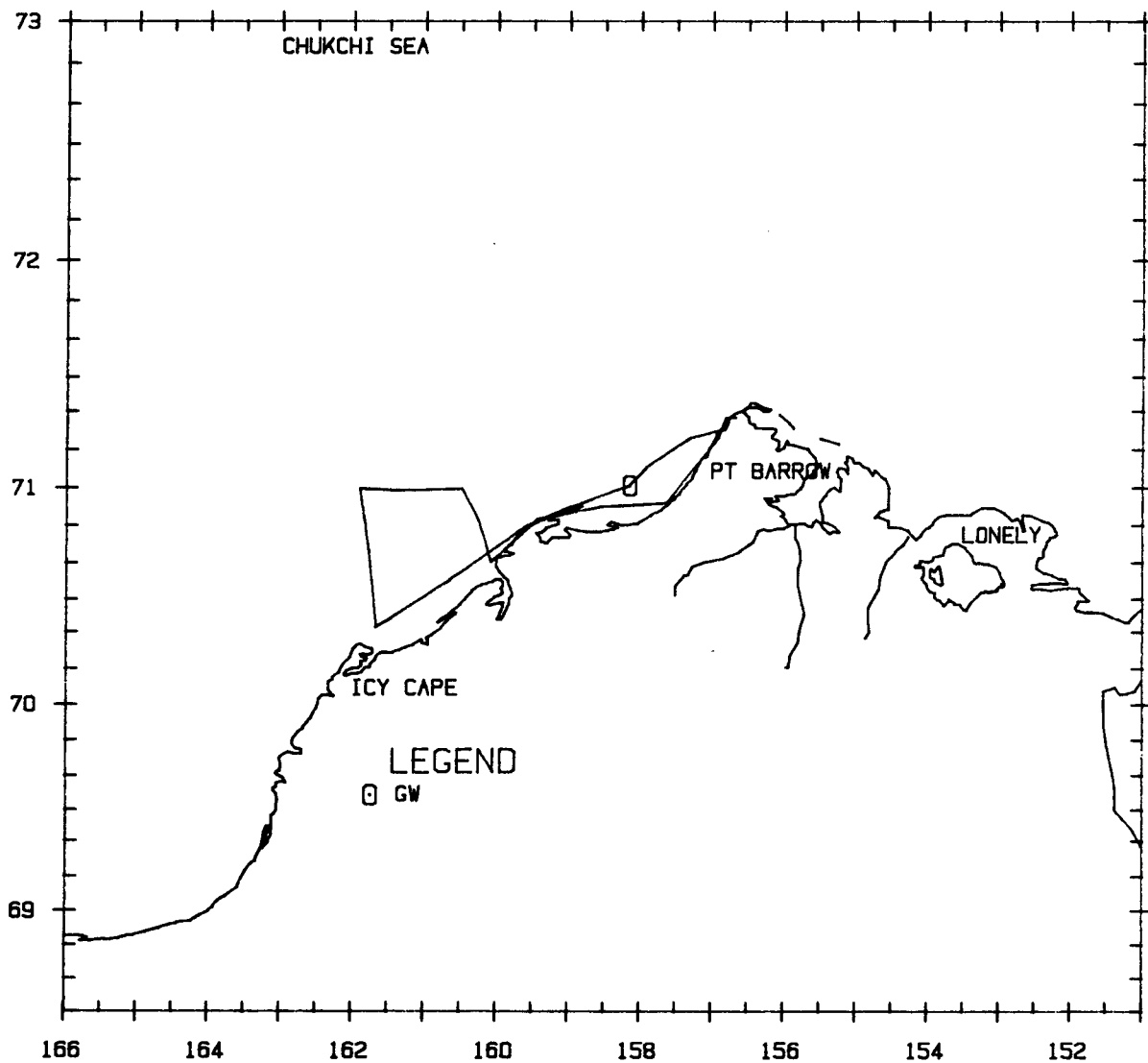


Flight 22: 1 October 1987

Flight was an attempted transect survey of block 17, which was aborted due to weather conditions. Low ceilings, fog, and reduced visibility predominated in most areas. Sea state varied from Beaufort 04 to 05 and there was no ice. One gray whale was seen.

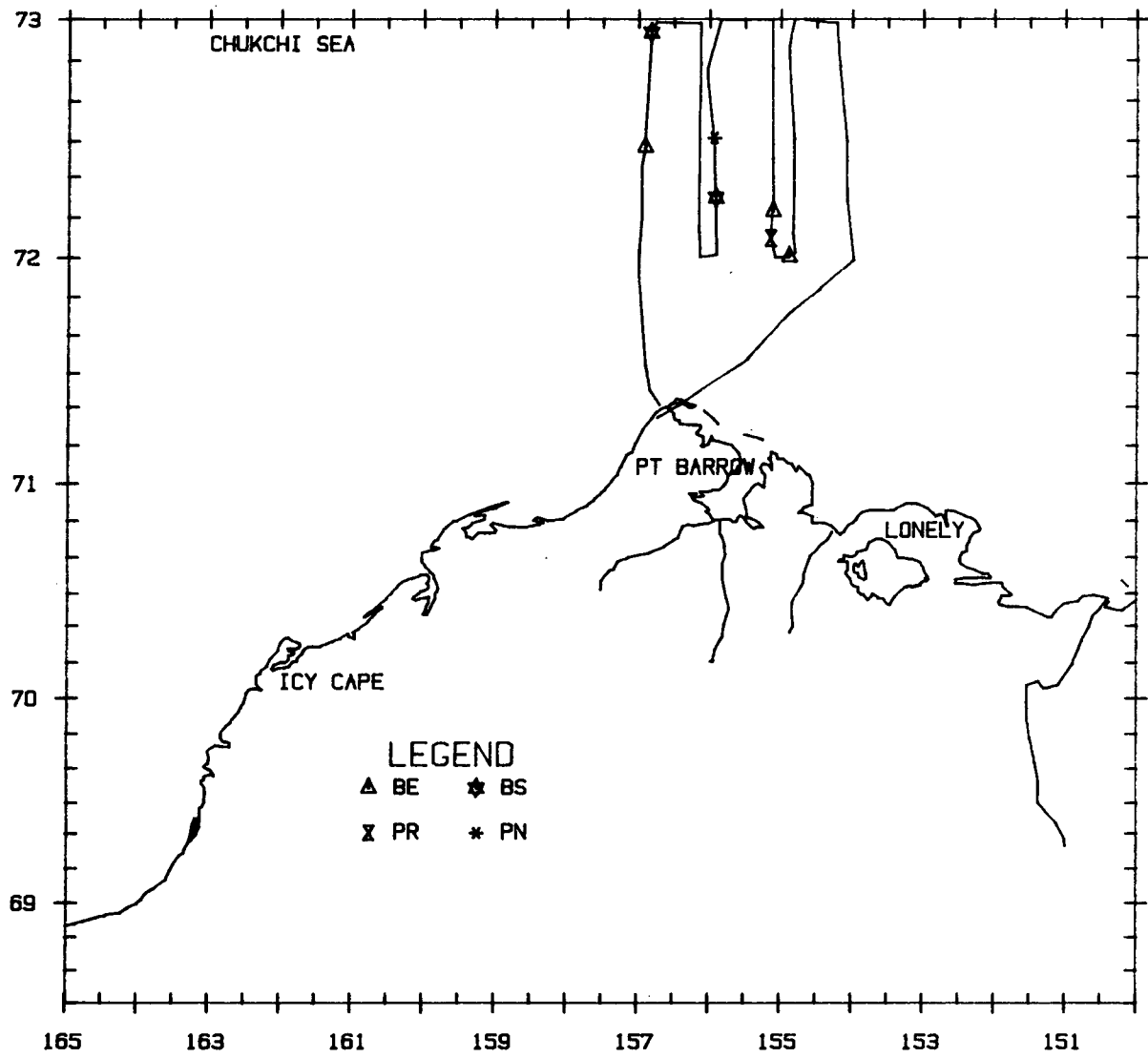
Gray Whale

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°00.4' | 158°08.9' | - | MP | FE | - | 0 | B4 | 20 |



Flight 23: 3 October 1987

Flight was a transect survey of block 12-N. Weather was clear and visibility unlimited. Ice cover in block 12-N ranged from 40 to 100 percent; open water extended approximately 65 km offshore. Sea state was Beaufort 00 to 02 in ice, 04 to 05 in open water areas. Belukhas, bearded seals, an unidentified pinniped, and polar bears were seen.



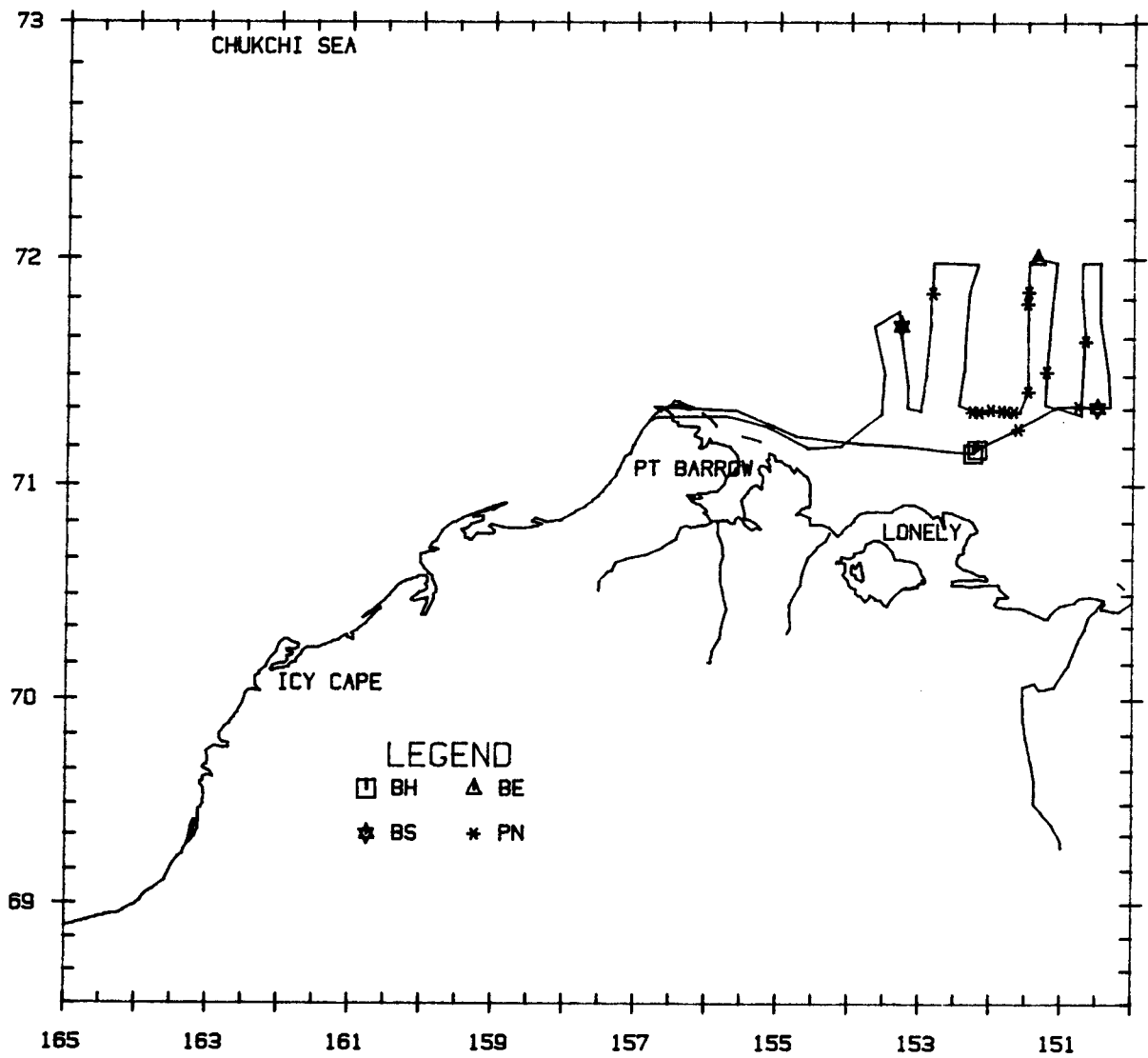
Flight 24: 5 October 1987*

Flight was a transect survey of block 11. Weather was mostly overcast with low ceilings, fog and snow flurries. There was 10 to 30 percent broken floe and new grease ice at the northernmost boundary of the block; otherwise there was no ice in the block. Sea state was Beaufort 02 to 03. Two bowheads were seen swimming slowly. A belukha, bearded seals, and unidentified pinnipeds were also seen.

Bowhead Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°09.4' | 152°12.2' | - | BO | SW | 240 | 0 | B2 | 13 |
| 1/0 | 71°08.4' | 152°15.7' | - | BO | SW | 150 | 0 | B2 | 13 |

*Data east of 154°W presented in Treacy (in prep.).



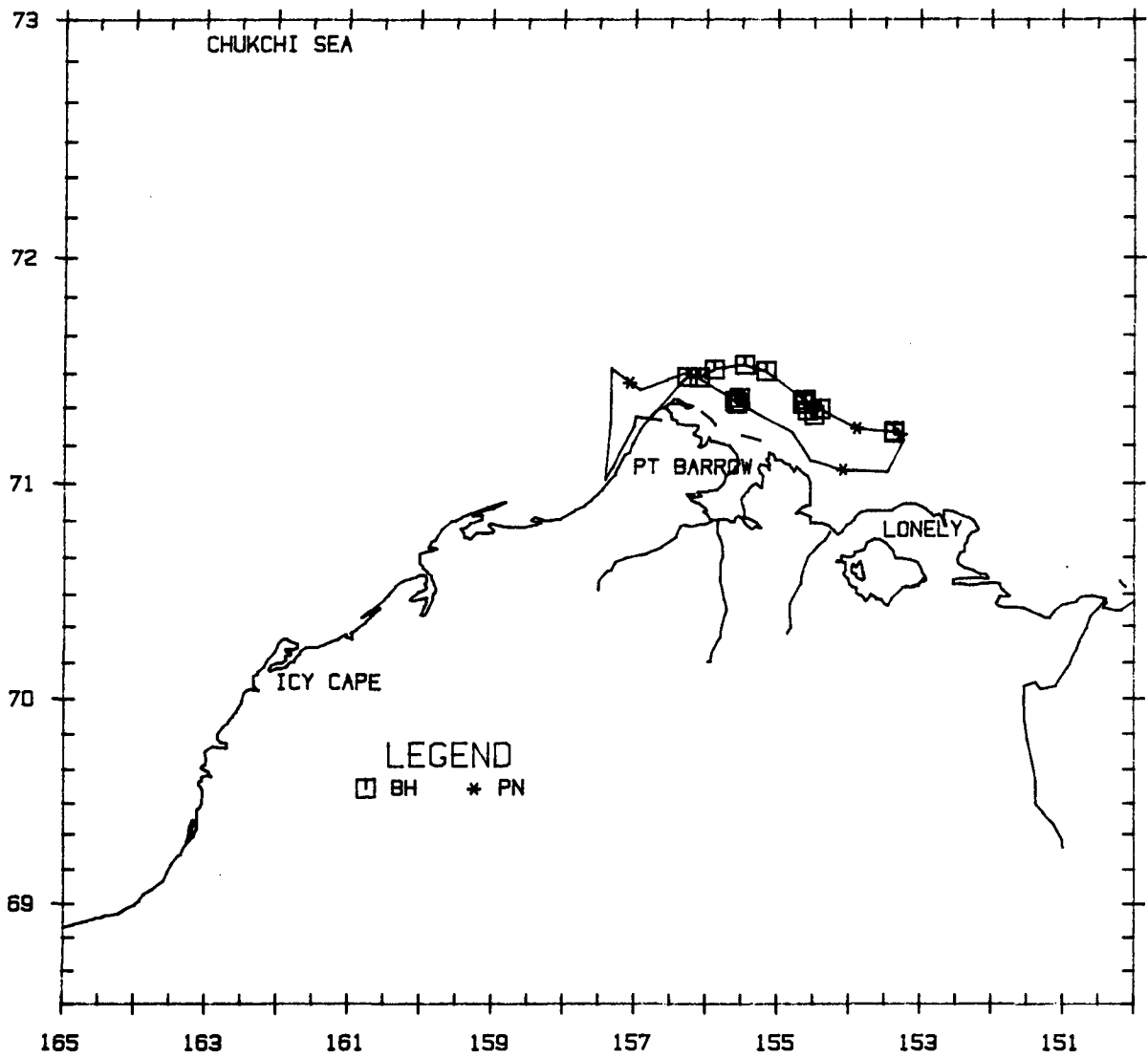
Flight 25: 6 October 1987*

Flight was an attempted transect survey of block 13, which was aborted due to widespread dense low-lying fog. The only fog-free area was nearshore north and east of Pt. Barrow, and a coastal search survey of this area was flown. Sea state was Beaufort 01, and there was no ice. Twenty-five bowheads were seen, most heading west and swimming moderately. Unidentified pinnipeds were also seen.

Bowhead Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 71°21.4' | 155°35.3' | 1407 | BO | SW | 30 | 0 | B2 | 9 |
| 1/0 | 71°22.3' | 155°31.8' | - | BW | SW | 20 | 0 | B2 | 9 |
| 1/0 | 71°20.9' | 155°34.0' | - | BO | SW | 30 | 0 | B2 | 9 |
| 2/0 | 71°13.3' | 153°22.2' | - | BO | SW | 250 | 0 | B2 | 22 |
| 2/0 | 71°13.7' | 153°21.9' | - | BO | SW | 260 | 0 | B2 | 22 |
| 2/0 | 71°19.6' | 154°24.6' | 3146 | BO | SW | 260 | 0 | B2 | 11 |
| 2/0 | 71°18.0' | 154°29.5' | - | BO | SW | 260 | 0 | B2 | 11 |
| 1/0 | 71°19.1' | 154°34.9' | - | BO | SW | 300 | 0 | B2 | 11 |
| 3/0 | 71°20.9' | 154°39.0' | - | BO | SW | 270 | 0 | B2 | 24 |
| 1/0 | 71°21.8' | 154°36.8' | - | BO | SW | 280 | 0 | B2 | 24 |
| 2/0 | 71°30.7' | 155°09.6' | - | BO | SW | 320 | 0 | B2 | 18 |
| 2/0 | 71°32.4' | 155°27.5' | - | BW | SW | 270 | 0 | B2 | 18 |
| 1/0 | 71°29.6' | 155°53.0' | - | BW | SW | 240 | 0 | B2 | 5 |
| 3/0 | 71°27.6' | 156°05.5' | - | BO | FE | - | 1 | B2 | 9 |
| 1/0 | 71°27.7' | 156°16.1' | - | BW | SW | 210 | 1 | B2 | 9 |

*Data east of 154°W presented in Treacy (in prep.).

