STATE OF ALASKA
DEPARTMENT OF FISH AND GAME

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30 December 1991

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Dr. Robert Spies
Applied Marine Sciences, Inc.
PO Box 824
2155 Las Positas Court, Suite V
Livermore, CA 94550

RE: Prince William Sound Killer Whales

Dear Bob,

I want to get my thoughts down on paper to you. First, I will summarize my views and analysis, and then I will explore things more completely.

SUMMARY: The number of whales in AB pod changed from 35 to 36 in the period 1984-1988 (Figure 1); there was no ongoing decline during this period. The 7 whales discovered missing immediately after the spill in 1989 and the other 6 were discovered missing in 1990 represent a mortality rate of about 20%, which is an order of magnitude greater than that seen in the 20-year study in British Columbia and more than three times the average mortality rate (6.1%) seen in AB pod during 1984-88, when fishery interactions were frequent.

The age composition of the whales discovered lost in 1989 and 1990 suggest unnatural mortality, given that several were older juveniles and prime adults. Emigration is not a general explanation, given that such dispersal would be unprecedented, based on about 20 years of research in British Columbia, where pods show extremely stable composition. Further, some of the missing individuals were adult females who left behind calves; emigrants would surely have taken calves with them.

The hypothesis that the 1989-90 mortality was a consequence of fishery interactions is most strongly supported by the fact that in the mid-1980s, AB pod animals are known to have taken fish from longlines set for blackcod and halibut. During this period, photo-identification studies documented that some AB whales acquired bullet wounds. If shooting were a significant cause of the 1989-90 mortality, one would predict that at least some of the surviving individuals would show evidence of new bullet wounds. However, it appears that the most recent bullet wound was discovered in 1987. The earlier understanding that there had been an ongoing decline in AB pod, prior to EVOS, possibly related to fishery interactions, is in error. Furthermore, fishing openings in 1988-89, following the last sightings of AB pod, do not appear to provide much of an opportunity for fishery interactions.Therefore, I reject this hypothesis.

The strongest evidence in support of the hypothesis that the mortality was related to EVOS is the correlation of the discovery that whales were missing from AB pod 7 days after the spill. The subsequent loss of an additional 6 whales in 1990 may be partially explained by the fact that some of these individuals were the young of whales discovered missing in 1989. While I have not yet been able to conceive of a satisfactory mechanism, I am not satisfied that I am able to adequately explore the possible scenarios. Therefore, at this time I am not prepared to reject this hypothesis. I believe that there is room for further exploration of the circumstances that may have existed in the few days immediately following the spill.

POPULATION TREND: The graph prepared by NMFS (Figure 2) is largely in error. This is unfortunate because it appears that for many people this figure has been the primary source of information about the trend of AB pod. The initial number of whales in AB pod is given as 44, although the pod never numbered more than 36. It appears that the starting number of 44 was derived by adding all of the births that took place in 1984-1988, which total 9, to the 1984 pod size of 35. The figures shown for other years were arrived at by progressively subtracting from 44 the mortalities discovered in those years. The following table summarizes the relevant numerical information that I have put together, primarily from the 8 November 1991 meeting in Seattle:

Year	Number Alive	Number Died	Mortality Rate	Number Born	Change
1984	35	--	-.-	--	---
1985	33	2	5.7%	0	-2 (-5.7%)
1986	32	3	9.1%	2	-1 (-3.0%)
1987	32	2	6.3%	2	0 (0.0%)
1988	36	1	3.1%	5	+4 (+12.5%)
1989	29	7	19.4%	0	-7 (-19.4%)
1990	23	6	20.7%	0	-6 (-20.7%)
1991	23	1	4.3%	1	0 (0.0%)

As can be seen from the above Table and Figure 1, AB pod did not undergo a decline during the period 1984-1988; it actually increased by 1. It should also be noted that the total number of whales in other resident pods in Prince William Sound increased from 87 to 101 during the 1984-1991 period, according to figures given in the 8 November meeting. Details of the changes in the other pods are not available to me. The other PWS resident pods do not show the bullet wounding that AB does, and it may be that the failure of AB pod to grow by more than 1 during the 1984-88 period may reflect the earlier wounding that took place..

