Alaska
Fisheries Science
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National Marine
Fisheries Service

U.S. DEPARTMENT OF COMMERCE

AFSC PROCESSED REPORT 92-03

Survey Designs for Assessment of Harbor Porpoise and Harbor Seal Populations in Oregon, Washington, and Alaska

March 1992

ERRATA NOTICE

Survey Designs for Assessment of Harbor Porpoise and Harbor Seal Populations in Oregon, Washington, and Alaska

Report of the Workshop

Held 9-11 April 1991

Edited by

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March 1992

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PREFACE

A workshop was held 9-11 April, 1991 at the National Marine Mammal Laboratory (NMML), Alaska Fisheries Science Center, Seattle, Washington, to promote the direct exchange of ideas among individuals from the marine mammal assessment community.

There were two motivations for holding the workshop. First was the desire to evaluate and improve four research plans funded by the Office of Protected Resources, National Marine Fisheries Service, to study the population biology of harbor porpoise and harbor seals in Oregon, Washington, and Alaska. The second reason was to improve understanding of assessment methods relative to the movements of animals and environmental variables. While the workshop focused on techniques to obtain "minimum" population estimates, discussions both in and outside the workshop revealed differing viewpoints on what constitutes a minimum population estimate and how that definition might vary depending on the nature of marine mammal/fishery interactions. For instance, a minimum estimate that is well below the actual population size may satisfy short-term management needs relative to establishing quotas for incidental takes (especially where the take is small), but in cases where removals may approach or exceed a quota then a defensible best estimate is appropriate, not just a minimum estimate. This issue will become important should (when) there be litigation.

The final proposals contained in the appendices to this report reflect the consensus of the workshop participants on the most appropriate survey design(s) for achieving the primary goal of estimating minimum population size. As a result of workshop discussions, we went into greater detail in planning the studies in Oregon and Washington because of the perceived need on the part of the NMML scientists for defensible best population estimates in part to meet the issues in the preceding paragraph. The proposed work will result in greater insight into critical natural history events, such as seasonal distribution and density, necessary for obtaining more precise and (possibly) accurate population estimates. Accordingly, I decided that it was appropriate to investigate biological parameters in greater depth (possibly including stock definition) under this program. This decision to carry out more in-depth studies responds directly to NOAA's Strategic Plan for ensuring the "continuous flow of scientifically sound information and a continued striving for greater accuracy to reduce risk and uncertainty."

Howard W. Braham (Convener)

INTRODUCTION

On 9-11 April 1991, the National Marine Mammal Laboratory (NMML), Alaska Fisheries Science Center, Seattle, Washington, convened a workshop to discuss draft proposals for the assessment of harbor porpoise (Phocoena phocoena) and harbor seal (Phoca vitulina) populations in Alaska, Oregon, and Washington. These studies were funded for Fiscal Year 1991 after consideration by the Marine Mammal Protection Act Task Group and National Marine Fisheries Service's Office of Protected Resources because the data needed to make current and precise minimum population estimates for these populations were lacking. These estimates are proposed for use in management regimes where the incidental take of marine mammals is regulated in commercial fisheries within the U.S. Exclusive Economic Zone (EEZ) by provisions of the 1988 amendments to the Marine Mammal Protection Act.

Invited participants, including researchers and managers with specialized expertise and interests in harbor porpoise and harbor seal survey techniques, were asked to evaluate and refine the survey plans presented by NMML research staff. Thirty-six participants representing Alaska Sea Grant, Alaska Department of Fish and Game, Cascadia Research, EBASCO Environmental, National Marine Fisheries Service, Oregon Department of Fish and Wildlife, Pacific States Marine Fisheries Commission, Scripps Institution of Oceanography, University of Washington, Washington Department of Wildlife, and Woods Hole Oceanographic Institution were in attendance (Appendix I).

The workshop was organized around the presentation of each proposal with an allowance of approximately one half day of discussion on each. On the first day, after initial introductions and opening remarks concerning the objectives of the workshop, discussions of the two harbor porpoise proposals (Alaska and Oregon/Washington) were addressed. The two harbor seal survey proposals (Alaska and Oregon/Washington) were the focus on the second day. Revisions to the original proposals were compiled and incorporated into new drafts by individual subgroups which met on the third day, following completion of the workshop (see agenda, Appendix II).

This report contains summaries of the four principal discussions which include responses to the initial survey designs as well as specific recommendations for their improvement. Final drafts of the four proposals incorporating workshop revisions are presented (Appendixes III - VI). Comments on a draft version of this report, received from workshop participants, were also incorporated wherever appropriate.

WORKSHOP OBJECTIVES AND CONSTRAINTS

The purpose of the workshop was to review four proposals relative to field and analytical methods for estimating minimum population abundance estimates of harbor porpoise and harbor seals; to determine the best method(s) for estimating their abundance; to design plans to carry out field studies in 1991. The workshop participants used the four proposals as starting points for discussion. The workshop group was given considerable flexibility to suggest changes necessary to arrive at optimal survey designs providing high probabilities of estimating minimum population size with satisfactory levels of precision. All suggestions would be considered in light of existing fiscal and temporal constraints as well as field conditions (e.g., weather, shoreline topography, size of area) and every attempt would be made to utilize significant modifications. When resources were not available to accommodate suggestions for the 1991 field season, plans could include a 1 or 2 year extension of survey designs. Based on information from the National Task Force, the level of precision for surveys that was considered minimally adequate was a coefficient of variation (CV) of 30%. If it was not possible to obtain abundance estimates with CVs less than 30%, the surveys would not be conducted.

The following sections summarize discussions of the four proposals. A brief description of the original proposal is followed by the group's reaction to the proposal. Specific recommendations for improvement of the original designs are included. The recommendations have been incorporated into the final drafts of the proposals found in Appendix III-VI.

HARBOR PORPOISE SURVEYS - OREGON AND WASHINGTON

Survey plans for harbor porpoise assessment in Oregon and Washington were divided into five subareas (Oregon coast, Washington coast, Straits of Juan De Fuca, the eastern bays and Puget Sound) both for consistency with previous studies and because different survey goals were identified.

Replicate aerial surveys were planned for coastal waters in both states. The objective was to obtain an estimate of the minimum population size for the outer coast.

The San Juan Islands and eastern bays would also be surveyed by air, but the convoluted coastline in these areas might necessitate further modifications.

Areas within Puget Sound would be surveyed by air to determine whether harbor porpoise still exist in those waters. Today, harbor porpoise are rarely sighted in the Sound, although the species was once abundant in these waters. If harbor porpoise were discovered, then the survey design would be expanded to develop a minimum population estimate.

The workshop group accepted the survey design, but suggested several revisions, in particular, regarding potential duplication of previous survey effort, choice of survey platform (e.g., air vs. vessel) and criteria used to subdivide the survey area. The following specific recommendations were made:

1. In light of the availability of current aerial survey data collected over the outer coast regions of Oregon and Washington by EBASCO Environmental, additional survey effort by

NMML would be unnecessary for determination of a minimum population estimate. If the EBASCO data yield a population estimate with acceptable precision, then that estimate would be adopted and NMML resources could be directed elsewhere. Until the EBASCO data analyses are completed, however, plans for coastal surveys should proceed.

2. If aerial surveys are conducted along the outer coast, the number of replicates needed to achieve the desired level of precision should be calculated and incorporated into the survey design. Such estimates would make use of existing published information.

3. The number of subareas considered should be reduced from five to three; the Strait of Juan de Fuca area should be included with the outer coast estimate and the eastern bays should be combined with the San Juan Island surveys.

4. If aerial surveys are conducted in the San Juan Island area, the amount of survey effort needed to provide an adequate level of precision should be determined using variance estimates based upon bootstrapping procedures.

HARBOR PORPOISE SURVEYS - ALASKA

The harbor porpoise survey plan for Alaskan waters differed from survey plans for Oregon and Washington waters in that the former would subsample harbor porpoise habitat while the latter was a comprehensive survey. Three survey locations were chosen based on factors including known sightings of harbor porpoise during spring and summer when surveys were possible, gillnet fishery activity, and availability of historical data. Bristol Bay, Prince William Sound, and Southeast Alaska were selected as the study areas.

In the original proposal, survey platforms and methods differed by area because of topographical constraints. Aerial surveys were planned for the Copper River Delta and Bristol Bay areas while boat surveys were proposed for Prince William Sound and Southeast Alaska. Ship surveys would employ the "distance method" instead of line transect techniques (i.e., the survey vessel stops at randomly selected stations and sightings are recorded around the vessel over a fixed period of time). The workshop group had two major concerns with the proposed design. First was the limited scope of the surveys and second was reliance upon the "distance method." It was not clear to the group how a minimum population estimate for the entire area could be extrapolated from the data for the small survey areas. Furthermore, considerable skepticism was voiced concerning the use of a recently developed and largely untested technique which, as proposed, would yield only a very small data set for the costs incurred. The workshop made the following recommendations.

1. Increase the scale of the study to a comprehensive level whereby all coastal waters would be systematically surveyed. The area should be divided into seven zones, a few of which could be surveyed intensively each year, and the completed survey accomplished over 3 years.

2. Eliminate plans to utilize the "distance method" and use shipboard line transect methods instead.

3. Use aerial survey methods where possible such as on the outer coastal areas of Southeast Alaska and in Bristol Bay.

4. Examine existing data to calculate the extent of sampling required to determine minimum population estimates within acceptable levels of precision for both aerial and shipboard surveys. These calculations should then be used to identify the areas which can be readily surveyed. It was suggested that a subgroup be formed to examine the requisite data, to perform the necessary calculations, and to revise the plans based on those results.

HARBOR SEAL SURVEYS - OREGON AND WASHINGTON

The surveys for harbor seals in Oregon and Washington would incorporate three elements: aerial counts of pups and adults during the pupping period, total counts during the molting period, and radio tagging to determine the number of animals not hauled out during the surveys. Counts during both the pupping and molt periods were included since it is not known when the peak number of adults are hauled out and are available for counting. Pup counts would be conducted to provide consistency with previous pup counts which have been used as an indicator of population trend.

Participants at the workshop generally agreed with the survey design, although considerable discussion focused on whether counts during both the pupping and molting periods were necessary. The group finally agreed that both counts were warranted for the 1991 season given the uncertainty of which period would yield the highest counts of adults.

The workshop also expressed concerns over the rationale behind the division of the survey area into subareas, particularly if separate estimates were derived for each area and the stock structure of the species is unknown. Although no firm consensus was reached relative to stock identification, it was agreed that the issue would need further attention in future studies.

Although the survey plan remained relatively unchanged, the workshop group made the following specific recommendations.

1. The number of replicate survey flights needed to calculate minimum population estimates with acceptable levels of precision should be calculated and incorporated into the survey plan.

2. The number of radio tags needed to achieve desired levels of precision for correction factors related to haul-out patterns should be calculated and incorporated into the survey plan.

3. The numbers derived from surveys in the various subareas should not be considered as estimates of stocks. Further emphasis on the need to identify stocks may, however, force some decision on the issue based upon biological information.

HARBOR SEAL SURVEYS - ALASKA

The draft harbor seal survey plan for Alaska was greatly modified in much the same way that the harbor porpoise plan for Alaska had been changed the previous day. Instead of surveying four specific study areas, the revised proposal included a comprehensive statewide survey. The coastal waters were divided into seven zones, all of which would be surveyed by the end of 3 years. Sample size requirements and availability of resources would determine which areas would be surveyed in any given year. Aerial surveys would be flown to photograph known haul-out locations. Counts from the photos would then be used to generate minimum population estimates. In areas previously unsurveyed, initial identification of haul-out locations might require more effort than subsequent replicates focusing on those sites. Counts would be concentrated primarily during the August/September molt period.

The workshop group's overall reaction to the plan was generally positive with most comments and discussion focusing on determination of which areas to survey during the first year. Accordingly, it was recommended that a calculation be made of the number of replicate flights needed to obtain minimum population estimates within acceptable limits of precision (CV=30%) and incorporate those calculations in the survey design.

CONCLUSION AND GENERAL RECOMMENDATIONS

The principal workshop objective to refine the four survey design proposals was fully met with ample discussion of all items on the agenda. Significant improvements were made on all four designs, but in particular, the two Alaska proposals were vastly altered through modifications of both scope and choice of survey platforms. Participants cautioned, however, that the proposals be implemented only if the resulting population estimates would be within desired limits of precision. If resources were insufficient to accomplish this, then those resources should be redirected to surveys likely to produce the requisite precision. Alternative plans for surveying problematic areas with adequate funding was addressed.

While many recommendations will be implemented during the 1991 field season and provisions will be made to incorporate other modifications over the next 2 years, the workshop group also identified several general recommendations for future consideration. The general recommendations are as follows:

1. Future research on stock identification should be emphasized for both harbor porpoise and harbor seal. If prioritized relative to lack of available data, such studies would address harbor porpoise in Alaska, followed by harbor porpoise in Oregon and Washington, and harbor seals in Alaska and Oregon/Washington, respectively. Among the studies to consider, for example, is tagging of harbor seals within the fishing areas and subsequent resighting effort at haul-out locations.

2. Future research on temporal scaling for estimating minimum population size should be conducted to investigate the

phenology of harbor seal haul-out patterns during both the pupping and molting periods.

3. Future research on harbor porpoise surfacing patterns should be initiated in order to develop correction factors for animals not at the surface during surveys.

4. The "distance method" survey approach should be tested and evaluated in terms of its applicability to marine mammal assessment objectives. These studies should initially include theoretical explorations.

5. Future research on factors affecting numbers of harbor seals hauled out such as weather, tide cycle, disturbance, etc. should be conducted.

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APPENDIX II

DRAFT AGENDA

MARINE MAMMAL SURVEY DESIGN WORKSHOP

Alaska Fisheries Science Center, Seattle, WA
April 9-11, 1991

Date/Time

Tuesday April 9, 1991

9:00 am — I. Welcoming remarks
Introductions, Background, Format, Agenda

9:15 am — II. Statement of the Problem, Goals and Objectives

III. Harbor porpoise

9:30 am — a. Presentation of draft proposals

1. Oregon and Washington coasts
2. Puget Sound
3. Alaska

10:30 am (break)

10:45 am — b. Statistical considerations, suggestions, problems, potential biases

1. Technique specific limits to the data
2. Indices and direct estimates
3. Subsampling strategy
4. Potential biases (e.g., vessel attraction or avoidance)

12:00 noon (break)

1:30 pm — c. Field techniques

1. Line transect approaches (Aerial and surface)
2. Stationary platform approaches

(Shorebased and floating platform)

3. Others?

2:30 pm d. Effects of behavior, movements, seasonal distribution etc. on sampling strategies

3:30 pm (break)

3:50 pm e. Geographic, stock structure and logistic considerations

4:30 pm f. Develop site specific survey protocol

5:30 pm (adjourn)

April 10, 1991

IV. Harbor seals

9:00 am a. Presentation of draft proposals

1. Oregon and Washington coasts
2. Puget Sound
3. Alaska

9:45 am b. Statistical considerations, suggestions, problems, potential biases

1. Technique specific limits to the data
2. Indices vs. direct estimates
3. Subsampling strategy
4. Critical biological issues (e.g., presence or absence during feeding, population composition)

10:30 am (break)

11:00 am c. Field techniques

1. Pup counts on rookery areas
   Aerial, surface collection
2. Counts during moult
   Aerial, surface collection
3. Estimating fraction counted

feeding cycles, portions of pups unborn or in water, further needs

4. Others?

12:00 noon (break)

1:30 pm d. Geographic, stock structure and logistic considerations

2:15 pm e. Develop site specific survey protocol

1. Oregon and Washington coasts

2. Alaska

3:45 pm (break)

4:10 pm V. Recommendations

5:30 pm (adjourn)

April 11, 1991

9:00 am VI. Report preparation

APPENDIX III

NMML Survey Plan for Harbor Porpoise in Washington and Oregon During 1991

INTRODUCTION

Harbor porpoise, Phocoena phocoena, are incidentally taken in commercial and native American tribal fisheries in the coastal and inland waters of Oregon and Washington. The impact of these takes on the harbor porpoise population is unknown because of the lack of information on the level of the take, the size of the porpoise population(s) and the discretness of the population. The 1988 amendments to the Marine Mammal Protection Act require minimum population estimates for those species incidentally taken in fisheries. Minimum population estimates would be used as a potential management tool to address impacts to local or regional populations.

