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TRUSTEE COUNCIL RECOMMENDATIONS TO THE TRUSTEES

Review of 1989 Natural Resource Damage Assessment for the Exxon Valdez Oil Spill and Proposals for 1990 Studies

February 26, 1990

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(RANK)
① prioritize studies 1) within subjects
2) entire package

② identify studies that are pillar for other studies

INTRODUCTION

Trustee Council Recommendations to the Trustees
Review of 1989 Natural Resource Damage Assessment for the Exxon Valdez Oil Spill and Proposals for 1990 Studies

Introduction

This report contains the recommendations of the Trustee Council regarding the Natural Resource Damage Assessment ("NRDA") Plan and Restoration Strategy for the Exxon Valdez Oil Spill ("EVOS"). It briefly reviews (1) studies conducted in the 1989 field season and (2) proposals for 1990 field studies (Note: Further description of the 1989 studies can be found in the 1989 plan and the detailed study plans completed last year. Detailed study plans for the 1990 studies will be completed by the end of March).

The Trustee Council analyzed each study in the 1989 study plan ("yellow book") from three perspectives. First, whether it allowed an estimation of population impacts resulting from the EVOS. Second, whether it showed evidence of "sublethal" impacts from the spill. Third, whether it showed injury to non-biological resources (e.g., air, land, and water). Our method of analyzing these three impacts is discussed in Section II. Section III contains our combined recommendations regarding the 1989 studies and the proposals for new studies. Section IV contains a summary description of the Restoration Planning activities for 1990. Section V contains a proposal to evaluate archeological and cultural injuries for the EVOS. Section VI, proposed Economic studies, has been reserved for further development. Section VII contains a summary of costs for all proposed studies.

This report was prepared with the full participation and cooperation of legal and management representatives of all Federal and State agencies involved in the NRDA process. Our review was conducted over a 2 1/2 month period. During this time, meetings were held with experts retained by the State and Federal Governments ("Peer Reviewers") and Principal Investigators from the agencies conducting the studies. Except as noted below, all of the recommendations contained in this report represent the consensus of the Trustee Council. The following points must be emphasized:

1. Because the timeline for the review process did not allow the Management or Legal Team or the Peer Reviewers to examine detailed study plans for 1990 studies, further analysis of the costs of the 1990 studies is appropriate. We anticipate conducting this

review following submission of detailed 1990 study plans.

2. Some studies that were judged not to be valuable for the NRDA process may be valuable for other purposes, such as restoration planning. Our recommendations are based solely on the usefulness of the various studies for natural resource damage assessment.

3. The Council either did not reach consensus or there was insufficient information to make a recommendation on the following studies:

   Birds 5: Peregrine Falcons
   Marine Mammals 1: Humpback Whale
   Terrestrial Mammals 3: River Otter
   Terrestrial Mammals 6: Mink Reproduction
   Fish/Shellfish 27: Sockeys Salmon Overescapement
   Fish/Shellfish 28: Run Reconstruction
   Fish/Shellfish 29: Ecological & Life History Model
   Fish/Shellfish 30: Salmon Database Management
   Technical Services 2: Histopathology

4. For studies proposed to be discontinued, we recommend a budget of $140,000 be included to summarize the data and write final Study Reports.

5. The budget estimates contained in Section III do not include overhead for administrative expenses. We recommend that 20% overhead be budgeted. This recommendation is included as a separate line item in the summary table in Section VII of the report.

6. Public comments on the State/Federal Natural Resource Damage Assessment Plan and Restoration Strategy were considered in preparing these recommendations.

METHODOLOGY FOR ASSESSING NATURAL RESOURCE DAMAGES

II. Methodology for Assessing Natural Resource Damages

A. Population Impact Assessment

One of the primary impacts of the oil spill was the short and long term injury to populations occupying the affected area. These injuries stem from (1) the immediate death of animals due to oil exposure; and (2) a change in vital rates such as post-spill reproductive or survival rates which cause a population depression. The depression may be temporary, followed by subsequent recovery, or it may be permanent, depending upon ecosystem dynamics.

The next section describes theoretical models of population perturbations which underlie our population dynamics analysis. Section 2 sets forth four methodologies which may be used to estimate total population loss. In Section 3, the applicability of these four methodologies to the EVOS is discussed.

1. Population Response to Perturbation[1]

One of the simplest perturbation models of an oil spill impact is an immediate kill followed by gradual recovery of the population to the level it would have achieved absent the spill. This is shown in Figure 1. The natural resource injury suffered consists of (1) animals initially killed plus (2) the loss of population during the recovery period. The "hatched" area in the figure represents the losses during recovery. The population recovery may be delayed if there is a continued post-spill impact on the population due to reduced reproduction, growth, or survival, or due to additional mortality. In that case the recovery would take longer than recovery from an initial kill, as shown in Figure 2.

If the perturbation resulted in permanent loss of habitat, change in the community composition, or permanent changes in survival rates, a population may never recover to its pre-spill abundance. Under this scenario, depicted in Figure 3, the legal damages for the injury would include the cost of artificial restoration, replacement, or the acquisition of equivalent resources.

It is possible that a population may experience an initial decline from immediate exposure and then recover to a level above the pre-spill population, due to decreased competition after the

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[1] The models presented below are simplified and are offered for conceptual purposes only. Population response in nature is generally much more complicated due to the influence of a variety of factors not discussed here.