I have not done a detailed analysis of age-specific mortality rates, although, this could be explored. However, I would like to point out that the overall mortality rate for killer whales in British Columbia and Washington is 1.8%. For reproductive females, the rate is 0.48%; for mature males, 3.9%; and for juveniles, 1.8%. It seems odd that none of the whales that went missing in 1989 and 1990 were mature males, and that so many were mature females and juveniles. The overall mortality rates of about 20% seen in AB pod in 1989 and 1990 are an order of magnitude higher than the comparable B.C. / Washington rates, and the age and sex composition of the mortalities are unusual as well. (B.C. / Washington data are from Olesiuk, P.F., M.A. Bigg, and G.M. Ellis. 1990. Rep. Int. Whal. Comm. Spec. Issue 12:209-243.)

(John Strand's analysis states that the maximum mortality in AB pod during the height of fishery interactions during 1984-87 "did not exceed 8%", although the above table shows a maximum value of 9.1% during that period. This may indicate further discrepancies in the data.)

FISHERY INTERACTIONS: AB pod has a history of interactions with longline fisheries, and it was discovered in the mid-1980s that AB whales were acquiring bullet wounds. This information led to the hypothesis that the unusually large number of whales that were discovered missing in 1989 could have been killed by fishermen. If this were true, one would predict that at least some of the surviving whales would carry fresh wounds as well. However, it is my understanding that the most recent bullet wound discovered during photo-indentification studies was seen in 1987. Furthermore, the opportunities for whales to interact with longline fisheries was limited after the last photo-identification encounter with AB pod in 1988; according to John Strand's memo, there was no blackcod fishery during that period, and there were only two 24-hour halibut openings.

The impression that there was an ongoing decline in AB pod that started at least as early as the mid-1980s and that was probably a consequence of fishery interactions resulted from an improperly prepared graph (Figure 2). There was no overall decline in AB pod from 1984-1988.

EFFECTS OF OIL: It is problematic to imagine a scenario in which oil could have caused the large mortalities discovered in 1989 and 1990. The usual scenarios consider that whales will surface in relatively thin slicks, blow any oil clear of the blowhole, and then inhale air that will contain non-damaging levels of volatile hydrocarbons. Could it be that very different circumstances obtained during the storm that occurred a few days after the spill? That there could have been the equivalent of "sea smoke" that would have resulted to whales in the slick breathing-in significant quantities of oil? Or could whales have suffered some sort of narcosis, similar to that apparently experienced by harbour seals,

under higher-than-expected concentrations of volatiles in the air above the slick? (However, under such scenarios, one would have expected the calves that accompanied the females that died to have been even more vulnerable than their mothers.)

Nor can I easily imagine AB pod animals ingesting harmful amounts of oil in their food. As resident whales, AB animals feed primarily on fish, the eating of which would not likely result in the ingestion of harmful amounts of oil. If they ate oiled harbour seals, they would have ingested larger amounts of oil than if they ate fish. Might they have ingested significant amounts by this route?

If we assume that EVOS caused some or all of the evident deaths, there appear to have been two phases of mortality, one within a few days of the spill, and another more than six months afterwards. However, this may not be as serious a problem as it first appears. I examined the data provided at the 8 November meeting for relationships between the animals lost in 1989 and those lost in 1990, but found only one example to a 1990 mortality that was an offspring of a female that died in 1989. [AB23 , dead in 1989, was the mother of AB36, a 4-year-old, dead in 1990.] However, John Ford may have information connecting two more of the 1990 mortalities to mothers that died in 1989. If this connection is true, it could explain three of the 1990 mortalities without having to hypothesize that there were two oil-related mechanisms.

CONCLUSION: There is a correlation between the discovery of unusually high mortality in AB pod and EVOS. While there is no clear mechanism for the action of oil on AB pod, there are many unknowns with respect to the conditions that AB pod may have encountered. The alternative hypothesis, that interactions with the longline fishery is responsible for all or part of the mortality, does not appear viable. A third "hypothesis", that there is some as yet unstated potential cause of the mortalities is not very useful.

There are a number of questions about the data on AB pod and on the other killer whales in Prince William Sound and the adjacent Gulf of Alaska. Some of these questions might be resolved by a thorough presentation and analysis of available data.

Given the high profile of killer whales, I believe that a significant segment of the public would support the use of EVOS funds for the study of this species even in the absence of a certain connection, especially given the difficulty of studying these animals under the conditions that obtained during the spill and the lack of stronger alternative hypotheses.