Information collected from 1988-89 illustrates the problem in Washington State (see Kajimura, 1991). In 1988-1990 an estimated 138 harbor porpoise were incidentally taken in the Makah Tribal set-net fishery of the north Washington coast (Kajimura, 1991; Gearin et al. 1991). Using the 2% rule (a default recruitment rate for cetaceans), the harbor porpoise population would have to be about 5,000 to sustain a take of 100 animals per year.

Abundance estimates for harbor porpoise have been conducted in Washington and Oregon by both vessel and aerial surveys. Barlow, (1988) Barlow et al. (1988) reported results of both vessel and aerial surveys in Oregon and Washington from 1984-86 and provided an estimate of 9,800 animals from the Washington coast (se = 4,300). During 1989 Calambokidis (1991) conducted vessel surveys along the north Washington coast and the Swiftsure Bank area and estimated that fewer than 1,000 individuals were in the region. Aerial line-transect surveys were conducted in Oregon and Washington in 1989 (Turnock et al. 1991), and in Washington in 1990 (Calambokidis et al.1991). In addition, Ebasco conducted marine mammal and bird surveys along the Oregon and Washington coasts during 1989 and 1990 as part of a Minerals Management contract. The Ebasco data estimated 3,078 harbor porpoise for the outer Washington coast and 6,205 for Oregon (Table 1). Comparisons of population estimates between the past surveys are difficult to make because of time and area coverage, sample sizes and different surveying and analysis methods. Additional abundance estimates are needed to determine potential impacts of incidental takes in fisheries.

OBJECTIVES

The research is designed to address the following general objectives:

1) Obtain minimum population estimates of harbor porpoise in Washington and Oregon.

2) Determine local distribution, presence, and relative abundance

along the northern Washington coast with respect to month.

3) Determine how harbor porpoise distribution is related to depth, location, and other oceanographic features.

METHODS

Survey methods used to complete the objectives include aerial line transect surveys and aerial coastal surveys.

Line Transect Surveys

Twin engine aircraft will be used to conduct line-transect surveys in the study area. Surveys will be flown at 600 foot altitude and a speed of 95 knots.

Stratification of Areas

The area surveyed will be stratified initially into five major blocks including the coastal waters of Oregon (Area 1), Washington

(Area 2), the Strait of Juan de Fuca including Swiftsure Bank (Area 3), San Juan Islands (Area 4), the Puget Sound and Hood Canal (Area 5) (Figure 1). For determining population estimates for the study area and sample sizes needed to derive precise estimates, some areas may be combined since information regarding stock discreetness of harbor porpoise occupying Oregon and Washington waters is lacking. Therefore the final analysis may combine Areas 2 and 3 into one block (including Swiftsure Bank).

Area 4 will be considered one separate block and Area 5 will be flown with a single engine aircraft to determine if porpoise are present in this region.

Transect Design

A saw-tooth survey design will be used as described in Turnock et al. 1991; Calambokidis et al. 1991; and Cooke 1985, 1986. This survey design was adopted in 1989 because transects cut across rather than along anticipated porpoise density gradients and because it is an efficient method which minimizes inactive cross-legs. Surveys will be flown from shore out to the 50 fathom isobath, extending in some areas 15-20 nm offshore. In light of findings by Ebasco which indicated Phocoena sightings occurred in depths exceeding 50 f, we will fly some survey tracks out to the 100 f isobath on the Oregon and Washington outer coasts. Spacing of transect legs will vary between areas but will range between 2 to 10 nm spacing depending on the topography and size of the area to be surveyed.

Area 1- Oregon coast

The Oregon coast will be surveyed from the shore out to at least the 100 f isobath using a saw-tooth design at 5 nm distances between adjacent survey legs (Figure 1). The Oregon coast would include 55 survey legs with an approximate linear distance of 656 miles. Coastal bays and estuaries would be surveyed in conjunction with the ocean areas using saw-tooth patterns at 2 or 3 nm distances and would add an additional 50 miles to the distance.

Area 2- Washington outer coast

The Washington State outer coast will be surveyed in essentially the same way as the Oregon coast, using a saw-tooth design with distances of 5 nm between legs. This area will include 29 survey legs and a linear distance of approximately 402 nm (Figure 3). The Columbia River estuary (east to Tongue Point), Willapa Bay, and Grays Harbor would be surveyed using a single engine aircraft to determine if porpoise are present in these inshore areas. If porpoise are found in the coastal estuaries, the areas will be surveyed again using line-transect methods. These areas would add an additional 50 nm to the Washington coastal area.

Area 3- Swiftsure Bank and the Strait of Juan de Fuca

This area will be surveyed using a saw-tooth survey design at 5 nm spacing, however, initially the legs will run shore to shore over depths exceeding 50 fathoms (Figure 3). The western boundary of this area will be Swiftsure Bank north to Pachena Point (Vancouver Island B.C.) and the eastern boundary will be the west side of Whidbey Island. If densities of porpoise appear to be significantly greater in depths of 50 fathoms or less, subsequent surveys in this region will be flown from shore out to the 50 fathom line on the north and south sides of the Strait. At 5 nm distances between legs, flying from shore to opposite shore, this area contains 23 survey legs and a linear distance of approximately 313 miles.

Area 4- San Juan Islands

This region includes the waters of the San Juan Islands north to Boundary Bay, south to a line drawn from Victoria, B.C. east to Deception Pass (Figure 4). This region will be surveyed using a saw-tooth design at 5.0 nm spacing. Because many survey legs cut across land and will result in a high number of sighting effort changes (e.g., on-effort/ off-effort) porpoise densities will be calculated for the entire area encompassed by these boundaries described above. The total linear distance of this region is approximately 186 nm which includes 8 transect legs (Figure 4).

Area 5- Puget Sound and Hood Canal

This area includes Puget Sound south of Possession Point, Hood Canal and the northern bays and estuaries including Skagit Bay, and Saratoga Passage (Figure 4 and 5) Line transect surveys to derive a population estimate may not be necessary in this region since harbor porpoise are not known to inhabit these waters (J. Calambokidis, S. Jeffries pers. comm. and Everitt et al. 1980). It may be more useful and practical to fly systematic surveys in this region with a single engine aircraft with the objective of determining if porpoise are present or not before conducting line-transect surveys designed to estimate abundance. There are 42 survey legs in this area and a total linear distance of about 249 miles.

Number and Timing

Comments by D. DeMaster at the workshop described the level of precision required for the population estimates which was agreed to be a coefficient of variation (CV) between .20 to .30 for the sample. The previous studies in Washington State by Turnock in 1989 and Calambokidis in 1990 used analytical methods to calculate CV's which are not comparable to methods used by Barlow (1988) and other researchers at the SWFC.

The effort required to complete the surveys with the acceptable level of precision requires that at least 30 individual porpoise sightings are made for any block or area from which a population estimate is to be made. It is estimated that each area would need to be flown at least twice to achieve 30 sightings.

Preliminary data from the Ebasco surveys of 1989 and 1990 have been reviewed by NMML (see Ebasco attachments 1-8). The CV values reported on Ebasco attachment 7 fall within acceptable boundaries of precision, however, the abundance estimates for Washington are considerably lower than those reported by previous authors (Table 1). As stated earlier, direct comparisons of these abundance estimates are difficult to make because of different surveying methods, stratification of areas and methods of data analysis. We conclude that the coastal surveys for Oregon and Washington should be repeated in 1991 due to the problems associated with making direct comparisons between surveys. The opportunity now exists to complete a survey from these areas which will meet the standards for completing the minimum population estimate requirements and which will be unequivocal.

During 1990, problems with weather precluded completion of the surveys in Oregon and Washington State since only a 2 week window was available to conduct the work. Since the area to be surveyed this year is considerably larger than 1990, the time window must be expanded to allow for completion of the surveys. The total linear distance surveyed for the five areas is approximately 1,900 nm (Table 2). At an average speed of 95 knots, the survey could be completed in about 25 flight hours (not counting transit time). Transit time can often use up 40 to 50% of total flight hours depending on weather and location. In order to complete 2 replicates for each area, we estimate that about 120 hours of flight time would be required. Line transect surveys will be conducted during July and August with the approximate starting date of 1 July and running to 15 August.

Data System and Recording

Sighting data will be entered by a recorder on a computer (which is interfaced to a Loran) on the aircraft or vessel. The data are also entered on a data sheet as insurance against loss. Numerous computer programs have already been developed to record essential data. At the end of each survey day data will be transferred to a floppy disc for safe storage.

Density Calculations

Line transect theory will be utilized to generate population estimates for the areas surveyed following methods described by Burnham et al. (1980) and adapted by Turnock et al. (1991) and Calambokidis et al. (1991). A correction factor for animals missed on the transect line will be derived from the literature and from previous studies.

Weather and Sea State Condition Requirements

Previous work involving line transect surveying from aerial platforms have shown the very limited conditions necessary for accurate results when surveying Phocoena. In general, sea states of Beaufort 2 or lower with cloud cover not exceeding 50% are required to conduct successful surveys. Sighting frequency declines rapidly at conditions of Beaufort 3 or higher and when cloud cover exceeds 50%. In addition, sun glare can cause problems but usually only on one side of the aircraft. Turbidity of the water column should somehow be incorporated into the viewing conditions as this parameter can affect sighting success. Some areas near the mouths of large coastal rivers (like the Columbia) can be very turbid especially during periods of heavy runoff.

Aircraft Requirements

High wing twin engine aircraft equipped with port and starboard bubble windows and a belly window for downward viewing will be used for the line-transect surveys. The aircraft must be able to carry at least three observers and one data recorder. Aircraft must have Loran and fuel capacity to fly 4-5 hours without refueling.

Parallel Coastal Surveys

The purpose of these surveys is to note the presence and relative abundance of Phocoena in specific locations during different months in the area of the Makah set-net fishery. Although these surveys are not within the scope of the major objective of determining minimum population estimates, they do relate to effective management in this region since seasonal presence or absence is a critical question in determining when Phocoena may be taken in this area.

The survey area will be the north Washington coast from Low Point south to La Push (Figure 6) and in area 5 (Figure 5). Surveys will be flown in a single engine aircraft (Cessna 172 or 182) at 600 foot altitude and will run parallel to the coast (in the north Washington coast area) primarily covering the inshore areas over depths of 20 fathoms or less. Survey track lines will be designated on charts and recorded so that effort for each survey is comparable. In areas where porpoise are observed, the aircraft will go off track and circle to count all groups and individuals. Numbers and positions of Phocoena will be determined by using a Loran system carried in the aircraft. Two observers will be used (one port and one starboard) and data will be recorded on tape and written on data forms. A chi-square analysis is proposed to compare relative abundances during different times and areas. In Area 5, presence or absence of harbor porpoise will be determined by flying saw-tooth transects at 5 or 10 nm spacing. If porpoise are observed in this area, and densities appear to be high enough to derive abundance estimates then this area may be flown again using line-transect methods.

Number and Timing of Surveys

Surveys will be flown at approximately 2 week intervals from 1 May to 1 September. Eight to ten surveys will be conducted on the north Washington coast. For the Hood Canal and Puget Sound region, 2-3 flights in early July may provide enough information about porpoise presence or absence. We also suggest flying similar surveys in some of the coastal bays and estuaries during different months to record presence or absence.

Number of Personnel Required

For the line transect surveys, one data recorder and three observers are required for each flight. A team of five to seven observers should be assembled prior to the surveys with three acting as alternates or fill-in observers. For the coastal surveys, two observers are adequate with one acting also as the data recorder.

Logistics

The planning for bases of operations is dependent on weather conditions. A plan should be developed which allows a great deal of flexibility in changing plans to go where the weather is suitable for surveys. The town of Hoquim, WA is a good location for the base of operations for the Washington coastal surveys and for Oregon because it offers the possibility of flying south to Oregon or north to the Washington coast depending on weather. The town of Newport, OR also is a good location from which to conduct the Oregon surveys since it is near the central coastal area. For the north Washington coast, Strait of Juan de Fuca, and Swiftsure Bank area, the Sekiu or Port Angeles , WA area would be a good location. For the San Juan Islands and northern Puget Sound, Seattle or Anacortes would be suitable. The Puget Sound and Hood Canal could be easily covered based out of the Seattle/Tacoma area.

Shore Based Surveys

Aerial/Land Calibration Study

An experiment to determine the number of harbor porpoise missed on an aerial flight by calibrating observations with a group of observers on shore was conducted in 1990 on the north coast of Washington State. Unfortunately, due to the short time frame available and inclement weather the sample size was too small to allow quantitative evaluation of sighting success (Calambokidis et al. 1991). This experiment may be repeated again this year in the same location, however, it may require a window of a week to ten days in order to obtain the necessary observations. Alternatively, these studies may also be conducted in the San Juan Islands area.

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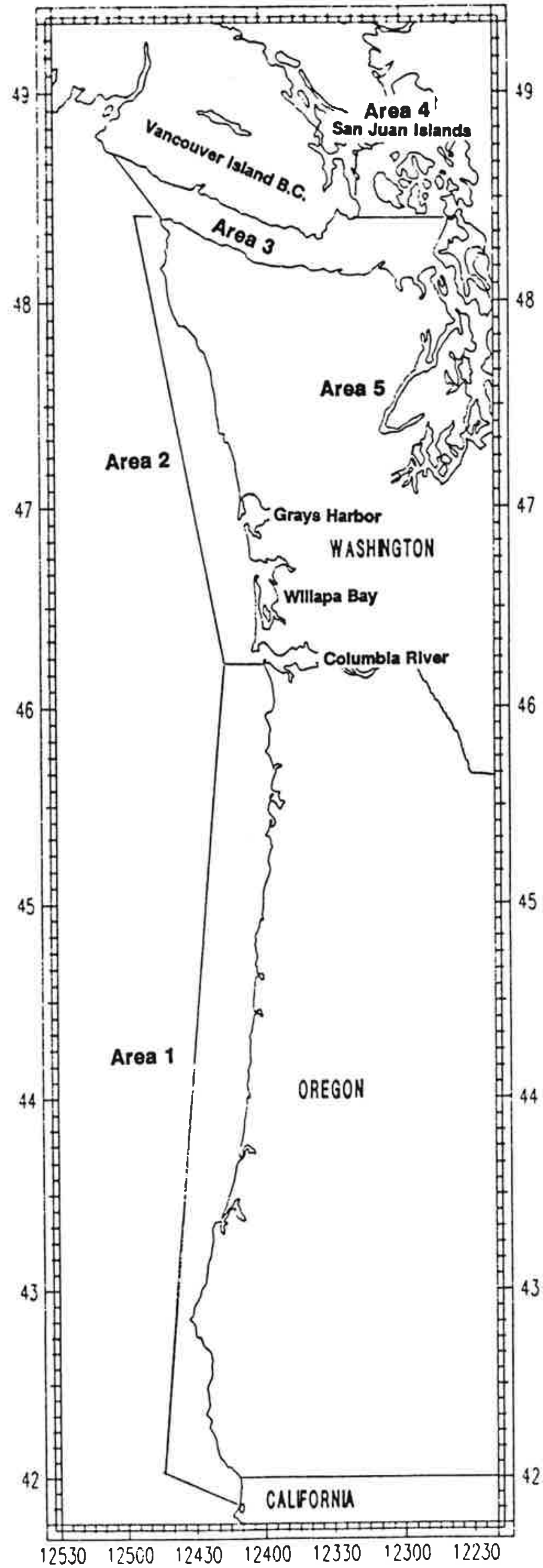

Figure 1. Harbor porpoise study Areas 1 through 5.