FIGURE 1

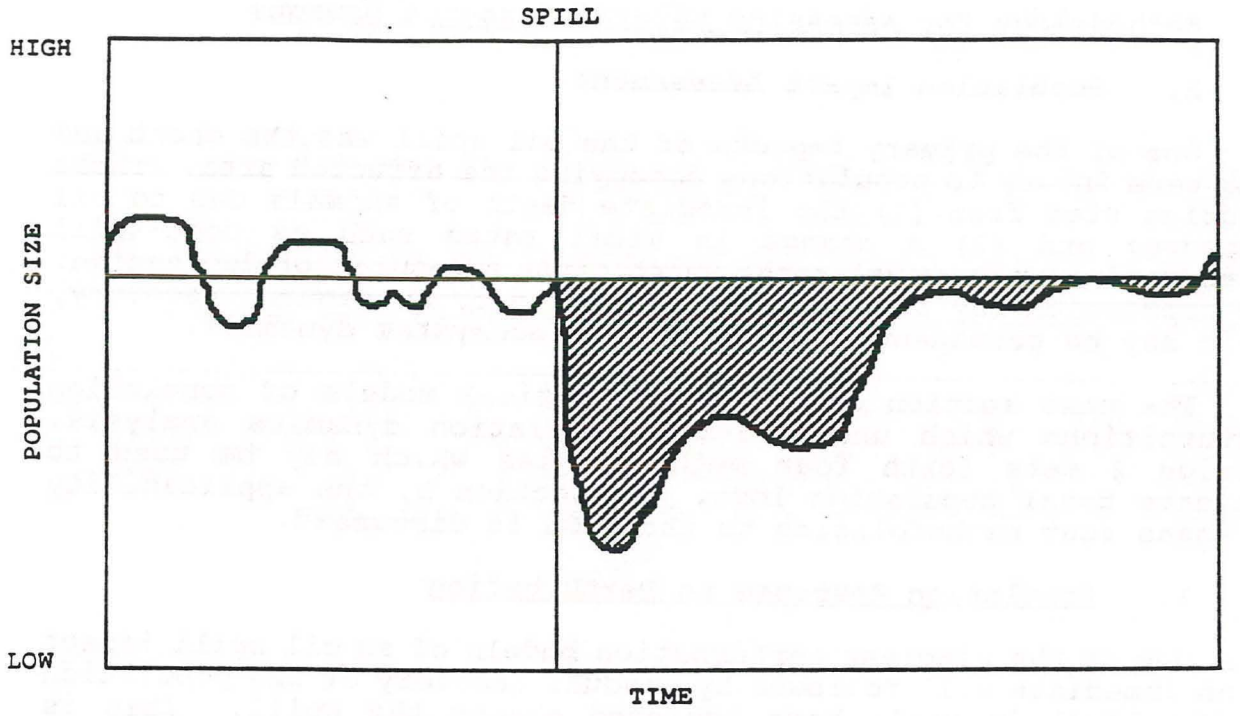


FIGURE 2

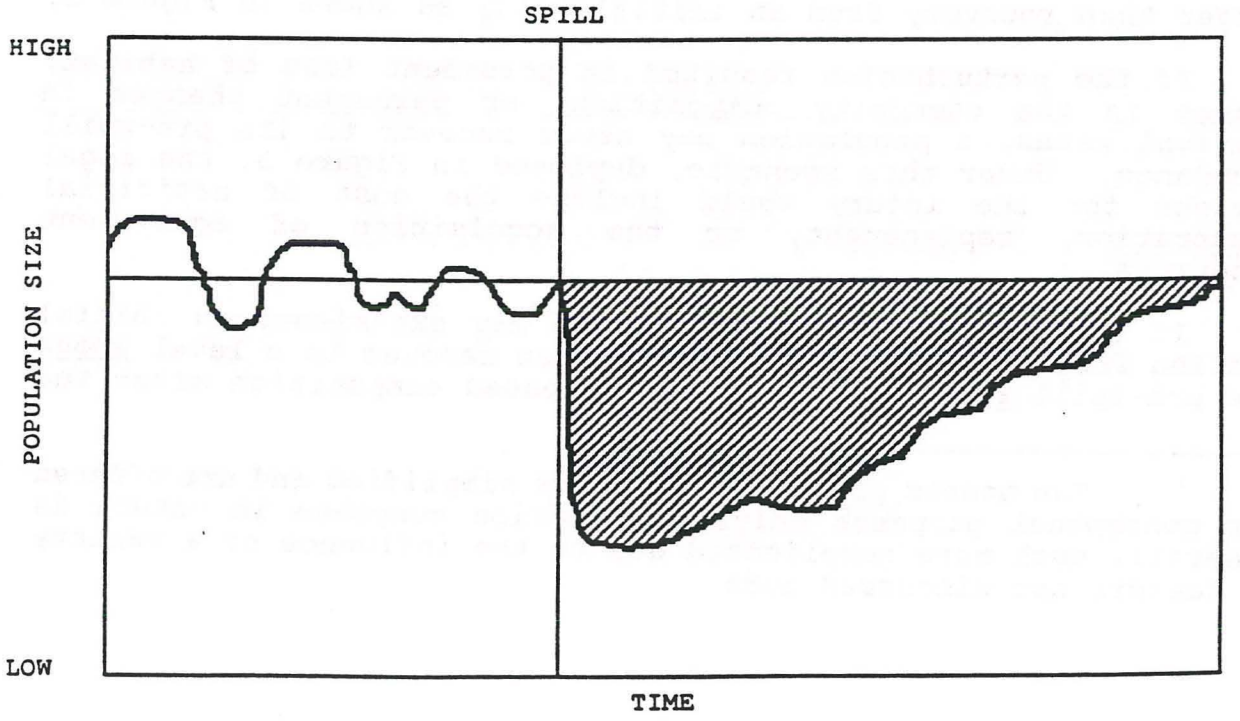


FIGURE 3

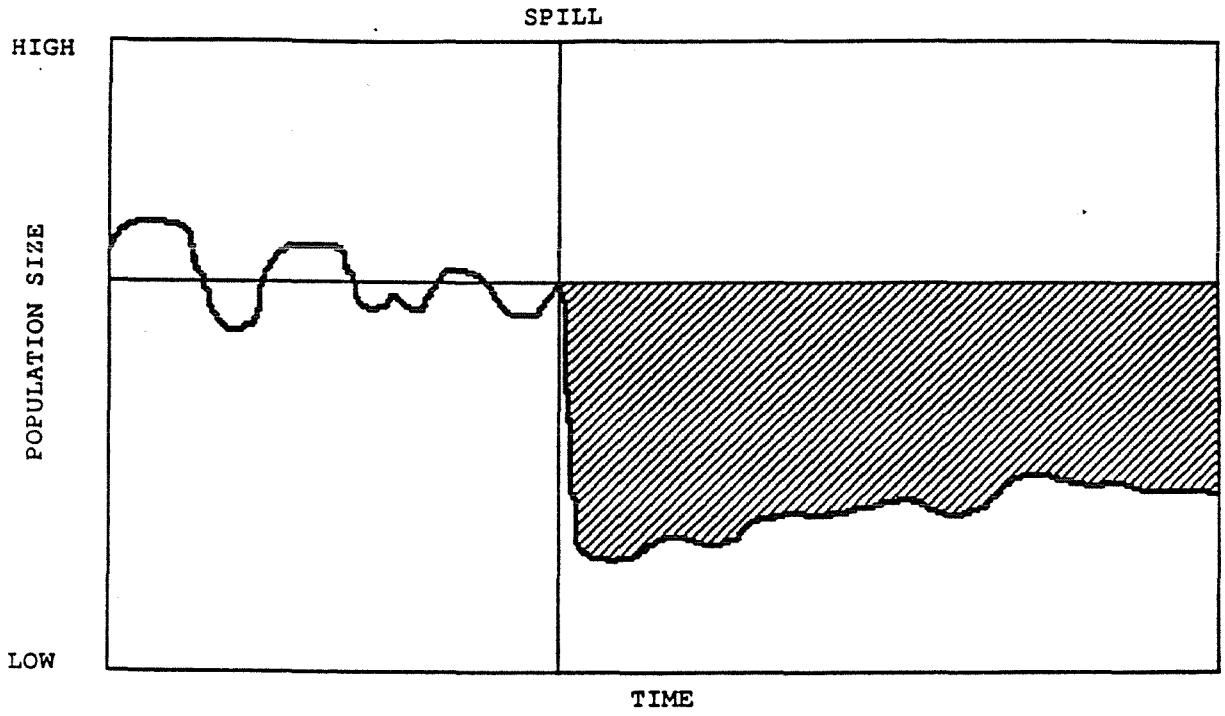
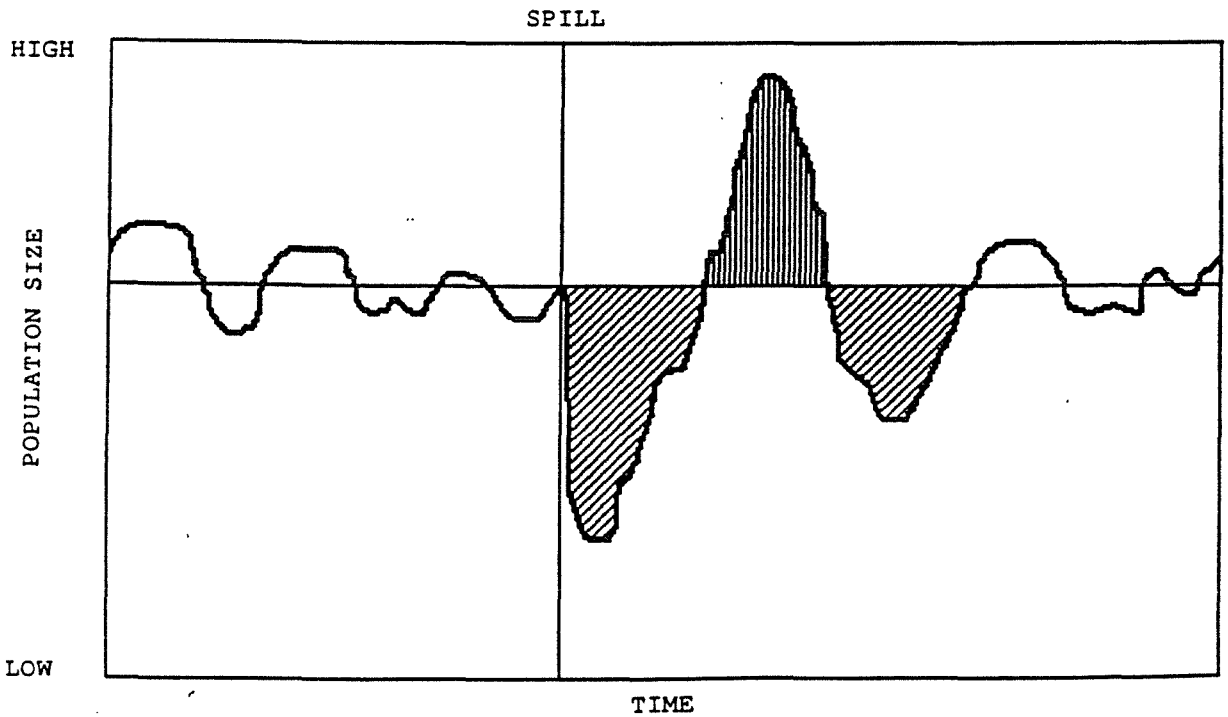


FIGURE 4



spill, a change in other pre-spill mortality factors such as commercial harvest rates, or some other permanent alteration of the ecosystem. Such a population "surge" may be followed by a significant decline prior to recovering to pre-spill levels. See Figure 4. Under this scenario, the injury would be the difference between the total population loss (represented by the diagonal lines) and the population surge (represented by the vertical lines).

2. Methodologies for Assessing Population Impacts

There are four general methodologies for assessing population impacts from an oil spill. The applicability of each methodology to a particular species will depend on whether the information needs of the methodology are available. The methodologies are:

a. Direct Mortality: Body Count and Enhancement

This methodology consists of determining the number of animals initially killed by the spill or the "immediate" impact. This is done by conducting an inventory of recovered carcasses, estimating what percentage of that number was killed by oil exposure, and estimating what percentage of the total population killed by oil was not recovered.

i. Recovered bodies

For some species, particularly birds and mammals, large numbers of dead animals have been recovered. A certain portion of those animals may have died of natural causes, while others probably died of exposure to oil. For each species, it will be desireable to determine what percentage of the recovered bodies were killed by oil.

ii. Estimated Total Immediate Deaths

The number of carcasses recovered after a spill usually represents only a fraction of the direct mortality. The proportion of total kill recovered may vary widely depending on the species, search effort, oil on the beach, scavenging, burying of carcasses, wind and current patterns, wave action, and other factors. When possible, an estimate should be made of what proportion of the total number of killed individuals were actually recovered. This may require establishing an experimental program to assess the wash-up rate of marked dead individuals, or simulating drift and recovery rates by some other method.

b. Temporal Comparisons of Population Sizes Before and After the Spill

When historical population data are available, comparison of pre- and post-spill numbers may be made to assess the change in population. Essentially, the pre-spill information can be used to forecast what the population would have been absent the spill. This may then be compared with the actual population as tracked after the spill. The statistical power of such a comparison will depend upon the reliability of the pre- and post-spill census methods, the natural variability of the population, the magnitude of change induced by the spill, and the total amount of data available for comparison.

c. Post-Spill Spatial Comparison of Population Size in Oiled and Unoiled Sites

When populations can be surveyed in otherwise comparable oiled and unoiled sites, it may be possible to assess the impact of the spill even when pre- and post-spill data are not available. Again, the power of this method will depend on the reliability of the census method, the natural variability from site to site, and the magnitude of the change induced by the spill.

Combining the temporal and spatial comparisons can provide the most powerful evidence of an impact, if such data are available. Such a "before and after" contrast of populations at oiled and unoiled sites controls for both spatial and temporal differences which are unrelated to the oiling. For example, it may be that the population of murres at an island which was heavily oiled has historically been approximately 15% lower than the population at one of the unoiled control sites. A post-spill comparison which indicates that the oiled site population is 30% lower than the unoiled, therefore, suggests that the spill caused a 15% population decline.

d. Measurement of Changes in Vital Rates and Prediction of Recovery Trajectory

Where populations have been sufficiently depressed or vital rates sufficiently impacted, it may take an extended period of time for the population to recover to the level it would have reached absent the spill. It may be necessary, therefore, to predict the recovery time using some type of model. In species where it is difficult to measure abundance, but vital rates can be measured, population dynamics models may provide the most useful tool for assessment of impacts. The standard models of population dynamics include:

i. the logistic growth model (Schaefer model) and its variations;

ii. the Leslie model of survival and fecundity; and

iii. the Beverton-Holt age structured models, with assumptions about recruitment and density dependent stages.

Where the relevant vital rates can be measured, they may be used in these population dynamics models to predict the future trajectory of the population.

3. Applicability of Population Dynamics Methodologies to Individual Species or Categories of Species

An analysis of population impacts for each species under consideration may include one or more of the four approaches described above. For some species counting dead bodies may not be possible, but it might be quite feasible to measure a change in survival rates. For other species, the data available may be sufficient to apply all four methodologies. Set forth below is a brief analysis of how relevant each methodology is for assessing population impacts on the species. Additional discussion of the appropriateness of these methodologies is contained in the specific comments for each study (Part III of the Report).

a. Finfish

Very few fish carcasses have been collected in connection with the EVOS. The only form of direct mortality that may be relevant to finfish is a change in egg or fry survival resulting from the spill. In the case of pink salmon, sockeye salmon, and herring, sufficient historical data are available to permit pre- and post-spill comparisons of population size. Post-spill spatial comparisons of oiled and unoiled sites are also possible for pink salmon, sockeye salmon, herring, Dolly Varden char, and cutthroat trout. Spatial comparisons for sockeye salmon and herring, however, would require several years of study given that it takes them 4-5 and 5 years respectively to be reared, migrate to sea, and then return to spawn.

A number of vital rates can be measured for pink salmon, including eggs produced per female, spawning success and egg retention, egg survival, fry to adult survival, fry to adult growth rates, and growth in the first few weeks of marine life. Differential rates between oiled and unoiled streams can be used in a life history model to estimate damage due to oiling. Similar comparisons can be made for sockeye salmon and herring.

1. Shellfish

Few if any shellfish carcasses were collected following the EVOS. Direct mortality estimates, therefore, are not available. In addition, pre-Spill data is not available for most of the shellfish studied.

Spatial comparisons between oiled and unoiled sites is possible and was undertaken for the brown king crab. Many of the shellfish populations, however, demonstrate a high degree of natural spatial variability, making it difficult to demonstrate impacts through oiled/unoiled comparisons.

Population impacts on clams and scallops could theoretically be assessed by analyzing changes in growth rates, as the shells for these species conveniently document seasonal growth patterns. The populations of dungeness crabs and sea urchins in affected areas were too small, however, for any spill impact to be detected by any of the population dynamics methodologies.

C. Marine Mammals

Of the marine mammals studied, only sea otter carcasses were found in any significant numbers. The carcasses collected can be analyzed to determine the general age structure of the population immediately impacted by the spill and the reproductive status of the females killed. It may be possible to use this information in turn to assess population recovery periods through the application of age structure models. The strength of any model prediction will depend, however, on whether we are able to adequately assess post-spill growth rates.

In general, for the other marine mammals studied, pre- and post-spill as well as spatial comparisons between oiled and unoiled sites represent the most feasible techniques for assessing population impacts.

d. Birds

All four methodologies are potentially relevant to a population dynamics damage assessment for birds. Heavily oiled birds came ashore in large numbers during the first months following the spill, and carcasses continued to wash up on beaches for much of the year thereafter. It will be desireable to sample some of the bodies recovered to determine what percentage actually died from exposure to oil. Typically, the number of bird carcasses recovered after a spill represents only from 5 to 60% of the direct mortality. Field studies and computer modelling designed to determine the rate of carcass loss can be used to arrive at an estimate of total immediate kill.

A comparison of pre- and post-spill population sizes requires a baseline set of data taken before the spill, and a replicate set of data collected after the spill. Colony and at-sea populations for seabirds are highly variable, however, and the historical data are, for the most part, insufficiently precise to be able to demonstrate limited die-offs for most seabird species. Generally, population changes less than 20% will be undetectable, and for some species it will be difficult to detect changes of less than 50% or more. In cases where a difference can be demonstrated, comparisons of populations in oiled and unoiled sites may be highly useful for inferring an oil spill impact.

Demonstrating long-term projections of population changes would require developing population models for the major species affected by the spill. Two basic kinds of data are required for such a model: survivorship rates and fecundity measured in terms of nesting, hatching, and fledgling success. Historical data on fecundity are available for some of the species involved, but survivorship data are generally lacking for birds in Prince William Sound and Alaska in general.

e. Terrestrial Mammals

Very few terrestrial mammal carcasses were found last field season which could be linked to the spill. Many of the animals studied spend more time in upland areas than on beaches and, therefore, their carcasses would be hard to locate even if many died of oil exposure. In addition, pre-spill data are lacking for all species studied. The most feasible methodologies for analyzing population impacts on terrestrial mammals, therefore, are spatial comparisons at oiled and unoiled sites and projecting population changes based on a change in vital rates.

Post-spill spatial comparisons between oiled and unoiled sites can be done through direct observation, by studying fecal droppings, and by tracking mammals fitted with radio transmitters. Data on mortality rates and productivity also can be collected through radio tracking and used in projecting population changes. It may not be feasible, however, to instrument enough animals in oiled and unoiled areas to provide statistically valid comparisons. The reasonableness of pursuing either of these methodologies will depend on the size of the populations at issue and the economic value which may be assigned to a population loss.

B. Methodologies for Assessing Sublethal Effects.

The preceding section described methodologies for quantifying the lethal effects of the EVOS. "Sublethal" impacts are effects at the organism, community, and ecosystem level that do not result in acute mortality of organisms.

1. Assessing Injury At The Organism, Community, And Ecosystem Level

Injury to the natural environment can be identified at organism and community levels and can be inferred to apply at the ecosystem level under certain assumptions. The potential exists for identifying and quantifying injury through direct observations and measurements or by inference from field and laboratory data or scientific literature. It is possible to translate injury at the organism level to injury at the community level in two ways: (1) when injury at the organism level is determined to be pervasive and the role of the organism is known to be prominent in strong ecological interactions (e.g., plant-herbivore, predator-prey, competitors); and (2) by manipulation of certain components or elements of the community to test the response to disruption of these ecological interactions. Extrapolation to the ecosystem level requires reliable knowledge of the extent, concentration, and form of the insult, the organisms' response, and the distribution of the community in the system.

2. Complementary Assessment Strategies.

The sublethal effect of the EVOS can be analyzed using four complementary strategies:

(1) statistically precise, unambiguous descriptive studies;
(2) field experiments;
(3) dose-response evidence based on field and laboratory measurements that relate injury to doses of petroleum and its derivatives; and,
(4) use of risk assessment methods to project injury based upon empirical relationships developed under the first three strategies, and on the use of scientific literature.

These strategies can be used to develop a cause-and-effect chain of evidence to demonstrate damages from oil contamination. Each of these strategies should, if possible, be focused primarily upon elements of the ecosystem and their interactions with ecological networks[2] of organisms that are both economically important and likely to have come in contact with oil and that are representative of the estuarine and marine communities that predominate in the affected ecosystem. This approach provides a "template" upon which each of the strategies, both singly and in concert, can be implemented in the most productive and defensible manner.