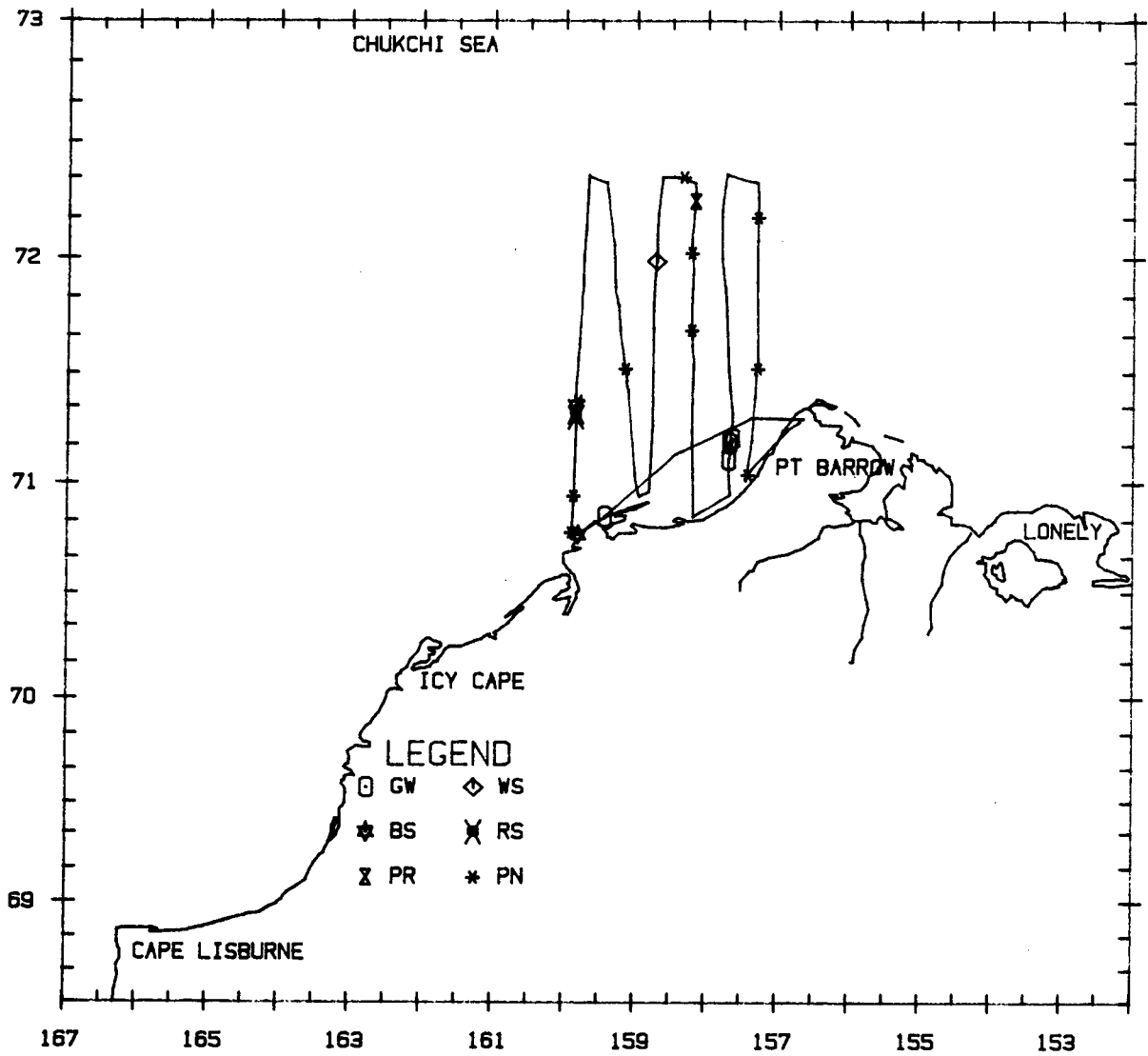


Flight 26: 8 October 1987

Flight was a transect of block 13 and the southern one-third of block 13-N. Weather was mostly overcast with low ceilings and fog. Visibility varied from unlimited to less than 1 km. There was 20 to 90 percent broken floe and new grease ice in block 13-N, and no ice in block 13. Sea state was Beaufort 01 to 02. Gray whales, walrus, bearded seals, ringed seals, unidentified pinnipeds, and a polar bear were seen.

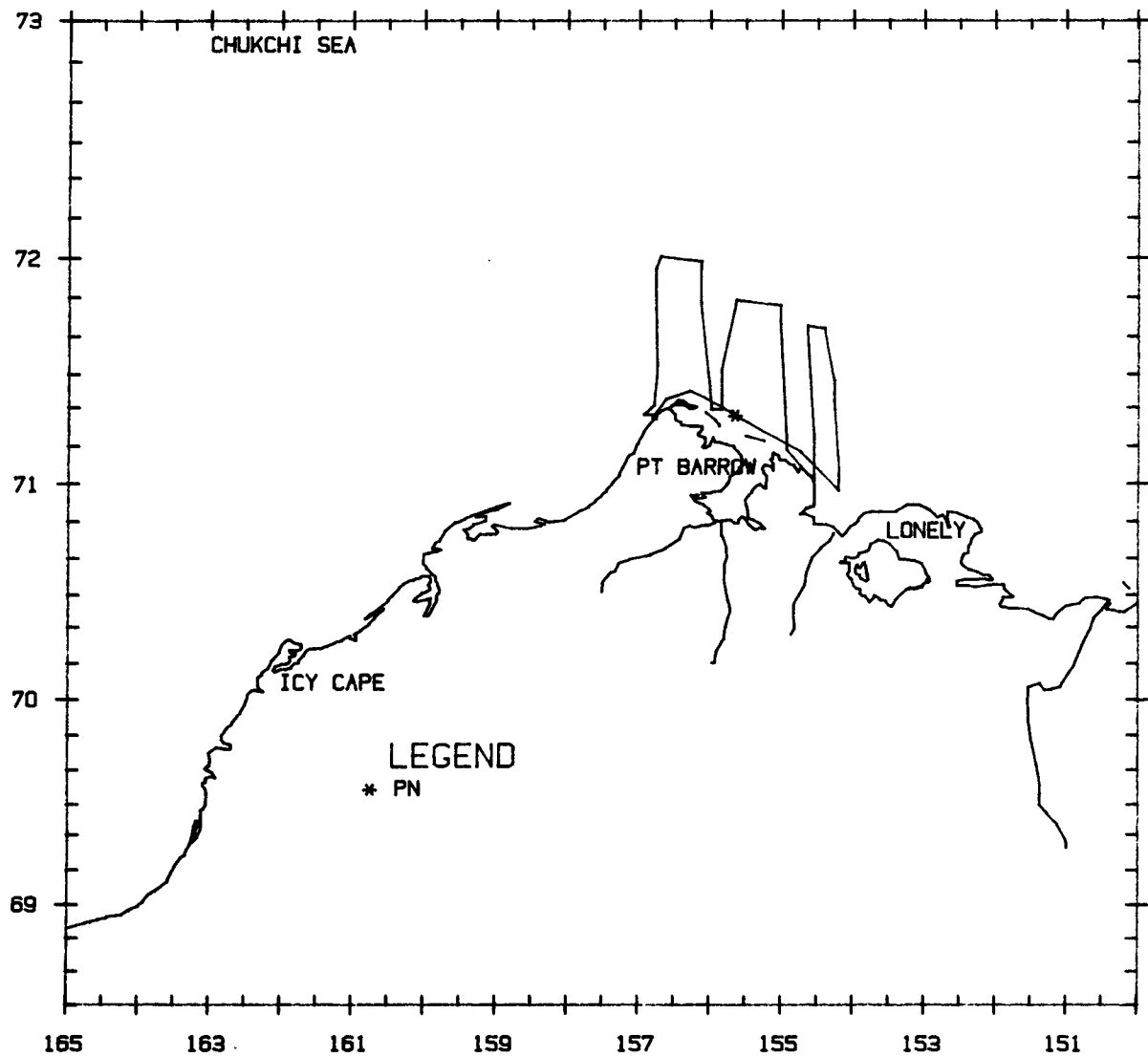
Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 4/0 | 71°10.8' | 157°40.6' | - | MP | FE | - | 0 | B2 | 42 |
| 2/0 | 71°11.9' | 157°38.0' | - | BW | SW | - | 0 | B2 | 38 |
| 2/0 | 71°06.4' | 157°41.4' | - | MP | FE | - | 0 | B1 | 22 |
| 1/0 | 70°51.3' | 159°25.8' | - | BO | SW | 30 | 0 | B1 | 18 |



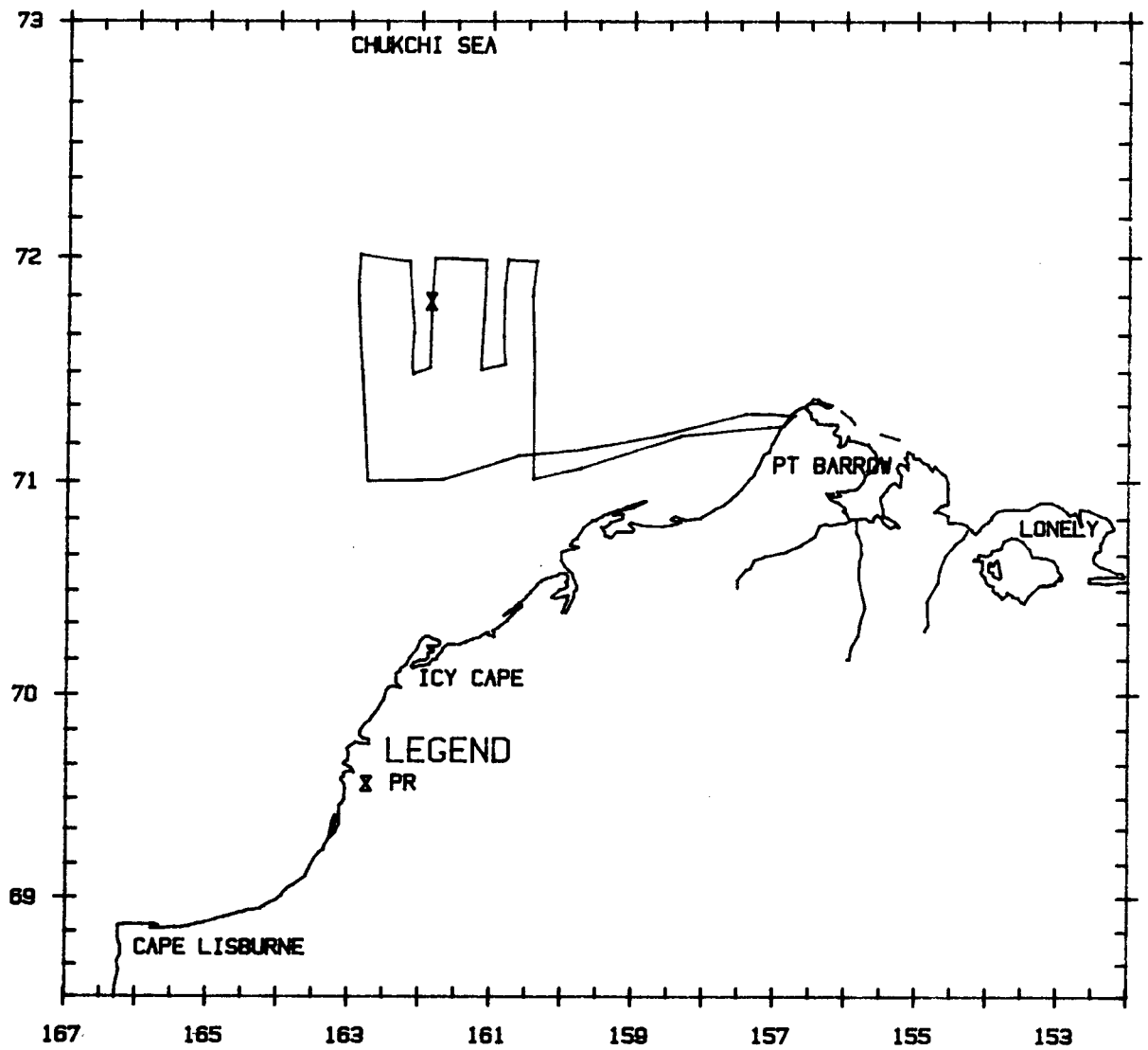
Flight 27: 10 October 1987

Flight was a transect survey of block 12. Weather was mostly overcast with areas of heavy fog and very low visibility, causing transect legs to be truncated at the northern end. Sea state was Beaufort 02 to 04, and there was no ice except in the northwestern corner where cover was 50 to 80 percent. One unidentified pinniped was seen.



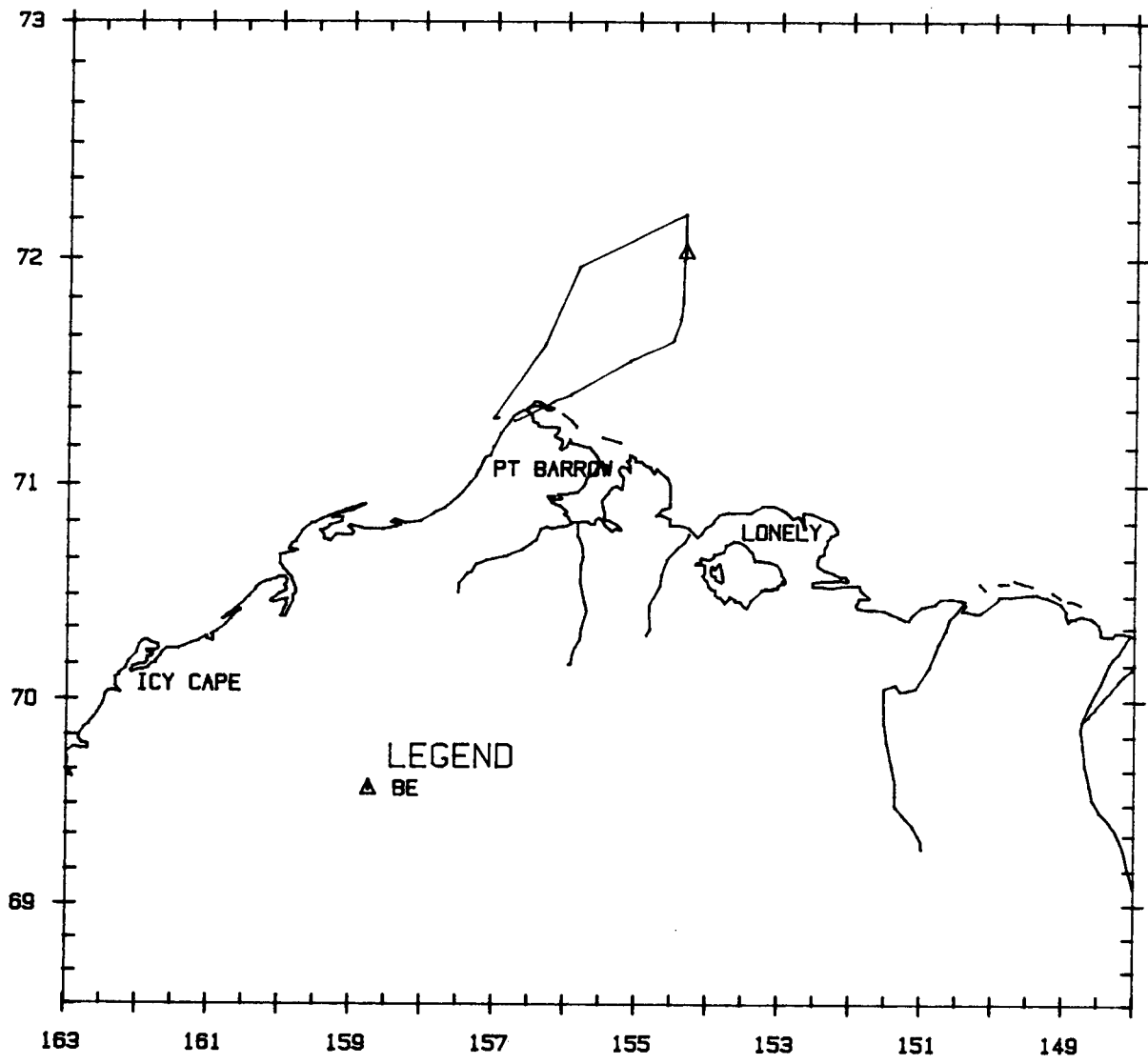
Flight 28: 11 October 1987

Flight was a transect survey of block 14. Weather was overcast with unlimited visibility in the northern half of the block and overcast with patchy fog and snow squalls with reduced visibility in the southern half. Ice cover was 75 to 95 percent new ice north of 71°45'N and open water south of there. Sea state was Beaufort 00 to 02 in areas with ice, and 05 in open water areas. One polar bear was seen.



Flight 29: 12 October 1987

Flight was an attempted transect survey of block 12 and 12-N. Weather was low fog and snow flurries with unacceptable visibility, causing the survey to be aborted. There was 50 to 85 percent broken floe and new ice north of 72°N and open water south of there. Sea state was Beaufort 04 to 05 in open water and 03 in the ice. One belukha was seen.