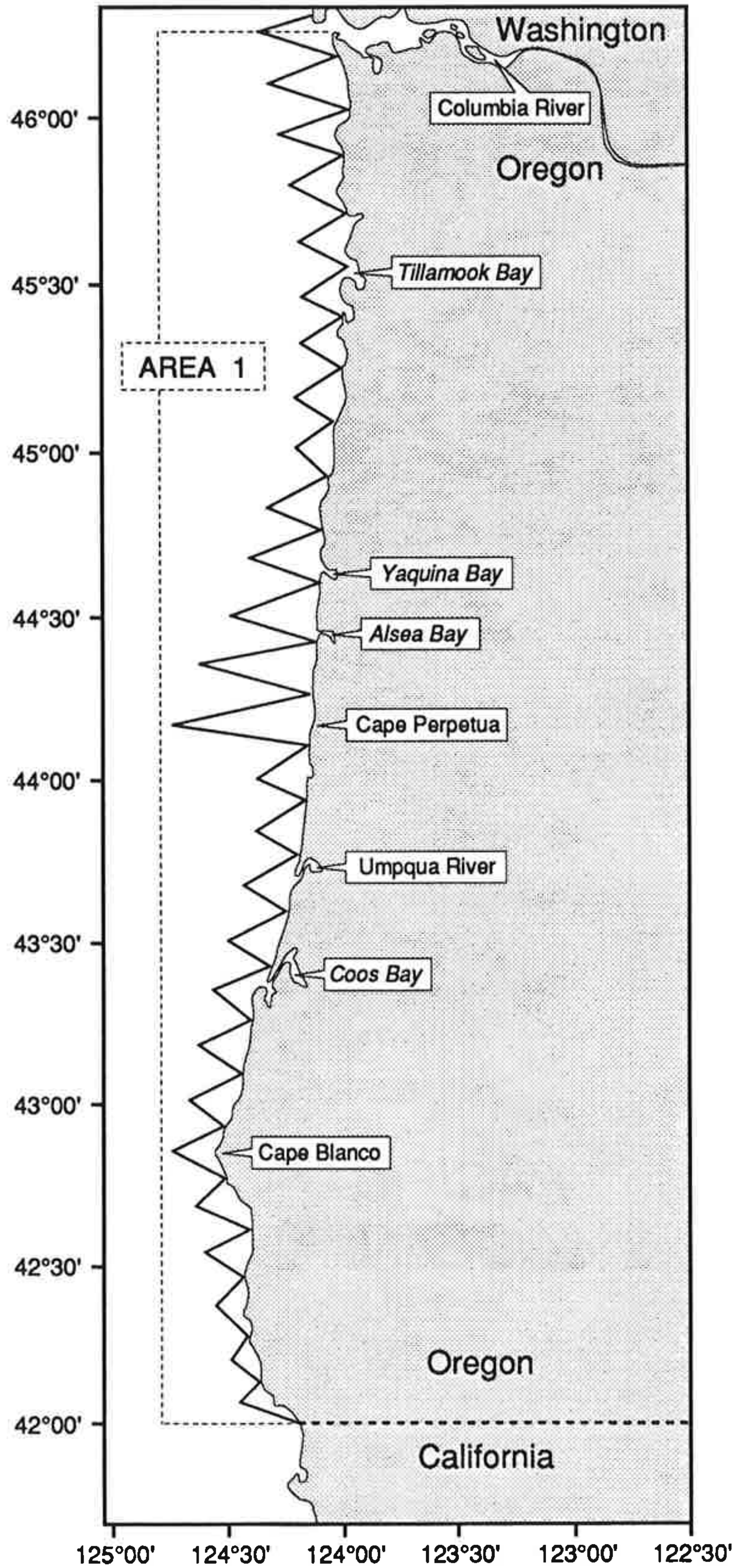

Figure 2. Oregon study Area 1.

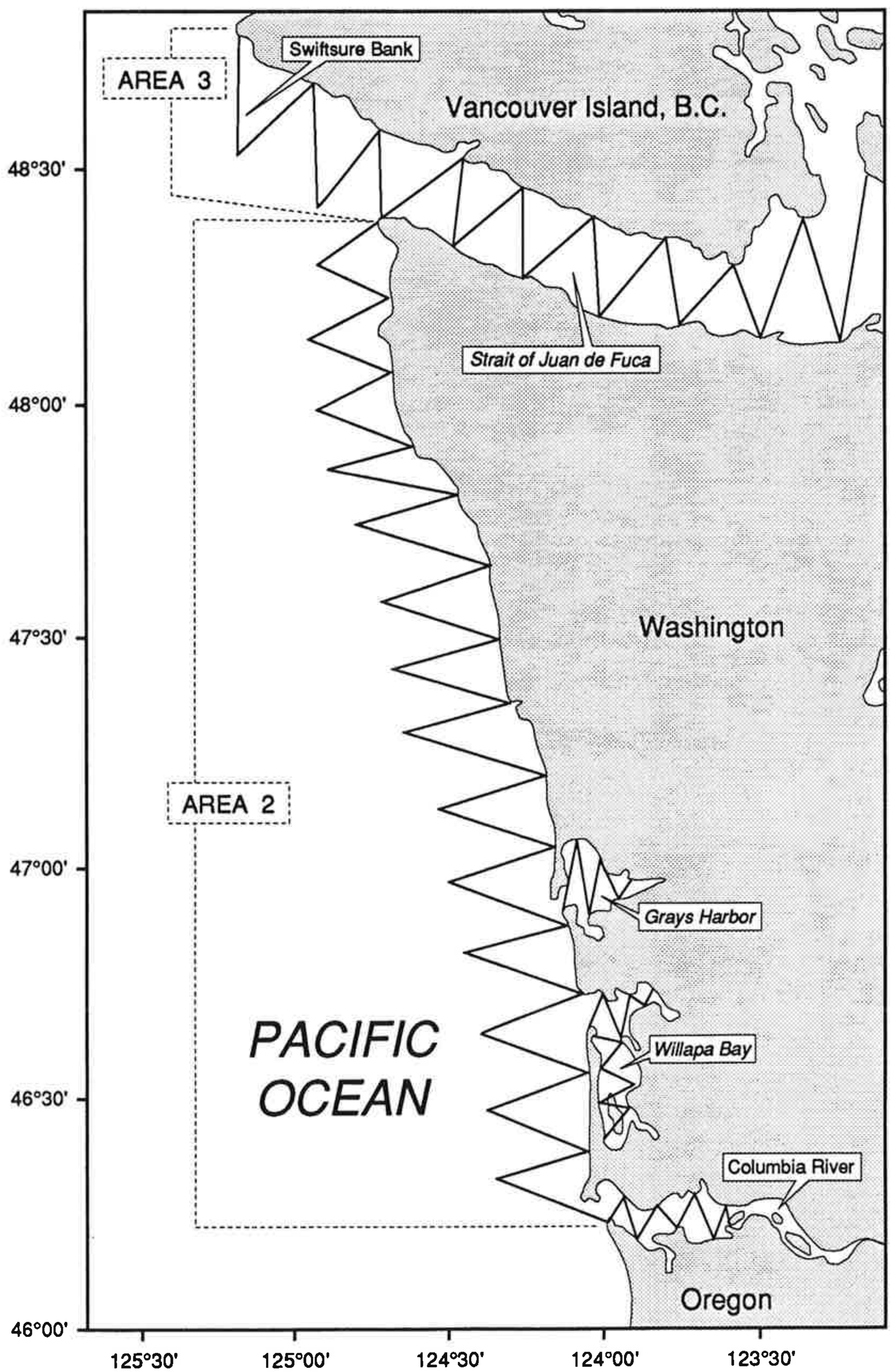

Figure 3. Washington coast, Swiftsure Bank, and Strait of Juan de Fuca areas 2-3.

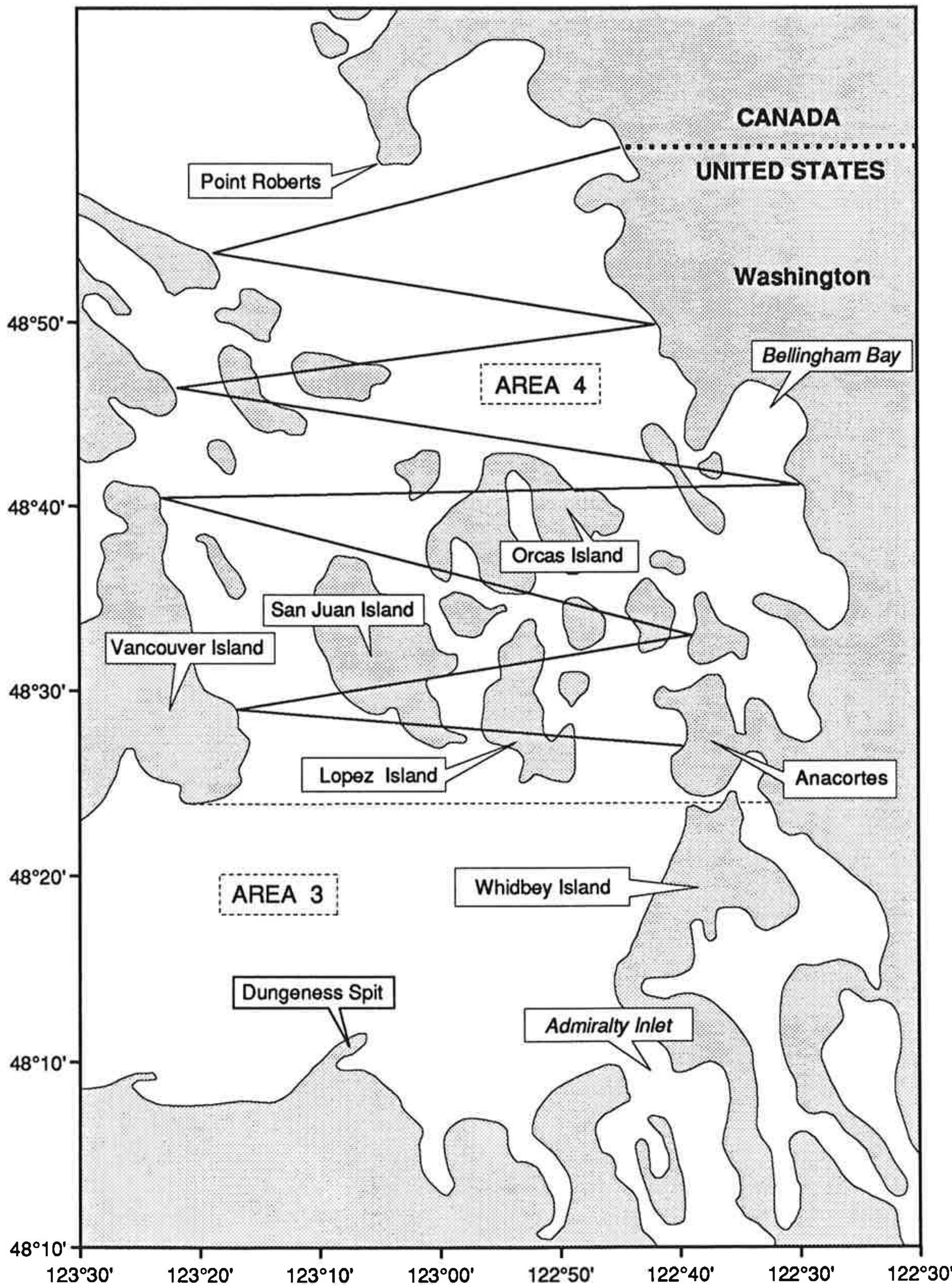

Figure 4. San Juan Islands study Area 4 and east end of Area 3.

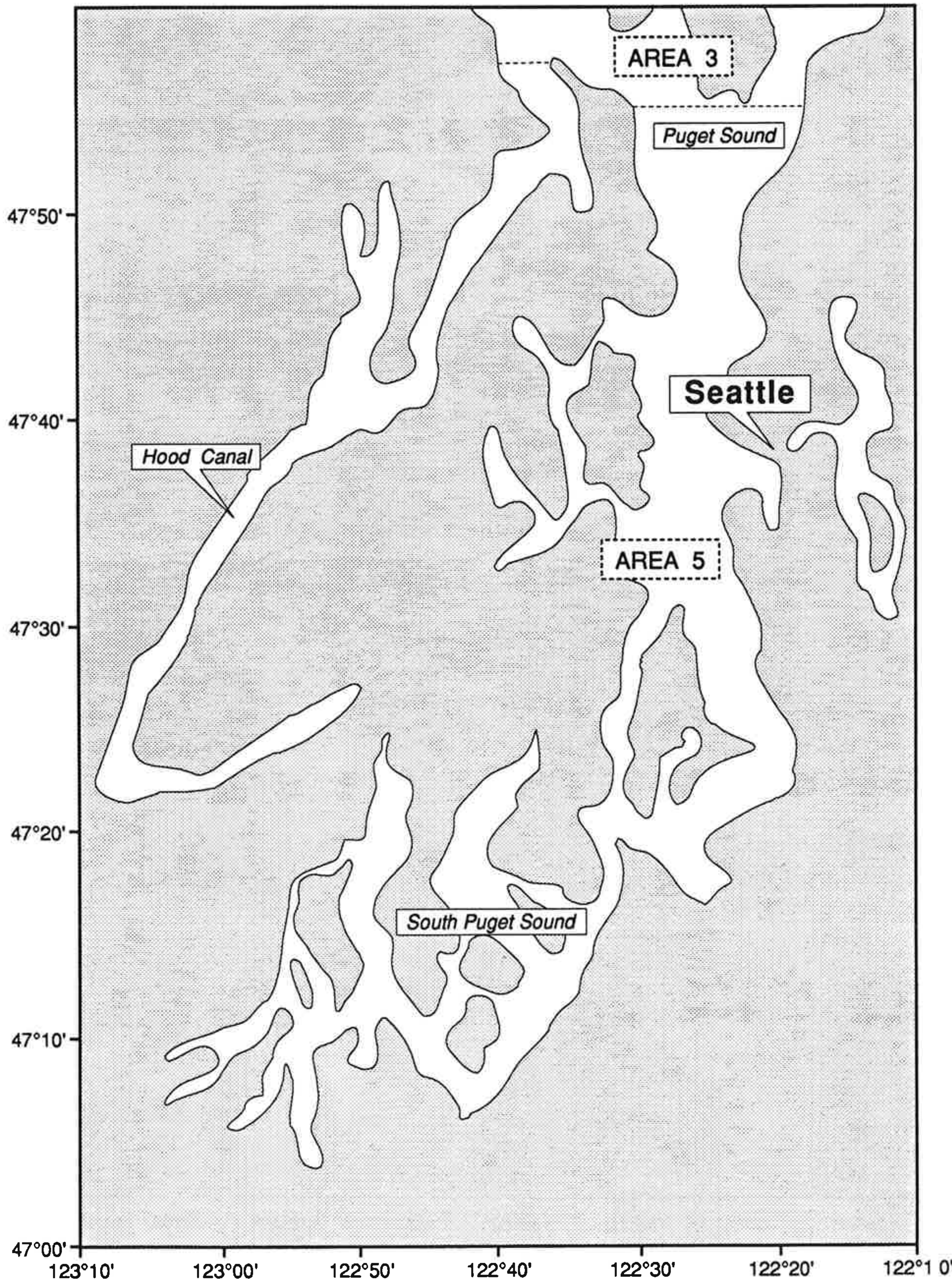

Figure 5. Hood Canal and Puget Sound study Area 5.