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[2] Ecological networks are defined as the complex web of linkages among species--typically food web linkages, but they may also involve competitive, inhibitory, or synergistic interactions.

In developing and implementing statistically precise descriptive studies, one must take into account natural variability and other characteristics of the areas affected by the spill (e.g., differences in exposure of intertidal communities, mainland, and island sites because of low salinties from freshwater run-off , and exceptionally cold temperatures before the spill). In many instances, effective selection of paired treatment sites (oiled/nonoiled, pre-/post-spill, or both) or field manipulative experiments (using techniques such as transporting oiled rocks between beaches to assess oil effects on recruitment) can be used to eliminate or minimize the influence of confounding factors.

Producing strong empirical or experimental results showing pervasive, long-term changes in communities which can be unambiguously tied to the EVOS is the ultimate goal. In many instances, however, direct evidence of such changes will probably not be available. As a viable alternative, studies that generate data in support of exposure and dose-response relationships with respect to the effects of petroleum (and its conversion products) on growth, reproduction, and behavior can be used to provide strong evidence demonstrating damage from oil contamination.

The first step in this cause-and-effect chain of evidence is to examine dose, i.e. (1) whether there are hydrocarbon derivatives in the immediate environment of the organism and (2) whether the organism accumulates hydrocarbons or their environmentally-formed derivatives. The most basic type of evidence in this regard is whether the oil physically contacted the species of interest. Photographs and records of visual observations can be effectively used in this case as supportive evidence. The other kind of basic evidence is whether hydrocarbon derivatives were measured in the environment of the organism. Measurements of concentrations of oil derivatives in the water, in sediments, in porewater, on rocks, or in the food of the species of interest are used to establish this link. If hydrocarbons or metabolites of oil components are detected in the organism, then the causal link to damage becomes stronger.

Since many species metabolize hydrocarbons, it is likely that analyses of tissues will either not detect the parent compounds or the concentrations will not be representative of the magnitude of exposure. It is therefore necessary to perform other analyses, such as to measure the levels of metabolites in the organism to estimate the degree of exposure or to measure the activity or concentration of enzymes that metabolize hydrocarbons. Since certain enzymes are inducible with exposure, measurement of these enzymes provides a surrogate estimate of dose that is indicative of exposure, usually for days to weeks. Another useful aspect of enzyme measurement is that the products of metabolism include some

community-ecosystem effects. Reduced growth or reproduction, or behavioral adjustments that can modify distribution or abundance, even acting in the absence of mortality, can produce important system-wide consequences.

In addition to the above strategies for demonstrating damage, various risk assessment methodologies can be used. The objective of an ecological "risk assessment" is to quantify injury. The magnitude and extent of injury are measured on the basis of a select set of ecological endpoints (i.e., death, growth, etc.) that are considered reasonable indices of the status of biological populations and communities.

Predicting injury through a "risk assessment" strategy broadens the legal and scientific basis for assessing injury and establishing costs associated with lost use and recovery. This is especially true in cases where injury to resources are obfuscated in the field.

The procedures for injury assessment discussed above are not unique. They are, in fact, similar in principal to approaches currently being used in ecological risk assessments for hazardous waste sites. Using the above-described strategies, one can develop an interlocking picture evidencing cause and effect of oil contamination on organisms and their ecosystem.

C. Methodologies for Identifying and Quantifying Impacts to Non-Biologic Resources

A group of studies in the 1989 Plan, particularly Air/Water Studies Nos. 1-5 and the Coastal Habitat study, were used to assess damages to non-biologic resources (surface water, water column, beaches (intertidal sediments), subtidal sediments and air) as well as to demonstrate exposure of biologic resources to hydrocarbons and by-products from the spill.

The strategy of the 1989 Studies was to locate and quantify hydrocarbons from the spill in the various compartments of the environment over space and time.

1. Impacts to water.

a. Surface water. Two methodologies for identifying and quantifying impacts to surface water were used in 1989: mapping of descriptive observations, and sample analysis for hydrocarbon components.

i. Descriptive observations (mapping). As part of its spill response function in 1989, the Alaska Department of Environmental Conservation (ADEC) tracked the spread of the spill by aerial overflights. Maps of the path of the slick are being

toxic compounds. Therefore enzyme assays are a measure of potential for injury as well as an indication of exposure.

Other examples of biochemical changes associated with oil exposure include adducts formed by the reaction of aromatic hydrocarbon metabolites with DNA or proteins, interference with lipid metabolism, and alterations of steroid metabolism. The consequence of exposure responses on higher levels of organization, i.e., at the tissue, organ, or integrative physiological level, can be shown in many ways. For example, disruption of membranes can indicate accumulation of hydrocarbon derivatives (e.g., metabolites) in the lipid layer of the membrane. Lipid accumulation in vacuoles can indicate effects of hydrocarbon derivatives on lipid metabolism. Narcosis may indicate the interference of hydrocarbons derivatives with the transmission of nerve impulses. Alteration of the number of eggs produced by females or in their viability may indicate that some aspect of reproduction, perhaps mediated by hormones, has been impaired. Hydrocarbon derivatives can also impair the efficiency of cellular immune responses so that the organism becomes more susceptible to disease.

The next link in the chain of cause-and-effect is to show population changes. For example, change in embryo viability, abundance of young, or in recruitment may be a direct effect of some impairment of reproduction. These alterations can then be manifested as a change in absolute abundance of the population or as a shift in the age structure of the population due to poor recruitment of larval survival. Controlled laboratory experiments can be conducted under conditions that mimic or partially adopt field conditions, and can assist in identifying damages to organisms that can be translated to population effects (i.e., effects on reproductive success, etc.). For example, pink salmon eggs and fry could be removed from oiled and unoiled redds (spawning grounds) to the laboratory for further monitoring of egg/alevin development and mortality, genetic abnormalities, and the induction of hydrocarbon-metabolizing enzymes, all of which are a measure of exposure to oil. The loop of causation as it affects populations is closed at this stage of ecosystem effect.

A complete ecosystem study and approach to the EVOS has been suggested by some public committees, but we find that it is scientifically impractical and therefore undesirable. The best way to achieve the goal of demonstrating ecosystem effects is to identify "ecological networks" (organisms linked by strong interactions such as plant-herbivore, predator-prey, competitor, parasite, etc.) known to be important in Prince William Sound and other ecosystems affected by the Oil Spill, and to identify key organisms in these networks upon which to focus studies and experiments. If sublethal effects can be clearly identified or predicted, some level of modeling can also be employed to estimate

prepared based on ADEC's aerial overflight data (Air/Water Study No. 1). These maps show the location of the large mass of oil on the surface relatively early in the spill. They do not show smaller quantities such as tarballs, oily debris, etc. on the surface of the water.

ii. Analysis for hydrocarbon components. The University of Alaska-Fairbanks (UAF) collected offshore surface water samples in Prince William Sound over the first three weeks of the spill for analysis for volatile hydrocarbons. In the nearshore zone, ADEC collected surface water samples at 22 moderately and heavily oiled sites in Prince William Sound in the fall of 1989. These studies were done as parts of Air/Water Study No. 3.

b. Water Column. Impacts to the water column were evaluated in 1989 by analysis of water samples taken at various locations, depths, and times, and using several techniques. Except where indicated below, these were done in Air/Water Study No. 3.

i. Analysis for hydrocarbon components. The National Marine Fisheries Service (NMFS) collected water samples from depths of one and five meters in Prince William Sound during the first five weeks after the spill. Concentrations of petroleum hydrocarbons were found to be generally below the detection limit of the screening technique (1 mg/l.). As part of its response function, outside the NRDA process, ADEC collected numerous water column samples during five cruises inside and outside Prince William Sound during the summer of 1989. The data require extensive review, however, to determine if they may be suitable for use in the NRDA process. ADEC also collected samples of water in the beach matrix for analysis for hydrocarbon components as part of its Air/Water No. 3 study.

ii. Deployment of mussel cages. Mussels bioaccumulate hydrocarbons in the water column and can indicate ongoing low-level contamination below the detection limits of water sample analyses. NMFS deployed mussel cages at 30 locations inside and outside of Prince William Sound to measure the presence of low level hydrocarbons.

iii. Analysis of sediments collected in sediment traps. Sediment traps are designed to collect sediments and associated hydrocarbons that are transported through the water column. ADEC deployed sediment traps subtidally in Prince William Sound as part of its 22-site study referred to above. The UAF also deployed sediment traps early in the spill, outside the NRDA process.

iv. Microbiological studies. The presence and metabolic activity of hydrocarbon-degrading bacteria provide a fairly inexpensive indication that hydrocarbons persist and natural degradation is not complete. As part of Air Water Study No. 2,

ADEC enumerated hydrocarbon-degrading bacteria in the nearshore water column and interstitial water and evaluated their ability to degrade hydrocarbons.

v. Toxicity analysis. Analysis of the toxicity of water that may contain hydrocarbons or oxidation by-products is another method of showing impacts to water. Continuing toxicity may occur in the water flowing through and off of beaches containing residual oil. This type of analysis is not presently being done, but could be useful in demonstrating ongoing injury to the intertidal environment. It would involve laboratory simulations and exposing organisms to the runoff water or laboratory exposure of organisms to water collected in the field.

2. Impacts to sediments.

a. Beaches and intertidal sediments. Impacts to intertidal sediments were evaluated in 1989 by descriptive surveys, sampling for hydrocarbon components, and analysis of microbial activity. Other methodologies that could be used include volumetric analysis to determine the total volume of hydrocarbons in the sediments, analysis of toxicity of sediments, and beach transecting to obtain more detailed observational data on oiling at a particular location.

i. Descriptive surveys (mapping). ADEC conducted aerial overflights to determine the extent of oil on the beaches in 1989 as part of its response function. The data from these surveys are being compiled on maps showing the surface distribution of oil in the areas impacted by the spill (Technical Services Study No. 3). These maps show the degree of oiling based on the surface coverage of the beach by oil. They do not reflect the thickness of oil or the depth of penetration into the sediments. More precise maps will be prepared using data from ADEC's walking survey ("walk-a-thon") of all moderately and heavily oiled areas conducted in September, 1989. This survey provides the most detailed and comprehensive view of oiling, although it was conducted late in the season when some of the oil may have been removed.

ii. Analysis for hydrocarbon components. Impacts to beaches and intertidal sediments are being evaluated by sampling for hydrocarbon components. NMFS took samples of intertidal sediments at 29 locations in Prince William Sound and 25 sites outside the Sound as part of Air/Water Studies Nos. 2 and 4. The Coastal Habitat Study group also took sediment samples at 111 study sites that are to be analyzed for hydrocarbon components. Finally, ADEC collected sediment samples in its 22-site study referred to above.

iii. Toxicity testing. NMFS tested the toxicity of intertidal and subtidal sediments collected in the Air/Water

Studies Nos. 2 and 4, using a Microtox bioassay to test the inhibition effect of sediment extracts on the bioluminescence of a species of bacteria. Other standard bioassay methodologies, such as using fish larvae, bivalve larvae, or amphipods as test organisms, are not being done.

iv. Microbiological studies. NMFS evaluated the hydrocarbon degrading potential of bacteria in intertidal and subtidal sediments and enumerated the numbers of hydrocarbon degrading bacteria in Air/Water Study No.4, as discussed above.

v. Analysis to determine the volume of oil in sediments. This is not presently being done. As part of its 1989 response effort, ADEC collected sediment samples from the intertidal zone at approximately 120 locations inside and outside Prince William Sound. The ADEC samples were collected for analysis of the amount of oil in the sediments and are presently archived.

vi. Beach transecting. This was done on a large scale by NOAA and ADEC as part of their 1989 response functions. The methodology involves establishing a beach transect perpendicular to the shoreline, diagramming the beach composition, elevation, and degree of oiling along the transect, and collecting samples for hydrocarbon analysis. It provides more detailed oiling descriptions than could be obtained from the aerial overflights and could be used to calibrate overflight data. ADEC evaluated some 120 such transects in Prince William Sound and NOAA evaluated additional transects in their response capacities. ADEC continued its program in conjunction with its study of 22 sites in Prince William Sound referred to above.

b. Subtidal sediments. Impacts to subtidal sediments have been evaluated by chemical and microtox sampling, as discussed above. Several different agencies have sampled the subtidal zone.

i. Analysis for hydrocarbon components. NMFS and ADEC collected subtidal sediments for analysis for presence of hydrocarbon components.

ii. Analysis for toxicity. NMFS analyzed subtidal sediments for toxicity using the Microtox method as part of Air/Water Studies Nos. 2 and 4.

3. Impacts to Air

a. Modelling of air impacts. Given the short duration of any impacts to air and the lack of direct measurements of such impacts, modelling is the only feasible methodology of evaluating impacts to air. A model is being developed under Air/Water Study No. 5.

4. Synthesis of Impacts to the Non-Biologic Resources.

An additional methodology for evaluating overall impacts to the non-biologic resources that is not presently being utilized is to synthesize the data on particular impacts into a mass-balance "budget" or accounting of the spill over time. Such a budget, which also is referred to as a mass balance or box model, can provide a comprehensive (quantitative and qualitative) description of the location of the oil and its degradation by-products in all major compartments of the environment over time, including, for example, amount evaporated, amount in intertidal sediments and toxicity, amount in water column and toxicity, amount in subtidal sediments and toxicity.

This type of synthesis can be developed using empirical data, as distinguished from purely theoretical predictive models. It can be used to make predictions based on the data to date as well as to present an integrated explanation of the fate of oil up to the present.