If it seems desirable to attempt a more complete analysis, I would suggest holding a workshop to more completely explore the existing information on killer whales and the environmental conditions that obtained in the early days of the oil spill. Such a workshop might include experts on killer whales, cetacean physiology and pathology, oil spills, and the air-sea interface. However, there are many unknowns surrounding the oil spill and the location of the whales at the time of the spill, and it is doubtful that the matter could be certainly resolved

Please feel free to contact me is you wish to discuss any aspect of the killer whales / oil spill relationship.

Sincerely,

Mark A. Fraker
OSIAR Wildlife Program Manager

attachments: Figure 1. Number of Killer Whales in AB Pod, 1984-1991.
Figure 2. AB Pod strength By Year. (Prepared by NMFS)

xc: J. Montague
J. Ford

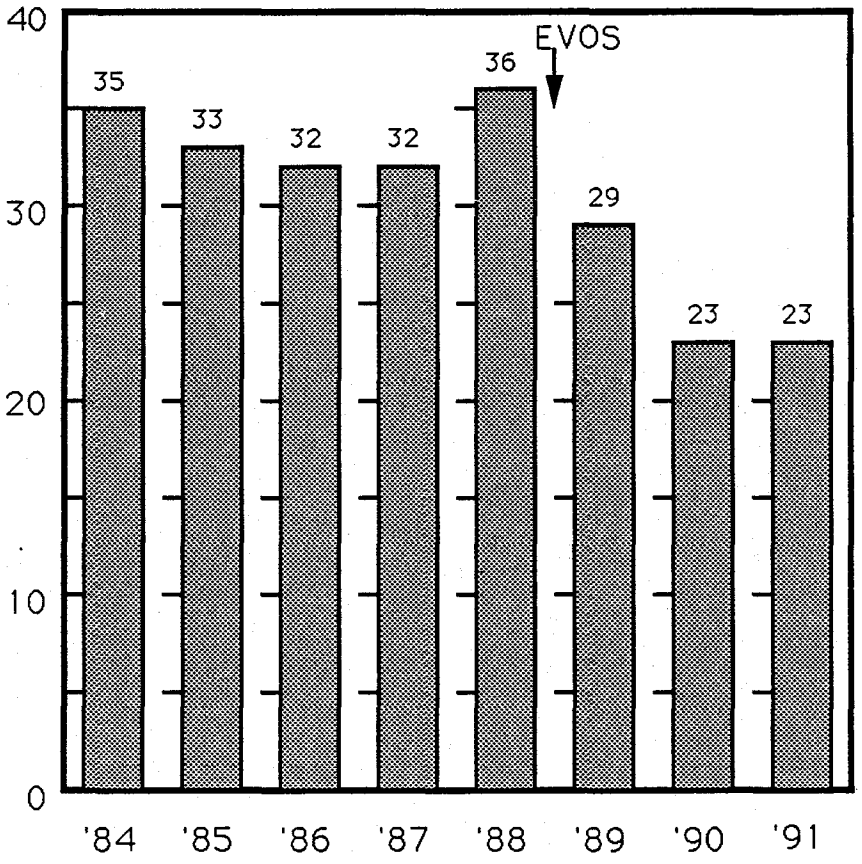

Figure 1. Number of Killer Whales in AB Pod, 1984-1991.