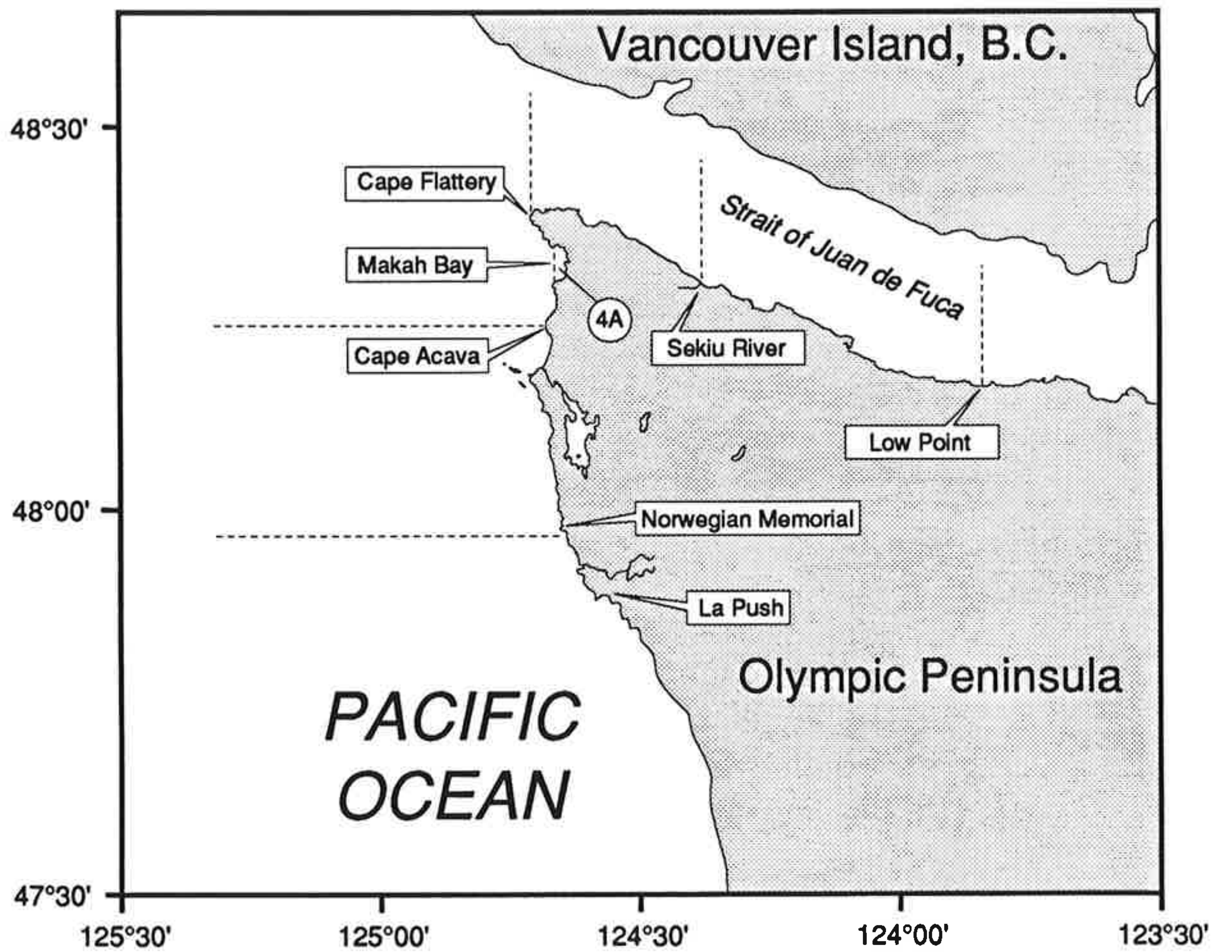

Figure 6. Area of North Washington coast showing the location of proposed parallel coastal surveys for harbor porpoise.

17-Apr-91

HARBOR PORPOISE-ABUNDANCE

JUNE-JULY (2)

	89	90
EFFORT	1269	1107
# REP. LINES	48	44
# SIGHTINGS	12	11
f(0)	9.48	9.48
var f(0)	0.5632	0.5632
DENSITY	0.0448	0.0471
var(D)	0.00018	0.00016
AREA (km2)	16056	16056
GROUP SIZE	1.45	1.45
var(G)	0.0039	0.0039
UNCORRECTED ABUNDANCE	1043	1097
var(N)	99399	88792
cv(N)	30.2	27.2

EBASCO attachment 1.

17-Apr-91

HARBOR PORPOISE-ABUNDANCE

MAY-SEPTEMBER

	89	90
EFFORT	2544	2821
# REP. LINES	91	100
# SIGHTINGS	24	46
f(0)	9.48	9.48
var f(0)	0.5632	0.5632
DENSITY	0.0447	0.07729
var(D)	9.5E-05	0.00018
AREA (km2)	16056	16056
GROUP SIZE	1.45	1.45
var(G)	0.0039	0.0039
UNCORRECTED ABUNDANCE	1041	1799
var(N)	53405	103388
cv(N)	22.2	17.9

EBASCO attachment 2.

17-Apr-91

HARBOR PORPOISE-ABUNDANCE SPRING

HARBOR PORPOISE ZONES

	1	2	3	4	5
EFFORT	349	736	787	1012	323
# REP. LINES	12	25	31	28	18
# SIGHTINGS	2	13	5	14	11
f(0)	9.48	9.48	9.48	9.48	9.48
var f(0)	0.5632	0.5632	0.5632	0.5632	0.5632
DENSITY	0.0271	0.0837	0.0301	0.066	0.1613
var(D)	0.00017	0.00082	0.00019	0.00034	0.0023
AREA (km2)	2266	4389	3888	4351	1162
GROUP SIZE	1.45	1.45	1.45	1.45	1.45
var(G)	0.0039	0.0039	0.0039	0.0039	0.0039
UNCORRECTED ABUNDANCE	89	533	170	416	272
var(N)	1847	33676	6081	13829	6654
cv(N)	48.3	34.5	46.0	28.2	30.0

EBASCO attachment 3.

17-Apr-91

HARBOR PORPOISE-ABUNDANCE SUMMER

HARBOR PORPOISE ZONES

	1	2	3	4	5
EFFORT	511	732	643	405	86
# REP. LINES	15	25	24	22	5
# SIGHTINGS	3	7	6	7	0
f(0)	9.48	9.48	9.48	9.48	9.48
var f(0)	0.5632	0.5632	0.5632	0.5632	0.5632
DENSITY	0.0278	0.0454	0.0442	0.082	0
var(D)	0.00059	0.00019	0.00027	0.00065	0
AREA (km2)	2266	4389	3888	4351	1162
GROUP SIZE	1.45	1.45	1.45	1.45	1.45
var(G)	0.0039	0.0039	0.0039	0.0039	0.0039
UNCORRECTED ABUNDANCE	91	289	249	517	0
var(N)	6373	7836	8681	26320	0
cv(N)	87.4	30.6	37.4	31.4	0.0

EBASCO attachment 4.

17-Apr-91

HARBOR PORPOISE-ABUNDANCE FALL

HARBOR PORPOISE ZONES

	1	2	3	4	5
EFFORT	500	618	512	410	152
# REP. LINES	12	20	23	14	11
# SIGHTINGS	2	14	8	8	4
f(0)	9.48	9.48	9.48	9.48	9.48
var f(0)					
DENSITY	0.019	0.1074	0.074	0.0924	0.1246
var(D)	0.00016	0.0018	0.00079	0.00087	0.0038
AREA (km2)	2266	4389	3888	4351	1162
GROUP SIZE	1.45	1.45	1.45	1.45	1.45
var(G)	0.0039	0.0039	0.0039	0.0039	0.0039
UNCORRECTED ABUNDANCE	62	683	417	583	210
var(N)	1731	73633	25384	35195	10850
cv(N)	66.7	39.7	38.2	32.2	49.6

EBASCO attachment 5.

17-Apr-91

HARBOR PORPOISE-ABUNDANCE WINTER

HARBOR PORPOISE ZONES

	1	2	3	4	5
EFFORT	51	122	49	279	169
# REP. LINES	4	7	5	9	5
# SIGHTINGS	1	1	1	7	14
f(0)	9.48	9.48	9.48	9.48	9.48
var f(0)	0.5632	0.5632	0.5632	0.5632	0.5632
DENSITY	0.0937	0.0389	0.0975	0.119	0.3934
var(D)	0.013	0.0014	0.0044	0.00084	0.022
AREA (km2)	2266	4389	3888	4351	1162
GROUP SIZE	1.45	1.45	1.45	1.45	1.45
var(G)	0.0039	0.0039	0.0039	0.0039	0.0039
UNCORRECTED ABUNDANCE	308	248	550	751	663
var(N)	140261	56710	140144	34418	63155
cv(N)	121.6	96.2	68.1	24.7	37.9

EBASCO attachment 6

17-Apr-91

HARBOR PORPOISE-ABUNDANCE STUDY AREA-2

	SPRING	SUMMER	FALL	WINTER
EFFORT	3208	2376	2192	668
# REP. LINES	110	91	79	26
# SIGHTINGS	45	23	36	24
f(0)	9.48	9.48	9.48	9.48
var f(0)	0.5632	0.5632	0.5632	0.5632
DENSITY	0.0664	0.0459	0.0778	0.1702
var(Dg)	0.00013	8.9E-05	0.00028	0.0017
AREA (km2)	16056	16056	16056	16056
GROUP SIZE	1.45	1.45	1.45	1.45
var(G)	0.0039	0.0039	0.0039	0.0039
UNCORRECTED ABUNDANCE	1546	1069	1811	3962
var(N)	74764	50268	157568	948840
cv(N)	17.7	21.0	21.9	24.6

EBASCO attachment 7.

Formulas used to calculate abundance in the ORWA report

1.

$$\hat{D}=\frac{nf(0)}{2L}$$

2.

$$var(n)=L\frac{\sum l_i[\frac{n_i}{l_i}-\frac{n}{L}]^2}{R-1}$$

3.

$$(cv(n))^2=\frac{var(n)}{(n)^2}$$

4.

$$(cv(f(0)))^2=\frac{var(f(0))}{(f(0))^2}$$

5.

$$var\hat{D}=D^2[(cv(n))^2+(cv(f(0)))^2]$$

6.

$$var(\overline{G})=\frac{\sum G_i-\frac{(\sum G_i)^2}{n}}{n(n-1)}$$

7.

$$\hat{N}=\hat{D}A\overline{G}$$

8.

$$var(\hat{N})=A^2[\hat{D}^2var(\overline{G})+\overline{G}^2var(\hat{D})-var(\overline{G})var(\hat{D})]$$

9.

$$cv(\hat{N})=\frac{100\sqrt{var(\hat{N})}}{\hat{N}}$$

10.

$$CI=\hat{N}\pm 1.96\sqrt{var(\hat{N})}$$

EBASCO attachment 8.

APPENDIX IV

HARBOR PORPOISE IN ALASKA

Study Plan 1991-1993

INTRODUCTION

Under the 1988 re-authorization of the Marine Mammal Protection Act, after a 5-year exemption period ending in 1993, the incidental take of marine mammals in commercial fisheries may be authorized from marine mammal stocks whose population level is within its optimum sustainable population (OSP) range. However, insufficient data exist to determine incidental take levels and OSP levels for most Alaskan cetaceans, particularly harbor porpoise, *Phocoena phocoena*. In Alaska, harbor porpoise range throughout southeastern Alaska, the Gulf of Alaska and Aleutian Islands, and Bering Sea. Their population status is unknown, but believed to be at low levels and stable or declining in some areas (Prince William Sound). Continued harbor porpoise take in Alaskan commercial fisheries may not be authorized after 1993 unless the population status is determined. Because harbor porpoise are distributed within coastal waters, they are commonly caught incidental to commercial and subsistence net fishing operations. The nature and magnitude of the incidental take is generally unknown but could be significant in some salmon and herring gill net and purse seine fisheries. In April 1991, the National Marine Mammal Laboratory will initiate studies on

Alaskan harbor porpoise to obtain minimum population estimates. The estimates will be used to assess the possible impact of incidental catch of harbor porpoise in commercial net fisheries on porpoise population levels.

OBJECTIVES

1. Obtain minimum population estimates of Alaskan harbor porpoise.
2. Establish a baseline for detecting changes in abundance of harbor porpoises through time (i.e., analysis of trends).

METHODS

Populations To Be Studied

Gaskin (1983) proposed that harbor porpoises inhabiting the Bering Sea and adjacent Arctic waters be considered provisionally as sub-populations: 1) the Bering Sea coast of Alaska including the islands of the shelf, the north coast of Alaska, and the Yukon coast of the Northwest Territories; 2) the Aleutian chain to Attu; 3) the Gulf of Alaska to Los Angeles harbor; and 4) the Kamchatka coast adjacent to the Bering Sea and the continental shelf area north to Wrangell Island and the summer ice limit. These divisions are suggested from morphological and genetic differences between areas and inferred from oceanographic conditions and topography of the area which might limit the movements of harbor porpoises (Yurick, 1977).

The nearshore waters of the state were divided into seven areas for survey purposes (Figure 1). The areas were chosen based on geographic considerations to facilitate survey coverage. Area 1 includes southeastern Alaska; area 2 includes the Alaskan panhandle; area 3 includes Prince William Sound and adjacent waters; area 4 includes Cook Inlet; area 5 includes the south side of the Alaskan Peninsula; area 6 includes Bristol Bay; and area 7 includes the Kodiak archipelago. The Aleutian Islands and the Bering Sea (Pribilof Islands) areas were not included because there are no commercial net fisheries (except offshore trawl fisheries) that could affect harbor porpoise and the level of incidental take is expected to be negligible.