NATURAL RESOURCE INJURIES STUDIES

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
1	Water Birds/ Beached Birds	X		USFWS	$258,000	$625,000

COMMENTS

This is one of the most important bird studies from a population dynamics perspective. Approximately 36,000 dead birds were recovered in the 1989-90 field season. This number provides a minimum estimate of bird mortality caused by the oil spill. The process of carcass loss both at sea and on the beach is poorly understood but is critical to the estimate of total mortality. The study should be modified in the 1990-91 field season to determine the mechanisms and rate of these processes and should include: (1) analysis of the recovered carcasses to determine what percentage of the 36,000 died from oiling rather than natural causes; (2) development of a model to estimate the potential total kill -- i.e. to estimate what percentage of birds killed by oil did not wash up on beaches. The general approach is to apply a hindcast model to work backwards from the place where the animals died to the beach where the carcasses were recovered; and (3) field experiments to support the modelling effort which will document oiled bird floatation times, drift, and survival rates once beached. In addition, documentation (photos and/or notes) of birds in oil at sea should be collected -- especially for birds under-represented in the beach counts.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds 2	Census & Seasonal Distribution	X		USFWS	$565,000	$470,000

COMMENTS

The shoreline boat survey documented a decline in several species. To the extent that these are breeding birds which normally demonstrate site fidelity, population loss would be the most reasonable explanation if birds fail to return to pre-spill abundance in 1990. Boat surveys should be continued in 1990 with increased coverage of oiled areas in PWS and the Kodiak area. Survey design should be reviewed by statistical consultants. Aerial surveys of waterfowl use should be repeated for all spill affected coastlines in Feb/March and Spring 1990 and again in Jan. 1991 if effect on seaducks is severe. It is essential to conduct winter and spring surveys by aircraft as well as long-term boat surveys. The 1990 survey should be comparable to the 1989 pre-spill survey.

*[illegible] budgeted figures, not amount as [illegible] spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds 3	Seabird Colony Surveys	X		USFWS	$440,000	$250,000

COMMENTS

This study is highly valuable to a population dynamics assessment, as it indicates there was a substantial die-off of murres (up to 60-70% of murres breeding on Barren Island). Body count evidence corroborates the hypothesis that missing murres were probably killed by oil (74% of beached birds were murres). Another census should be conducted in 1990 for murres and kittiwakes. In addition, an effort should be made to link murre reproductive failure to oil, including conducting hydrocarbon tests on eggs and old and new nest material in oiled and un-oiled areas. Also, investigators should attempt to gather evidence showing murre numbers had not declined before the spill. The status of other colony nesting seabirds should be evaluated as various locations are visited.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
4	Bald Eagles	X		USFWS	$445,000	$500,000

COMMENTS

Last year's study revealed that the oil spill resulted in significant mortality and a decline in productivity of bald eagles. Nest failure rates were significantly higher along heavily and moderately oiled beaches than along lightly and un-oiled beaches. This study is highly valuable to completion of a population assessment of oil spill effects.

Aerial surveys of the eagle population should be completed in spring 1990 to assess whether the population has declined since the April 1989 pre-spill count. If this survey indicates a significant decline, it could be used to project a much higher population effect than the 153 recovered carcasses. Additionally, comparisons of eagle reproduction rates should be made in oiled and comparable oil-free areas. Prey samples should be collected in the 1990 survey. Results of hydrocarbon analysis of prey, blood samples, and eggs will be important for linking productivity changes to oil contamination. Blood samples should be assayed for hemolytic anemia. Tracking of radio-tagged eagles should continue to determine if the birds are foraging in oil-contaminated areas.

*Accts budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
5	Peregrine Falcons		Pending	USFWS	$43,000	($120,000)[2]

COMMENTS

The population of falcons inhabiting PWS and the coastal Kenai Peninsula is estimated at 40-60 pairs. The 1989 survey demonstrated lower numbers of occupied nests and lower numbers of young produced per successful nest than historical rates in Queen Charlotte Islands, the Western Aleutians and Norton Sound.

Objectives of this study would be to: 1) test the hypothesis that nest site occupancy and productivity are lower in the project area as a result of EVOS than in other populations; 2) test the hypothesis that the quantities of vanadium and nickel in peregrine feathers are the same for birds nesting in oiled and non-oiled areas; 3) count and identify prey remains collected at eyries in oiled and non-oiled areas; 4) test the hypothesis that pesticide contamination of egg clutches in the project area are less than contamination levels reported in scientific literature as causing reproductive failures in peregrine falcons; and 5) identify methods of restoration where injury has occurred.

[2]Council did not reach agreement. State of Alaska feels this study should go forward at $120,000. DoI, USDA, and NOAA recommend to discontinue.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds 6	Marbled Murrelets		X	USFWS	$115,700	-0-

COMMENTS

This study will not produce substantial useful information if continued as originally planned. All 1989 hydrocarbon samples should be analyzed, and murrelets should be observed as part of the 1990 survey for Bird Study #2.

*Full-term budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
7	Storm Petrels		X	USFWS	$135,000	-0-

COMMENTS

No measurable population impact was demonstrated by the 1989 study. No significant difference was found in reproductive success. Analysis of stomach oils, eggs, and dead chicks for hydrocarbons should be completed, as the results could demonstrate contamination that would be useful in painting a picture of broad ecological damage.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds 8	Black-Legged Kittiwakes		X	USFWS	$190,000	-0-

COMMENTS

Approximately 1220 dead kittiwake carcasses were collected after the spill as part of the beached bird count. An estimated 40,000 of these birds nest in 30 colonies in Prince William Sound. Of the 24 colonies studied, 10 were oiled. The USFWS has an ongoing base-funded project on kittiwakes in PWS. Information from these studies will be made available to the NRDA process.

* Budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
9	Pigeon Guillemots		X	USFWS	$109,500	-0-

COMMENTS

This study will not provide further useful information if continued. Boat surveys conducted under study #2 should observe pigeon guillemots to assess population trends.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds 10	Glaucous-Winged Gulls		X	USFWS	$73,000	-0-

COMMENTS

This study focused on the reproductive biology of gulls nesting on Egg Island, outside Prince William Sound, and demonstrated no population injury.

* 89 budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
11	Sea Ducks	X		USFWS	$146,000	$100,000

COMMENTS

Preliminary analysis of results indicates that harlequin ducks which forage in the intertidal area are in poorer condition than those sea duck species which forage farther offshore. This study has potential, therefore, to provide evidence of either a decline in food sources in near-shore oiled areas or direct hydrocarbon contamination of intertidal-feeding ducks. The study does not support a population dynamics analysis, since it focuses on habitat and species contamination and does not provide an estimate of the number of sea ducks killed by the spill. It has value, however, in a sublethal analysis, particularly in demonstrating food chain impacts.

We recommend that the study focus on the status and food habits of harlequin ducks and golden-eyes.

Objectives of this study are to: 1) test the hypothesis that the prevalence of petroleum hydrocarbons in gut samples from collected sea ducks is higher in the oil spill areas than in the control area; 2) test the hypothesis that the prevalence of petroleum in tissues of collected sea ducks is significantly higher in the two spill areas than in the control area; 3) from evidence of histopathology, estimate the ingested petroleum hydrocarbon effects on morbidity, mortality, and reproductive potential; and 4) Identify restoration methods where injury has occurred.

* Reflects budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
12	Shorebirds		X	USFWS	$166,000	-0-

COMMENTS

Black Turnstones: This study described the use of staging and foraging areas by migrant shorebirds, in particular black turnstones and surfbirds, and provided information on turnstone reproduction on the Yukon-Kuskokwim Delta. No useful information will be gained if this study is continued.

Oystercatchers: Study showed reduced chick survival and reduced food intake rates in oil-contaminated areas. Value to population dynamics assessment is low, however, given the relatively small number of chick mortalities involved. The consensus among the Peer Reviewers was that the oystercatcher study was well designed and well executed, but unlikely to provide substantial further information.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
13	Passerines	X		USFWS	$59,000	$10,000

COMMENTS

Onshore behavioral surveys of the shoreline should continue to record passerine observations in the intertidal zone, at a reduced level from what was proposed in 1989. Oiled versus unoiled areas will be visited and species composition and activity recorded. This work will be carried out by outside contract.

* Authors' budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
14	Migratory Birds		X	USFWS	$10,000	-0-

COMMENTS

This study was not done in 1989 and has not been proposed for continuation in 1990.

* Budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
1	Humpback Whale	Pending[2]		NOAA	$226,000	($90,000)[2]

COMMENTS

This study did not detect a decline in the population of humpback whales in Prince William Sound, but it did find the apparent reproductive rate for these whales to be at its lowest in eight years. Results from 1989 suggest a re-distribution of whales within Prince William Sound, possibly in response to increased levels of vessel traffic associated with cleanup activities. It may not be possible to conduct a chemical analysis for sublethal effects. Observations on humpback whales would be coordinated with the Killer Whales study #2 to see if there is any significant change in the Humpback Whale population. Laboratory research/literature regarding known oil effects on baleen whales will be assessed prior to any field effort.

Continuation of the survey portion of this study is contingent upon review and approval of the detailed study plan by the Trustee Council, and results of laboratory/literature review.

[2]Council did not reach consensus; DoI, USDA recommend to dincontinue, NOAA and State of Alaska recommend to continue at $90,000.

* Reduced budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
2	Killer Whale	X		NOAA	$200,000	$255,000

COMMENTS

Seven individuals from one pod (the A/B pod) as well as members from several other pods were found to be missing this year. If these seven whales do not appear in 1990, the 1988-89 mortality rate would be 19.4%. If confirmed, this mortality rate would result in an unprecedented mortality rate for killer whales based on 24+ years of killer whale research in the eastern North Pacific Ocean. Second year field studies are required to determine if the missing whales are dead or if they return in 1990. Good data from earlier years exists. If the missing whales fail to appear again next year, continued observation and tracking of the whales seems worthwhile. The main reason for continuing this study is the high visibility that killer whales maintain within the public eye and the high value they might correspondingly be assigned should an impact be demonstrated.

* Budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
3	Cetacean Necropsy		X	NOAA	$73,000	-0-

COMMENTS

This study found a number of stranded whale carcasses, but was unable to sample most of the decomposing carcasses for tissue analysis. It is unlikely that samples taken from cetaceans will be fresh enough for histological examination. Even if obtained in a timely manner, it is unlikely that any causal relationship could be established. The samples should be held but not analyzed at this time.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
4	Sea Lion	X		NOAA	$270,000	$161,000

COMMENTS

Results of aerial surveys and pup counts in 1989 failed to document an oil spill effect. The major decline overshadowed any possibility of detecting losses due to the oil spill. However, exposure to oil during 1989 may deleteriously affect the reproductive capability of female sea lions during 1990. The effects may be magnified by increased rates of abortions or premature births during 1990. The magnitude of premature pupping will be documented by placing biologists at two rookeries during March and April at a location near the oil spill (Cape St. Elias) compared to one far from the spill (Chirikof Island) where the rate is expected to be lower.

Additional population dynamics analysis of sea lions is not recommended as results from 1989 did not demonstrate significant body counts or significant difference between pre- and post-spill populations. This may be due in part to the fact that variances on aerial counts of these marine mammals is quite high, making it difficult to detect changes in distribution and abundance, and the sea lion population in Prince William Sound and the Gulf of Alaska has been in decline over the last 30 years. In addition, sea lion mobility confuses oiled and unoiled comparisons, and modelling population impacts and recovery rates using changes in vital rates would be very difficult to do.

Nevertheless, we believe sea lions are worth studying as part of a sublethal analysis. This study should focus on analyzing whether there has been a change in premature pupping, reproductive rates, and behavior, which could indirectly suggest population changes. Scientists should also collect the placentas for tissue analysis for mixed function oxidaze (MFO) on surviving and non-surviving pups.

Objectives of this study are to: 1) test the hypothesis that numbers of sea lions using keries and hauling areas from Cape St. F s to Chowiet Island are lower during the

*as budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals 4	Sea Lion					

COMMENTS

(-Page 2-)

breeding season and test the hypothesis that lower numbers are due to EVOS; 2) test the hypothesis that premature pupping occurs at a higher rate at a hauling area nearer EVOS; 3) test the hypothesis that pup production is lower in the vicinity of EVOS; 4) estimate hydrocarbon levels in tissues and test the hypothesis that tissue damage has occurred.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
5	Harbor Seal	X		NOAA	$245,000	$135,000

COMMENTS

Results of 1989 field work indicated that over 70% of the seals in oiled areas were oiled. Carcasses of 39 seals were necropsied and sampled, but sample analysis is not complete. Investigators for this study were able to conduct a pre- and post-spill comparison of oiled and unoiled sites. This comparison revealed a greater-than-expected population decline in oiled areas. Aerial surveys of haul-outs and rookeries, therefore, should be continued to monitor population numbers and estimate adult to pup ratios. The investigator should also continue taking a full range of samples for toxicology and histopathology analyses from any animals that are collected. However, no additional live seals should be collected under existing federal collection permits unless positive evidence of oil contamination and related physiological changes are found in existing samples and until investigators have received approval from the Trustee Council. Toxicology and histopathology tests should be completed as soon as possible, especially those taken from collected animals. As feasible, the investigator should collect information on reproductive behavior, pup growth rates, and food habits.