KILLER WHALES

AB Pod

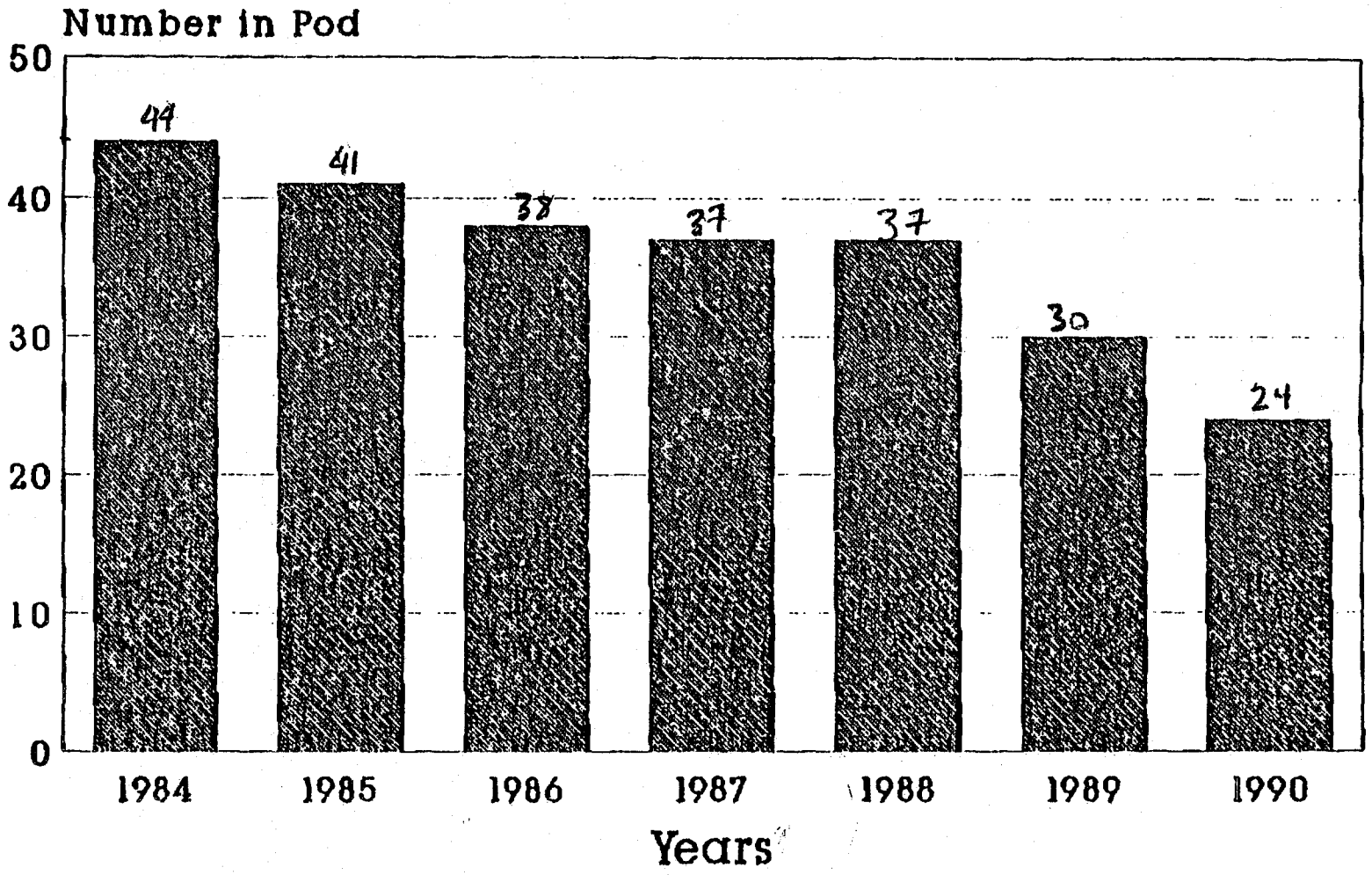

Figure 2. AB Pod Strength by Year. (Prepared by NMFS)

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1991 RESTORATION SCIENCE PROGRAM

RECOVERY MONITORING STUDY:

Killer Whale Monitoring and Habitat Studies

Study No. 2

PRINCIPAL INVESTIGATORS

Marilyn E. Dahlheim and Thomas R. Loughlin

Alaska Fisheries Science Center
National Marine Mammal Laboratory
7600 Sand Point Way N.E., Bin C15700
Seattle, Washington 98115

Lead Agency: National Marine Fisheries Service
National Oceanic and Atmospheric Administration

Cost: $43.5K

Effective Dates: 1 March 1991 to 29 February 1992

AUTHORIZATION:

	Signature	Date
Restoration Manager: John Strand (907) 789-6605	John Strand	5/23/91
Chief, Office of Oil Spill Damage Assessment and Restoration: Byron Morris (907) 789-6600	Byron Morris	5/22/91

Killer Whale Monitoring and Habitat Studies

Study ID Number: Marine Mammals Study Number 2

Project Leader(s): Marilyn E. Dahlheim and Thomas R. Loughlin

Lead Agency: National Oceanic and Atmospheric Administration

Cooperating Agency(ies): Federal: None
State: None

Cost of Proposal: $43.5K

Dates of Study Plan: 1 April 1991 through 31 March 1992 (Year 1).