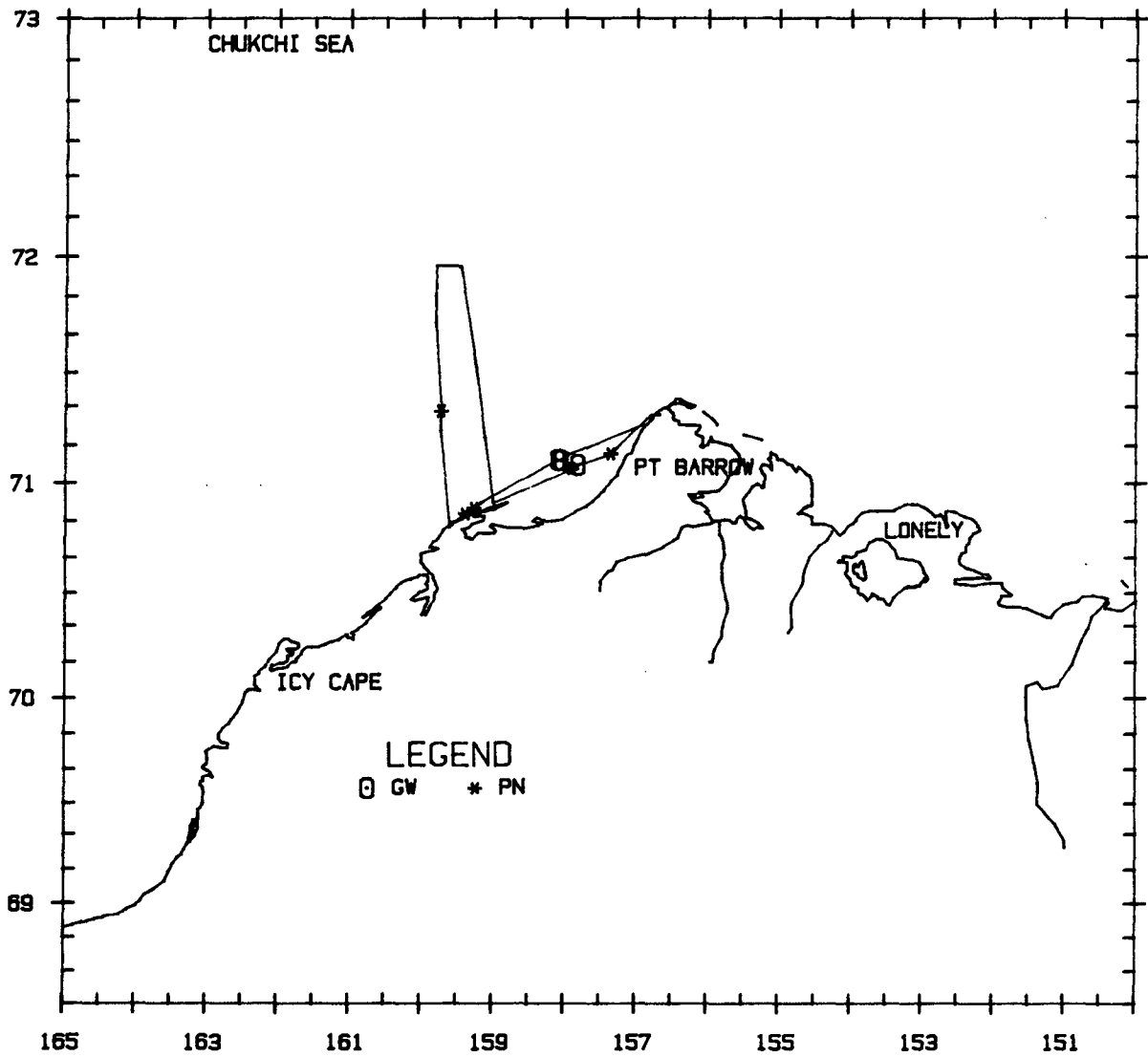


Flight 30: 15 October 1987

Flight was a transect survey of the western one-third of block 13. The survey was aborted due to the failure of the aircraft navigation system and widespread low-lying fog rolling in from the north. Weather in the area surveyed was partly cloudy with unlimited visibility. Sea state was Beaufort 01 to 02 and there was no ice. Gray whales and unidentified pinnipeds were seen.

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 4/0 | 71°06.1' | 158°04.0' | - | MP | FE | - | 0 | B1 | 20 |
| 3/0 | 71°06.3' | 158°06.7' | - | BW | FE | - | 0 | B1 | 20 |
| 2/0 | 71°05.0' | 157°50.0' | - | BO | SW | - | 0 | B1 | 64 |



Flight 31: 16 October 1987

Flight was a transect survey of block 12 and the eastern two-thirds of block 13. Weather was clear with unlimited visibility. Sea state was Beaufort 02 to 03 and there was no ice. Bowheads, gray whales, unidentified cetaceans, belukhas, and unidentified pinnipeds were seen. The unidentified cetaceans were seen only from a distance and dove before they could be positively identified.

Bowhead Whales

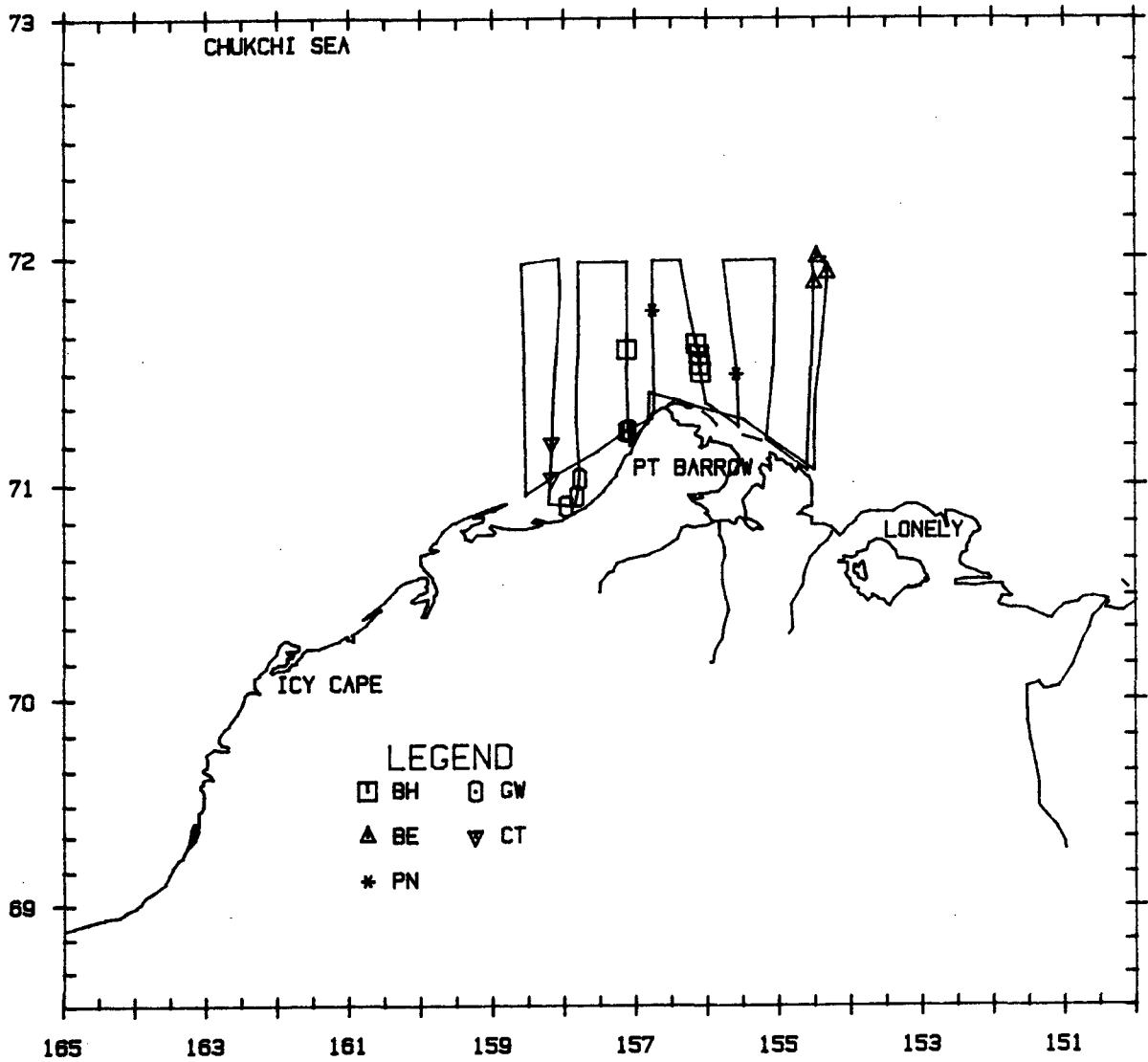
| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 71°36.3' | 157°08.1' | 825 | BW | SW | 240 | 0 | B2 | 145 |
| 1/0 | 71°37.9' | 156°09.6' | 838 | BO | SW | 270 | 0 | B3 | 123 |
| 1/0 | 71°35.0' | 156°07.5' | 1446 | BO | SW | 250 | 0 | B3 | 7 |
| 1/0 | 71°32.3' | 156°06.5' | 2080 | SP | SW | 280 | 0 | B3 | 7 |
| 1/0 | 71°28.9' | 156°05.7' | 398 | BO | SW | 170 | 0 | B3 | 9 |

Gray Whales

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 71°13.8' | 157°08.7' | - | MP | FE | - | 0 | B2 | 18 |
| 1/0 | 70°54.3' | 157°58.9' | 587 | BW | FE | - | 0 | B3 | 9 |
| 1/0 | 70°56.9' | 157°49.8' | 838 | MP | FE | - | 0 | B3 | 18 |
| 3/0 | 71°01.5' | 157°47.5' | 2196 | BO | FE | - | 0 | B3 | 27 |
| 1/0 | 71°14.1' | 157°05.8' | - | BW | SW | - | 0 | B2 | 18 |

Unidentified Cetaceans

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 71°01.8' | 158°11.1' | - | BW | SW | - | 0 | B3 | 20 |
| 1/0 | 71°10.9' | 158°10.9' | 2507 | BW | SW | - | 0 | B2 | 22 |



Flight 32: 17 October 1987

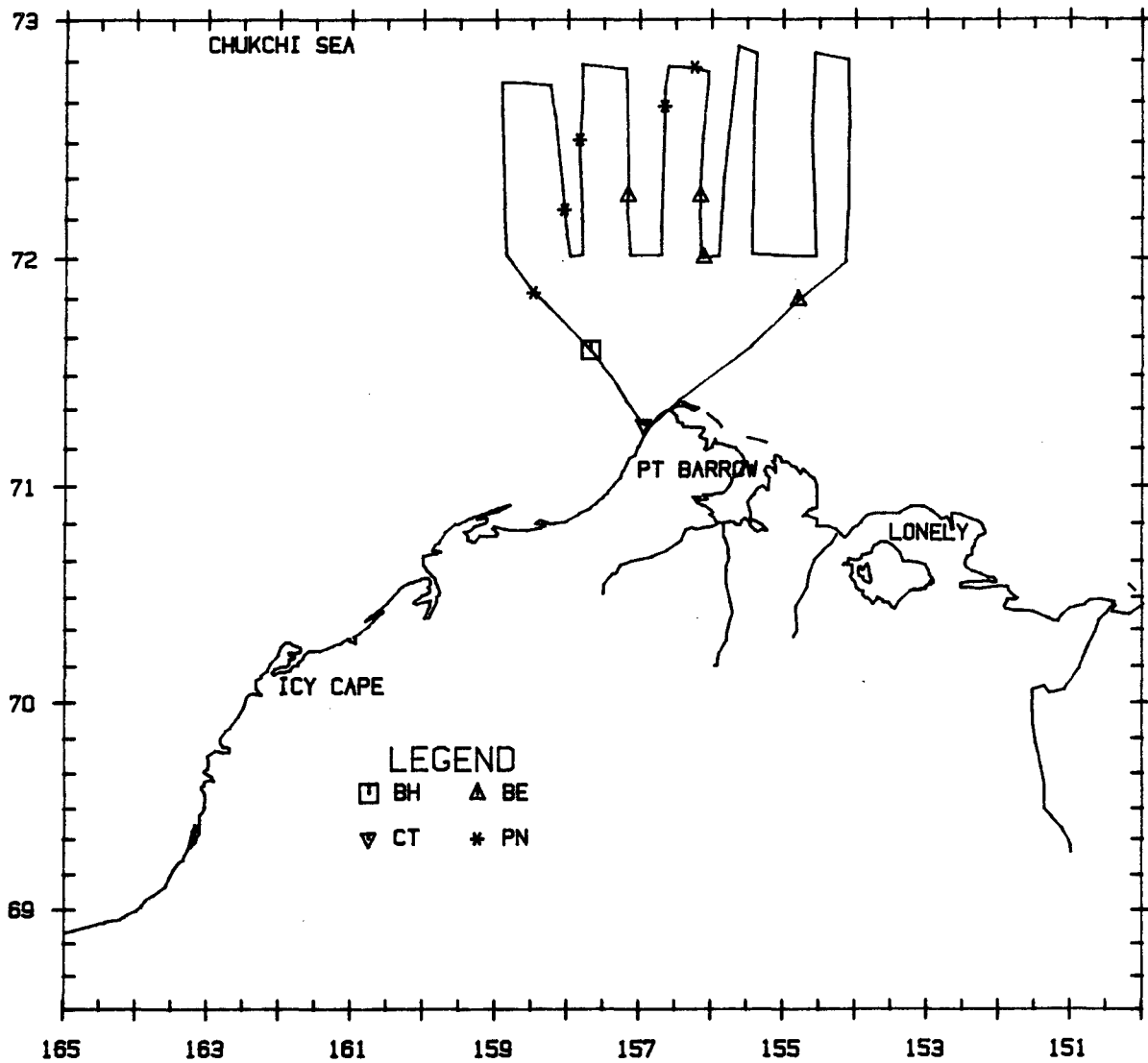
Flight was a transect survey of block 12-N and the eastern two-thirds of block 13-N. Weather was clear with unlimited visibility. The northern half of both blocks was covered with 95 to 99 percent new grease ice with open water to the south. Sea state was Beaufort 01 to 03. One bowhead, two unidentified cetaceans, belukhas, and unidentified pinnipeds were seen. The unidentified cetaceans were seen close to shore near mud plumes and were probably gray whales, but could not be positively identified.

Bowhead Whale

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 71°36.6' | 157°41.7' | 1314 | BW | SW | 220 | 0 | B2 | 55 |

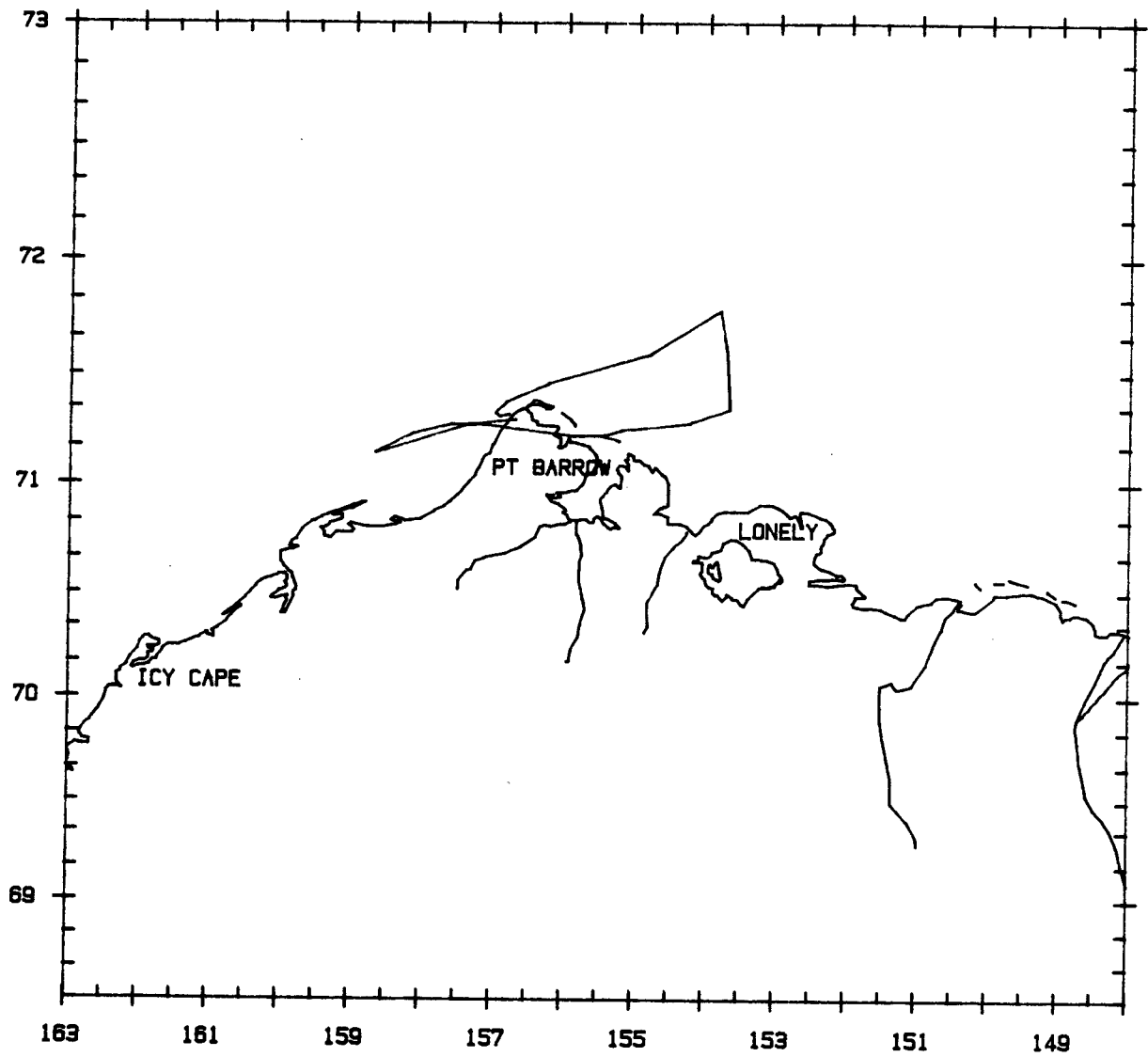
Unidentified Cetaceans

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 2/0 | 71°16.1' | 156°57.3' | - | BW | SW | - | 0 | B2 | 18 |



Flight 33: 19 October 1987

Flight was an attempted transect survey of blocks 17 and 11. Weather was low overcast with snow squalls, fog and icing conditions, causing the surveys to be aborted. The sea state was Beaufort 04 to 05 due to high winds, and there was no ice. No marine mammals were seen.