Because the amount of coastline to be surveyed is enormous (over 3,000 straight-line miles), each one of the seven areas will be surveyed only once during a three-year period. Surveys will occur in areas 1, 4 and 6 during 1991, and areas 2 and 3 during 1992. In 1993, areas 7 and 5 will be surveyed, including any area scheduled for previous years but missed due to inclement weather, mechanical breakdown, or incomplete transects.

Minimum population estimates will be obtained in all seven study areas and summed for the entire state.

Survey Methods - Southeast Alaska (Area 1)

Harbor porpoise surveys in the inland waterways of Southeast Alaska will be conducted from the NOAA vessel JOHN N. COBB. The vessel is 185 gross tons, 93 feet (28.3 m) in length, and has a bridge height of approximately 14 feet. A 17-foot Boston Whaler will be used to collect sightings of harbor porpoise in the upper parts of inlets or bays that are not accessible from the larger vessel. When possible, behavioral data on porpoises (e.g., respiration rates) will be collected. To account for variation in seasonal occurrence of harbor porpoise, three separate surveys are scheduled:

Leg I - 20 April to 4 May 1991

Leg II - 15 to 25 July 1991

Leg III - 13 to 20 September 1991

Approximately 1,000 nautical miles will be surveyed using line transect methodology (Figure 2). A precision estimation is discussed in Appendix A. Sighting data will be recorded by three observers (one port, one starboard and one recorder focussed on the entire trackline). Observers will rotate among the three positions, spending approximately two hours on shift and two hours off. We will have a team of six biologists on board. Observation teams will be randomized. Standardized effort forms will be used. Data entries on this form include: start/end time of transect, position, sea state, weather, visibility, observer order, and sighting information. An entry will be made each time a change occurs in course, weather, or vessel speed. Each time a sighting occurs, a standardized marine mammal sighting form will be completed. Angles to each sighting will be obtained through the use of a pelorus (accuracy to within 5 degrees). Distance estimates will be collected through the use of Fuginon reticle binoculars. When a horizon is not visible, distances to the target will be estimated. In the case where a shoreline but not horizon is visible during a sighting, the vessel will take a radar fix to the shoreline along the sighting angle and distance will be noted. The reticle number where the target was located will also be recorded. Transects will be terminated when sea conditions exceed Beaufort 2 and visibility changes to poor from good, or worse.

Survey Methods - Areas 4 and 6

Fixed-wing amphibious aircraft will be used to survey areas 4 and 6 in late July and early August 1991. The design and number of surveys is yet to be determined (see Appendix A - Aerial survey design). An adequate number of surveys must be completed to obtain an estimate with a coefficient of variation (standard deviation of the counts divided by the mean) less than 30%.

Data Management and Analysis

Time permitting, data will be transferred to the computer during field surveys. Analysis will employ standard line transect analysis procedures.

All sighting data will be reviewed to determine porpoise distribution relative to depth, tidal conditions, time of day, etc. Data collected on harbor porpoise respiratory activities will be analyzed to obtain average dive times. Information collected during the 1991 season will be used to improve future survey work in Alaska.

PERSONNEL/LOGISTICS REQUIRED

A team of six observers is required for each vessel survey. To provide consistency, the same three observers will participate in all surveys.

Survey work will be weather dependent. A plan will be developed which permits a great deal of flexibility in altering plans to go where the weather may be suitable for surveys. In Southeast Alaska, the town of Juneau, Alaska, will serve as the base of operations. Juneau is easily accessible by plane and boat which will facilitate loading and off-loading of scientific equipment and personnel.

SUMMARY OF AVAILABLE DATA

There are few survey data available for Alaskan harbor porpoise. Aerial surveys for marine mammals in Prince William Sound during 1978-1979 (Hall, 1979) included estimates of harbor porpoise abundance. Leatherwood et al (1983) conducted aerial surveys in the eastern Bering Sea and in Shelikof Strait (near Kodiak Island) and included harbor porpoise, but these surveys did not extend to Bristol Bay. The only other systematic surveys for Alaska are shore-based surveys from Glacier Bay (Taylor and Dawson, 1984). Braham et al (1983) plotted harbor porpoise sighting data from the Platforms of Opportunity program. Additional surveys which report sightings of harbor porpoise in Alaska include: Forsell and Gould (1981) for the Kodiak area, and Brueggeman (1987, 1988) for the Aleutian Islands.

MILESTONE SCHEDULE FOR FIELD WORK

Scheduling of NOAA Ship	Feb/April
Contacts for Aerial Surveys	Apr/May
Vessel Surveys - Southeast Alaska	Apr/May
Vessel Surveys - Southeast Alaska	July
Aerial Surveys - Area 4 (Cook Inlet)	July
Aerial Surveys - Area 6 (Bristol Bay)	August
Surveys - Southeast Alaska	September
Final Report	February

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Appendix A

PRECISION ESTIMATION

Southeast Alaska - Ship Survey

The goal of the ship survey is to obtain a minimum estimate of harbor porpoise abundance in southeast Alaska with a coefficient of variation of no more than 30%. This also corresponds to a C.V. in the density estimate of 30%. The largest factor in determining the C.V. of a density estimate is the number of sightings made. Our approach to precision for the proposed ship survey will be to determine how many sightings need to be made to achieve a C.V. of 30%. Knowing this we will calculate how high the porpoise density must be in southeast Alaska in order to achieve this number of sightings given the logistic constraints of the cruise, weather, etc.

To estimate the number of sightings required to get a C.V. of 30% in density, we used a series of density estimates made for 8 regions of California, Oregon, and Washington (Barlow 1988). The C.V. of these 8 density estimates were based on a bootstrap approach (for f(0)) and a jackknife method (for number of groups seen), combined using the product-variance formula. We estimate that 60 to 80 sightings must be made to achieve a C.V. of 30%, given the variability in sighting rates that were observed for harbor porpoise in this area (Figure 3). We will assume that conditions will be similar in Alaska and will use a target of 60 to 80 sightings.

The density of groups is estimated as the number of groups seen (n) times the mean group size (ss) times the inverse of the effective strip width (f(0)) divided by 2 times the length of the transect (L) times a correction factor for missed trackline animals (g(0)):

$$D = \frac{n * f(0) * ss}{2 * L * g(0)}$$

For harbor porpoise, f(0) depends to a great degree on the height above the water. On a large research vessel with an observation height of 33', 1/f(0) was about 0.25km. Given that the R/V Cobb has an observation height of only 14', we guessed that 1/f(0) would be only about 0.10km. Therefore we assume f(0) will be 10. We assume that mean group size is 2 (this is the mean seen in California and is within the range found in Alaska). We assume that only 50% of the trackline animals are seen (per Calambokidis 1990). We make no adjustment for missed harbor porpoise due to ship's speed.

Given the above guesses and assumptions, the required harbor porpoise density to give a C.V. of 30% can be estimated as

$$D = \frac{2000}{L}$$

On the first cruise in S.E. Alaska, we are limited to 14 days. Given a 10-hour survey period per day, the vessel will cover approximately 100 nm per day or 1400 nm (2500 km) for the survey. Assuming that acceptable survey conditions average 50%

of available survey time, the vessel would be expected to survey 1250 km during the 14-day period. We therefore assume L = 1250 km.

Harbor porpoise density must therefore be a least 1.6 porpoise per km in order for the proposed survey to give acceptable levels of precision (C.V. < 0.3). This is near the bottom of the range of harbor porpoise density seen in Glacier Bay Alaska (Taylor and Dawson 1984). [The Glacier Bay study site was, however, chosen on the basis of it high harbor porpoise abundance.] It is near the mean density of porpoise along the coasts of California, Oregon and Washington (1.7 porpoise per km, Barlow 1988).

It is impossible to predict the porpoise density in southeastern Alaska prior to these surveys. Typically harbor porpoise have a clumped distribution and are more likely to occur in ceratin areas. Thus we believe that if porpoise density in southeastern Alaska is similar to other areas that have been studied, the proposed survey is likely to achieve the target level of precision (C.V. < 0.3).

<u>Alaska Harbour Porpoise Aerial Survey -- Survey Design</u>

The same process used to estimate effort needed to obtain a specified C.V. of density for the ship survey can also be applied to the aerial survey. Aerial surveys will be flown at approximately 500 feet and 90 knots using a saw-tooth type transect. Again, we assume that seeing 100 groups of animals will lead to a C.V. of .30 and that mean group size is 2 animals per group. Aerial surveys for harbour porpoise in California, Oregon, and Washington result in effective strip widths in the same range as the ship surveys. We therefore assume f(0)=10, an effective strip width of 100 meters, as in the ship survey exercise. The proportion of groups available to be seen on the track line has been estimated to be .25 in good weather (Beaufort 0, no cloud cover). Weather will not be good in Alaska, so we arbitrarily assume the that the proportion of groups available to be seen is .083, 3 times worse than under ideal conditions. The formula for the estimate of density is D = (n * f(0) * ss * c) / 2L * g(0), where n= # of sightings, ss= mean group size, c=correction factor, g(0) the probability of seeing a group on the track line, and L=effort in km. Therefore, D = 100 * 10 * 2 / 2L * .083,

and,

D = 12000/L.

The expected density of animals throughout Alaska is unknown. Estimated density for Washington, Oregon, and California was 1.73 from Barlow (1988). Densities of approximately 1 to 5 were estimated by Taylor and Dawson for Glacier Bay, Alaska, a place of known high density of harbour porpoise. It is not known how much of the Alaska coast is harbour porpoise habitat, as confirmed sighting records show large gaps. A conservative estimate of harbour porpoise density in Alaska for this exercise could be taken as .5 porpoise per km squared. Using the above formula, we can calculate the amount of effort needed for a variety of given densities.

Density (per square km)	Effort needed (km)
.5	24,000.
1.0	12,000.
1.5	6,000.

Without any additional data from which to work, a minimum of 24,000 km of realized effort should be planned for any region from which an estimate of abundance is desired.

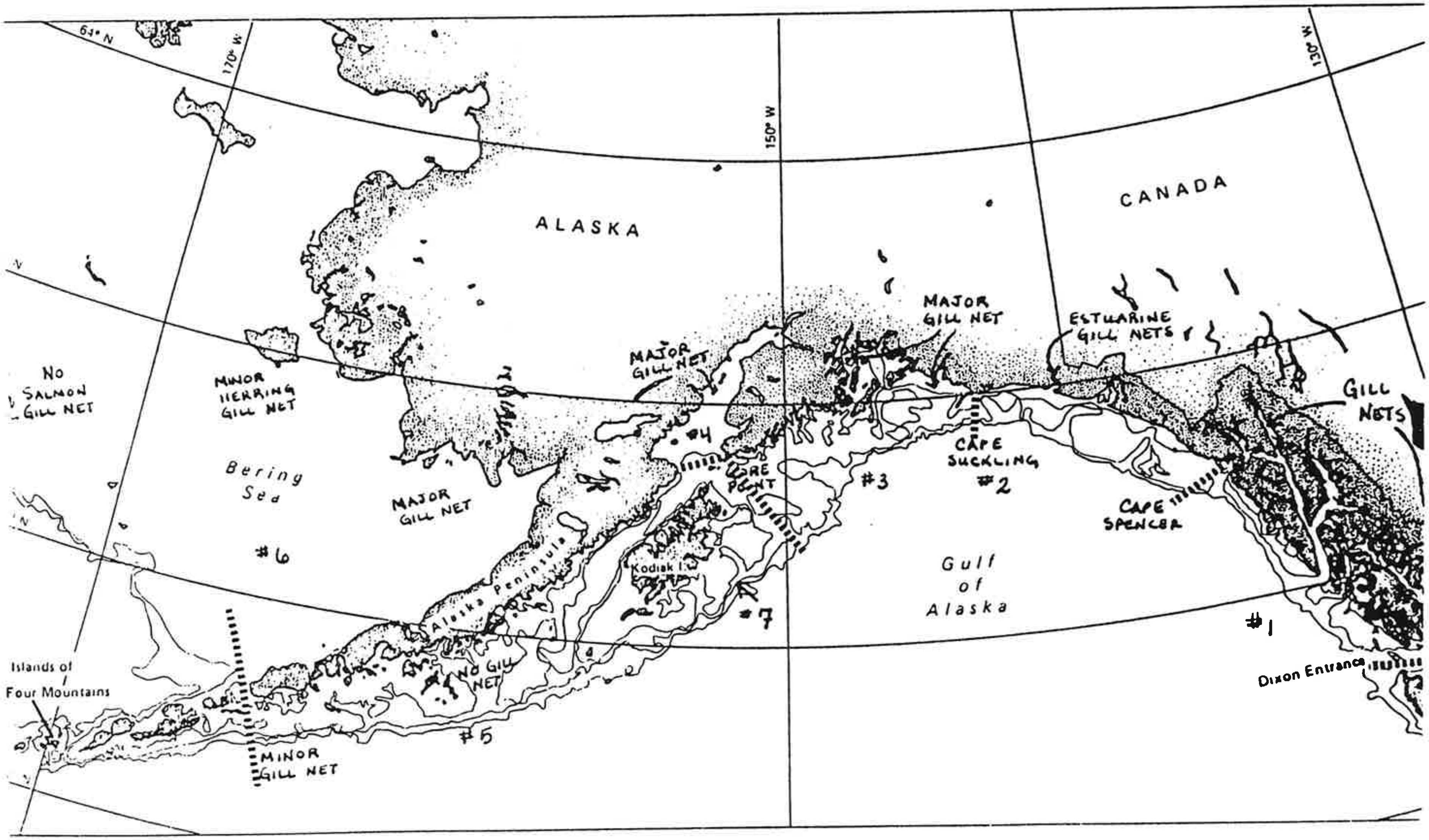


Figure 1. Alaskan survey areas for harbor porpoise assessment studies.