Marilyn E. Dahlheim, Ph.D.
Project Leader

Thomas R. Loughlin, Ph.D.
Project Leader

for Howard W. Braham, Ph.D.
Organization Leader

Joanne Wejak
Financial Officer

Alaska Fisheries Science Center
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206/526-4045

14 May 1991

INTRODUCTION

Photographs of individual killer whales occurring in Prince William Sound were collected from May to September 1989 and 1990 to assess the potential impacts of the Exxon Valdez oil spill on killer whale life history and ecology. Research vessels traversed over 20,000 nautical miles in search of whales or while photographing whales, reflecting 507 days of field research. An unusually high number of killer whales were reported missing from the spill area. In addition to missing whales, changes occurred in the social structure and distribution of affected pods.

Restoration of cetaceans can be enhanced by protecting sensitive habitats, minimizing fishery interactions, reducing or redirecting other human-use impacts, and promoting public education. The designation of critical habitats has occurred in the United States to protect recovery of pinnipeds and also internationally to protect cetaceans. Recently Robson Bight in British Columbia has been designated as a critical habitat for killer whales (Rennie, 1989). It should be understood, however, that little or no quantitative information exists on habitat needs for killer whales in Prince William Sound and adjacent waters on which to base a recommendation to limit or otherwise change human-use activities.

Continued monitoring of the status and distribution of killer whales in Prince William Sound is required to facilitate recovery of injured populations and to obtain needed information on habitat requirements. In 1991, field studies will be supported under the Natural Resource and Damage Assessment (NRDA) Program to determine reproductive rates and trends in abundance. The 1991 restoration science studies are presented in this proposal and are aimed at determining the adequacy of the damage assessment database to support decisions on habitat protection and other management activities. The feasibility of developing satellite transmitters for killer whales to determine seasonal movements is also addressed.

OBJECTIVE

Proposed 1991 restoration studies will identify and describe habitat requirements for killer whales, a prerequisite to developing realistic restoration options for the species.

METHODS

A. Sampling Methods

Initial assessment of habitat use for Prince William Sound killer whales will include a review of all available sighting data. Federal and State agencies, as well as independent researchers,

will be contacted and will be requested to supply sighting data on killer whales. Published and unpublished data will be reviewed. We will attempt to correlate sighting data with water depth and sea surface temperature. Review of fishery catch data may facilitate correlation of killer whale distribution with potential prey concentrations. General behavior of killer whales and the presence of other marine mammals will be noted.

To more accurately determine habitat use and overall distribution and movements of killer whales, we will explore the feasibility of placing satellite transmitters on Prince William Sound killer whales. Recently, many successful deployments of satellite transmitters on cetaceans and pinnipeds have provided important ecological information and each year brings about major advances in technology. If feasible, and after extensive examination of existing technology, we may propose to place satellite tags on at least three whales in Prince William Sound.

Year one investigations (1991) will involve a review of all information pertaining to satellite tagging and a determination of the likelihood of success in placing satellite tags on killer whales. Scientists with expertise in satellite tagging will be consulted. If the likelihood of success is considered high, year two (1992) could be devoted to the engineering of the satellite linked radio tag for placement on killer whales. If the necessary equipment is obtained in 1992 and we are satisfied with all aspects of the work (delivery system, attachment device, minimal disturbance to whales, etc.), we could propose to initiate satellite tagging during the 1993 field season (year three). The permit process for this activity would begin in mid-1992.

B. Data Analysis

Killer whale habitat usage will be investigated by plotting all observations of killer whales obtained from the various historical databases. A summary report will be provided and will include any information collected on water depth, water temperature, and potential prey species.

In addition to the report submitted on overall distribution of killer whales, a progress report will be written assessing the feasibility of placement of satellite transmitters on killer whales based upon the information obtained during 1991 investigations. This would include recommendations for either continuation or cancellation of this aspect of the work.

FUTURE STUDIES

If the proposed review of the historical database is found inadequate to support future decisions to implement restoration (e.g. habitat protection), it can be expected that additional

habitat-use surveys will be proposed for the 1992 field season and beyond.

SCHEDULES & PLANNING

A. Data Submission and Archival

A data submission schedule is attached listing milestone dates and activities (Attachment 1). No other special reports or additional visual data will be submitted other than those described in the reports.

Reports will be available through the National Marine Mammal Laboratory, Seattle, Washington (Attn: Drs. Dahlheim and Loughlin) summarizing the 1991 studies. Reports are written in a scientific format and contain an Abstract, Title Page, Table of Contents, List of Tables and Figures, Introduction, Materials and Methods, Results, Discussion, and Conclusion/Recommendation Section.