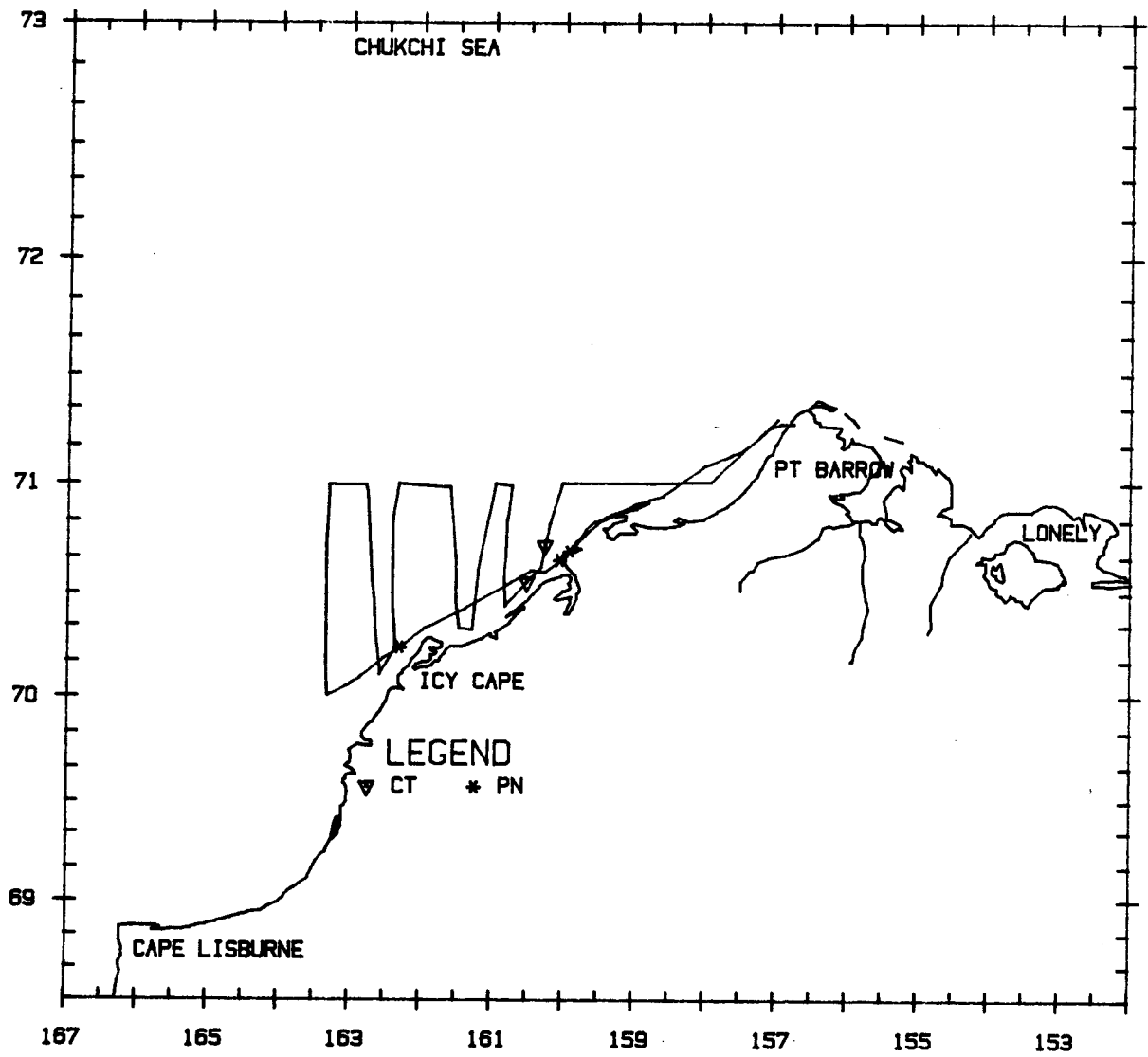


Flight 34: 20 October 1987

Flight was a transect survey of block 17 and the easternmost line in block 18. Weather was overcast with intermittent snow squalls and fog. Visibility varied from unlimited to less than 1 km. Sea state was Beaufort 01 to 03, and there was no ice except for some slushy new ice very near shore. Two unidentified cetaceans were seen, but could not be positively identified. Both sightings were of blows, seen from some distance, and each animal appeared to stay only very briefly at the surface. Unidentified pinnipeds were also seen.

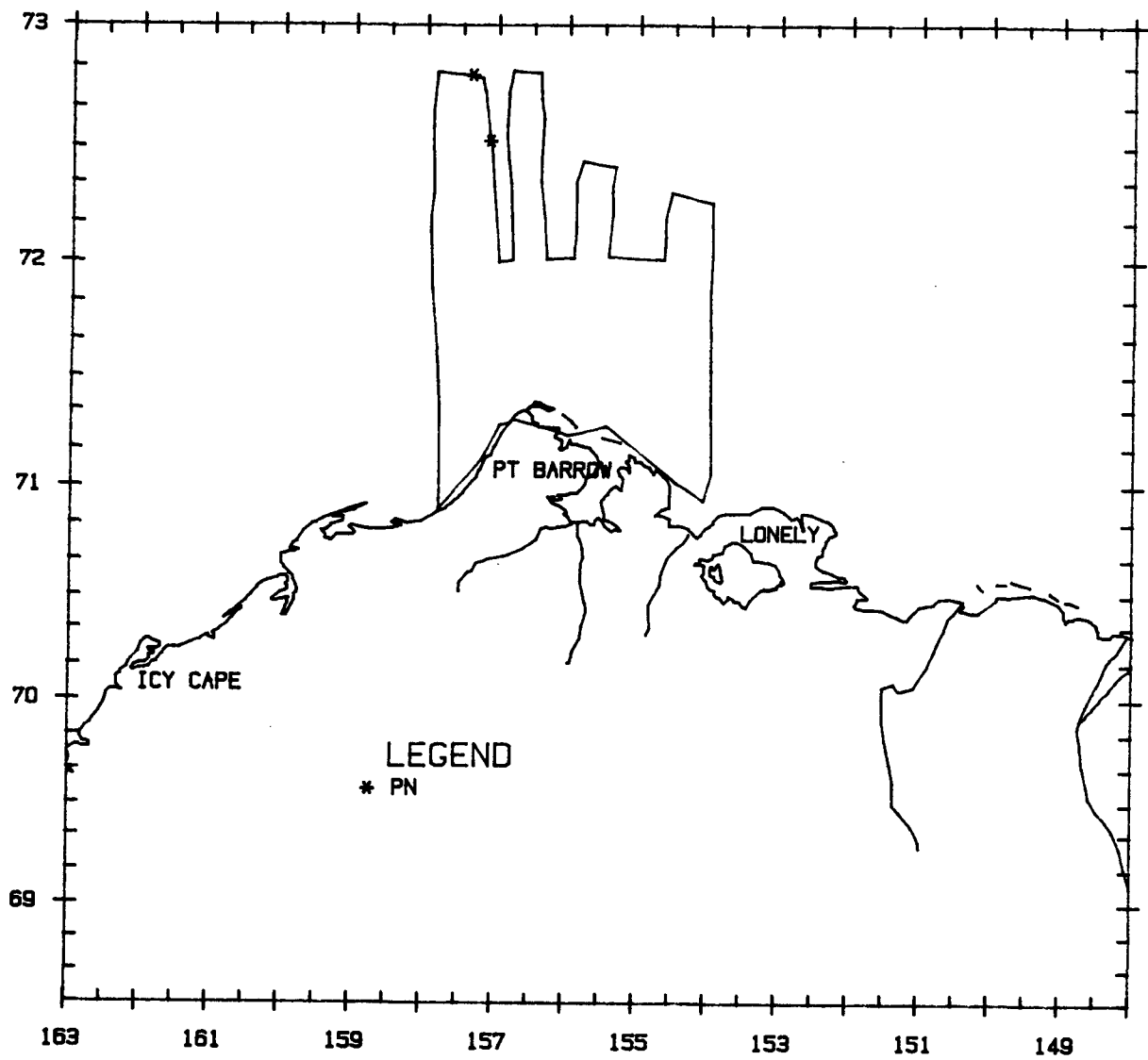
Unidentified Cetaceans

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 70°43.2' | 160°16.8' | 882 | BW | SW | 345 | 0 | B2 | 18 |
| 1/0 | 70°33.2' | 160°31.9' | 2080 | BW | SW | - | 2 | B1 | 18 |



Flight 35: 21 October 1987

Flight was a transect survey of the southern half of block 12-N and the easternmost two lines in block 13-N. Weather was overcast with low ceilings and fog, and visibility varied from less than 1 km to unlimited. There was 90 to 95 percent broken new ice starting at 72°10'N in eastern block 12-N, although the ice edge moved progressively north towards the west. In block 13-N, the ice edge was at 72°45'N. Sea state was Beaufort 00 in the ice and 01 to 03 in open areas. Unidentified pinnipeds were the only marine mammals seen. A sonobuoy was dropped just south of the ice edge. No whales were heard.



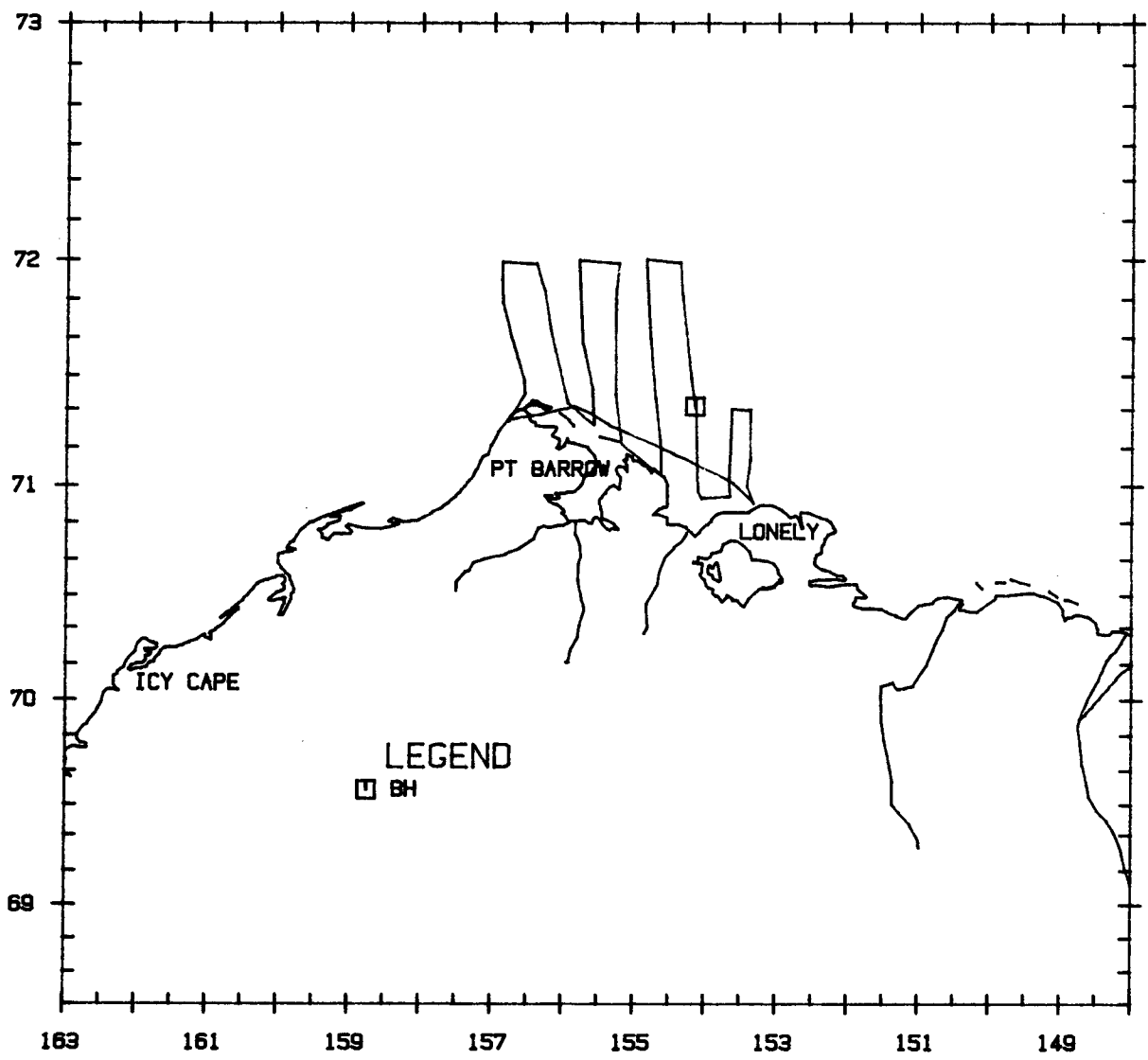
Flight 36: 23 October 1987*

Flight was a transect survey of block 12 and the western one-quarter of block 3. Weather was overcast with low ceilings, fog and snow squalls. Visibility varied from 10 km to less than 1 km. There was no ice except for slushy new ice just offshore of the barrier islands. Sea state was Beaufort 03 to 04. One bowhead was seen.

Bowhead Whale

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 71°20.5' | 154°09.9' | 317 | BO | SW | 110 | 2 | B3 | 24 |

*Data east of 154°W presented in Treacy (in prep.).



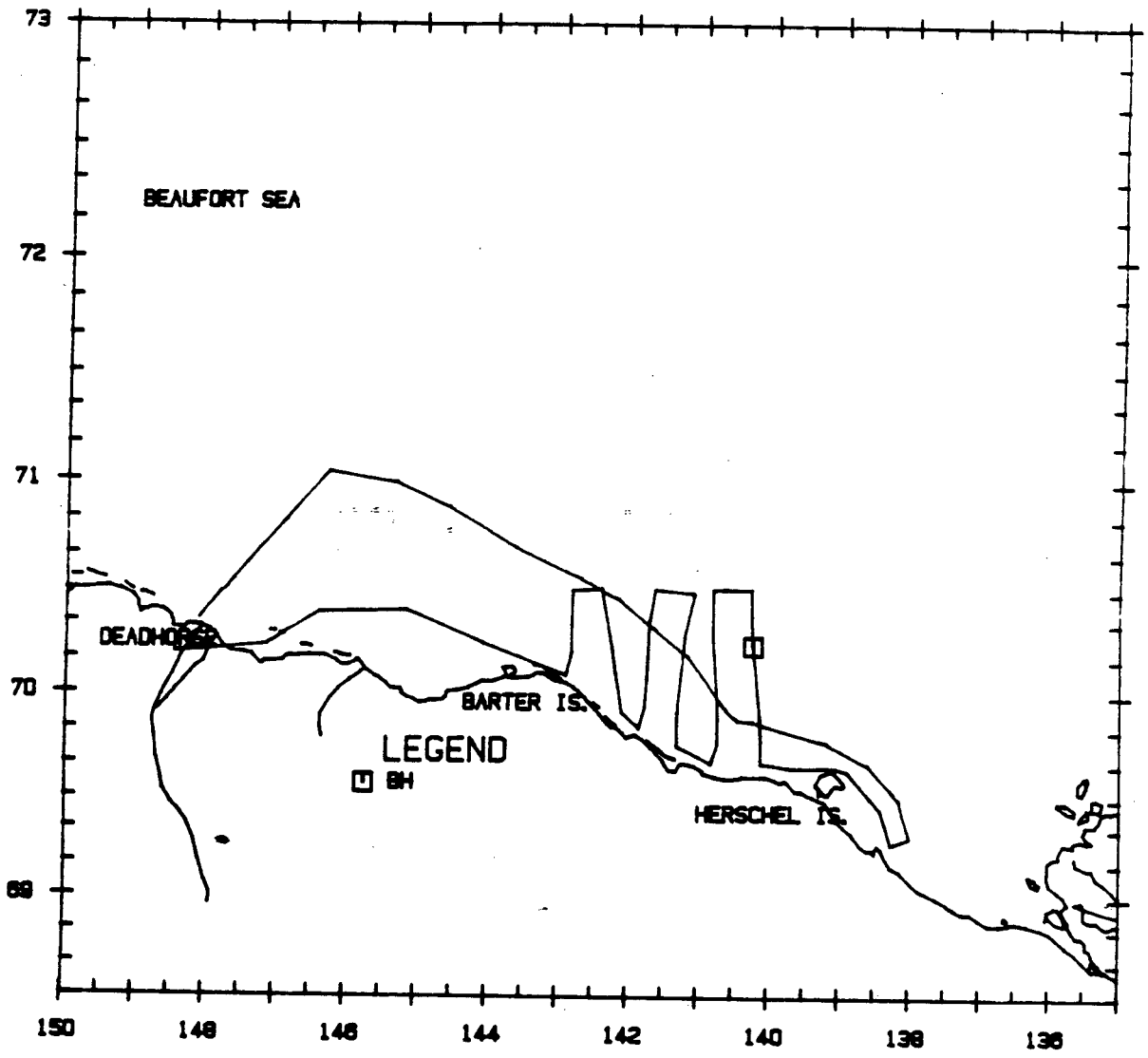
Flight 37: 25 October 1987*

Flight was a transect survey of block 5 and a search survey of blocks 1, 4, 5, and into the Canadian Beaufort. Weather was clear with unlimited visibility. There was slushy new ice in the very nearshore regions, with open water north of there. Sea state was Beaufort 01 to 02, except east of Herschel Island, Canada, where it was 04 to 05. One bowhead was seen.

Bowhead Whale

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 70°13.8' | 140°14.0' | 1446 | SP | SW | 240 | 0 | B2 | 62 |

*Data east of 154°W presented in Treacy (in prep.).