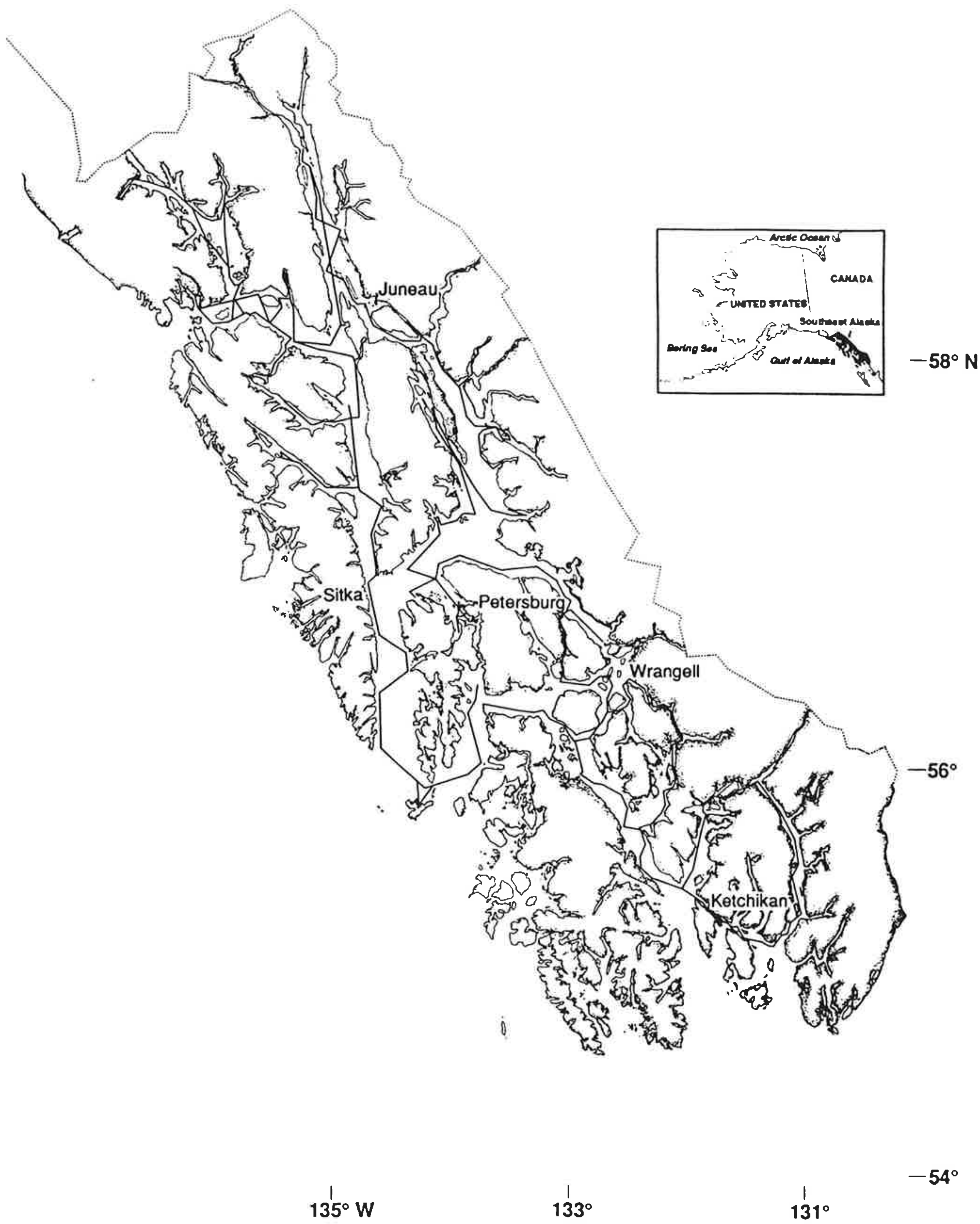
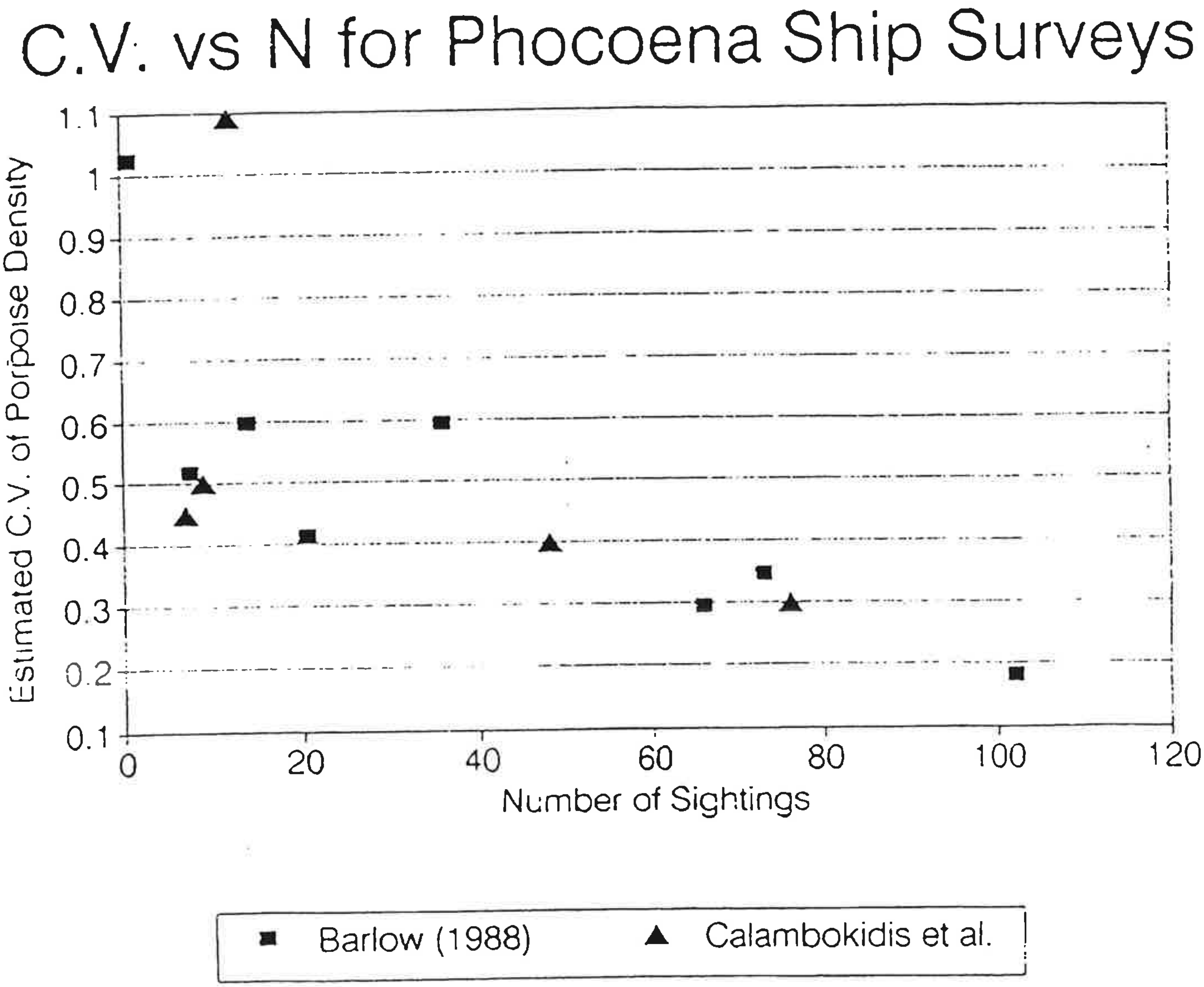


Figure 2. Proposed trackline for harbor porpoise surveys in SE Alaska. Vessel surveys - JOHN N. COBB.

Figure 3. Number of sightings of harbor porpoise and the coefficient of variation (C. V.) for porpoise density based on Barlow (1988) and Calambokidis et al. (1991).



APPENDIX V

NMML Harbor Seal Draft Survey Plan

Washington and Oregon, 1991 - 1993

INTRODUCTION

Pup counts have been used in Washington and Oregon to assess harbor seal population status and trends since the early 1970s. The most recent work includes censuses conducted by Washington Department of Wildlife (1977-1990) in Grays Harbor, Willapa Bay, Columbia River, Washington coast, San Juan Islands, and Eastern Bays; Cascadia Research Collective (1977-1990) in Hood Canal, Southern Puget Sound and the San Juans; Oregon State University (1977-1982) and Oregon Department of Fish and Wildlife (1983-1990) in northern and southern Oregon. Incidental take of harbor seals occurs in the Columbia River salmon gill net fishery and the Makah tribal set net fishery in the Neah Bay area which are both category I fisheries. There is also some undocumented incidental take of harbor seals in commercial gill net fisheries in the Strait of Juan de Fuca, Puget Sound, San Juan Islands, and Eastern Bays.

At present it is unknown how the minimum harbor seal population estimates obtained from previous data correlate with the true size of the total harbor seal population in Washington and Oregon. Estimates for the range of the total population in Washington and Oregon vary from 25,000 to 36,000 based on a best guess of 1.4 to 2.0 times the number of animals hauled out

(Boveng 1988). By radio tagging harbor seals in various age and sex classes in the proportion in which they exist in the population and using radio telemetry simultaneously with the censuses, it will be possible to determine the proportion of each age and sex class hauled out during the pupping season and during the molt season censuses. This will enable us to obtain a correction factor which takes into account the different hauling patterns of various age and sex classes during different seasons. The biology of harbor seals in Washington state is quite complex; unlike California or Oregon, the pupping season in various areas extends over an eight month period (May to December) which overlaps the molt season (July to January?). This spread and overlap precludes a single census period at either pupping or molt to obtain a state-wide maximum numbers.

OBJECTIVES

1. To assess the population of harbor seals in Washington and Oregon.
2. To document the pupping phenology at Cape Johnson and Cape Alava on the Washington coast and at Protection Island in the Strait of Juan de Fuca and the molt phenology at Grays Harbor and the Washington coast.
3. To determine the proportion of radio tagged animals ashore during the pupping and molt seasons.

Census Area

The census area is separated into 11 survey zones: the north and south Oregon coast; Columbia River, Willapa Bay, and Grays Harbor; Washington coast; Strait of Juan de Fuca; San Juan Islands and Eastern Bays; and Hood Canal and South Puget Sound. These areas are depicted in Figure 1.

Census Constraints

Factors which affect the number of harbor seals hauled out include season, time of day, tide, weather, and disturbance. All areas in Washington and Oregon have highest numbers hauled out at low tide except for Hood Canal which has maximum numbers at high tide. A few artificial areas such as log booms and floats are unaffected by tides but may be more affected by human disturbance than other areas. Human disturbance of harbor seals (particularly during good clamming tides) precludes surveys on weekends on the Oregon Coast and in the San Juans during summer. Studies in Grays Harbor during the pupping season determined that the maximum number of pups (> 83%) hauls out between 1.5 hours before low tide and 1.5 hours after low tide, the maximum number of non-pups also hauls out at this time. There was no difference in numbers hauled out during rising and falling tides. Maximum counts of total animals and of pups occurred when tides were <1.0 foot during the morning or early afternoon. Subsequent counts of animals from photos taken during aerial surveys (of estuaries) provided higher counts of both pups and non-pups than ground or boat counts (Stein 1989). However on rocky or broken substrate ground counts may be more accurate (Hanan 1987).

Background

Seasonal variation occurs in the number of harbor seals hauled out; highest counts in most areas are obtained during the pupping or molt periods. The exceptions are areas where harbor seals are feeding on locally abundant prey such as eulachon in the Columbia River in winter. In Washington and Oregon neither the pupping nor the molt seasons are synchronous, thus it is impossible to make a single, area-wide census to obtain a minimum population figure during either period. High site fidelity is expected during the pupping season and substantial inter-area movement is expected prior to and during molt, therefore it is probable that maximum counts during the pupping season are a more reliable indicator of minimum population in this area. In California, peak annual counts occur during molt in July in undisturbed areas. However, long-term monitoring studies of the harbor seal population document post-breeding peak counts in June to avoid high intensity human disturbance which coincides with low tides during the peak molt period.

Estimates of the minimum harbor seal population in Washington and Oregon are complicated by variation in timing of the pupping season in different areas. Pupping is earliest in southern Oregon and latest in Hood Canal. Explanations proposed for this variation are genetic differences evolved in response to seasonal variation in food availability for newly weaned pups and photoperiod (Bigg 1973, Bigg and Fisher 1975). Approximate extent of the pupping season for each area is shown in Table 1. The pupping phenology at Sand Island in Grays Harbor is described in two ways in Figure 2. The dotted line is the cumulative number of observed births. The solid line in Figure 2 is the mean weekly count of pups based on daily censuses. When peak numbers of pups occur (week of 3-9 June), more than 95% of pups have been born. The highest number of births occur between 13 to 26 May and most pups are weaned an average of 25-28 days after birth (Stein 1989). From radio tagging studies, females and pups apparently remain in the estuary of birth for up to two weeks after birth (Allen 1988). Pupping phenology shows that the number of pups ashore during low tide decreases rapidly after 10 June as pups born in mid-May are weaned. Because maximum counts are also dependent on the combination of daylight, low tides, weather, and lack of disturbance, it is sometimes not possible to fly surveys on the same day each year. Knowing the rate of change in numbers of pups ashore would allow adjustments to be made to counts to make them comparable from year to year (assuming the phenology does not change from year to year). We propose to document the pupping phenology from two sites on the Washington coast and from Smith-Minor Island and Protection Island in the Strait of Juan de Fuca in 1991 in order to determine when maximum numbers of pups are hauled out for the outer coast and the Strait of Juan de Fuca. One observer will cover both sites on the outer coast, counting pups during low tide at Cape Johnson for 2-3 days and then moving to Cape Alava for 2-3 days. Observations will run from 1 June to the end of July. A second observer will monitor the number of pups born and number of pups hauled out at low tide at Smith-Minor Islands from 15 June to 15 August and at Protection Island from 15 July to 15 September.

The peak molt period in Washington and Oregon is presumed to be 4 to 6 weeks after peak pupping. The presumed molt periods are shown in Table 2. Because of the uncertainty of the molt period in Washington and Oregon we have scheduled two sets of aerial surveys for Grays Harbor and the outer coast to determine when the peak number of animals is hauled out during the molt season. One ground observer will monitor numbers hauled out during the molt period between 30 July and 30 September in Grays Harbor and from 21 August to 15 October at the outer coast. In Oregon, aerial surveys will be flown approximately every two weeks from 27 June to 29 August to document when maximum numbers are ashore. There is some indication that recently weaned pups and yearlings may not be represented in molt counts and that subadults molt at irregular times. The total number of harbor seals will be counted during pupping season and molt season in 1991 to determine which count is higher. The higher count will be used to determine minimum harbor seal population in Washington and Oregon and will be used in subsequent years.

Table 3 shows annual rates of change in pup counts in Oregon and Washington for each survey zone. These counts should not be construed as estimates of harbor seal stocks. At this time there is no evidence of different harbor seal stocks in Washington or Oregon. The only area showing a decrease is southern Oregon. This decrease is most likely an artifact of survey timing since, in 1988, it was surveyed after weaned pups had left the rookeries (Brown, pers. comm.). Table 4 gives the number samples necessary to detect a trend of given magnitude if sampling is done on an annual basis. The CV for harbor seal pup counts ranges from .04 to .19 and for total counts during the pupping season the CV ranges from .02 to .20.

Even at optimal census times an unknown proportion of the population are in the water (Table 5). This proportion varies depending on season and perhaps age and sex class. Two studies have addressed the problem of proportion of radio tagged seals hauled out at low tide (Pitcher and McAllister 1981; Harvey 1987). We propose to radio tag 60 harbor seals in Washington during 1991. The radio transmitters will be attached to Temple tags which will be applied to the hind flippers of pups, yearlings, subadults and adults (males and females) in proportion to their presence in the population. Using an assumed birth rate of .20 (20 pups/80 non-pups), assumed pregnancy rate of .80, equal sex ratio to age 20, female maturity at 4-5 years, and male maturity at 5-6 years (based on data in Bigg 1969 and Pitcher and Calkins 1979) the proportion in various sex and age categories was estimated (Table 6). The radio tags were further assigned to the population based upon the proportion of the total pups born in different habitats (Table 6).

The majority of problems associated with interpreting radio tagging data brought up in Boveng (1988) have been addressed in this study:

1. Radio transmitters were applied to flipper tags so that information could be obtained during the molt period.
2. Telemetry and aerial surveys are conducted simultaneously.
3. Automatic data collection computers are placed at each area where animals are tagged to detect animals which are not hauled out during aerial surveys and receivers tuned to all frequencies deployed are present on aerial surveys in Oregon and other areas of Washington to detect movement out of the area of tagging.
4. Radio tags were placed selectively on various age and sex categories of harbor seals in the proportion that these age and sex classes exist in the population.