All documents and materials associated with this monitoring and habitat study will be stored at the National Marine Mammal Laboratory, Seattle, Washington under the Alaska Ecosystem Program. Equipment purchased for the investigations will be properly labelled. Serial numbers will be listed when available. Equipment will be stored in the custody of the Project Leaders at the NMML.

B. Management Plan

NOAA, Alaska Fisheries Science Center, National Marine Mammal Laboratory, 7600 Sand Point Way N. E., Bin C15700, Seattle, Washington 98115 (206/526-4045).

Dr. Marilyn E. Dahlheim, Project Leader
Duties: Project development, research design and implementation. Coordination of, and participation in, field research.

Dr. Thomas R. Loughlin, Project Leader
Duties: Project development and research design.

Ms. Joanne Wejak, Financial Officer
Duties: Administrative officer in-charge of processing financial paperwork associated with research.

Temporary Biologist
Duties: Laboratory/Field Assistant

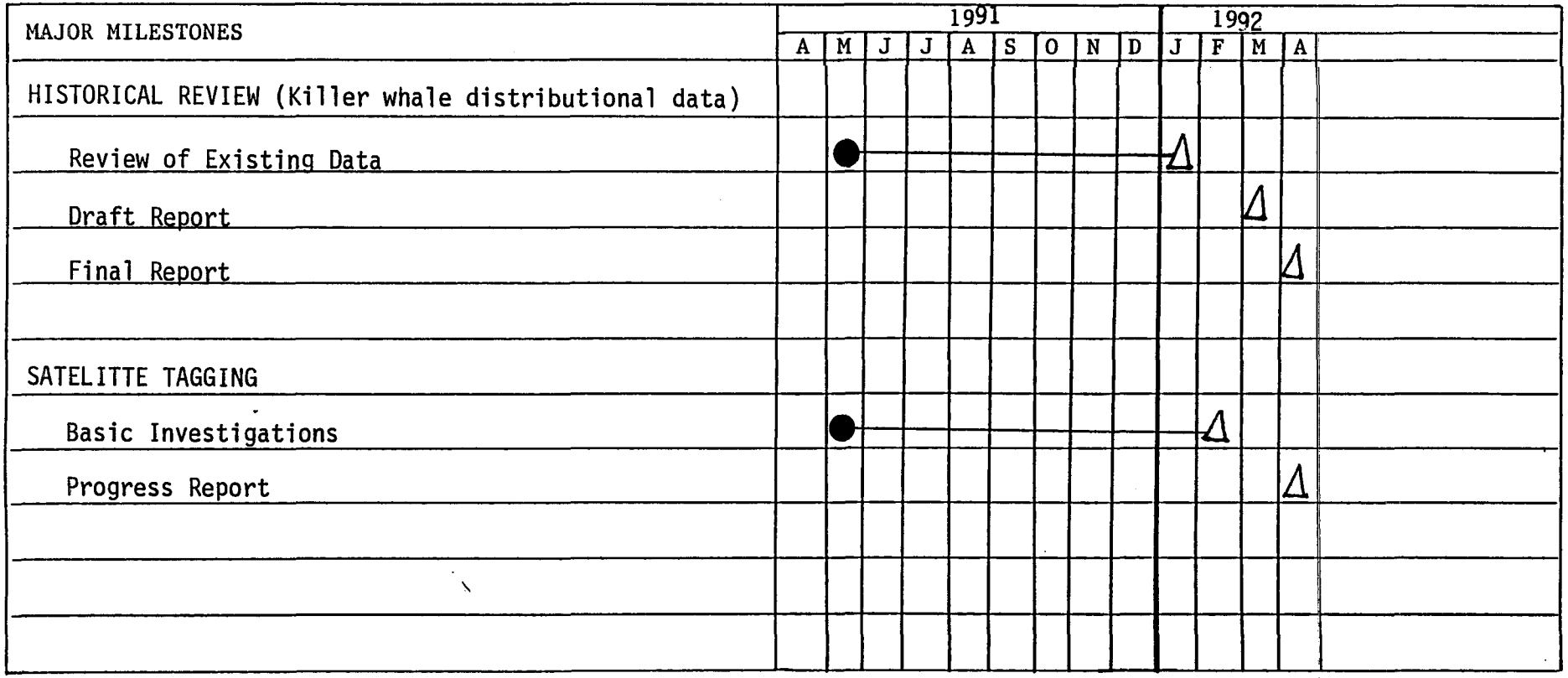
Actual Start Date ●
Planned Completion Date △
Actual Completion Date ▲

M I L E S T O N E C H A R T

SP #: Marine Mammals
Study Number 6

PI: Drs. Dahlheim and Loughlin

Major Milestones: Reports, cruises, field effort, data management, workshops, significant contractual requirements, etc.