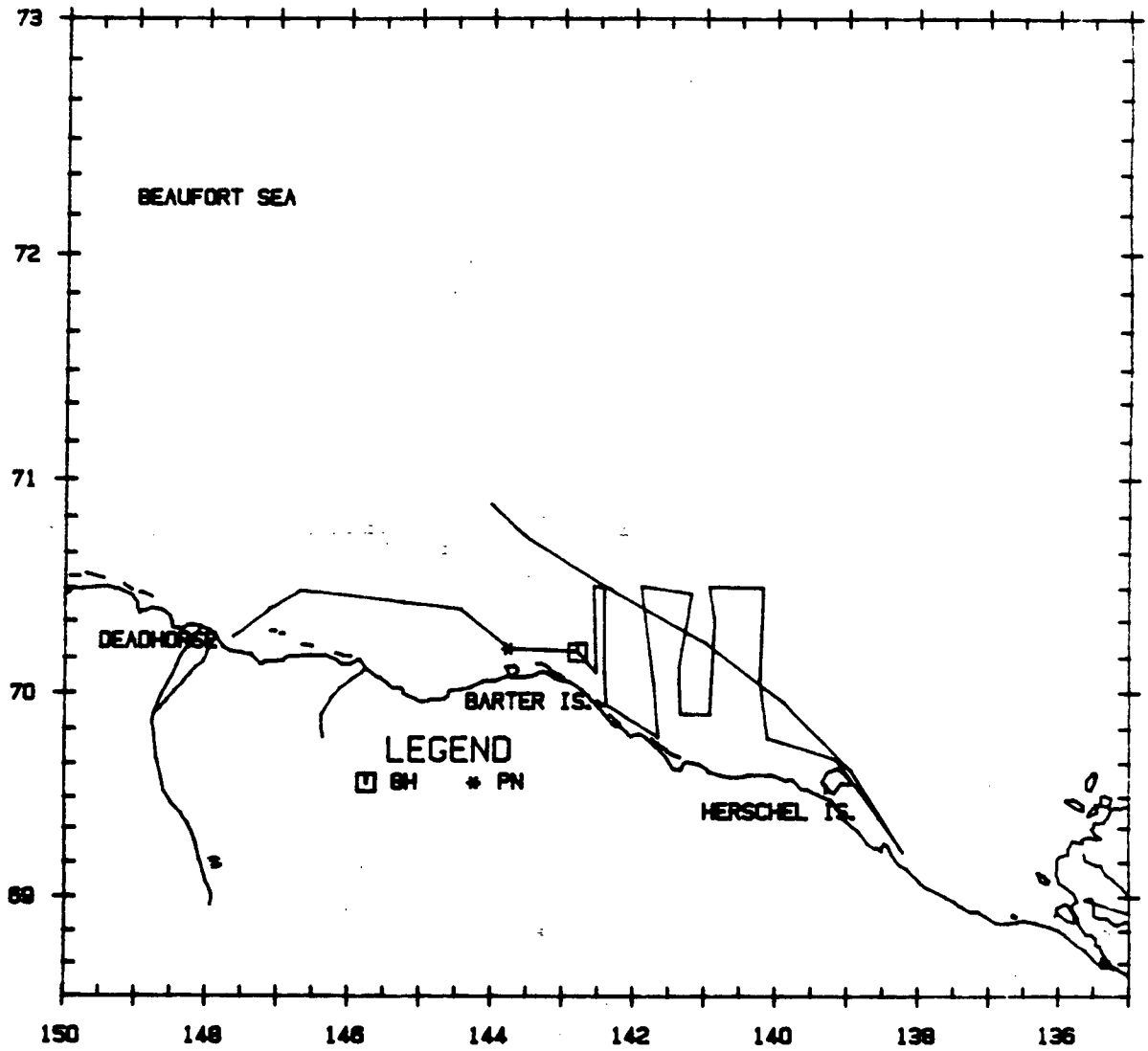
Flight 38: 28 October 1987*

Flight was a transect survey of block 5 and a search survey of blocks 1, 4, 5, and into the Canadian Beaufort. Weather was overcast with patchy fog, snow and low ceilings, especially in nearshore areas. Visibility varied from less than 1 km to unlimited. There was 60 to 75 percent slushy new ice from the shoreline out to 70°15'N, and open water with no ice north of there. See state was Beaufort 00 to 01 in areas with ice and 02 to 03 in open water. One bowhead and one unidentified pinniped were seen.

Bowhead Whale

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|------|-----|-----|-----|-----|----|-------|
| 1/0 | 70°11.6' | 142°46.6' | 1006 | BO | SW | 240 | 65 | B1 | 22 |

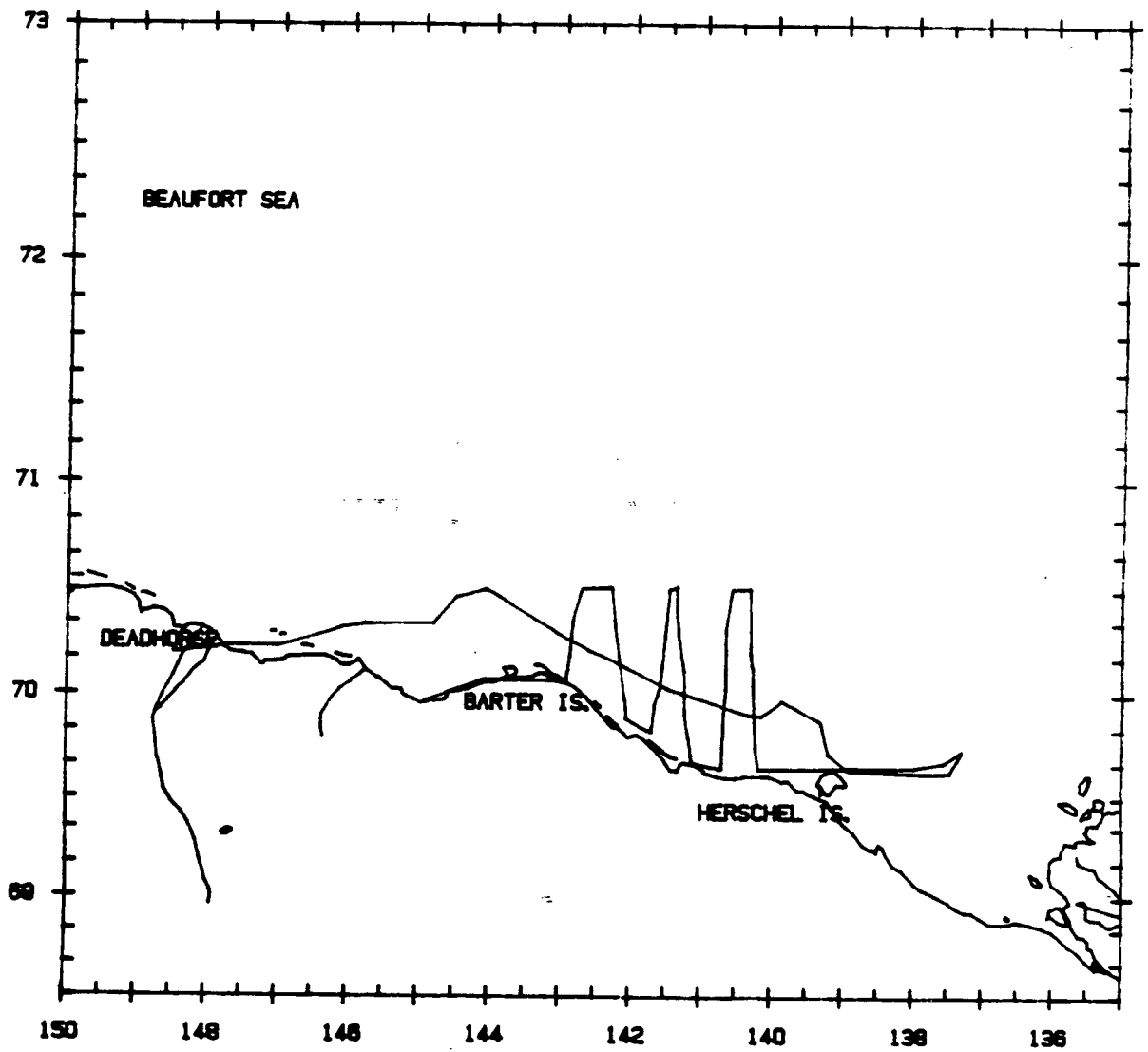
*Data east of 154°W presented in Treacy (in prep.).



Flight 39: 29 October 1987*

Flight was a transect survey of block 5 and a search survey of blocks 1, 4, 5, and the Canadian Beaufort. Weather was overcast with patchy fog, snow and low ceilings. Visibility varied from less than 1 km to unlimited. There was 85 to 95 percent grease ice south of $70^{\circ}15'N$ in block 5, with open water north of there. Most of the Canadian Beaufort east to $137^{\circ}30'W$ was open. Sea state was Beaufort 00 to 01 in areas with ice and 03 to 04 in open water. No marine mammals were seen.

*Data east of $154^{\circ}W$ presented in Treacy (in prep.).



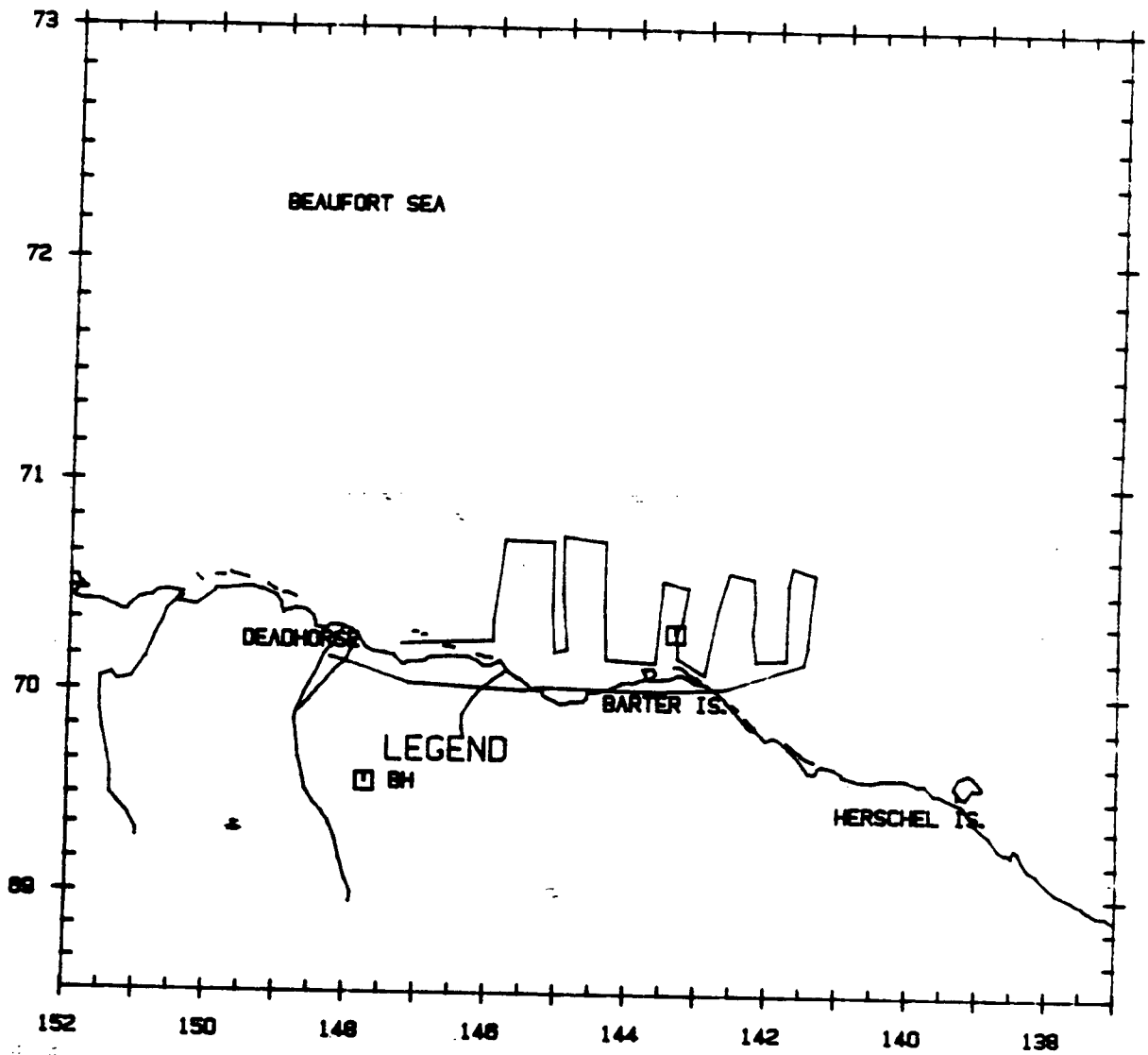
Flight 40: 30 October 1987*

Flight was a transect survey of portions of blocks 4, 5, 6, and 7. Weather was overcast with fog, snow squalls, and low ceilings. Visibility varied from less than 1 km to unlimited. There was 99 percent slushy new ice south of 70°N and 60 to 95 percent slushy new ice north to 70°20'N. Open water prevailed north of there. Sea state ranged from Beaufort 00 to 02 in ice, and 04 to 05 in open water. One bowhead was seen.

Bowhead Whale

| T#/C# | LAT | LONG | DIS | CUE | BEH | HDG | ICE | SS | DEPTH |
|-------|----------|-----------|-----|-----|-----|-----|-----|----|-------|
| 1/0 | 70°17.5' | 143°19.7' | - | BO | SW | 240 | 5 | B4 | 22 |

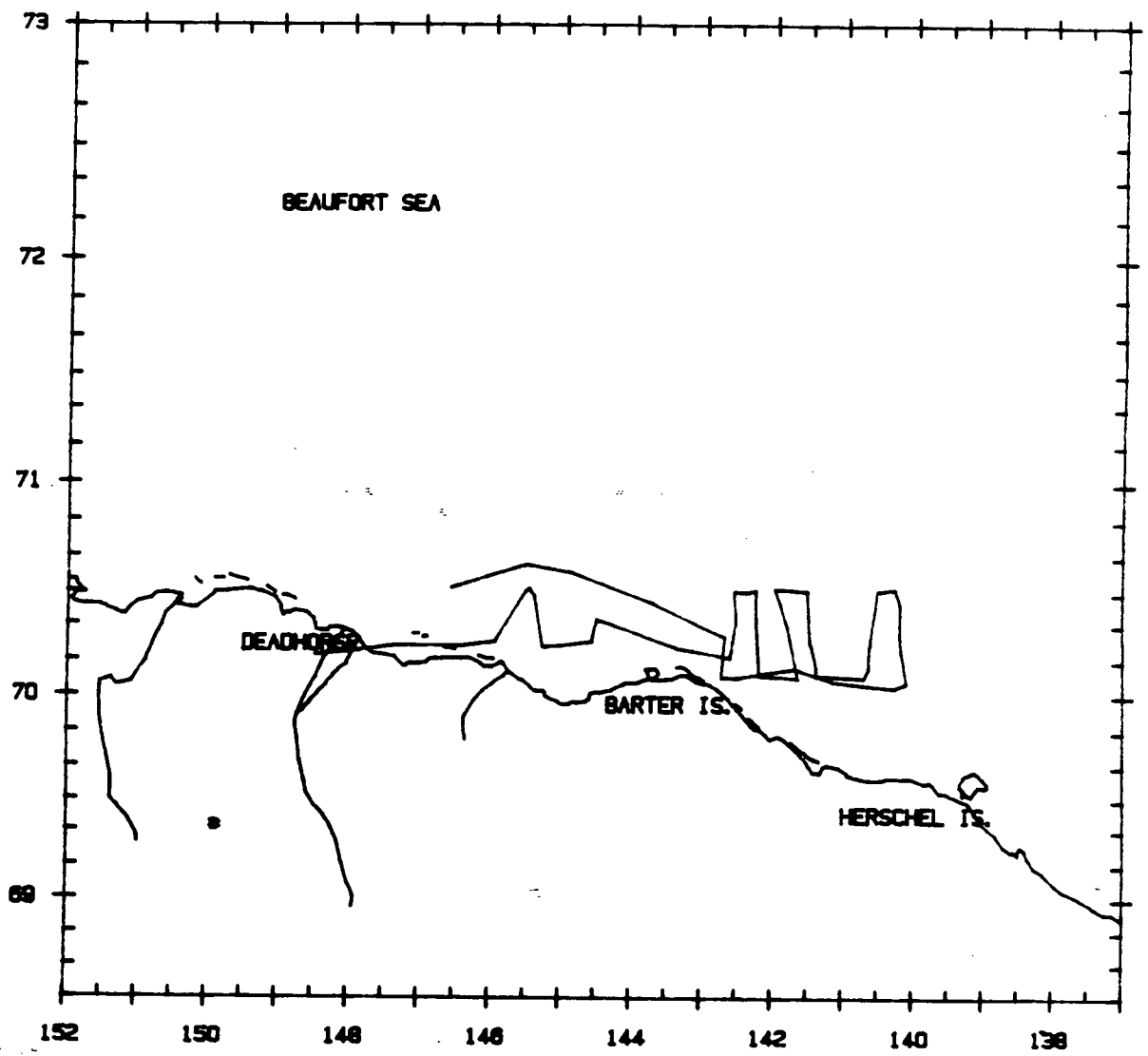
*Data east of 154°W presented in Treacy (in prep.).



Flight #1: 31 October 1987*

Flight was a transect survey of portions of blocks 4 and 5. Weather was overcast with low ceilings, fog, and snow squalls, which caused transect lines to be truncated. Visibility varied from less than 1 km to 5 km. There was 60 to 99 percent slushy grease ice in block 4 and the southern half of block 5, and open water in the northern half of block 5. Sea state varied from Beaufort 00 to 01 in ice to 02 to 03 in open water. No marine mammals were seen.

*Data east of 154°W presented in Treacy (in prep.).



APPENDIX B

**OBSERVED DENSITIES OF BOWHEAD AND GRAY WHALES
IN THE WESTERN BEAUFORT AND EASTERN CHUKCHI SEAS, 1979-87**



CONTENTS

| | Page |
|--|------|
| INTRODUCTION | B-1 |
| METHODS | B-1 |
| Density Estimates | B-1 |
| Strip and Line Transect Methodologies | B-3 |
| Map preparation | B-6 |
| Data processing and quality control | B-6 |
| Definition of Areas and Methodological Limitations | B-7 |
| Beaufort Sea Study Area (A-D) | B-8 |
| Survey Regions and Depth Contours | B-9 |
| Stratum (= region) Names | B-10 |
| Chukchi Sea Study Area | B-11 |
| Survey Regions 15-20 | B-11 |
| Statistics Presented in Tables | B-12 |
| Region Area km ² | B-12 |
| Percent of Total Area | B-12 |
| Percent of Area Surveyed | B-12 |
| Survey Time HR:MIN | B-12 |
| Percent of Total Time | B-12 |
| Number of Transects Flown | B-12 |
| Number of Bowheads Observed | B-12 |
| Density as Number per km ² , | B-13 |
| Variance and Confidence Interval | |

| | Page |
|---|-------------|
| RESULTS | B-13 |
| Estimates of Bowhead Whale Density | |
| Beaufort Sea Study Area | B-14 |
| September 1987 | B-14 |
| September Summary Statistics 1979-86 | B-15 |
| October 1987 | B-16 |
| October Summary Statistics 1979-86 | B-17 |
| Chukchi Sea Study Area | B-18 |
| September and October 1987 | B-18 |
| Estimates of Gray Whale Density | |
| Chukchi Sea Study Area | B-19 |
| September and October 1987 | B-19 |
| REFERENCES | B-20 |

FIGURES

| | Page |
|--|------|
| B-1. Due to aircraft design, the assumption of unity at centerline is modified to assume unity at two parrallel lines drawn by the 70° angle for the highest altitude flown | B-5 |
| B-2. The Beaufort Sea study area was divided into four regions: A, B, C, and D | B-8 |
| B-3. Map depicting the survey regions in the Beaufort Sea after stratification by contour intervals at 10m, 20m, 50m, 200m and 2000m | B-9 |
| B-4. Map depicting Beaufort Sea stratum names. Strata A1, B1, C1, D1A and D1B extended from the coast out to the 10-meter depth contour. Strata A2, B2, C2, D2A and D2B fell between the 10- and 20- meter depth countours; A3, B3, C3 and D3, fell between the 20- and 50- meter depth contours; etc. | B-10 |
| B-5. Map depicting coastal survey regions 16 and 17 and offshore regions 15, 18, 19 and 20 in relation to depth contours in the Chukchi Sea | B-11 |

TABLES

| | Page |
|--|------|
| B-1. Statistics from aerial surveys of bowhead whales conducted September 1987 in the Beaufort Sea | B-14 |
| B-2. Statistics from aerial surveys of bowhead whales conducted September 1979-86 in the Beaufort Sea | B-15 |
| B-3. Statistics from aerial surveys of bowhead whales conducted October 1987 in the Beaufort Sea | B-17 |
| B-4. Statistics from aerial surveys of bowhead whales conducted October 1979-86 in the Beaufort Sea | B-18 |
| B-5. Statistics from aerial surveys of bowhead whales conducted September and October 1987 in the eastern Chukchi Sea | B-21 |
| B-6. Statistics from aerial surveys of gray whales conducted September and October 1987 in the eastern Chukchi Sea | B-22 |

INTRODUCTION

This appendix presents an analysis of endangered whale aerial survey data collected during 1987, and a summary of similarly analyzed data for 1979-86. The objectives of the analysis were to estimate the density of bowhead whales in the western Beaufort Sea, and of gray whales in the eastern Chukchi Sea. Estimating the density of a species provides an evaluation of the relative importance of an area to that group. The density estimate for a particular area is useful when assessing how a portion of a species' range is utilized by the population. Sequential density estimates provide an invaluable tool when determining a population's response to its environment through time.