Radio-tagged seals will be monitored with receivers and data loggers to assess presence of tagged animals in areas over the pupping and molt season and the proportion of time ashore. Proportion of time ashore at the time of surveys will be assessed with receivers/data loggers on survey aircraft. The proportion of time ashore assessed at the time of the survey will be used as a correction for counts. The average proportion of time ashore based upon season long assessments will be available to calculate a correction factor should there be a problem with the equipment on the day of surveys, although this correction factor is less desirable than the proportion of animals ashore on the day of the survey.

Aerial census

Surveys will be flown in a single engine, high winged airplane (Cessna 172) at altitudes of 200 m and speed of 80 knots. Photographs will be taken with SLR 35mm hand held camera equipped with a 135mm telephoto lens and polarizing filter using Kodak High Speed Ektachrome exposed at ASA 400 or with a high resolution video camera. Personnel will include at least two people beside the pilot. The primary observer (right front seat) will estimate number of pups and total animals and photograph sites, the secondary observer (right rear seat) will record sites, estimates and comments. Small groups ($\pm$ 25 animals) need not be photographed. 276 hours of aerial surveys are scheduled for Washington and Oregon (Table 7). Multiple flights are scheduled for each "tidal window" to compensate for bad weather. Three counts per area per season will be attempted although (assuming that the proportion ashore is .5, the number of radio tags deployed >10 per habitat type, and the CV of the count <.2), two replicates may be sufficient to keep the CV of the estimate of total population below .3. After 3 replicates for an area are completed the remaining flights will be canceled.

In the laboratory, photos from the aerial surveys will be projected onto a piece of paper and a mark made for each animal to prevent under or over counting. If the high resolution video camera is used, marks will be made on a piece of acetate covering the monitor screen to aid in accurate counting.

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Table 1. Approximate extent of pupping for harbor seals in Washington and Oregon.

```
   AREA                                        MONTH

                                     J  F  M  A  M  J  J  A  S  O  N  D

A--Puget Sound                                         ----------
B--Hood Canal                                           ---------------
C--Eastern Bays                                       ------
D--San Juan Islands                                   ------
E--Straits of Juan de Fuca                           ------
F--Washington Coast                                ----- 
G--Grays Harbor                                   -----
H--Willapa Bay                                    -----
I--Columbia River                                 -----
J--North Oregon Coast                             -----
K--South Oregon Coast                           -----
```

Table 2. Presumed molt period for harbor seals in Washington and Oregon.

AREA	J	F	M	A	M	J	J	A	S	O	N	D
A--Puget Sound											--	--
B--Hood Canal	---											----
C--Eastern Bays										---	---	
D--San Juan Islands										---	---	
E--Straits of Juan de Fuca									-	---	--	
F--Washington Coast									---	---		
G--Grays Harbor								---	---			
H--Willapa Bay								---	---			
I--Columbia River								---	---			
J--North Oregon Coast								---	---			
K--South Oregon Coast							---	---				

Table 3. Annual rate of change in harbor seal pup counts in Washington and Oregon, 1977-1989.

AREA	Year	# of pups	Year	# of pups	interval	annual rate of change
Puget Sound	1977	35	1984	142	7	+.221
Hood Canal	1977	48	1984	115	7	+.133
Eastern Bays	1984	171	1989	391	5	+.179
San Juans	1984	184	1989	368	5	+.149
Straits	1983	92	1989	246	6	+.178
Wash. Coast	1977	192	1989	653	12	+.117
Grays Harbor	1977	362	1989	1651	12	+.135
Willapa Bay	1977	125	1989	570	12	+.135
Columbia River	1976	9	1988	22	12	+.071
N. Ore. Coast	1984	161	1988	300	4	+.168
S. Ore. Coast	1984	477	1988	415	4	-.034

Table 4. Number of annual samples needed to detect a given rate of change for varying CV.

Rate of change	Coefficient of Variation .05	.10	.15	.20
.025	9	14	18	22
.05	6	9	12	14
.10	4	6	8	9
.15	3	5	6	7
.20	3	4	5	6

Table 5. Summary of studies of time ashore for radio tagged harbor seals.

Study Area	Number of animals tagged	Results	Source
Kodiak, AK	24 ad F 5 im F 5 ad M 1 im M 35	50% hauled out during low tide pupping season 41% hauled out during low tide molt season	Pitcher and McAllister, 1981
SNI, CA	4 F 6 M 10	65% hauled out each day in May 58% hauled out each day in June 41% hauled out each day in July	Stewart and Yochem 1983
Klamath River, CA	6 ad M 2 im M 1 pup M 2 ad F 2 im F 13	seals hauled out 56% of days in April seals hauled out 63% of days in May	Herder 1986
SMI, CA	13 M 5 F 18	proportion of seals hauled out during daylight hours ranged from .14 to .19 23 Oct to 6 Dec	Yochem et al. 1987
Alsea Bay, OR	22 F 4 M 26	proportion of seals hauled out during low tide .09 (Oct - Feb) .53 (Mar - Jul)	Harvey 1987

Table 6. Number of harbor seals to be radio tagged in Washington in 1991 by age class and habitat type.

AREA	HABITAT	AGE CLASS					
		Ad F	Ad M	Subad	Yrlg	Pup	TOTAL
Grays Harbor	mudflat	9	8	7	4	7	35
Smith-Minor	cobble	2	2	2	1	2	9
Protection Island	cobble	2	2	2	1	2	9
Gertrude Island	cobble	2	2	1	1	1	7
TOTALS		15	14	12	7	12	60

Table 7. Proposed harbor seal aerial surveys Washington and Oregon, 1991 (SO=southern Oregon, NO=northern Oregon, CR=Columbia River, WB=Willapa Bay, OC=Washington coast, JF=Straits of Juan de Fuca, SJI= SAN Juan Islands, EB= Eastern Bays, SP= So. Puget, HC=Hood Canal) P=PUP SURVEY, M=MOLT SURVEY.

	AREA						TIDE			
Date	SO	NO	CR	WB	GH	OC	day	ht	time	estimated flight hr
May 19	P	P					Su			3.5
20	P	P					M	-0.3	11:48	3.5
21	P	P					T	.3	12:44	3.5
22	P	P					W	1.0	13:40	3.5
23	P	P					Th			3.5
31	P	P	P	P	P		F	- .9	09:17	8.5
Jun 1			P	P	P	P*	Sa	- .3	09:54	5
2			P	P	P		Su	0.0	10:28	5
3	P	P	P	P	P		M	.3	11:17	8.5
4	P	P	P	P	P		T	.8	11:59	8.5
5			P	P	P		W	1.3	12:45	8.5

Date	SO	NO	CR	WB	GH	OC	day	ht	time	estimated flight hr
Jun 16					P	P	Su	-1.6	10:25	5
17					P	P	M	- .8	11:12	5
18					P	P	T	.1	12:02	5
19					P	P	W	1.1	12:54	5
27	X	X								3.5
28	X	X								3.5
29	X	X								3.5
Jul 2	X	X								3.5
3	X	X								3.5
4	X	X								3.5
5	X	X								3.5
15	X	X								3.5
16	X	X								3.5
17	X	X								3.5
18	X	X								3.5

Date	SO	NO	CR	WB	GH	OC	day	ht	time	estimated flight hr
Jul 29	M	M	M	M	M		M	- .5	09:05	8.5
30	M	M	M	M	M		T	.1	09:37	8.5
31	M	M	M	M	M		W	.7	10:09	8.5
Aug 1		M	M	M	M		Th	1.3	10:40	8.5
Aug 12	M	M			M	M	M	-1.1	08:48	8.5
13	M	M			M	M	T	- .4	09:30	8.5
14	M	M			M	M	W	.6	10:12	8.5
15	M	M			M	M	Th	1.5	10:54	8.5
26	X	X				M	M	- .1	08:00	8.5
27	X	X				M	T	.3	08:36	8.5
28	X	X				M	W	.9	09:08	8.5
29	X	X				M	Th	1.5	09:39	8.5

Date	JF	SJI	EB	SP	HC		day	ht	time	estimated flight hr
Aug 11	P	P	P				S	-1.1	11:29	5
12	P	P	P				M	.0	12:11	5
13	P	P	P				T	1.3	12:53	5
24		P	P				S	- .2	10:09	5
22		P	P				Th	- .2	08:59	5
23		P	P				F	- .3	09:37	5
Sep 6	M			P			F	- .8	08:50	6
7	M			P			Sa	- .4	09:39	6
8	M			P			Su	.3	10:24	6
9	M			P			M	1.2	11:06	6
Sep					P					
Oct					P					
Nov					P					

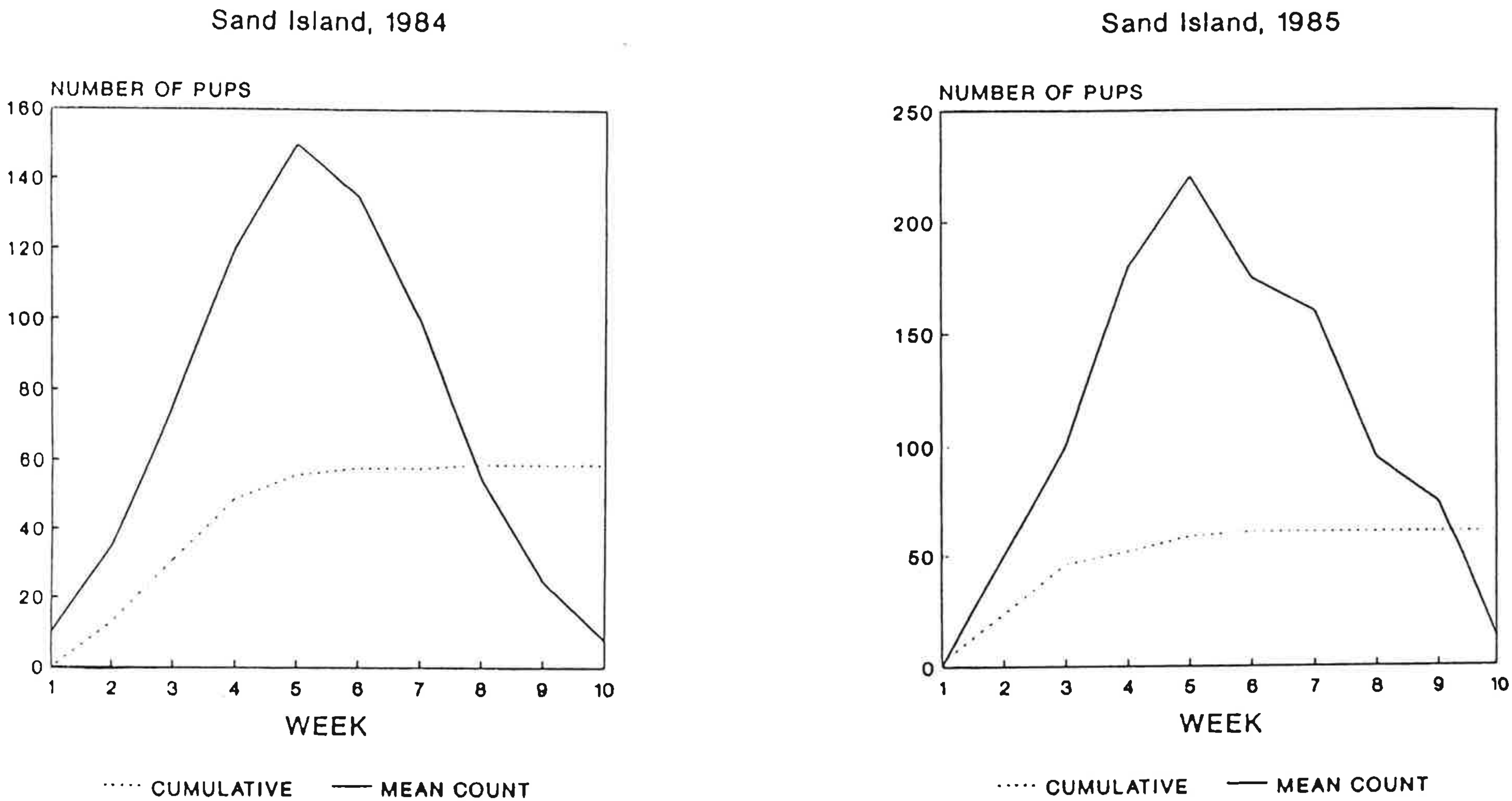

Figure 2. Number of harbor seal pups at Sand Island, Grays Harbor, 1984 and 1985

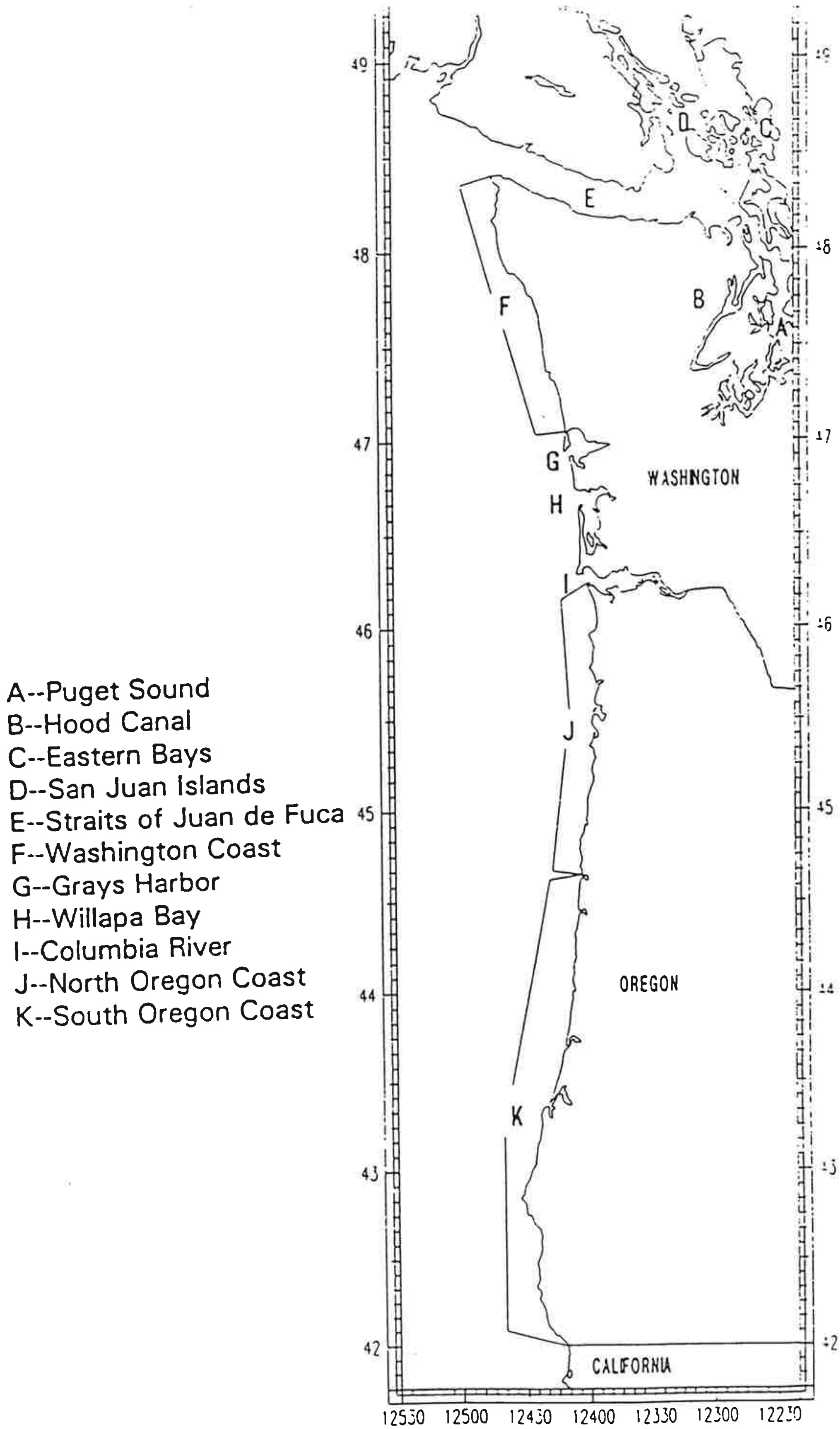

Figure 1. Harbor seal survey areas, Washington and Oregon.