Objectives of this study are to: 1) describe the characteristics and persistence of oiling of pelage that resulted from contact with oil; 2) test the hypothesis that harbor seals found dead in the EVOS area died due to oil toxicity; 3) test the hypothesis that the levels of hydrocarbons and incidence of pathological changes in tissues from visibly oiled seals are higher than from seals that are not visibly oiled; 4) test the hypothesis that the proportion of harbor seals on the trend count route during pupping and molting decreased, relative to other years, in the area affected by EVOS and associated activities; 5) test the hypothesis that the abundance of harbor seals decreased in oiled portions of PWS as compared to unoiled areas; 6) test the hypothesis that pup production was lower in oiled portions of PWS as compared to unoiled areas; and identify restoration methods where injury has occurred.

*Some budgeted figures, not allocated entirely spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
6	Sea Otter Impacts	X		USFWS	$763,000	$1,056,000

COMMENTS

This study is very important given the number of sea otters in nearshore areas directly impacted by the spill (over 1000), the potential for estimating recovery rates, and the relatively high economic value that is likely to be assigned to sea otters. In addition, it appears that otters in off-shore areas may also have been impacted. If this is substantiated by additional study, it could dramatically increase mortality estimates.

Tests on beached carcasses should be completed to determine what percentage died from oiling and to determine the age of the otters killed. These data may allow projection of population recovery rates. A carcass search should be conducted in early spring to supplement the body count. A drift experiment should be undertaken as well to determine wash-up rates.

Sublethal impacts should also be studied as blood samples show potential liver and kidney damage. We recommend investigators apply DNA and hemoglobin adduct analyses to samples from the tagging study and existing samples, examine tag/recaptured animals for cataracts, ensure histopath analysis is double blind random. We strongly recommend a high priority be placed on body burden sample analysis, especially on tagged individuals (30-40 animals from Fall '89). Investigators should attempt to gather corroborating data on behavior, especially weanlings which can be linked to chemical analyses and fresh carcasses. The PIs should be given guidance on sampling invertebrates for toxic dose information. Further comments: 1984-85 baseline data exists; female-pup ratio data not available over time but comparable over space; use weanling mortality as a prime indicator of habitat change.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals 7	Sea Otter Rehabilitation	X		USFWS	$108,000	$130,000

COMMENTS

This study should continue as designed for the same reasons cited in comments to Study #6.

* budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals 1	Sitka Black-Tail Deer	X		ADFG	$87,000	$17,300*

COMMENTS

Systematic counts of dead deer were proposed as one of the major methods for assessing spill effects on Sitka Black-Tailed deer. However, a pilot study conducted two months after EVOS occurred found no deer mortality that could be linked directly to oil exposure. Therefore, the counts were suspended until results of aerial surveys conducted along oil contaminated beacheds during January through April are available. if deer concentrate on oiled beaches, and if there are indications of oil toxicity, a systematic gound count is proposed. We recommend that investigators complete the winter aerial survey at a budget level of $17,300. The viability of systematic ground counts should be based on those aerial survey results and should proceed only upon approval of the Trustee Council with funding of $109,300.

Objectives of this study are to: 1) test the hypothesis that deer on heavily oiled islands have tissues and rumen contents contaminated by oil; 2) test the hypothesis that deer found dead have rumen contents in their lungs; 3) estimate the number of dead deer per unit area on both a heavily oiled and non-oiled island in PWS; and 4) identify restoration methods where injury has occurred.

* [illegible]

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals						
2	Black Bear	X		ADFG	$139,700	$10,000

COMMENTS

Principal investigators were not able to use helicopters to capture bears for marking and therefore had to discontinue the project in 1989. Investigators propose to undertake a limited literature search in 1990 to determine whether prior studies have demonstrated that black bears are impacted when denied their preferred food source. We recommend this literature search receive funding.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals						
3	River Otter	Pending[2]		ADFG	$287,700	($300,000)[2]

COMMENTS

Preliminary analysis indicates that the rate of mink fecal deposition rates between oiled and unoiled areas is approximately the same. Investigators propose to complete the radio-tagging of 40 river otter in 1990 to compare population size, food habits, and habitat use in oiled and unoiled areas. Very little data was collected in 1989 because most of the effort was devoted to establishment of study areas and development of techniques. However, 40% of the radio collared river otters are now emitting signals indicating probable death.

Objectives of this study would be to: 1) determine cause of death for river otters recovered from oiled areas; 2) test for higher hydrocarbon levels in river otter in oiled versus unoiled areas; 3) estimate population sizes of river otter on oiled and control areas; 4) estimate rate of fecal deposition for river otter; 5) test for lower survivorship of river otter on oiled versus control areas; 6) test for difference in food habitats of river otter before and after EVOS on the oiled study area; 7) test for differences in food habits of river otters on oiled and control areas; 8) test for differences in activity patterns (foraging) of river otters between oiled and control areas; 9) test for differences in habitat selection in river otters between oiled and control areas; 10) identify restoration methods where injury has occurred.

[2]Council did not reach consensus; will make recommendation following review of detailed study plan; cost estimated at $300,000 if continued.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals						
4	Brown Bear	X		ADFG	$162,700	$115,100

COMMENTS

Thirty brown bears were captured and fitted with radio collars in the oiled study area along the Katmai coast. They were relocated at 2-3 day intervals until entering winter dens. No mortalities were observed among radioed animals. Most aspects of this project were planned to yield results beginning in autums 1990. Investigators propose to maintain a fall total of at least 30 bears with radio-collars and follow them for three years to obtain mortality, population, and hydrocarbon contamination data. The results will be compared with a similar study now being conducted in the unoiled Black Lake area. Since brown bears are a high profile species that are endangered or threatened in all states other than Alaska, we recommend the study be continued.

Objectives of the study are to: 1) test the hypothesis that radio-collared brown bears in the oiled area ingested hydrocarbons at higher concentrations than radio-collared bears in an unoiled area; 2) test the hypothesis that natural mortality rates of female bears in the oiled area is higher than in unoiled areas for a period of 3 years following EVOS; 3) test the hypothesis that some natural mortality of brown bears in the oiled area can be attributed to the physiological affects of ingesting hydrocarbons; 4) estimate the adult brown bear population density of the study area to obtain a coefficient of variation on the degree of petroleum exposure; and 5) identify restoration methods where injury has occurred.

*Reflects background figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals 5	Carnivores/ Small Mammals		X	ADFG	$302,400	-0-

COMMENTS

This study has not been proposed for continuation.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals						
6	Mink Reproduction		Pending[2]	ADFG	$192,200	($139,000)[2]

COMMENTS

This study is designed to determine if short and long-term ingestion of weathered Prudhoe Bay crude oil by captive ranch mink affects female reproduction. The reproductive variables to be studied would include breeding behavior, number of kits per litter, kit survival, kit growth and maturation, and histology of adult and kit reproductive traits. Observations would continue until weaning, when animals would be euthanized and necropsied. While the study itself is well designed, there is no demonstrated connection between the lab experiments and the actual exposure animals are receiving in the environment. Given the relatively high cost of this study, the lack of any data to suggest the actual mink mortality caused by the spill was significant, and the relatively low value likely to be assigned mink, we recommend this study be discontinued.

Objectives of this study would be to: 1) identify the concentration of weathered Prudhoe Bay Crude (WPBC) oil in mink feed that does not produce clinical illness or significantly reduce palatability; 2) determine the total mean retention time of oil within the mink alimentary tract; 3) test the hypothesis that short-term low level ingestion of WPBC oil during pre-estrus, diapause, gestation, or lactation does not produce a significant difference in female mink reproduction; 4) test the hypothesis that continual, low-level ingestion of WPBC oil starting during pre-estrus and continuing through to weaning of kits does not produce a significant difference in female mink reproduction.

[2]Council did not reach consensus; will make recommendation following review of detailed study plan; cost estimated at $139,000 if continued.

*1989 budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 1	Salmon Spawning Area Injury	X		ADFG	$144,800	$391,300

COMMENTS

This study is an integral part of any pink salmon population impact assessment in Prince William Sound. It supplements the existing escapement database and will contribute to a pre- and post-spill comparison of population size, a post-spill spatial comparison in oiled and unoiled sites, and in measuring changes in vital rates between oiled and unoiled streams.

A survey of the distribution of oil contamination was completed for 441 intertidal salmon spawning streams in Prince William Sound during the 1989 field season. Nearly all streams surveyed were aerial photographed, the intertidal areas of oiled streams were mapped, and the type and extent of oil contaminatino were recorded. Mussel samples were collected for hydrocarbon analysis at all streams where escapement ground surveys were conducted. Pink and chum salmon escapements for 1989 were enumerated by tidal zones for 138 streams. In order to provide a time series of pre- and post-spill pink and chum salmon escapements in Prince William Sound, an analysis of the historical data base must be completed and post-spill escapement surveyes must be validated.

This project is also designed to document oil contamination of intertidal spawning habitat.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 2	Salmon Eggs and Preemergent Fry	X		ADFG	$149,100	$302,800

COMMENTS

This study has already demonstrated oil spill population impacts by revealing a substantial increase in egg mortality. It supplements the existing egg deposition and pre-emergence data, particularly by including more oiled sites in the sample. The results could provide direct mortality data by comparing egg survival rates in oiled and unoiled areas. In addition, the study will contribute data relevant to pre- and post-spill population comparisons, post-spill population comparisons, post-spill spatial comparisons, and to measuring changes in vital rates.

The study also could provide valuable information for an analysis of sublethal impacts. We recommend expansion of studies with field experiments to assess long-term and sublethal effects of spawning habitat contamination, including transplanting (in baskets) of fertilized (hatchery) eggs into streams with varying degrees of contamination, followed by regular monitoring of egg development and survival. Investigators should do MFO measurements in field-collected eggs, larvae and fry. In laboratory studies, investigators should measure egg membrane disruption, cytogenetics, and growth behavior.

This study is designed to assess possible changes in pink and chum salmon egg to preemergent fry survival in intertidal and upstream areas relative to oil contamination.

*Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 3	Salmon Coded Wire Tagging	X		ADFG	$1,943,400	$1,943,400

COMMENTS

Catch and survival rates of pink salmon released from four Prince William Sound hatcheries in 1988 were estimated for 1989 recoveries. Almost 1.4 million tagged pink, chum, sockeye, and coho salmon were released from five hatcheries in 1989. Future catches will be scanned for these marked fish. Marine survival of each stock will be calculated when they return. Tagged pink and coho salmon will return in 1990. Chum and sockeye salmon will begin returning in significant numbers in 1991, and recovery efforts will continue through 1992 to encompass the majority of adult returns from the 1989 release. Based on results from Fish/Shellfish Study 1 and 2, six streams have been chosen for pink salmon tagging and measurement of outmigration in 1990. Tag recoveries from harvest and stream surveys in 1991 will provide estimates of survival rates. Over 90 thousand sockey smolts were tagged at Eshamy and Coghill Rivers in 1989.

This study provides information useful to a population dynamics analysis. The coded wire tagging allows investigators to analyze survival rates for fish released into oiled versus unoiled hatcheries and wild streams. This information primarily contributes to an analysis of vital rate changes, although differences in survival can be thought of as body counts. The coded wire tag (CWT) fish will also be used to analyze early marine distribution and growth in study #4.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 4	Early Marine Salmon Injury	X		ADF&G/NOAA	$829,200	$630,000

COMMENTS

This study found different migration patterns for fry released in oiled vs. oil-free areas. Growth rates were also significantly lower in oiled than in unoiled areas. Both juvenile pink and chum salmon were also more abundant in non-oiled areas, but corroboration of this resulting from oil exposure requires analysis of tissues for levels of hydrocarbons.

This study should be redesigned to focus on elements relevant to a sublethal analysis. The study should consists solely of laboratory and/or field manipulative experiments, with priority on field manipulative experiments measuring growth using otoliths/diet composition/consumption. This study should be further reviewed to determine if pens are the best means to analyze effects.

*Some budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 5	Dolly Varden/ Cutthroat Injury	X		ADFG	$437,400	$290,000

COMMENTS

Of all of the finfish species, Dolly Varden char and cutthroat trout are the most exposed to the oiled marine environment. Oil contamination may affect growth and survival. There is, however, no background data on either species. In 1989, emigrating fish were counted, measured, aged, and tagged in several systems, including oiled and unoiled areas. In 1990, investigators propose to sample the fish tagged in 1989 to determine growth and survival rates. Re-sampling during the 1991 field season may be necessary for reliable survival estimates. Post spill spatial comparisons constitute the only possible population dynamic assessment technique for these species. The experimental design is such that comparisons are almost sure to detect differences if they exist. This study provides the data needed to conduct this assessment.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 6	Sport Fishery Harvest & Effort		X	ADFG	$175,900	-0-

COMMENTS

This is an economic study.

Sport harvested fish were examined for signs of oil contamination including oxganoleptic tests and residues of oil in the digestive tracts. The sport harvest was then apportioned to percentage of oil contaminated fish in the catch.

Study objectives were also to determine recreational catch and harvest of salmon, rockfish, halibut, cutthroat trout, and Dolly Varden char. Angler effort and temporal and spatial distribution and location of origin for angler effort identified

The Resurrection Bay area near Seward was documented as experiencing the lowest Sport Fishing angler effort ever recorded.

*Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
7	Salmon Spawning Area, Outside PWS	X		ADFG	$320,300	$539,400

COMMENTS

Overescapement caused by closure of the fisheries is felt to be the major oil spill impact on pink salmon in the Kodiak area (7b). The first component of this study supplements the existing escapement database and is essential to estimating overescapement impacts on pink salmon. Damage from overescapement may include a decline in average egg survival as a function of spawning density. Published studies on overescapement can be used to determine the effect of overescapement on vital rates. Escapement counting methods used for the Kodiak area will need to be validated.

A second component of this study takes place in Lower Cook Inlet (7a), and parallels the project being conducted within Prince William Sound under study #2.

Pink and chum salmon escapements for 1989 were enumerated by tidal zones for 9 streams within the Lower Cook Inlet/Kenai Fjords area. Survey stream was aerial photographed, the intertidal areas of each oiled stream was mapped, and the type and extent of oil contamination was recorded. Mussel samples were collected for hydrocarbon analysis at all streams where escapement ground surveys were conducted. Preliminary estimates of numbers of pink and chum salmon spawning within four oiled and five unoiled streams have been made. Differences in the distribution of both pink and chum salmon have been documented between oiled and unoiled streams, however one or more additional years of study are needed to evaluate the cause of these differences. In order to provide a time series of pre- and post-spill pink and chum salmon escapements in the Lower Cook Inley/Kenai Fjords area, an analysis of the historical data base must be completed and the post-spill escapement surveys must be repeated for several more years.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 8	Egg & Preemergent Fry, Outside PWS	X		ADFG	$111,400	$293,300

COMMENTS

This study has 2 components, one in Lower Cook Inlet (8a) and the other in the Kodiak area (8b). It supplements the existing egg deposition and pre-emergence data, particularly by including more oiled sites in the sample. The results could provide direct mortality data by comparing egg survival rates in oiled and unoiled areas. In addition, the study will contribute data relevant to pre- and post-spill population comparisons, post-spill spatial comparisons, and to measuring changes in vital rates.

Sampling of eggs and early preemergent fry was successfully completed at nine streams in the Lower Cook Inlet/Kenai Fjords area during the fall of 1989. Estimates of mortality from the egg to preemergent stage for progeny of 1989 brood year spawning of pink salmon within the study streams will be made following the completed of data collection in the spring of 1990. It may not be possible to make similar estimates for chum salmon, since few chum salmon eggs were collected in 1989.

These studies will supplement the existing egg deposition and preemergence data and could provide direct mortality data by comparing egg survival rates in oiled and unoiled areas. In addition, they will contribute data relevant to pre- and post-spill population comparisons, post-spill spatial comparisons, and to measure changes in vital rates.

Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 9	Early Marine Salmon Outside PWS		X	ADFG	$348,500	-0-

COMMENTS

This study was not scheduled to begin until 1990.

This study would not provide any meaningful information for assessing the impact of overescapement. In addition, in the absence of coded-wire tag fish, it does not assist in assessing growth or migration patterns in oiled and unoiled sites outside of PWS.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 10	Dolly Varden/ Sockeye, Lower Kenai		X	ADFG	$152,600	-0-

COMMENTS

Field work was not scheduled to begin for this study until 1990. We do not believe, however, that the study will produce meaningful information for a population or sublethal impact assessment.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
11	Herring Injury	X		ADFG	$374,500	$400,000

COMMENTS

Direct mortality of adult spawning herring, eggs, and larvae due to oil contamination was measured in 1989. Although the majority of the petroleum hydrocarbon samples that were collected in this study have yet to be analyzed, preliminary findings seem to indicate strong evidence of egg/larvae impacts. The proposed 1990 study will expand the 1989 data base and further quantify impacts to the Prince William Sound herring population. In addition, since herring are an integral part of the food chain, there is evidence that oil contamination of herring could impact predators such as shore birds, sea birds, marine mammals and other marine fish species.

This study includes intensive spawn sampling and special egg mortality studies. Data gathered will be valuable for a population dynamics assessment. With regard to a sublethal analysis, no petroleum hydrocarbon sample results are available but there is seemingly strong evidence of egg/larvae impacts. We recommend (1) MFO on existing archived samples; (2) analyses for body burden; and (3) specific laboratory studies (if not available in literature) of dose-response relationship.

Specific objectives for this study are: (1) to estimate the abundance of herring using spawn deposition studies, age-weight-sex and fecundity data, and aerial survey data; (2) document the occurrence of herring spawning in oiled and unoiled areas and validate the oiled sites with quantified oil level information: (3) collect hydrocarbon samples to determine the level of contamination in adults, larvae, and eggs; (4) evaluate egg mortality and egg loss; and (5) rear herring eggs and larvae from Prince William Sound and Southeast Alaska under laboratory conditions and compare differences in egg mortality, hatch success, viable hatch, occurrence of abnormalities, growth, and larval feeding.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
12	Herring, Outside PWS		X	ADFG	$60,000	-0-

COMMENTS

Aerial surveys to determine the location of spawning areas and the magnitude of herring spawn, and to document the occurence and biomass of stocks on Kodiak Island and the Alaska Peninsula were limited due to a late beginning, lack of available charter aircraft, and poor weather. No direct herring mortality was observed, and an influx of juvenile herring (age 1 and 2) was noted in many bays of the Kodiak Area. Historical data on herring length at age, from age-weight-length-sex (AWL) samples taken during the sac roe fishery, 1981-1989, are being compiled and analyzed to test against future samples for year, area, and oil spill effects on herring growth.

No significant departures have been made from the objectives of this study. They are:

1. Document the occurence of herring stocks and spawn in oiled and non-oiled areas of the Kodiak Archipelago and the Alaska Peninsula.

2. Estimate the injury to herring eggs and larvae by directly applying results from Prince William Sound Injury assessment studies.

3. Test the hypothesis that incremental growth by age is independent of oil impacts.

[illegible] budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 13	Clam Injury	X		ADFG	$86,200	$175,000

COMMENTS

To date 20 clam hydrocarbon samples (sediments and tissues) have been submitted for analysis, 10 samples from within Prince William Sound (PWS) and 10 from outside PWS. Results from these hydrocarbon samples have not been received yet, however it is expected that clams from the heavily oiled beaches will show a high level of contamination. Additional hydrocarbon analyses and histopathology analyses can be conducted once the initial sample results are received. Length measurements for clams inside and outside PWS were recorded. Findings from this study are expected to make a valuable contribution to sublethal/ecosystem damage assessment.

The value of this study, therefore, appears to be in the contribution it would make to a sublethal/ecosystem damage assessment. We recommend sampling Protothaca, Saxidomus, and Siliqua under a balanced oiled and unoiled, clean and not cleaned design, and expanding growth analyses to include analysis of shell microstructure and an oil "stress check." We suggest conducting reciprocal transplants with indigenous clams and with a common, clean source of clams. This is a substantial redesign of the 1989 studies. Our recommendation is to combine former studies 13 and 21 into a single clam study including selected areas outside PWS.

* Reduce budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 13	Clam Injury					

COMMENTS

(-Page 2-)

This study is designed to determine injuries to little neck clams, butter clams, razor clams and their habitats that have been impacted by the Exxon Valdez oil spill, both within and outside Prince William Sound. Specific objectives for this study are: (1) determine the level of hydrocarbon in these sites; (2) evaluate the effect of oil contamination on the tissue and organs of calms; (3) measure growth rates and determine the effect of oiling on growth; and (4) study changes in numbers of young-of-the-year clams on unoiled, oiled, and mechanically cleaned beaches.

Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
14	Crab Injury		X	ADF&G/NOAA	$142,000	-0-

COMMENTS

Insufficient numbers of Dungeness crabs exist in western PWS to test for oil effects. Lack of baseline data on brown king crabs precludes population change detection for that species. Not enough samples were taken in unoiled sites to permit a statistically reliable comparison of oiled and unoiled areas. Also, there is no definite evidence of subtidal contamination. We recommend, therefore, that this study be discontinued.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 15	Shrimp Injury	X		ADFG	$60,500	$65,000

COMMENTS

Sampling conducted in 1989 suggested lower catch-per unit effort in oiled areas and higher mortality of eggs (which are held externally) in oiled areas. These shrimp are relatively immobile. Adult shrimp usually inhabit deep water (20-120 fathoms) areas with near-shore rocky terrain. Since oil at depth is more likely to occur after the oil has hit the adjacent beach and been picked up in sand and debris particles, this study will provide information on damage at depth as opposed to damage at or near the surface of the water.

This study addresses effects of oil on spot shrimp growth and reproduction. Sampling conducted in 1989 suggested lower catch-per-unit effort in oiled areas and higher mortality of eggs (which are held externally) in oiled areas. These shrimp are relatively immobile, near shore, and relatively deep. Oil at depth is probably more likely sometime after the oil has hit the adjacent beach and picked up in samd and debris particles. This study would provide information on damage at depth as opposed to damage being a near surface phenomenon.

There will be problems applying results to the population at large by the relatively low costs associated with this project make it worthwhile.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 16	Oyster Injury		X	ADFG/NOAA	$30,500	-0-

COMMENTS

Analysis of oil spill impact cannot be made based on the results of the 1989 study. A new study could be designed using before and after spill data at the three existing oyster farms to assess whether oil affected oyster mortality or growth. Such a project may cost around $30,000. Since oysters are not a native species, however, the value of such a study to the natural resource damage assessment process is highly limited. In addition, the oyster studies are largely redundant of mussel studies.

* Reduce budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 17	Rockfish Injury	X		ADF&G	$45,600	$73,000

COMMENTS

Oil spilled from the Exxon Valdez killed demoreal rockfish in Prince William Sound in 1989. Of 20 dead demoreal rockfish brought to collection centers in Valdez and Cordova from sites of reported fish kills, five were sampled and crude oil was found to be the cause of death. Eleven of 36 bile samples analyzed from oiled areas, six weeks after the March 24 oil spill in Prince William Sound, were exposed to oil within two weeks prior to sampling. Bile is continually being produced in a rockfish's gall bladder, and the local volume of bile is replaced every two weeks. Therefore, it is apparent that oil contamination persisted in the environment well after oiling and that oil contamination has extended to benthic habitate. To date, these reports from the public and the demoreal rockfish sampled in response to these reports are the only direct evidence of death to finfish as a result of exposure to crude oil from the Exxon Valdez in Prince William Sound. Result of hydrocarbon analysis from later sampling trips will help determine how long hydrocarbons persist in the environment and the food chain.

In light of the 1989 findings of oil impacts on rockfish populations, continued study is warranted to determine the extent of oil contamination to shallow reef habitats. This study will help determine if is oil being transported to subsurface habitats and it will help determine if it is oil being transported to subsurface habitats and it will quantify the extent to which these residual hydrocarbons persistence in the environment. Continued studies will also help determine long term histopathological effects of oil contamination on rockfish and affects on the quality for human consumption.

The peer review committee suggest that this study sould be reoriented to provide evidence of the geographic extent or spill impacts on the reef community. The modified study should include (1) capturing recently recruited rockfish for age, growth, and contamination analyses; (2) sampling sessile invertebrates (e.g. suspension feeders such

*Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 17	Rockfish Injury					

COMMENTS

(-Page 2-)

Reef and the Lower Kenai Peninsula should be included in the study. Compile and interperate historical data on reef communities in Prince William Sound and the Lower Kenai Peninsula. This new study design will provide useful data for population dynamics assessment.

Continued studies of demersal rockfish populations is warranted to determine the extent of oil contamination to shallow reef habitats. Specific objectives include: (1) determine the presence or absence of hydrocarbons in demersal rockfish, benthic prey species, benthic suspension feeders, and sediments from paired oiled and unoiled sites in Prince William Sound; (2) determine the feasibility of using otolith microstruction to evaluate depressed growth as a result of oil contamination; and (3) determine the feasibility of using histopathological evaluations of gonads and pituitary glands to ascertain effects of oil contamination on growth and reproduction.

* Reserve budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
18	Trawl Assessment	X		NOAA	$738,800	$186,000

COMMENTS

This trawl assessment surveys for finfish other than salmon, herring, Dolly Varden char, cutthroat trout, or rockfish. These "other" finfish live their entire lives in the marine environment. Little is known about the spacial movements of some of these fish, making it difficult to determine whether any change in abundance is due to redistribution, recruitment, or survival. In addition, it is difficult to measure vital rates of these fish. Realistically, because of the high natural variability of the species, lack of data points, and uncertainty in migration patterns, there is little possibility of detecting population dynamics impacts.

Preliminary sampling, however, indicates that some fish from the first year trawl had abnormally high levels of contaminants in their bile. We recommend, therefore, a continuation of this study but at a substantially reduced level.

Representative samples of offshore trawl species should be processed for body burden. If evidence of burden exists, investigators should follow up by analyzing corresponding histopath samples, i.e. gonadal material. Investigators need to coordinate fish sample analyses with sediment sample analyses to confirm hydrocarbon source. In addition, investigators need to analyze stomach contents and literature for representative prey and to sample benthic prey for contamination (especially nearshore).

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 19	Larval Fish Injury		X	ADF&G	$413,400	$5,000

COMMENTS

This study will not prove useful in any population dynamics assessment. We recommend that he 1989 samples be archived.

* Funding will be necessary to archive samples and to complete study.

* Indicates budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 20	Underwater Observations		X	ADF&G	$550,100	-0-

COMMENTS

It is not recommended that this study continue, as no oil was observed in 1989 at any of the sites surveyed.