An important component of this analysis was determining the distribution of survey effort within specific areas. The western Beaufort Sea was treated as one study area bounded by 153°30'W and 157°W longitude and 72°N latitude to the coastline. The Chukchi Sea was treated as a second study area bounded by 67°30'N and 72°N latitude and the coastline to 166°W longitude. Both study areas were subdivided to more precisely illustrate survey effort and density of animals. Distribution of survey effort and density of bowhead whales in the western Beaufort and gray whales in the eastern Chukchi Seas were examined during September and October.

METHODS

Density Estimates

Estimating population density requires calculating the portion of that population which is never sighted. In order to correctly estimate density of any population, four underlying assumptions must be adhered to. The assumptions are as follows:

- There are no measurement errors and no rounding errors.
- Sightings are independent events.
- Individuals are fixed at an initial sighting position and no individuals are counted twice.
- A sample of the population is collected at random; no individual is biasedly selected during a count (Cox, 1958; Anderson et al., 1976).

Two factors inherent in a study of cetaceans that cause an individual to be missed during a count are sightability and submergence. Sightability means an individual may be at the surface but missed by the observer. As the distance increases between the observer and a whale, the chance of sighting the whale decreases (Doi, 1974). Transect estimators are designed to work in planar situations. Hence, it is the portion of a population surfaced but not sighted that is calculated when estimating population density. Secondly, whales are not sighted because they are submerged. A distinction must be made between whales at the surface but not sighted, and submerged whales that cannot be sighted. Submerged whales are **never** calculated in the population density estimate. These whales represent a source of known but currently unmeasurable error in the total population estimate (Eberhardt et al., 1979). Additional assumptions peculiar to estimating cetacean density that stem from their sightability and submergence characteristics are:

- o Only surfaced animals are counted, and density estimates are calculated only for the population of whales not submerged during an observation period.¹
- o The whales' behaviors do **not** change over the period for which an estimate is calculated (i.e., whales maintain the same swimming speeds and dive patterns throughout the migratory period). This assumption is critical, but difficult to satisfy because whales' behaviors do change over the period of migration.
- o Observers are equally effective on both sides of the aircraft and in all areas of the sighting sector. This assumption is necessary since each observer's sightings are weighted equally by formulas used in calculating population size. Any deviation from this assumption will cause a negative or downward bias on the final estimate.

¹A combined estimate of the population of surfaced and submerged whales can be calculated if a ratio of dive time to surface time is known. This ratio is a correction factor which permits one to adjust the population estimate to incorporate submerged whales. Presently no good correction factor exists for all behavioral situations. Bowheads seen during the fall in the Alaskan Beaufort Sea can either be actively migrating, moving slowly, resting, milling, or feeding.

- o Group size does not affect detection of whales. A violation of this assumption would cause a negative bias, since some classes of groups would not be sighted. This assumption is probably violated because larger groups are indeed easier to sight and because the larger the group, the higher the probability of having a whale at the surface.
- o Whales do not evade the aircraft. This assumption is probably met because the speed of the aircraft is so much greater than that of the whales (i.e., the aircraft probably approaches a whale before the whale can evade it by diving).
- o Unity of detection occurs on the flight track. All whales are sighted if they are on the transect line. The only whales that an observer fails to sight are those that are some distance away from the survey aircraft (Burnham et al., 1980).

Strip and Line Transect Methodologies. Strip transect and line transect represent two analytical methodologies used to derive density estimates. The fundamental difference between the two is that a strip transect samples a strip defined by boundaries, while line transect samples an area without boundaries. Both methods sample from a predetermined, randomly selected transect. The basic formula for strip transect estimators (Hayne, 1949) is:

$$N = \frac{nA}{2LH} ,$$

where N is the estimated animal population, n is the number of individuals counted, A is area of strip, L is the transect length, and H is the mean sighting distance. Strip transects have a predetermined strip width, within which the observer is required to be certain of counting all individuals. This method does not utilize a detection function that incorporates sightings to the horizon. Individuals outside the strip are not counted, even if seen. For this reason, strip transect methods are recommended when the species density is high and individual counts are large. Line transect estimators are, conceptually, a strip transect with infinite strip width. Line transect methods use the following formula to estimate density:

$$D = \frac{n f(o)}{2L} ,$$

where D is the estimated density, n is the number of animals sighted while surveying from a transect, $f(o)$ is the normalized detection function or the probability of sighting an animal, and L is the total transect length surveyed. The number of animals sighted and the transect length surveyed are known parameters. The detection function is the probability of sighting a surfaced whale at a known distance from the transect and must be estimated for density to be calculated. It is used to determine the number of animals on the surface that are not seen. As long as sampling is completed as a series of random transects, the detection function $f(o)$, is the critical estimation made. Determining which specific mathematical model best fits the detection function is most easily done by program computer models. TRANSECT (Burnham et al., 1980) is a program inclusive of parametric and nonparametric mathematical models applicable to fitting curves to data consisting of perpendicular distances.

A critical assumption that must be satisfied to validate the detection function is unity at the transect line; all individuals that occur on the transect line are counted. This assumption was violated because the aircraft's design prevented searching between clinometer angles of 90° and 70° from the horizon. To compensate, all perpendicular distances were adjusted by subtracting a distance from the transect's centerline to a parallel line drawn by the 70° angle specific for the highest altitude flown. The original assumption of unity is modified to assume unity of sightings at these two parallel lines (figure B-1). The lines are placed at a position equidistant from the transect line, the distance being the perpendicular distance for a 70° clinometer angle at the highest altitude surveyed.

Previous studies have shown that both the accuracy and precision of line transect estimators rely on the ability of the observer to determine the exact distance of an individual sighting from the transect line. A fundamental problem now arises. The transect line has been transformed to represent two parallel lines determined by a 70° clinometer angle at the highest altitude surveyed. If a sighting occurs at an altitude lower than the altitude used to attain the parallel transect lines, but at a 70° angle, the sighting will occur in a mathematical "blind spot", the blind spot being the area between the two parallel lines. A blind spot confuses any effort to mathematically model the true probability of detecting whales at varying distances from the survey aircraft. A negative bias or underestimation of the true population is the result of a mathematical blind spot.

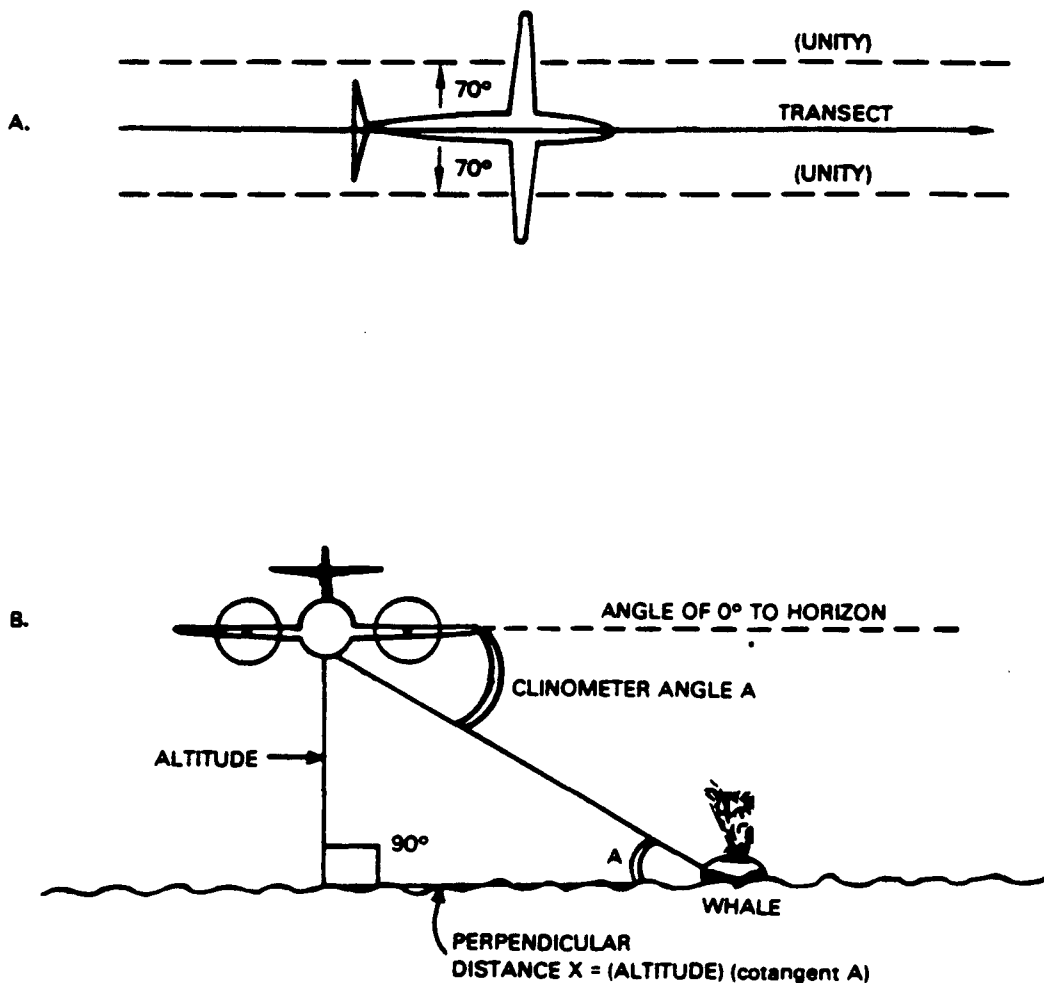


Figure B-1. Due to aircraft design, the assumption of unity at centerline is modified to assume unity at two parallel lines drawn by the 70° angle for the highest altitude flown.

A second method employed by Leatherwood et al. (in press) to compensate for the blind spot beneath the aircraft during line transect analysis, replaced the parallel-line assumption with a new one that requires all marine mammals to be seen at some fixed perpendicular distance (x_0) from the transect line. The resulting density values experience no aliasing, as introduced by the subtraction method when estimating sightability via the detection function, but nevertheless result in a minimum estimate.

One additional assumption that may be violated is that there are no measurement errors and no rounding errors. Exact sighting angles are difficult to obtain. A deviation of several degrees from the true sighting angle will significantly alter a line transect density estimate.

Map Preparation

Maps were prepared using the computer program AMP (A Mapping Package), consisting of FORTRAN subroutines which can be used for customized plotting applications. AMP was used to plot aerial survey data that resided on file as a series of geographic coordinates (latitude and longitude) associated with time and sightings of whales. Land masses are part of the AMP database. Depth contours were plotted by reading a separate file of data points prepared for this analysis.

Depth contours were digitized using several reference maps. It was necessary to use more than one map because not all contours were available on any one map. The U.S. Geological Survey Map Open - File 76 - 823, Sheet 1 or 2 was used to digitize the 50-m and greater depth contours, plus all contours shown in the Chukchi Sea except for the 30-m depth contour off the Soviet coastline. The 30-m depth contour off the Soviet coastline and in the Bering Sea was taken from U.S. Department of Commerce map 514, 4th Ed., Apr. 11/81. In the Beaufort Sea, the 10-m, 20-m, and 30-m depth contours were taken from two maps labeled Data from: Geophysical Corp. of Alaska, 1975, NOAA, Department of Commerce Charts, USGS Department of Interior Charts, which were additionally labeled as Eastern Beaufort Sea and Western Beaufort Sea.

When the depth contours were merged onto a single data file and plotted, some inconsistencies became apparent. For example, a 30-m depth contour from one map file crossed over the 50-m depth contour from another map file. When this situation occurred, a portion of one of the depth contours was clipped to resolve the inconsistency. Note that portions of the 20-m and 30-m depth contours were clipped near Pt. Barrow, Alaska, and that the 50-m depth contour was clipped near St. Lawrence Island in the Bering Sea.

Data Processing and Quality Control

A computer program (SPEED) was written to screen for bad data values and to check the chronological order of time. Aerial survey data files were screened for obvious errors in geographic position by separately plotting the course of each daily aerial survey. A computer program was used to calculate flight speeds and distances on a point-to-point basis, and listings of these values were scanned for suspiciously slow or fast speeds. The listings and maps were compared; errors were flagged and edited and the process was repeated until data files were error-free with respect to these conditions.

Definition of Areas and Methodological Limitations

The Beaufort Sea study area was divided into four regions from west to east (figure B-2). Region A extended from 157°00'W to 153°30'W, region B from 153°30'W to 150°00'W, region C from 150°00'W to 146°00'W, and region D from 146°00'W to 141°00'W. Depth contours were used to stratify the Beaufort Sea from north to south. Depth contours of 10 m, 20 m, 50 m, 200 m, and 2000 m were selected (figure B-3). The stratum from the coastline to 10 m corresponded closely to the area inside the barrier islands (A1, B1, C1, D1A, and D1B). The shelf area (10 m to 200 m) and offshelf (200 m to >2000 m) were stratified from 10 m to 20 m, 20 m to 50 m, 50 m to 200 m, 200 m to 2000 m, and deeper than 2000 m. Areas A2, B2, C2, D2A and D2B corresponded to the 10-m to 20-m strata; areas A3, B3, C3, and D3 corresponded to the 20-m to 50-m strata, and so on (figure B-4).

In 1987, Beaufort Sea transect surveys were conducted by MMS personnel between 140°W and 146°W to 71°10'N, and between 146°W and 154°W as far north as 71°20'N. This area corresponds to portions of regions B, C, and D. In addition, all survey effort and bowhead sighting data in region B collected by this project were incorporated with the MMS data, with resultant density estimates for (sub)regions B, C, and D presented in the MMS report (Treacy, in prep.) along with the survey effort and sighting data. Density estimates for region A are presented here because this area corresponds to survey effort and sighting data presented in the body of this report.

Survey regions in the Chukchi Sea were determined based on survey effort and animal distributions (figures B-5). Transect surveys have been conducted in the Chukchi Sea only since 1982. Prior to 1982, coastal search surveys were infrequently flown through the study area. The establishment of coastal (regions 16 and 17) and offshore survey regions (15 and 18-20) reflect this distribution of survey effort. These regions did not conform to survey blocks.

A digitizer was used to trace region boundaries, which led to a boundary problem termed "splinter error." The technique used to digitize each region was to circumscribe it by tracing the boundary of the region. Thus, when two regions were adjacent, the common boundary would be digitized twice. In fact, a boundary was often digitized more than twice. For example, the boundary between regions A1 and B1 was digitized four times because it served not only as a boundary between regions A1 and B1 but also between the larger regions A and B. A splinter error occurred when one set of points defining a common boundary did not exactly match the second, third, or fourth set of points used to define the same boundary for other regions.

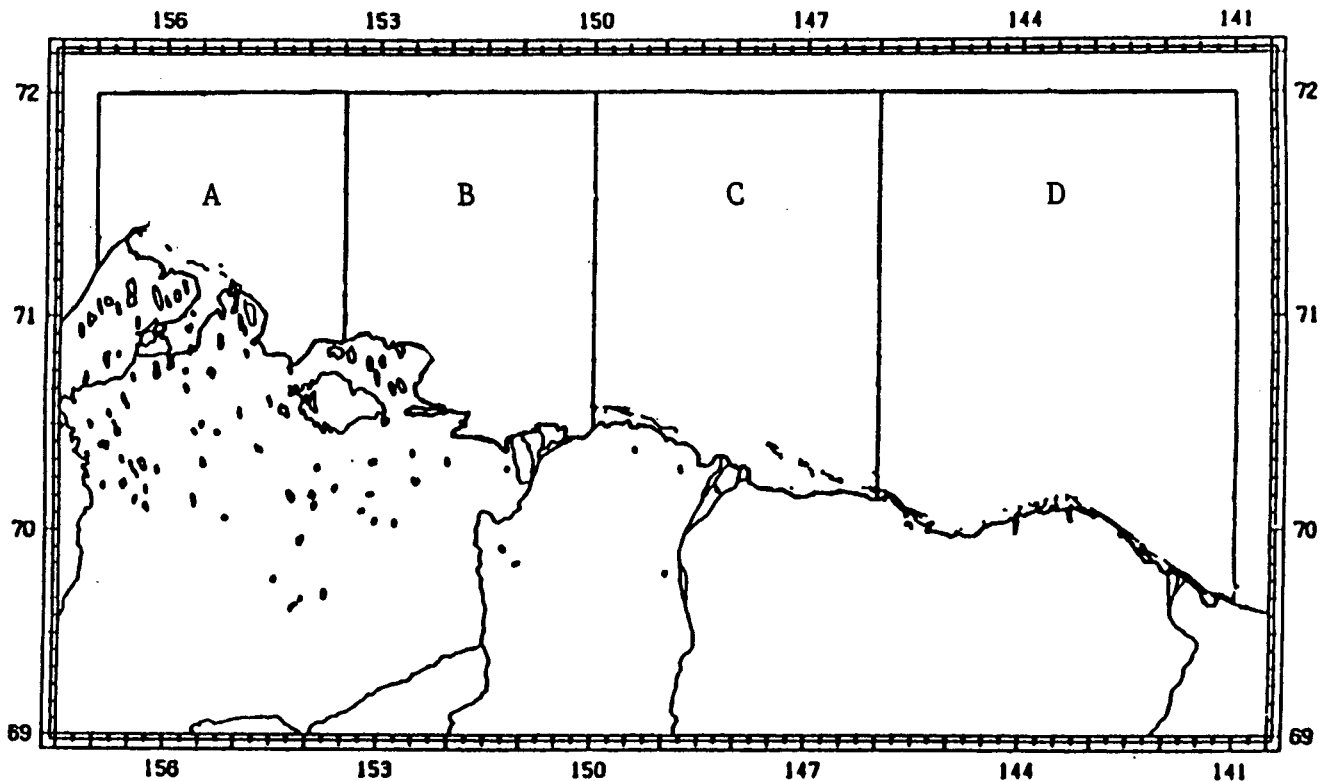


Figure B-2. The Beaufort Sea study area was divided into four regions: A, B, C, and D.