APPENDIX VI

HARBOR SEALS IN ALASKA

1991-1993 Study Plan

INTRODUCTION

Under the 1988 re-authorization of the Marine Mammal Protection Act (MMPA), after a 5-year exemption period ending in 1993, the incidental take of marine mammals in commercial fisheries may be authorized from marine mammal stocks whose population level is within its optimum sustainable population (OSP) range. However, insufficient data exist to determine incidental take levels and OSP levels for most Alaskan pinnipeds, particularly harbor seals, *Phoca vitulina richardsi*. In Alaska, harbor seals range throughout southeastern Alaska, the Gulf of Alaska and Aleutian Islands, and Bristol Bay (to about 60°N). Once they were considered abundant in all parts of their Alaskan range until surveys in the 1980's indicated declining trends in some areas (e.g., Pitcher 1990). Authorization for continued harbor seal take in Alaskan commercial fisheries may not be authorized after 1993 unless the population status is determined.

Because harbor seals are distributed within coastal waters, they are commonly caught incidental to commercial and subsistence net fishing operations. The nature and magnitude of the incidental take is generally unknown but could be significant in some salmon and herring gill net and purse seine fisheries. They are commonly taken in low numbers in commercial trawl nets (Loughlin et al.

1983; Perez and Loughlin 1990). Observations of nearshore salmon fisheries in the Copper River Delta, Prince William Sound and Unimak began in 1989 and the level of incidental take in those fisheries is as yet undetermined. The extensive net fisheries in other parts of the state have not been monitored.

OBJECTIVES

1. Determine a minimum population estimate of harbor seals in most of Alaska (excluding the Aleutian Islands).
2. Determine trends in numbers as a means of assessing long-term fluctuations in seal populations.

METHODS

Study Area

The study in 1991 will consist of aerial surveys lasting 3-4 weeks during the summer pupping season and autumn molt. Two weeks are required for the surveys in each area; the additional time is needed to allow for missed days due to inclement weather. At some sites (e.g., Bristol Bay) aerial surveys will be conducted during the breeding season in June/July and during the molt in August/September. At all other sites aerial surveys will be conducted only during the molt period.

The state was divided into seven areas for survey purposes (Figure 1). The areas were chosen based on geographic considerations and not any biological criteria related to stock identification since there are no data presently available to distinguish Alaskan harbor seal stocks or populations. Area 1 includes southeastern Alaska; area 2 includes the Alaskan panhandle; area 3 includes Prince William Sound and adjacent waters; area 4 includes Cook Inlet; area 5 includes the south side of the Alaska Peninsula; area 6 includes Bristol Bay; and area 7 includes the Kodiak archipelago. The Aleutian Islands area was not included because there are no commercial net fisheries (except offshore trawl fisheries) there that could affect harbor seals and the level of incidental take is expected to be negligible.

Because the amount of coastline to be surveyed is enormous (over 3,000 straight-line miles), each one of the seven areas will be surveyed only once during a three-year period. Surveys will occur in areas 3, 4, and 6 during 1991; areas 2, 5, and 7 during 1992; and area 1, and any area scheduled for previous years but missed (due to inclement weather, mechanical breakdown, etc.) or incompletely surveyed, during 1993. Harbor seals in each of these study areas are near important commercial salmon gill net, salmon purse seine, herring gill net, or groundfish trawl fisheries.

Minimum population estimates will be obtained in all seven study areas and summed for the entire state. Past surveys in parts of the state were designed to assess trends in which specific haul out or rookery sites were surveyed during different years. There was no effort to count all animals within the study area. We propose to continue with these trend surveys by counting at all the historical sites (Alaska Peninsula, Prince William Sound, Tugidak Island, and southeastern Alaska) to obtain current trends in abundance. Recent counts for these trend count surveys are presented in Tables 1 to 3. Additionally, we will also survey all available coastlines to obtain a minimum population estimate for the study area. A minimum population estimate will be the more important parameter to measure, so that a baseline number can be established for assessing incidental take relative to a possible quota system.

Survey Methods

Past surveys along the Alaska Peninsula were conducted during the June/July pupping period when adults and pups were counted; molt period surveys were not conducted. We will survey this area during the pupping period to obtain comparable data to past surveys for trends and pup production estimates. We will also survey during the molt period to obtain a minimum population estimate comparable to other survey areas.

Fixed-wing aircraft will be used to photograph harbor seals while they are on land to pup and mate (June/July) and molt (August/September). The molt period is the optimal period to obtain minimum population estimates because that is when the greatest number of harbor seals spent the greatest amount of time hauled out on land (Pitcher and Calkins 1979; Calambokidis et al. 1987). At least four repetitive photographic counts will be obtained for each major rookery and haul-out site within each study area over a 1-2 week period. Four or more repetitive surveys are needed to obtain an estimate with coefficient of variation (standard deviation of the counts divided by the mean) less than

30%. Four to five surveys resulted in the desired results in past harbor seal surveys in Alaska and have proven to be an effective way of counting the maximum number of animals (Pitcher 1989, 1990). Numbers of harbor seals on land at the study locations varies throughout the day, even during periods of peak abundance. Repetitive surveys are essential to obtain maximum on-land counts and to reduce count variance. Pups and non-pups will be counted in the laboratory from the projected photographs. Three counters will score the number of seals on the photographs for each area for each survey day and the arithmetic mean calculated. The largest arithmetic mean obtained for each area will be used as the minimum population estimate. Visual estimates of abundance will also be recorded at the time of the survey.

Surveys will be flown at about 100-150 m altitude at about 80 knots air speed. Harbor seals will be photographed using 35mm and high 8mm video cameras. Where overhead photography is not possible, the aircraft will remain about 500 m offshore and photographs will be taken from an oblique angle with a hand-held 35 mm camera. High 8mm video photography has been used to photo-identify bowhead whales and was tested during 1990 to count harbor seals. The stop-image is crisp and clear, far superior to earlier video images. Surveys will be flown within one hour of daytime low tides which is when maximum numbers of seals are usually hauled out (Pitcher 1990).

<u>Data Management and Analysis</u>

The Kruskal-Wallis one-way analysis of variance test will be used to compare counts of seals between past years and the survey year (Pitcher 1990), for grand trend analysis. Linear regressions of the natural logs of mean season counts by year will be used to determine if trends in seal abundance exist, and to estimate _r_, the observed mean annual exponential rate of change. Given the limitations of this study design, we will assume that seasonal and diurnal haulout (patterns) behavior will not, and has not, changed over the years.

Generally for harbor seals, maximum counts on land during the molt period can be used to represent a minimum population estimate. Although some animals will remain in the water (feeding, traveling, etc.), maximum numbers should be available to count. We will conduct repetitive surveys during the period when these maximum numbers of seals are on land and use the counts obtained as the minimum population estimate. Repetitive surveys are required because of the variability in the number of animals on land during successive days. Land-based studies at Tugidak Island, Alaska, have verified that the period of maximum numbers on land occur during the molt period and generally during the middle of the day (depending on the tide). However, these studies are not adequate to define which days are optimal for obtaining maximum counts.

PERSONNEL/LOGISTICS REQUIRED

Only one observer is required to be in the airplane to locate then photograph harbor seals hauled out onto land. In some areas (e.g., Bristol Bay, Prince William Sound, and southeastern Alaska) two or more survey aircraft will be needed in order to cover the entire area during the survey period.

Cessna 180 or equivalent aircraft will be used. Surveys will be weather and tide dependent. Alaska Peninsula pupping period surveys will be flown during the period June 10-25; all molt surveys will be flown during late August-early September. Approximately 40 to 80 hours of flight time are required for each survey area.

SUMMARY OF AVAILABLE DATA

The abundance of harbor seals in Alaska prior to 1972 has been roughly estimated at 270,000 animals. However, this estimate is equivocal because no range-wide systematic work was carried out for counts or haul out behavior. Recent trend counts suggest that this estimate may be high. The Alaska Department of Fish and Game has conducted trend surveys of harbor seals in each of our four proposed study areas at infrequent intervals since the 1970's (Pitcher 1986, 1990; Pitcher and Calkins 1979). Results of the trend surveys indicate that the number of harbor seals in southeast Alaska are probably stable, but in the Kodiak Island Archipelago, Prince William Sound and Bristol Bay they are probably declining. Estimates of abundance and trend analysis for the Aleutian Islands and areas north of Kvichak Bay (Bristol Bay) are not available. Trend counts, rather than abundance estimates, are usually done in Alaska because of the difficulty in locating all haul out and rookery sites along the complex Alaskan coastline. Summary costs are also a major factor (long distances to remote areas, airplane down time due to weather, and general high costs of aircraft time). Correction factors for animals missed during surveys have not been calculated for Alaskan harbor seals.

The proposed study areas are consistent with areas suggested for study by the Marine Mammal Commission (Lentfer 1988).

MILESTONE SCHEDULE FOR FIELD WORK-1991

Contracts for airplanes	April/May
Conduct pupping surveys (Bristol Bay)	June
Preliminary counts from June surveys	July
Final Counts from June surveys; interim report	August
Conduct August/September (molt) surveys (Bristol Bay, Prince William Sound, Cook Inlet)	August/Sep.
Preliminary counts from molt surveys	September
Final counts from molt surveys	October
Interim report	February

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Table 1. Summary of mean counts of harbor seals on the Alaska Peninsula, 1975-1990 (from Pitcher, 1986, and NMML unpubl. data).

Year	Port Heiden	Seal Island	Port Moller	Cinder River	Total
1966-73	2,633	925	2,251	1,108	6,917
1975-77	6,318	490	5,284	2,577	14,669
1985	5,602	1,081	3,465	0	10,148
1990	4,196	710	2,515	737	8,158

Table 2. Summary of repetitive counts of harbor seals on the southwestern Tugidak Island, Alaska, hauling area during the molt period, 1976-1990 (from Pitcher, 1991).

Year	Mean Count	Coefficient of Variation	Minimum	Maximum	n
1976	6,919	0.280	2,800	9,300	12
1977	6,617	0.005	6,595	6,640	2
1978	4,839	0.270	2,532	6,817	12
1979	3,386	0.200	2,572	4,886	21
1982	1,575	0.390	660	2,323	10
1984	1,390	0.380	789	2,187	9
1986	1,270	0.230	639	1,673	10
1988	1,014	0.240	605	1,437	10
1990	960	0.245	433	1,283	9

Table 3. Mean harbor seal counts in Prince William Sound (PWS) and two trend count routes in southeastern Alaska by year. (data from K. Pitcher, unpublished reports, ADF&G)

Year	PWS	Sitka	Ketchikan
1983	1,584	1,131	1,058
1984	1,800	1,201	1,517
1988	1,036		1,820
1989	784		
1990	776		

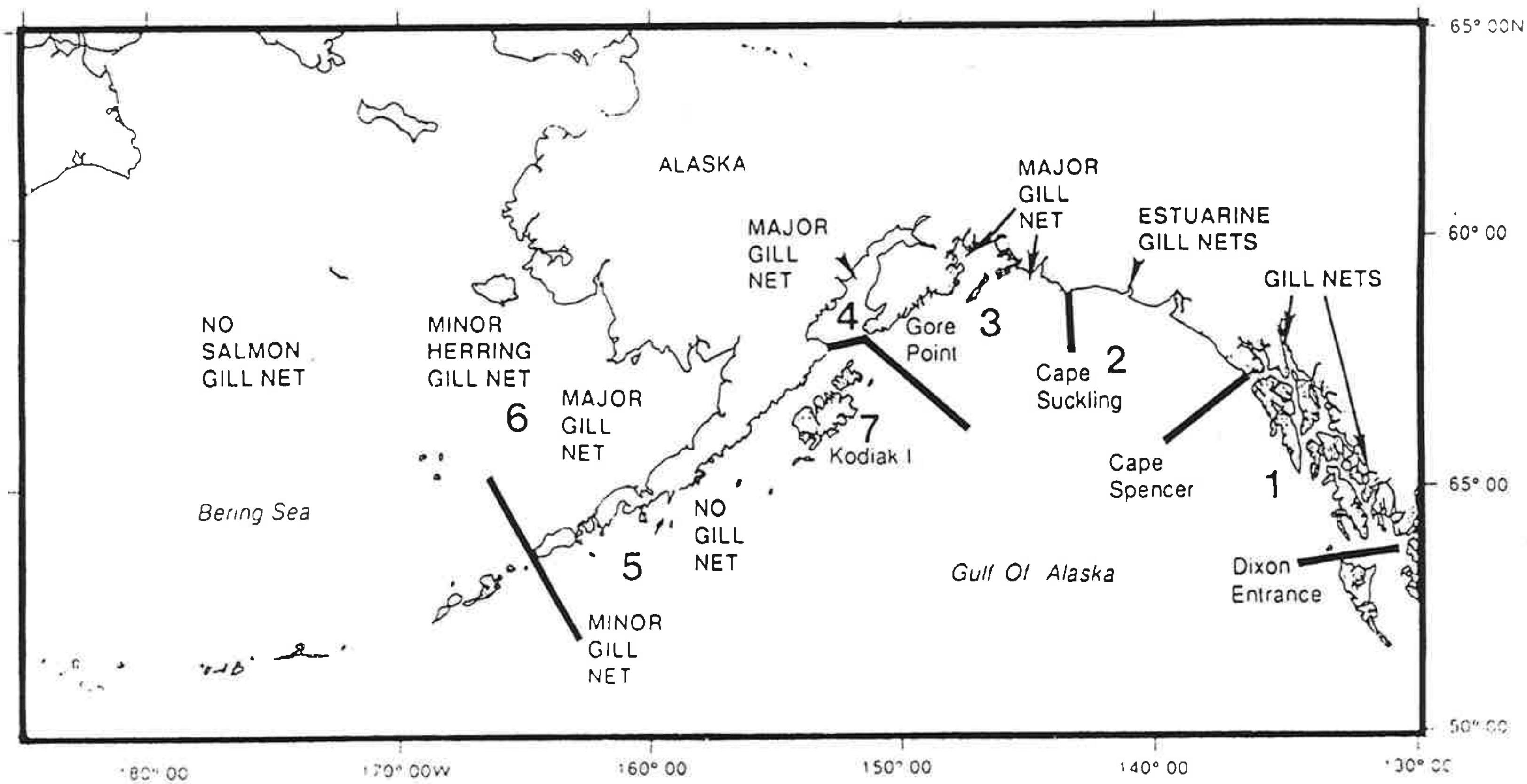

Figure 1. Map of Alaska showing seven study areas.