Attachment 1

NOAA, WASC, Procurement Division, 7600 Sand Point Way N. E., Bldg. 1, Location 22, Seattle, Washington 98115.

Duties: Contract Negotiations and Administration
206/526-6494

BUDGET

A. Costs (in thousands of dollars = K)

	Line					
	100	200	300	400	500	Total
-Projected Expenses 4/91 - 3/92	40.5	3.0	0.0	0.0	0.0	$ 43.5K*

* An additional $186.0K is provided under Damage Assessment for Year One (1991). The annual budget of Restoration monitoring studies is projected between $250.0K to $300.0K.

PROJECTED EXPENDITURE BREAKDOWN

Line 100 - Salaries

Level	Name	Months	Salaries & Benefits/Month	Total
GM-14	Loughlin	1.0	5,800.00	5,800.00
GS-12	Dahlheim	5.0	4,200.00	21,000.00
GS-07	Assistant	6.0	2,275.00	13,650.00
			Total	$40,450.00

Line 200 - Travel

Travel would include trips from Seattle, Washington to Newport, Oregon to consult with experts in the field of telemetry systems. In addition, monies are set aside for travel to Alaska for required restoration meetings.

Total	$ 3,000.00
GRAND TOTAL	$43,500.00

PERSONNEL QUALIFICATIONS

Curriculum Vitae of Project Leaders is provided (Attachment 2 and 3).

Attachment 2

CURRICULUM VITAE (abbreviated)

Marilyn E. Dahlheim, Ph.D.
National Marine Mammal Laboratory
7600 Sand Point Way N. E., Bin C15700
Seattle, Washington 98115-0070

From 1978 to the present time have participated and designed marine mammal vessel and aerial surveys in Alaskan waters (Bering, Chukchi and North Pacific). Have collected and analyzed acoustical data on whales and seals inhabiting Arctic waters from vessel, ice, and helicopter platforms. Collected data on movements, behavior, and distribution of marine mammals and correlated distributional data on marine mammals with physical environment. Co-chief scientist on USCGC Icebreaker POLAR SEA in charge of shipboard activities and selection of personnel from multidisciplinary fields to define winter habitat of bowhead whales. Helped developed use of passive acoustics as a censusing device to monitor whales. Training of personnel on correct methods of collection and analysis of scientific data. Responsible for reviewing outside research proposals for accuracy of scientific hypotheses and methods. Review of numerous environmental assessments, impact statements, and marine mammal permits. Reviewer for two scientific journals and participation with other governmental agencies regarding solutions to problems arising from increasing oil development and vessel traffic and the acoustical effect on marine mammals. Principal investigator for five consecutive years conducting acoustical research on gray whales in Mexico. Principal investigator gray whale census (three consecutive years). Task leader on killer whale/blackcod fishery interactions in Prince William Sound, including photo-identification research. Task leader for photo-identification studies on killer whales in the Bering Sea (four years). Project leader on NRDA studies 1989-1991 on humpback and killer whales. Representative of the National Marine Mammal Laboratory at international conferences/ meetings; submission/acceptance of independent research proposals. Has published extensively in peer reviewed scientific journals and lay publications.

Attachment 3

CURRICULUM VITAE (abbreviated)

Thomas R. Loughlin, Ph.D.
National Marine Mammal Laboratory
7600 Sand Point Way, NE
Seattle, WA 98115-0070

From 1977 to 1981 was Acting Chief, Research and Management Division, NMFS, Washington, D.C., and was responsible for development, implementation, and coordination of the national research and management program consisting of research into the life history and population dynamics of marine mammals and endangered species. Currently is leader of the Bering Sea/Gulf of Alaska Ecosystem Program, National Marine Mammal Laboratory and is responsible for developing and executing ecosystem based research regarding marine mammal abundance, distribution, trophic relationships, and environmental and fishery data throughout Alaska. Also responsible for the design, supervision, and execution of research addressing marine mammal fishery interactions between foreign and domestic commercial fisheries in Alaska. Has been Chief Scientist on numerous ship and terrestrial research programs spanning fifteen years of marine mammal research along the west coast of North America. Associate Professor (courtesy), Oregon State University, and reviewer for scientific papers submitted to over eleven scientific journals. Has published extensively in peer reviewed scientific journals and lay publications.