*Note budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 21	Clams, Outside PWS		X	ADF&G	108,800	-0-

COMMENTS

See comments for study #13

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 22	Crabs, Outside PWS		X	NOAA	$111,500	$110,000

COMMENTS

In the fall, the 1989 study lacked adequate control sites to determine whether a statistically significant population difference existed between oiled and unoiled sites. No growth data were taken. Tissue hydrocarbon data were collected but cannot be readily related to growth. This study documented the occurrence of Dungeness crabs in oiled environments in the Kodiak area and collected both crabs and sediments for hydrocarbon analysis. Only one female Dungeness Crab was captured in the fall, so a fecundity analysis was impossible. This study will be completed with a spring sampling cruise to conclude its analysis of oil effects on crab fecundity.

*Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 23	Rockfish, Halibut, Lincod - Lower Kenai		X	ADFG	$108,400	-0-

COMMENTS

It was felt that this study be discontinued because the study would not address population dynamics and is not likely to demonstrate impacts.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	ONE YEAR BUDGET 1989 BUDGET *	ONE YEAR BUDGET 1990 BUDGET
Fish Shellfish 24	Trawl Assessment Outside PWS	X		NOAA	$2,495,000	$450,000

COMMENTS

Preliminary sampling indicates that some fish in nearshore areas outside Prince William Sound have abnormally high levels of hydrocarbon metabolites in their bile. Continued exposure of these fish to hydrocarbons in the nearshore environments can cause long-term biological effects, such as reproductive dysfunction and histopathological lesions. The final decision to continue the second years' sampling is pending approval of a detailed study plan for 1990. We recommend continuing this study, but limiting it to nearshore areas outside Prince William Sound and with a reduced effort.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 25	Scallop Resources Injury		X	ADFG	$53,800	-0-

COMMENTS

The field experiment should be discontinued because of the difficulty in correlating natural scallops and aquaculture situations.

* Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 26	Sea Urchin Injury		X	ADF&G	$45,000	-0-

COMMENTS

Any population impact, if detected, would not be large because the geographic overlap of oiled areas and green urchin distribution is so small. Moreover, the sampling protocol prevents a quantitative analysis of oil impacts for those limited areas where urchins were present. Also, other interactions may confound interpretation of any density differences. We recommend, therefore, that this study be discontinued.

*Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment	X		USFS	$5,436,000	$6,300,000

COMMENTS

GENERAL RESULTS/ACCOMPLISHMENTS THRU 2/28/90

The overall objective of this study is to determine the effects of various degrees of oiling on the quantity (abundance nad biomass), quality (reproduction, condition, and growth rate), and in composition (diversity and proportion of population) of key species in the critical trophic levels of coastal communities. These data will provide the evidence of damage to the overall health and productivity of these critical coastal habitats, and provide information necessary to successfully analyze the more species-specific studies on the effects of the oil spill on important terrestrial and marine mammals, marine birds, and fish and shellfish.

INITIAL RESULTS

1. Intertidal data analysis is still proceeding from 78 sampling sites involving over 4 tons of samples. Initial analysis of some samples from Prince William Sound indicate: (1) reduced glycogen production in mussels which is essential for reproduction; (2) gills of intertidal fishes from heavily oiled sites are deformed as compared to unoiled sites (these fish provide an important food link to may important predators such as bald eagles and others); and (3) other detailed findings are found in the interim report prepared 1/15/90

2. Shallow subtidal work found a "dead zone" where many fish (pacific cod, flatfish, and others) and invertebrates (squid, starfish, etc.) were found dead (see report prepared 1/15/90)

* Exclusive budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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SPECIFIC CHANGES FROM 1989 TO 1990

1. To reduce data analysis and costs but still maintain a statistical design capable of extrapolation to entire spill area: (1) greatly reduce the supratidal work, limiting it to the Alaska penninsula with some limited ruminent analysis for support to terrestrial mammals; (2) drop estuarine and fine testured replicate sites in Prince William Sound (this would reduce the total sites by 20, leaving 30 sites in coarse textured, sheltered, and exposed rocky shores); and (3) drop exposed rocky shores in Cook Inlet/Kenai Fiords area (reducing number of sites by 10, leaving 40 in estuarine, sheltered rocky, fine testured, and coarse textured beaches).

2. Increase emphasis on direct biological effects involving recolonization, growth rates of survivors, reproductive success by increasing the number of sites visited in-part by adding 5-10 new sites in each of the Cook Inlet and Alaska Penninsula/Kodiak areas to correspond to previous work conducted by NPS at 49 sites, responding to PR comment #2.

3. Differentiate the effects of beach clean-up from the effects of MOD/heavy oiling, concentrating the activity in one location in Herring Bay in PWS (further analysis is still needed).

*Some budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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SPECIFIC COMMENTS

1. Scale back supratidal field study. Focus on particular beaches where damage is likely, such as beaches wehre winter storms force oil onto supratidal areas. Coordinate supratidal study with terrestrial mammal studies to provide information required. Continue small 1990 sampling effort on how oiling affects digestibility of key forage species (especially Elmius) in one-step and two-step digestion processes in the supratidal. Consider using walkathons to obtain information on scope of oiling. Should develop standardized procedures for photography of oiled areas.

2. First priority in intertidal habitat study should be to utilize existing "before and after" data bases to test whether oil had any biological effects on intertidal communities, and the magnitude of any such effects. An experiment-oriented scientist shuch as Highsmith should choose those data sets that represent the appropriate and rigorous contrast of control (unoiled) and oiled sites before and after oiling, using sites that were initially biologically similar. The National Park Service's quantitative quadrat data, especially the data collected by Dr. David Duggins, may be the best data for this purpose. The photographic transect data collected by the NOAA Auke Bay coastal habitat study may also be suitable, depending on whether it includes both oiled and unoiled stations, incorporates replication, contains photographs taken at exactly repeated quadrats, utilized a scale of photographs that allows sufficient discrimination of organisms, and includes oiled and unoiled sites that were initially similar biologically. All photographs that can be used in a rigorous before/after

* Authority budgeted figures, not necessarily actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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contrast should be analyzed to obtain biological data, and those data should be analyzed statistically and interpreted.

3. The major effort of the Coastal Habitat Study in Prince William Sound should be directed towards rocky intertidal and coarse textured biota on sheltered and exposed shores. This focus is a result of the extensive exposure of these areas to oil, and the importance of these areas to oil, and the importance of these areas to the foold chain. Key food chains include (1) mussels to sea otters, ducks, surf birds, and subsistence users, (2) limpets to oystercatchers and surf birds and (3) seaweeds (Fucus, etc.) to amphipods and small snails to fishes and others. Mussels are particularly important as organizing species within the rocky intertidal community and as forage species. There is a substantial ecological literature on the impact of mussels on other organisms.

4. The statistical design, which provides for sampling at random within habitat types in order to permit inductive extension to entire geographic areas, is appropriate. It must be supplemented, however, by selection of some non-random, deliberately selected, control and oiled sites. Sampling of lightly oiled sites should be scaled back. Should consider experimental study to determine effects of light vs. moderate/heavy oiling.

The problem of providing control sites with similar geographical, biological and salinity characteristics must also be addressed. Although the statistical framework is elegant, it should be maintained only for the intertidal study habitats and even for those the overly ambitious work schedule may prevent the use of this statistically elegant approach.

* Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
~~Coastal Habitat~~ 1	Comprehensive ~~Assessment~~					

COMMENTS

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5. The major problem with the study is how to reduce the balance of the work load of the biologists with the analytical resources so that results can be obtained in a timely fashion. Either sites must be reduced or more lab sorters hired. Data collection and analysis for the summer 1990 field season should be completed by January 31, 1991.

6. The oiling status used to classify intertidal sites and to extrapolate to basin-wide effects cannot be based solely upon the September walkathon, because there had been significant decreases in oiling at some sites by September. The study should use observational data, plus all available historical data pertaining to the study sites. The Department of Environmental Conservation will provide a geomorphologist for each sampling area that will accompany the field sampling crew to document the amount of oil along each sampling transect, as well as, the horizontal, vertical, and penetration.

7. All possible information on cleanup efforts must be assembled and compared against each study site to insure that cleanup has not caused an improper assignment of oiling status at any study site.

8. For rocky intertidal sites, and perhaps for some other intertidal habitat categories, some of the seven set-aside areas where no oil cleanup was performed should be utilized to assess the biological impact of oiling as separate from cleanup activities. This is important both to show effects separtately and for future management of oil spill response activities. A study to separate effects of oil and cleanup requires careful

* Indicates budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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pairing of some oiled set-aside areas with nearby presumably ecologically analogous unoiled sites and oiled-but-cleaned sites. Since several different cleanup methods wereemployed, this design could become rather elaborate and extensive but limited information on the exact mode and intensity of cleanup activity probably precludes an elaborate design.

9. The 1990 study of intertidal areas should include explicit attempts to assess recovery rates of oiled systems. These should include some studies of recolonization rates on oiled vs. unoiled plots and should incorporate the necessary statistical designs to permit powerful tests of effects of oiling on recruitment of key rocky intertidal species. If any long-lived species or species with limited dispersal abilities appear affected by oiling, some attention to their site of recruitment and recovery should be made. Such species include certain starfish, soft corals, coralline algae, tunicates, etc.

10. Larval recruitment of barnacles, limpets and possibly benthis algae could be measured by matching rocks of similar composition from heavily oiled and totally unoiled sites, cleaning half of each rock chemically, stabilizing the rocks in intertidal areas both that retain oil and are free of oil. The design has four treatments, control for the chemical treatment site affects, and will permit a quantitative assessment of recruitment. The same design using fibrous materials such as hemp or polyester rope could be used to study recruitment of mussels.

* Reflects budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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11. Reestablishment of soft botton benthos could be studied by constructing bottomless and topless boxes of some inert material such as plexiglass, filling half with oiled sediment and half with clean sediment, after removing most or all of the resident fauna. Replicated pairs are placed in unoiled and oiled environments, perferably in low energy areas.

12. Annual or daily growth rates, corrected for individual size of bivalves, fish or benthic algae should be compared on a before-and-after or on an oiled vs. unoiled basis to provide information on whether the presence of oil is correlated with impaired biological performance.

13. Shallow subtidal studies should focus on three habitat types: nereocystis, laminarian and eelgrass beds. A limited number of sites (approximately 6) should be selected to represent heavily oiled and control sites with appropriate comparisons for each of the three habitat types and enclosed embayments and more exposed shores.

Sufficient replication to allow statistical application to the entire affected areas is not feasible. Comparisons must be made between selected oiled sites and appropriate controls on a pair-wise basis. This means that there are no compelling reasons to continue the spatial coupling of intertidal and shallow subtidal studies.

* Refers to budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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Rather, the following criterial should be used (in order of importance) to guide the selection of sampling sites: (1) Representative of targeted habitat types coupled with appropriate controls; (2) consideration of sites sampled in 1989; (3) Tie in with subtidal sediment sampling; (4) Tie in with intertidal sampling.

It is critical to limit the extent of these studies such that they may be feasibly completed by January 31, 1991. Accordingly, consideration should be given to limiting quadrat size and the depth ranges sampled. Additionally, experimental studies and observations contributing to the sublethal effects assessment of key species should be integrated with the field studies and performed at the same locations. In this regard, sampling at the subtidal habitat sires may be conducted twice during the field season at selected sites, allowing the deployment and recovery of field experiments. Attention should be directed to the sampling of epiphytic crustaceans which are important preyitems for a variety of resource species.

In developing the detailed study plan, investigators should consider taking one sampling in 1990 rather than two out of concern for cost and ability to analyze samples.

*Outlook budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air Water 1	Geog. Extent Temporal Persistence		X	ADEC	$343,500	-0-

COMMENTS

A report will be available in late February consisting primarily of an atlas of maps showing the type and location of oil from all aerial tracking performed by ADEC with confirming data where available from NOAA overflights. Satelite observational data, analyzed by the University of Alaska at Fairbanks, will also be available, showing location and extent of oil on days where satelite imagery was available. This study has been subsumed in large part by proposed Air/Water Study #6. We recommend, therefore, that it be discontinued but that $25,000 be allocated to complete maps and reports (included in wrap-up costs).

The objective of this study is to document the location and extent of oil sheens in the water.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air / Water						
2	Injury to Sub-tidal Resources	X		NOAA/ADEC	$883,000	$800,000

COMMENTS

A total of 1,160 sediment samples were collected from the inter-tidal and near shore sub-tidal regions of PWS and the Gulf of Alaska. No final results are available because analyses have not been completed. However, preliminary analysis of about 800 samples using the ultra-viloet fluorescence spectrophotometry indicates that, in bays where oil heavily contaminated the intertidal region, subtidal sediments may have suffered injury.

We recommend this study continue as "Injury to Intertidal and Subtidal Sediment Resources" with emphasis on determination of degradation rates for the higher molecular weight components typical of residual oil.

Objectives of this study are to: 1) determine occurrence, persistence, and chemical composition of petroleum hydrocarbons in subtidal marine sediments; 2) Provide marine sediment data to assist agencies in mass balance calculations on the fate of oil in the marine environment; 3) Relate subtidal oil concentrations to adjacent intertidal concentrations and other studies; and 4) Identify restoration methods where injury has occurred.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air Water 3	Geog. & Temp. Distrib. in Water Column	X		NMFS	$595,500	$564,500

COMMENTS

Water samples were collected in 1989 to measure the levels of water column contamination by dissolved aromatic hydrocarbons. Mussels were deployed in cages to document the longer-term presence of hydrocarbons in these waters.