Because of this splinter error problem, a very small percentage of the total area may be shared by two regions or may be left out of a region. For example, because of overlap, a small portion of the Beaufort Sea may have been shared during the analysis of two adjacent regions. Conversely, if two sets of points defining a common boundary diverged slightly, a small portion of the Beaufort Sea could have been left out of the analysis.

The implications of the splinter error problem are small in relation to this study. Statistics reported for each subregion, region, and the total study area are valid, but there may be small discrepancies when the values of subregions are summed and compared to the values reported for larger regions, e.g., number of survey hours flown, listed in the tables as survey time.

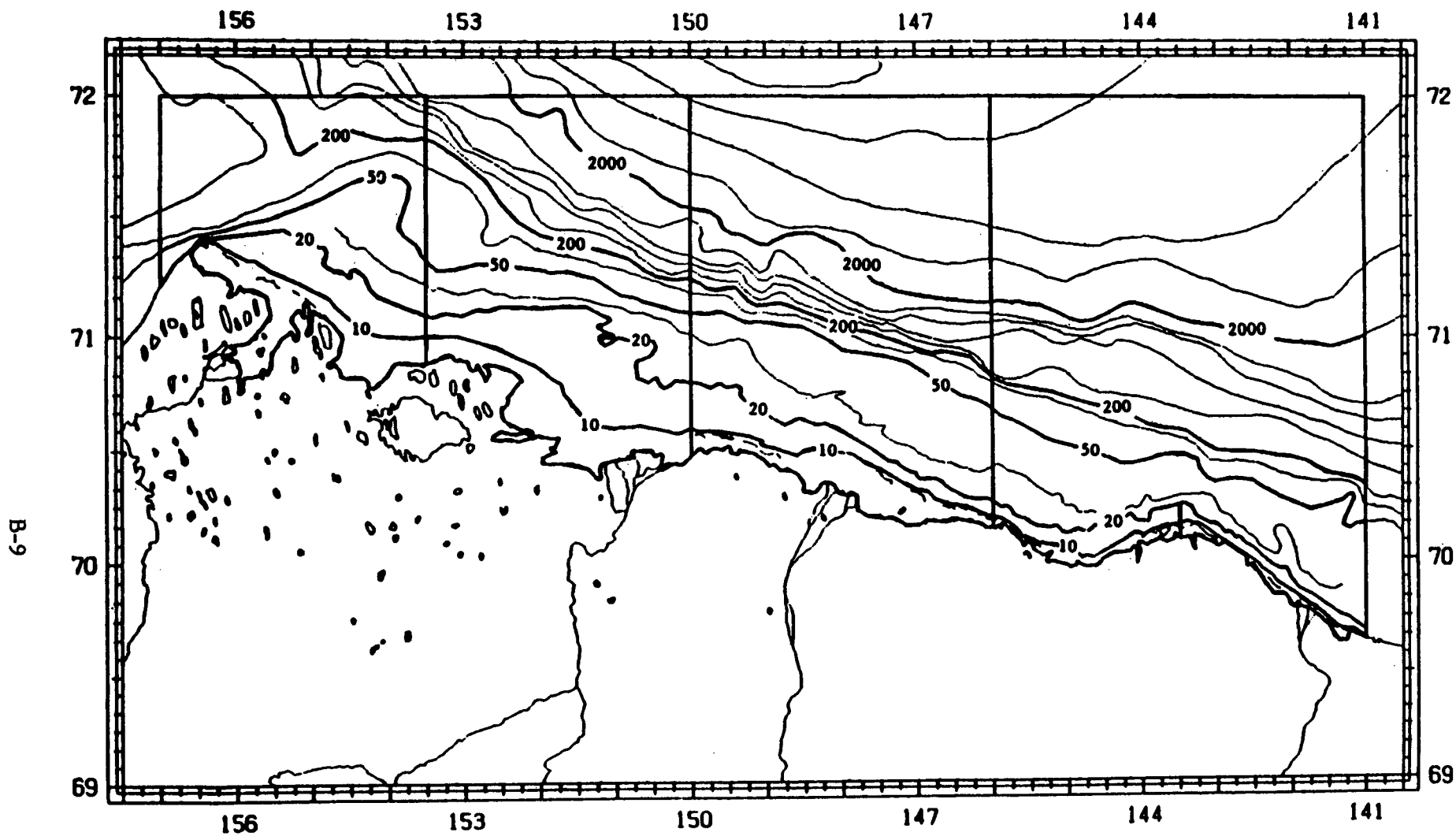


Figure B-3. Map depicting the survey regions in the Beaufort Sea after stratification by contour intervals of 10 m, 20 m, 50 m, 200 m and 2000 m.

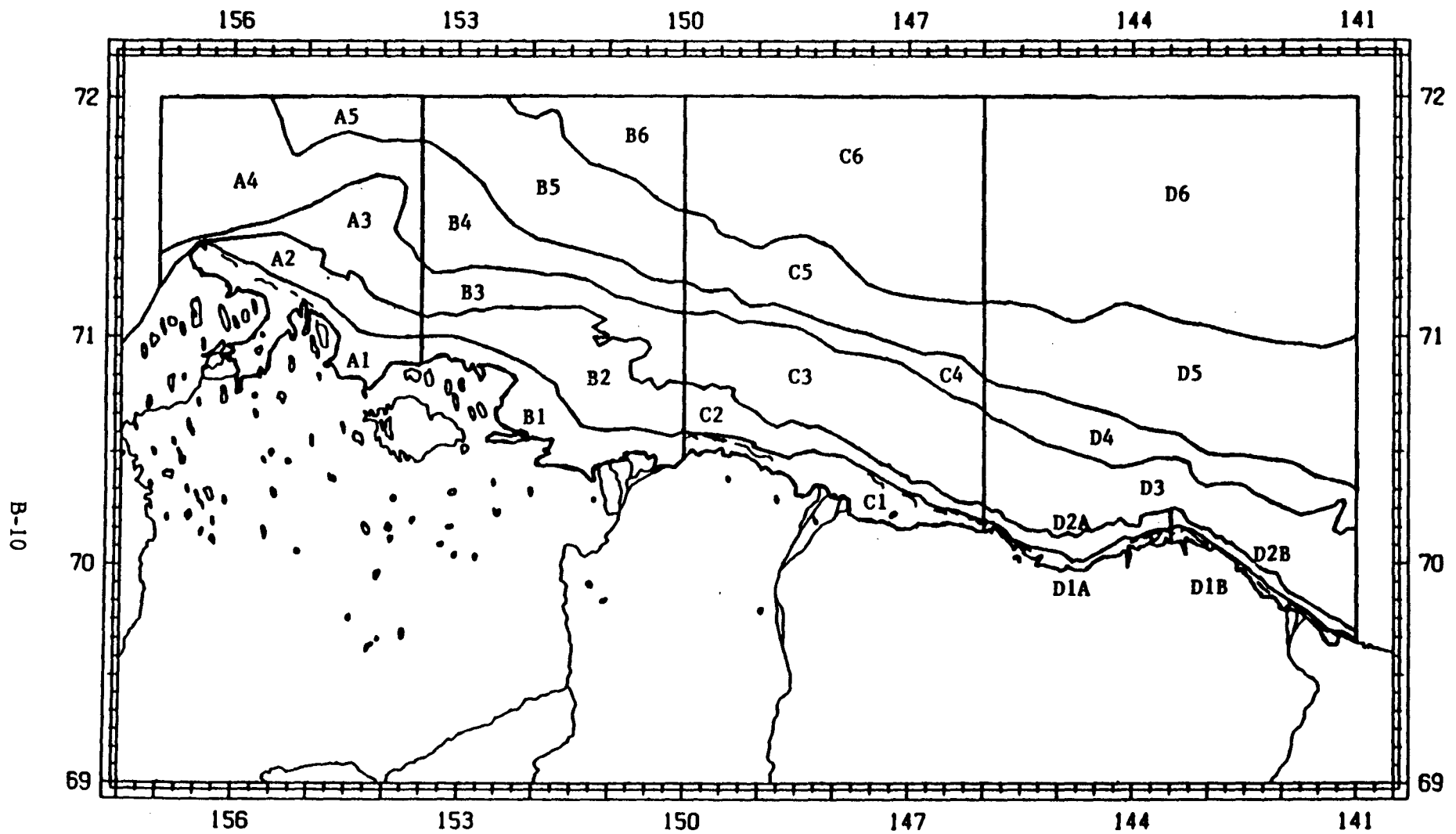


Figure B-4. Map depicting Beaufort Sea stratum names. Strata A1, B1, C1, D1A and D1B extended from the coast out to the 10 meter depth contour. Strata A2, B2, C2, D2A and D2B fell between the 10- and 20-meter depth contours; A3, B3, C3 and D3, fell between the 20- and 50-meter depth contours; etc. Strata D1A, D1B, D2A and D2B are enlarged in Figure B-6.

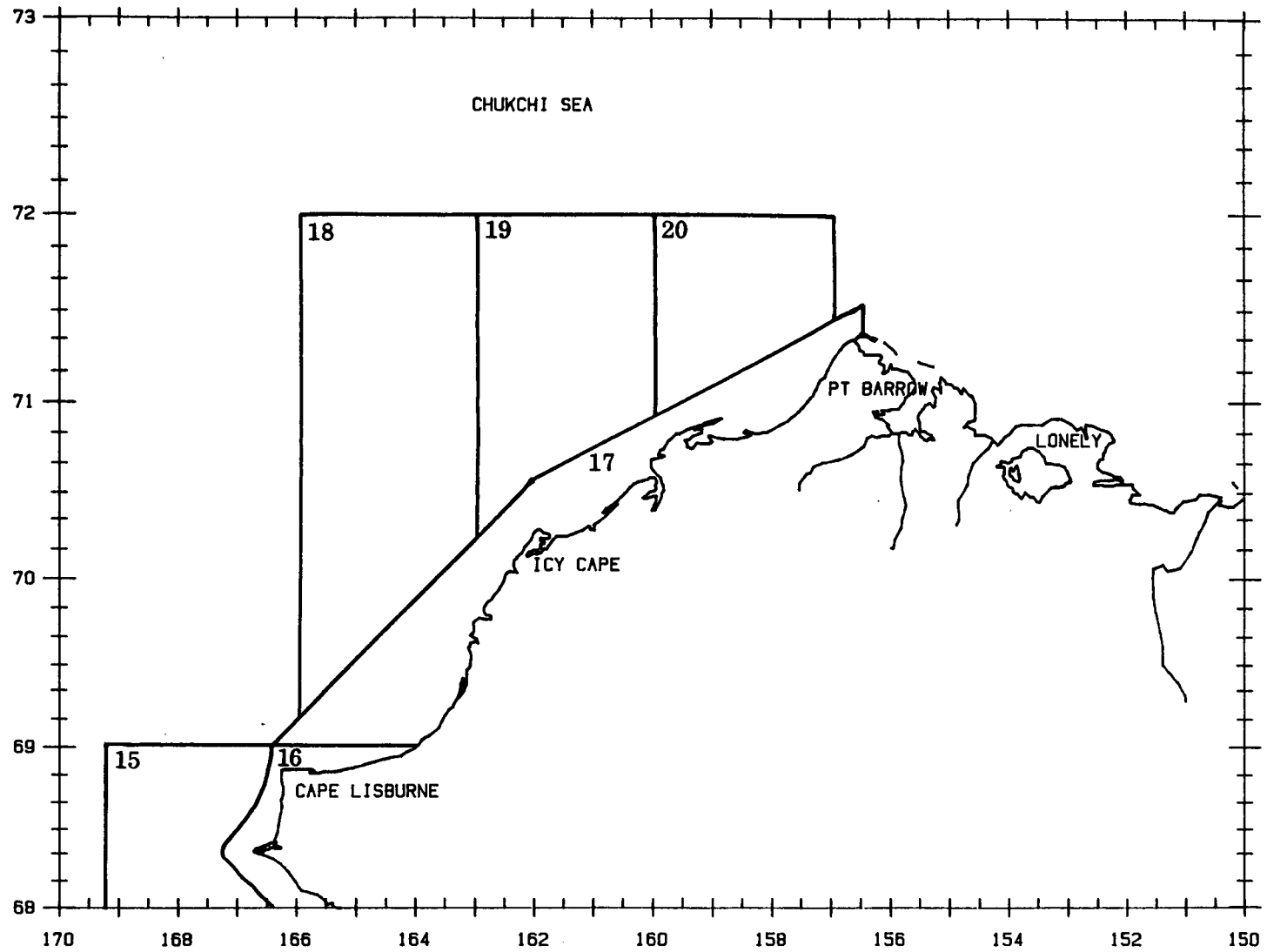


Figure B-5. Map depicting coastal survey regions 16 and 17 and offshore regions 15, 18, 19 and 20.

Statistics Presented in Tables

Region Area km². Areas were approximated by straightline integration which contributed to discrepancies between the summation of subregion areas and areas calculated for larger regions. Area calculations are accurate to within about 1 percent of the true area.

Percent of Total Area. The percent of total area was calculated as the region area divided by the sum of all subregion areas; this quantity was then multiplied by 100.

Percent of Area Surveyed. The percent of area surveyed is a relative measure of survey effort expended per survey region. Strip width was defined as 2 kilometers (i.e., 1 kilometer on either side of the aircraft). Therefore, the total number of kilometers flown equalled half the number of square kilometers surveyed. The percent of total area was calculated as the number of square kilometers surveyed divided by the region area; this quantity was then multiplied by 100.

This technique did not account for overlapping aerial survey strips which result in double counting the area surveyed. Therefore, some areas surveyed may show more than 100-percent coverage.

Survey Time HR:MIN. This is the time in hours and minutes spent surveying an area. Because of splinter errors and rounding errors, the values reported for time spent surveying subregions did not always equal those reported for larger regions.

Percent of Total Time. This is the time in hours and minutes spent surveying a region divided by the sum of survey times reported for each subregion.

Number of Transects Flown. Transects or flight legs were defined as units of survey effort by the aerial survey team. The beginning and ending of transects were further defined by the survey region boundaries. A portion of an aerial survey leg passing over a region was treated as a transect relative to that region. Thus, one transect could be broken into several transects with respect to subregion analyses. For this reason, the sum of the transects based on subregions was greater than the total number of transects reported for the total region.

Number of Bowheads Observed. This indicates the number of bowhead whales observed within one kilometer of either side of the aircraft.

Density as Number per km², Variance and Confidence Interval. Calculation of density statistics for each stratum followed the method employed by Krogman et al. (1979), which was based on the strip transect technique described in Estes and Gilbert (1978):

$$\hat{R} = \Sigma y_i / \Sigma x_i \quad (1)$$

where \hat{R} = observed density of whales per square kilometer
 y_i = number of whales observed in the i th strip transect
 x_i = area of the i th strip transect.

$$S^2_{\hat{R}} = [\Sigma (y_i^2 / x_i) - R \Sigma y_i] / (n-1) (\Sigma x_i) \quad (2)$$

where $S^2_{\hat{R}}$ = variance of R
 n = number of strip transects.

$$C.I. = \hat{R} \pm t_{0.05(2)V} \sqrt{V(\hat{R})}. \quad (3)$$

The notation $t_{0.05(2)V}$ refers to the critical value of t where alpha (α) = 0.05 (1- = 0.95) based on two-tailed test with V degrees of freedom. Degrees of freedom were calculated as the total number of transects minus one.

RESULTS

Results are presented by species, area, and month as outlined in the table of contents. Each presentation consists of a:

- Table of statistics associated with each region presenting 1987 data
- Summary table of statistics associated with each region, 1979-86

Table B-1. Statistics from aerial surveys of bowhead whales conducted September 1987 in the Beaufort Sea. Values for each region were summed where appropriate. Region numbers refer to areas depicted in Figure B-4. Survey effort in region B 405 hr/37 transects incorporated in Treacy (in prep.).

| Region Name | Region Area km ² | Percent of Total Area | Percent of Area Surveyed | Survey Time HR:MIN | Percent of Total Time | Number Transects Flown | Number Bowheads Observed | Density as Number per 100 km ² | Variance (10 ⁻⁴) | Confidence Range of Density |
|-------------|-----------------------------|-----------------------|--------------------------|--------------------|-----------------------|------------------------|--------------------------|---|------------------------------|-----------------------------|
| Total | * 32,953 | 100.00 | 7.08 | 14:17 | 100.00 | 170 | 1 | 0.014 | 0.0003 | 0-0.049 |
| A | 13,360 | 40.54 | 38.37 | 10:14 | 71.71 | 133 | 1 | 0.020 | 0.0006 | 0-0.066 |
| A1 | 2,361 | 7.16 | 9.66 | 00:29 | 3.37 | 20 | 1 | 0.438 | 0.0778 | 0-1.022 |
| A2 | 1,648 | 5.00 | 40.55 | 01:20 | 9.33 | 24 | 0 | 0 | 0 | 0 |
| A3 | 2,688 | 8.16 | 40.69 | 02:11 | 15.32 | 36 | 0 | 0 | 0 | 0 |
| A4 | 5,166 | 15.68 | 50.14 | 05:10 | 36.18 | 35 | 0 | 0 | 0 | 0 |
| A5 | 1,497 | 4.54 | 36.42 | 01:04 | 7.51 | 18 | 0 | 0 | 0 | 0 |

*The total area of all regions was approximately 32,953 km²; areas were approximated by straight line integration.