SELECTED CITATIONS

The following killer whale articles are pertinent to the studies.

Anon. 1982. Report on the workshop on identity, structure, and vital rates of killer whale populations. Rept. Int. Whal. Commn, 32: 617-631..

Balcomb, K. C. 1978. Orca Survey 1977. Final Report of a Field Photographic Study Conducted by the Moclips Cetological Society in Collaboration with the U. S. National Marine Fisheries Service on Killer Whales (Orcinus orca) in Puget Sound. Unpub. Report to the Marine Mammal Division, National Marine Fisheries Service, Seattle, Washington, 10 pages.

Bigg, M. A. 1982. An Assessment of Killer Whale (Orcinus orca) Stocks off Vancouver Island, British Columbia. Rept. Int. Whal. Commn., 32: 655-666.

Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford and K. C. Balcomb. 1990. Social Organization and Genealogy of Resident Killer Whales (Orcinus orca) in the Coastal Waters of British Columbia and Washington State. Rept. Int. Whal. Commn., Special Issue No. 12.

Braham, H. W. and M. E. Dahlheim. 1982. Killer Whales in Alaska Documented in the Platforms of Opportunity Program. Rept. Int. Whal. Commn. 32: 643-646.

Calambokidis, J., J. Peard, G. H. Steiger, J. C. Cubbage, and R. L. DeLong. 1984. Chemical contaminants in marine mammals from Washington State. Natl. Oceanic Atmospheric Admin., Tech. Memo, NOS OMS, 6: 1-167.

Dahlheim, M. E. 1988. Killer Whale (Orcinus orca) Depredation on Longline Catches of Sablefish (Anoplopoma fimbria) in Alaskan Waters. National Marine Mammal Laboratory, Seattle, Washington.

Ellis, G. 1987. Killer Whales of Prince William Sound and Southeast Alaska. A Catalogue of Individuals Photoidentified, 1976-1986. Sea World Research Institute/Hubbs Marine Research Center, Technical Report No. 87-200. April 1987.

Fowler, C. W. 1984. Density Dependence in Cetacean Populations. In "Reproduction in Whales, Dolphins, and Porpoises". Eds. W. F. Perrin, R. L. Brownell, and D. P. DeMaster. Rept. Int. Whal. Commn., Spec. Issue 6: 373-380.

Hall, J. D. 1981. Aspects of the Natural History of Cetaceans of Prince William Sound. Ph.D. Dissertation. University of California - Santa Cruz. 148 pp.

Heyning, J. E. and M. E. Dahlheim. 1988. Orcinus orca. Mammalian Species Account, No. 304, pp. 1-9, 4 figs.

Leatherwood, S., K. C. Balcomb, C. O. Matkin, and G. Ellis. 1984. Killer Whales (Orcinus orca) of Southern Alaska - Results of Field Research 1984 Preliminary Report. Hubbs Sea World Research Institute Tech. Report No. 84-175, 59 pp.

Leatherwood, S., A. Bowles, E. Krygier, J. D. Hall, and S. Ignell. 1985. Killer Whales (Orcinus orca) in Southeast Alaska, Prince William Sound, and Shelikof Strait; A Review of Available Information. Rept. Int. Whal. Commn., SC/35/SM 7., 10 pp.

Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Life History and Population Dynamics of Resident Killer Whales (Orcinus orca) in the Coastal Waters of British Columbia and Washington State. Rept. Int. Whal. Commn., Special Issue No. 12.

Perrin, W. F. and S. B. Reilly. 1984. Reproductive Parameters of Dolphins and Small Whales of the family Delphinidae. In "Reproduction in Whales, Dolphins, and Porpoises". Eds. W. F. Perrin, R. L. Brownell, and D. P. DeMaster. Rept. Int. Whal. Commn., Spec. Issue 6: 97-134.

Rennie, F. 1989. The National Significance of Robson Bight, British Columbia. Final Report, Park Systems Planning Division, National Parks Branch, Ottawa, Canada.

von Ziegesar, O., G. Ellis, C. Matkin, and B. Goodwin. 1986. Repeated Sightings of Identifiable Killer Whales (Orcinus orca) in Prince William Sound, Alaska 1977-1983. Cetus, Vol. 6, No. 2, 5 pp.