Table B-2. Statistics from aerial surveys of bowhead whales conducted in September, 1982-86. There were no bowheads seen on transect in regions A in September 1979-81; for summary effort data please see Ljungblad et al. (1987).

| Region Name | Region Area km ² | 1982 | | | 1983 | | | 1984 | | |
|-------------|-----------------------------|--------------------------|--------------------------|---|--------------------------|--------------------------|---|--------------------------|--------------------------|---|
| | | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² |
| Total | 32,953 | 25.34 | 5 | 0.06 | 41.06 | 12 | 0.09 | 15.06 | 3 | 0.06 |
| A | 13,360 | 13.85 | 2 | 0.11 | 32.20 | 5 | 0.12 | 10.45 | 3 | 0.22 |
| A1 | 2,361 | 8.00 | 0 | 0.0 | 8.79 | 0 | 0.0 | 3.41 | 0 | 0.0 |
| A2 | 1,648 | 24.03 | 0 | 0.0 | 36.17 | 0 | 0.0 | 12.94 | 0 | 0.0 |
| A3 | 2,688 | 25.53 | 0 | 0.0 | 43.55 | 2 | 0.17 | 11.81 | 1 | 0.32 |
| A4 | 5,166 | 10.39 | 2 | 0.37 | 34.45 | 3 | 0.17 | 11.98 | 2 | 0.32 |
| A5 | 1,497 | 2.78 | 0 | 0.0 | 36.59 | 0 | 0.0 | 11.09 | 0 | 0.0 |

| Region Name | Region Area km ² | 1985 | | | 1986 | | |
|-------------|-----------------------------|--------------------------|--------------------------|---|--------------------------|--------------------------|---|
| | | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² |
| Total | 32,953 | 6.84 | 0 | 0.0 | | 0 | 0.0 |
| A | 13,360 | 8.68 | 0 | 0.0 | 10.26 | 0 | 0.0 |
| A1 | 2,361 | 2.61 | 0 | 0.0 | 2.14 | 0 | 0.0 |
| A2 | 1,648 | 10.71 | 0 | 0.0 | 10.94 | 0 | 0.0 |
| A3 | 2,688 | 10.31 | 0 | 0.0 | 11.28 | 0 | 0.0 |
| A4 | 5,166 | 10.05 | 0 | 0.0 | 12.98 | 0 | 0.0 |
| A5 | 1,497 | 8.31 | 0 | 0.0 | 11.13 | 0 | 0.0 |

Table B-3. Statistics from aerial surveys of bowhead whales conducted October 1987 in the Beaufort Sea. Values for each region were summed where appropriate. Region numbers refer to areas depicted in Figure B-4.

| Region Name | Region Area km ² | Percent of Total Area | Percent of Area Surveyed | Survey Time HR:MIN | Percent of Total Time | Number of Transects Flown | Number Bowheads Observed | Density as Number per 100 km ² | Variance (10 ⁻⁴) | Confidence Range of Density |
|-------------|-----------------------------|-----------------------|--------------------------|--------------------|-----------------------|---------------------------|--------------------------|---|-------------------------------|-----------------------------|
| Total | * 32,953 | 100.00 | 4.60 | 09:26 | 100.00 | 114 | 3 | 0.064 | 0.0008 | 0.0093-.12 |
| A | 13,360 | 40.54 | 26.86 | 07:16 | 77.03 | 91 | 3 | 0.084 | 0.0012 | 0.014-0.154 |
| A1 | 2,361 | 7.16 | 6.88 | 00:24 | 4.29 | 14 | 0 | 0 | 0 | 0 |
| A2 | 1,648 | 5.00 | 35.57 | 01:09 | 12.11 | 17 | 0 | 0 | 0 | 0 |
| A3 | 2,688 | 8.16 | 33.10 | 01:50 | 19.46 | 24 | 1 | 0.112 | 0.0040 | 0-0.243 |
| A4 | 5,166 | 15.68 | 31.57 | 03:15 | 34.53 | 25 | 2 | 0.123 | 0.0079 | 0-0.306 |
| A5 | 1,497 | 4.54 | 21.33 | 00:38 | 6.64 | 11 | 0 | 0 | 0 | 0 |

*The total area of all regions was approximately 32,953 km²; areas were approximated by straight line integration.

Table B-4. Statistics from aerial surveys of bowhead whales conducted October 1979-86.

| | | 1979 | | | 1980 | | | 1981 | | |
|-------------|-----------------------------|--------------------------|--------------------------|---|--------------------------|--------------------------|---|--------------------------|--------------------------|---|
| Region Name | Region Area km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² |
| Total | 32,953 | 5.64 | 7 | 0.376 | 19.66 | 1 | 0.015 | 11.45 | 3 | 0.080 |
| A | 13,360 | 7.69 | 0 | 0.0 | 5.46 | 0 | 0.0 | 1.44 | 0 | 0.0 |
| A1 | 2,361 | 0.00 | 0 | 0.0 | 5.79 | 0 | 0.0 | 1.50 | 0 | 0.0 |
| A2 | 1,648 | 1.40 | 0 | 0.0 | 15.66 | 0 | 0.0 | 4.04 | 0 | 0.0 |
| A3 | 2,688 | 8.44 | 0 | 0.0 | 12.39 | 0 | 0.0 | 3.38 | 0 | 0.0 |
| A4 | 5,166 | 12.87 | 0 | 0.0 | 0.04 | 0 | 0.0 | 0.0 | 0 | 0.0 |
| A5 | 1,497 | 7.46 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0.0 |

| | | 1982 | | | 1983 | | | 1984 | | |
|-------------|-----------------------------|--------------------------|--------------------------|---|--------------------------|--------------------------|---|--------------------------|--------------------------|---|
| Region Name | Region Area km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² |
| Total | 32,953 | 18.33 | 13 | 0.215 | 25.07 | 7 | 0.085 | 36.53 | 26 | 0.216 |
| A | 13,360 | 24.09 | 5 | 0.155 | 32.88 | 4 | 0.091 | 35.51 | 19 | 0.40 |
| A1 | 2,361 | 6.72 | 0 | 0.0 | 6.16 | 0 | 0.0 | 4.83 | 0 | 0.0 |
| A2 | 1,648 | 21.70 | 2 | 0.559 | 34.35 | 0 | 0.0 | 44.63 | 6 | 0.82 |
| A3 | 2,688 | 27.26 | 1 | 0.136 | 35.40 | 3 | 0.315 | 38.45 | 5 | 0.48 |
| A4 | 5,166 | 31.53 | 2 | 0.123 | 42.92 | 1 | 0.045 | 44.39 | 8 | 0.35 |
| A5 | 1,497 | 22.79 | 0 | 0.0 | 34.20 | 0 | 0.0 | 37.94 | 0 | 0.0 |

| | | 1985 | | | 1986 | | |
|-------------|-----------------------------|--------------------------|--------------------------|---|--------------------------|--------------------------|---|
| Region Name | Region Area km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² | Percent of Area Surveyed | Number Bowheads Observed | Density as Number per 100 km ² |
| Total | 32,953 | 24.61 | 8 | 0.099 | 20.48 | 4 | 0.059 |
| A | 13,360 | 32.69 | 4 | 0.092 | 26.47 | 4 | 0.113 |
| A1 | 2,361 | 10.82 | 0 | 0.0 | 6.04 | 0 | 0.0 |
| A2 | 1,648 | 44.10 | 1 | 0.138 | 29.90 | 1 | 0.203 |
| A3 | 2,688 | 41.84 | 0 | 0.0 | 28.68 | 3 | 0.389 |
| A4 | 5,166 | 35.64 | 3 | 0.163 | 34.02 | 0 | 0.0 |
| A5 | 1,497 | 28.01 | 0 | 0.0 | 24.85 | 0 | 0.0 |

Table B-5. Statistics from aerial surveys of bowhead whales conducted September and October 1987 in the eastern Chukchi Sea. Region numbers refer to areas depicted in Figure B-7.

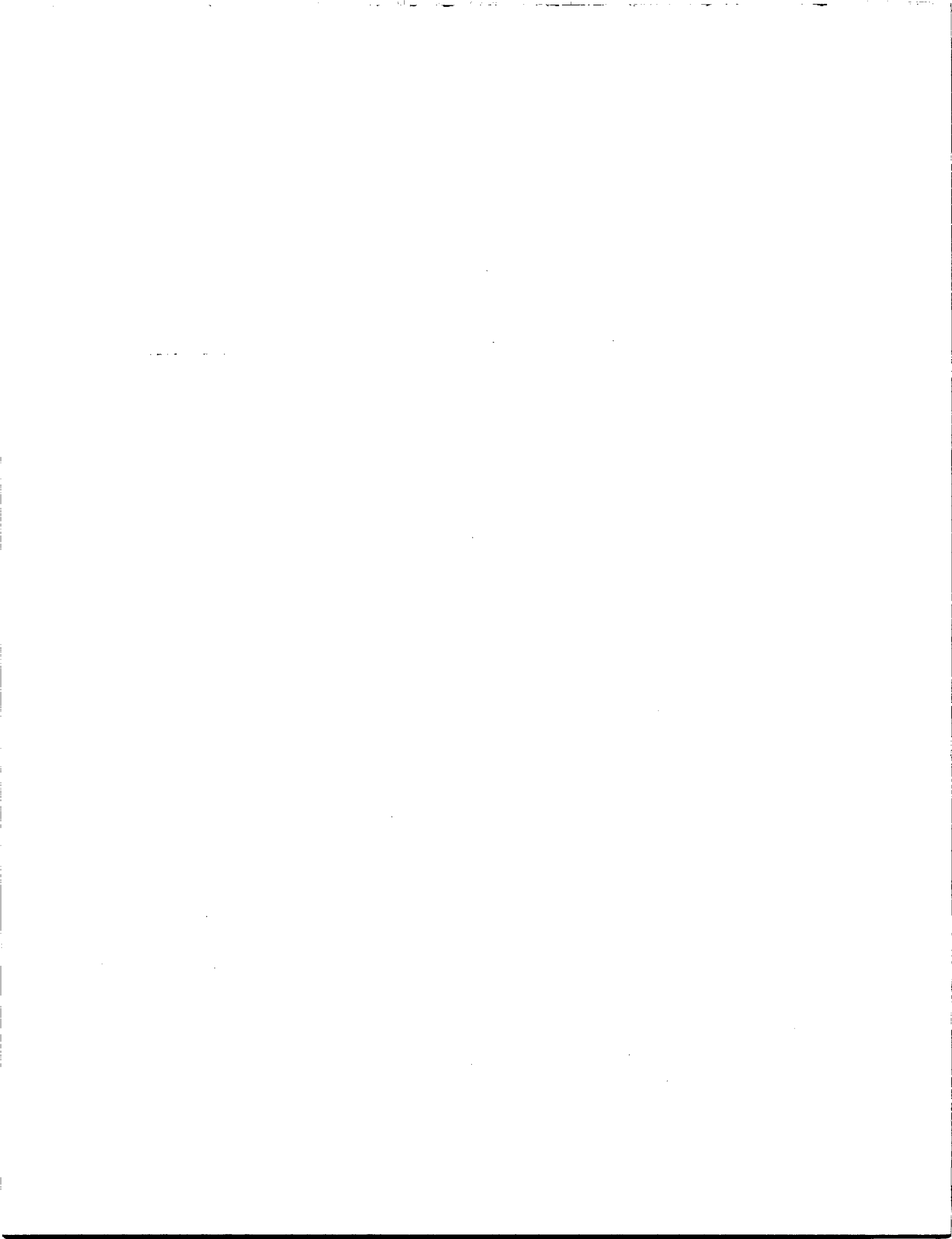
| Region Name | Region Area km ² | Percent of Total Area | Percent of Area Surveyed | Survey Time HR:MIN | Percent of Total Time | Number Transects Flown | Number Bowheads Observed | Density as Number per 100 km ² | Variance (10 ⁻⁴) | Confidence Range of Density |
|-------------|-----------------------------|-----------------------|--------------------------|--------------------|-----------------------|------------------------|--------------------------|---|-------------------------------|-----------------------------|
| SEPTEMBER | | | | | | | | | | |
| Chukchi | | | | | | | | | | |
| | *91,431 | 100.00 | 17.68 | 32:53 | 100.00 | 131 | 1 | 0.006 | 0 | 0-0.017 |
| 15 | 19,780 | 21.63 | 3.74 | 01:29 | 4.52 | 8 | 0 | 0 | 0 | |
| 16 | 5,159 | 5.64 | 5.36 | 00:35 | 1.77 | 7 | 0 | 0 | 0 | |
| 17 | 17,479 | 19.12 | 15.77 | 05:37 | 17.09 | 42 | 0 | 0 | 0 | |
| 18 | 27,579 | 30.16 | 10.67 | 05:49 | 17.67 | 17 | 0 | 0 | 0 | |
| 19 | 15,779 | 17.26 | 26.09 | 08:21 | 25.38 | 26 | 0 | 0 | 0 | |
| 20 | 10,655 | 11.65 | 50.05 | 11:02 | 33.56 | 31 | 1 | 0.019 | 0.0004 | 0-0.059 |
| OCTOBER | | | | | | | | | | |
| Chukchi | | | | | | | | | | |
| | 91,431 | 100.00 | 6.34 | 11:54 | 100.00 | 61 | 1 | 0.017 | 0.0002 | 0-0.047 |
| 15 | 19,780 | 21.63 | 0.0 | 00:00 | 0.0 | 0 | 0 | 0 | 0 | |
| 16 | 5,159 | 5.64 | 0.0 | 00:00 | 0.0 | 0 | 0 | 0 | 0 | |
| 17 | 17,479 | 19.12 | 9.11 | 03:25 | 28.71 | 28 | 0 | 0 | 0 | |
| 18 | 27,579 | 30.16 | 0.68 | 00:22 | 3.05 | 1 | 0 | 0 | 0 | |
| 19 | 15,779 | 17.26 | 8.94 | 02:54 | 24.36 | 14 | 0 | 0 | 0 | |
| 20 | 10,655 | 11.65 | 24.50 | 05:13 | 43.88 | 18 | 1 | 0.038 | 0.0017 | 0-0.126 |

*The total area of all regions was approximately 91,431 km²; areas were approximated by straight line integration.

Table B-6. Statistics from aerial surveys of gray whales conducted September and October 1987 in the eastern Chukchi Sea. Region numbers refer to areas depicted in Figure B-7.

| Region Name | Region Area km ² | Percent of Total Area | Percent of Area Surveyed | Survey Time HR:MIN | Percent of Total Time | Number of Transects Flown | Number Grays Observed | Density as Number per 100 km ² | Variance (10 ⁻⁴) | Confidence Range of Density |
|------------------|-----------------------------|-----------------------|--------------------------|--------------------|-----------------------|---------------------------|-----------------------|---|-------------------------------|-----------------------------|
| SEPTEMBER | | | | | | | | | | |
| Chukchi | | | | | | | | | | |
| | *91,431 | 100.00 | 17.68 | 32:53 | 100.00 | 131 | 35 | 0.217 | 0.0247 | 0-0.527 |
| 15 | 19,780 | 21.63 | 3.74 | 01:29 | 4.52 | 8 | 0 | 0 | 0 | |
| 16 | 5,159 | 5.64 | 5.36 | 00:35 | 1.77 | 7 | 16 | 5.791 | 20.6376 | 0-16.907 |
| 17 | 17,479 | 19.12 | 15.77 | 05:37 | 17.09 | 42 | 17 | 0.617 | 0.0704 | 0.081-1.153 |
| 18 | 27,579 | 30.16 | 10.67 | 05:49 | 17.67 | 17 | 0 | 0 | 0 | |
| 19 | 15,779 | 17.26 | 26.09 | 08:21 | 25.38 | 26 | 2 | 0.049 | 0.0011 | 0-0.118 |
| 20 | 10,655 | 11.65 | 50.05 | 11:02 | 33.56 | 31 | 0 | 0 | 0 | |
| OCTOBER | | | | | | | | | | |
| Chukchi | | | | | | | | | | |
| | 91,431 | 100.00 | 6.34 | 11:54 | 100.00 | 61 | 1 | 0.017 | 0.0003 | 0-0.053 |
| 15 | 19,780 | 21.63 | 0.0 | 00:00 | 0.0 | 0 | 0 | 0 | | |
| 16 | 5,159 | 5.64 | 0.0 | 00:00 | 0.0 | 0 | 0 | 0 | | |
| 17 | 17,479 | 19.12 | 9.11 | 03:25 | 28.71 | 28 | 1 | 0.063 | 0.0025 | 0-0.165 |
| 18 | 22,579 | 30.16 | 0.68 | 00:22 | 3.05 | 1 | 0 | 0 | 0 | |
| 19 | 15,779 | 17.26 | 8.94 | 02:54 | 24.36 | 14 | 0 | 0 | 0 | |
| 20 | 10,655 | 11.65 | 24.50 | 05:13 | 43.88 | 18 | 0 | 0 | 0 | |

*The total area of all regions was approximately 91,431 km²; areas were approximated by straight line integration.



REFERENCES

- Anderson, D.R., J.L. Laake, B.R. Crain, and K.P. Burnham. 1976. Guidelines for line transect sampling of biological populations. Utah Cooperative Wildlife Research Unit, Logan Utah.
- Burnham, K.P., D.R. Anderson, and J.L. Laake. 1980. Estimations of density from line transect sampling of biological populations. Wildl. Mono. vol. 72: 1-202.
- Cox, D.R. 1958. Planning of experiments. J. Wiley, New York.
- Doi, T. 1974. Further development of whale sighting theory.. Chapter 16, pp. 359-368, In: The Whale Problem, W.E. Schevill (ed.), Harvard University Press, Cambridge.
- Eberhardt, L.L., D.G. Chapman, and J.R. Gilbert. 1979. A review of marine mammal census methods. Wildl. Mono. vol. 63: no. 1-46.
- Estes, J.A., and J.R. Gilbert. 1978. Evaluation of an aerial survey of Pacific walruses (Odobenus rosmarus divergens). J. Fish Res. Board Can. vol. 35: 1130-1140.
- Hayne, D.W. 1949. An examination of the strip census method for estimating animal populations. J. Wildl. Manage. vol. 13: 145-147.
- Krogman, B.D., H.W. Braham, R.M. Sonntag, and R.G. Punsley. 1979. Early spring distribution, density, and abundance of the Pacific walrus (Odobenus rosmarus) in 1976. Outer Continental Shelf Environmental Assessment Program Research Unit 14 Final Report, no. R7120804.
- Leatherwood, S., P.S. Hammond, and R.A. Kastelein. (in press). Estimation of numbers of Commerson's dolphins in a portion of the northeastern Strait of Magellan, January-February, 1984. In: Cephalorhynchus, G.R. Donovan and R.L. Brownell, Jr. (eds.), Rep. int. Whal. Commn., spec. iss. 7. xxxx. (in press).