Surface water was sampled for analysis of voltaile aromatic hydrocarbons at ten locations and interstitial water was sampled for broader hydrocarbon analysis and microbial studies at twenty-four sites. In surface water, detectable concentrations of aromatic hydrocarbons were found in 7 of 22 samples. For interstitial samples, hydrocarbon analysis has not been completed. However, preliminary microbial studies suggest that populations on impacted shorelines are responding to oiling by shifting towards greater numbers of hydrocarbon degraders and that these degraders possess the ability to mineralize the relatively persistent and toxic polynuclear aromatic hydrocarbon fractions in situ.

Continue with the following modification: 1) Terminate water quality cruises; 2) expand deployment of mussel cages to test for the presence and bioavailability of petroleum hydrocarbons in the water column; deployment sites should focus on areas of heavy intertidal contamination and sites representative of degrees of intertidal and subtidal oiling, substrate type, and type of exposure; 3) delete interstitial water sampling component, since technique does not accurately gauge injury to interstitial water; 4) ADEC should review its 1989 water quality data in conjunction with Technical Services No. 1 investigators for possible incorporation into study (separate database); this is important as it is key evidence of early acute exposures in the water column; and 5) obtain 1989 sediment trap data from UAF and incorporate as separate data base if QA/QC standards are met.

* Reduced budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air / Water 3	Geog. & Temp. Distrib. in Water Column					

COMMENTS

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Objectives of this study are to: 1) document water column hydrocarbon concentrations at a range of depths, locations, and times; 2) quantify injury to water resources; 3) Relate water injury to biological injury; 4) evaluate trends in ambient water quality using biological indicators as surrogates for chemical measurements; and 5) identify restoration methods through assessment of natural microbiological capacity to mineralize petroleum.

*Where budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air Water 4	Injury to Deep Water		X	NOAA	$378,900	-0-

COMMENTS

We recommend that this study be combined with Air/Water No. 2 and that Air/Water No. 4 be discontinued.

Objectives of this study were to: 1) estimate exposure of benthic resources to petroleum; 2) determine and quantify injury to the benthic infaunal resource; 3) determine persistence of injury to benthic resources; and 4) identify restoration methods where injury has occurred.

* Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air *Water* 5	Injury to Air		X	ADEC	$106,500	-0-

COMMENTS

A contract for completion of this modeling study has recently been awarded, therefore, no results are available at this time. We recommend that work in process be completed and that no additional work be undertaken.

Objectives of this study are to: 1) model loss rate of VOCs from crude oil; 2) model the ambient VOC concentrations as a function of time and distance from Bligh Reef; 3) Establish "zones of concentration" from predicted VOC concentration isopleths for levels of health-related injury; and 4) Evaluate "zones of concentration" for risk assessment impacts on the environment.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Technical Services 1	Hydrocarbon Analysis	X		NOAA/USFWS	$2,300,000	$2,000,000

COMMENTS

This study implemented the hydrocarbon quality assurance/quality control programs and directed the analyses of all hydrocarbon-matrix samples through qualified contractor laboratories. Analysis of all 1989 samples is not complete and will continue into 1990

Continue with the following modifications: 1) establish an ultraviolet fluorescence (UVF) screening procedure for 1990 sediment analyses and provide collection and handling procedures to PIs; this will allow prioritization of samples for GC/MS and provide a quick indicator of sediment contamination; 2) review ADEC and NOAA response data and any other available data and incorporate into data base if QA/QC standards are met, establishing separate data base(s) for unprivileged and less reliable data; 3) institute bar coding of samples for more efficient sample tracking; 4) review and approve all analytical QA/QC plans (e.g. for DNA adduct analyses); 5) prepare brief quarterly report showing type and number of samples that have been analyzed, are being analyzed or awaiting analysis, and showing the number of replicates and samples to be archived; and 6) continue training investigators in proper procedures.

* Budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Technical Services						
2	Histopathology	Pending[2]		ADFG	$440,200	($75,000)[2]

COMMENTS

Some samples have been archived and are available for analysis, as needed. The State of Alaska will provide a budget to archive existing histopathological samples and any samples taken in 1990.

Objective:

A) Measure the incidents of histopathological conditions, and external lesions in selected species of birds, mammals, finfish, and shellfish collected in collaboration with relevant biological field investigations.

[2]Pending review and development of recommendation by Management Team regarding future storage of samples; anticipated cost if continued $75,000.

*Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Technical Services						
3	Mapping	X		ADNR/USFWS	$670,000	$798,200

COMMENTS

Continue to QA/QC all maps. Coordinate with resource specific studies.

This project provides geographic mapping of all resource inventory data and related damage statistics and models statistical questions against this database such as, "How may miles of State tidelands were oiled, plot the average animal and plant killl statistics sampled over these lands, and determine an injury amount by projecting these field conclusions over all State tidelands that could not be sampled due to const constraints and the remote nature of the affected coastline miles." Specifically, this project provides the following services:

1) Capture and manage the base resource inventory data needed to conduct damage assessment work, which includes uplands land status (ownership), ecological shoreline classifications, and the degree of oil impact over the extent of the spill. These data are being fully qutomated on the oil spill computer subsystem and integrated to a common coastling model.

2) Upon this common resource inventory base, combine the following damage statistics:
   a) The locations and values of all chemical point samples collected by researchers at both NOAA and ADEC.
   b) The locations and values of ecosystem impacts collected by the Coastal Habitat Study Group headed by USFS and ADF&G.
   c) The locations and values of injury statistics compiled by the Fish/Shellfish, Marine Mammals, and Birds study groups

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Technical Services 3	Mapping					

COMMENTS

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d) The locations of all State land resources to include their usage designations. These data will include locations of shore fishery leases, anadromous stream locations, and lands designated with recreational uses.

3) Provide the study group with maps and statistical reporting that represent unique combinations of the data relevant to thier study conclusions of total damage assessed. For example, the Coastal Habitat Study Group designed a stratified sample using groupings of ecological shoreline classifications and oil impact. As of August 1998, over 250 individual map products have been generated and distributed to this study group.

4) Provide rigorous data repository and archival services to the State and CERCLA litigation teams. Insure documentation of all data standards and procedures, and project audit trails to meet standards of data admissibility.

5) Provide models of selected combinations of collected data that are appropriate to specific damage assessment problems. For example, provide volume estimates of oil moving into selected resource environments relative to State civil fine statutes.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Technical Services 3	Mapping					

COMMENTS

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6) Work cooperatively with ADEC, ADF&G, and the Attorney General's office to provide geographic information computer support. Work cooperatively with the federal agencies coordinated through the CERCLA Trustee Council.

7) Provide map products and statistical reports to upper level decisionmakers for public presentation and congressional/legislative review.

* Budgeted figures, not amount actually spent.

NEW STUDIES

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air *Water* 6	Oil Toxicity	X		NOAA	-0-	$870,000

COMMENTS

I. Introduction

The rationale for this study is simply that there is no existing program that will supply all the needed data on the geographical spread, chemical characteristics and toxicity of oil remaining in Alaskan waters from the Exxon Valdez spill. The proposal presents a coordinated plan for obtaining such information. It will generate data that will be used to assess the geographical extent and degree of damage to the environment from residual oil. The data from this proposed study can be used to counter the argument that weathering and degradation have rendered the remaining oil non-toxic. It is expected that elements of this project will require at least two years of study.

Study Plan

There are four main components to the program; (1) a mass balance or oil budget, (2) assessment of toxicity of environmental samples of oil in a standard bioassay, (3) assessment of the toxicity and chemical characteristics of oil degradation products, (4) assessment of the toxicity of weathered oil in laboratory studies using sensitive early life history stages of marine animals (e.g. larval fish). Some data from existing studies can be used, for example many of the G.C./M.S. analyses of weathered oil in sediments for various studies can be used to support this present study. Nonetheless, a substantial amount of new effort will be required to provide useful information for the case. A preliminary mass balance model is anticipated to be constructed with one year's expenditure, and if necessary can be modified to provide more detail as determined to be necessary. Data from toxicity studies will be analyzed on an ongoing basis to determine the need for continued study.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air / Water 6	Oil Toxicity					

COMMENTS

(-Page 2-)

The mass balance study will estimate the amount of oil in the water, on the beaches and in the air at several times after the spill and continuing past 1991. Some new information will be required but much of the currently available data would be used to provide even rough estimates of where the oil has gone. Based on these preliminary results, it may be desirable to undertake a more comprehensive mass-balance program. That effort needs further refinement and is not budgeted in this proposal.

The assessment of toxicity of oil remaining in the environment will be based on sampling at 15-20 sites, spread over a large geographical area and assessed using a standard toxicity assay, such as microtox. These sites will be sampled every six months and assayed. As deemed appropriate chemical analyses of environmental samples will be done to correlate with the results of the bioassays. Samples from the supratidal, intertidal and subtidal areas of each site will be screened initially with UV fluorescence to eliminate samples inappropriate for further analysis. Emphasis will be placed on testing sand, gravle and cobble samples. In heavily oiled beaches interstitial water samples will be tested. The 15-20 sites will be selected to cover a wide geographic range and deliberately placed at sites most likely to show continuing effects.

The assessment of the toxicity and chemical characteristics of oil degradation products will also be based on environmentally collected samples from heavily oiled beaches. Large volumes of interstitial water and smaller volumes of variously weathered oil residues will be chemically fractionated using standard techniques of column chromatography. A polar fraction will be eluted from the column for each sample.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air / Water						
6	Oil Toxicity					

COMMENTS

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A small number of selected samples will then be subjected to further analyses by mass spectrometry, gas chromatography, liquid chromatography, infrared spectrophotometry and nuclear magnetic resonance spectrometry to determine its composition. Subsamples of these fractions will be tested in simple assays to determine their toxicity. Microtox and fish cell assays are appropriate for toxicity testing on small volume samples of this sort. Based on the results of detailed characterization of these samples of degradation products and their toxicity, the study will either be expanded or curtailed.

The laboratory studies will test the toxicity of weathered oil to sensitive early life history stages of marine organisms. Columns of beach cobble and gravel coated with oil will be flushed with sea water on a periodic basis and the resultant effluent used to expose larval stages of animals. Various lethal and sublethal endpoints will be measured. In addition this will be closely coordinated with the studies of oil degradation products. It is suggested that pink salmon and herring be used as study species to provide cooroborative evidence for initial findings of damage to these species in 1989.

II. Personnel and Organizations

Not all aspects of this study can be carried out by the same organization, but they should be coordinated by one scientist with some experience in hydrocarbon chemistry, toxicology and microbiology. Properly qualified individuals in each case should carry out the research. Most of the chemical analysis can be done under the current technical

* Reduced budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air *Water* 6	Oil Toxicity					

COMMENTS

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services components of the NRDA studies. The bioassay of environmental samples would probably be best done by a commercial laboratory experienced in running the microtox assay. The assessment of oil degradation products could be let as a contract to a university research laboratory. The laboratory exposures of eggs and larvae could be done by an existing laboratory, e.g. Auke Bay laboratory. Scientific coordination should be done by a designated scientist in consultation with a small working group of peer review scientists.

III. Budget

Estimated costs.

Mass Balance	100K
Bioassays of environmental samples	250K
Degradation products	120K
Laboratory toxic experiments	250K
Logistics	150K
TOTAL COST	870K

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Fish Shellfish 27	Sockeye Salmon Overescapement	Pending[2]		ADFG	-0-	($589,300)[2]

COMMENTS

In 1989, excessive over-escapement of sockeye salmon occured in upper Cook Inlet (Kenai River), Chignik, and in Kodiak associated with extensive fishery closures due to oil from the Exxon Valdez Spill. As a result, the number of sockeye salmon entering four important sockeye producing lake systems exceeded levels that are thought to produce maximum sustained yield.

These sockeye systems are thought to be rearing limited where very large spawning escapements produce more fry than can be supported by the lake's productivity. When the fry abundance greately exceeds the lake's carrying capacity, prey resources are cropped to the extent that very reduced growth, increased freshwater mortality, poor qualiyt smolts, increased carryover percentage, and increased marine mortality occur.

This project will examine the effects of large 1989 spawning escapements on the resulting progeny for a selected subset of the above mentioned sockeye producing lake systems. This project will yield information on the loss of future sockeye salmon products from this large 1989 overescapement.

For each of the 4 lake systems identified, the following will be conducted:

1. A hydroacoustic/townet survey will be conducted during the summer (late June) and fall (September) of 1991 and 1992, to estimate abundance, size, and age composition of the juvenile sockeye population.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 27	Sockeye Salmon Overescapement					

COMMENTS

(-Page 2-)

2. Fyke net or inclined plane trap sampling will be conducted during 1991 and 1992 to estimate age and size composition of the outmigrating smolt population.

3. For Kenai/Skilak lake, the abundance of the 1991 and 1992 outmigrating smolt population will be estimated with a mark/recapture study using inclined plane traps.

[2]Council to make recommendation following review of detailed study plan; anticipated cost if continued - $572,000.

*[illegible] budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 28	Run Reconstruction		Pending[2]	ADFG	-0-	($50,000)[2]

COMMENTS

It is expected that a number of the Fish Projects being conducted on salmon in Prince William Sound, Cook Inlet and Kodiak will demonstrate the causes of damage due to the Exxon Valdez oil spill. The ability to quantify the amount of damage may rest heavily upon an assessment of the returning adults. Using the tools developed under Fish 30 Database Management and Fish 28 Ecological/Life History Modelling and the recaptures from the coded wire tag experiments, various combinations of catch and escapement can be calculated that will be used to estimate the total return (catch plus escapement). The differences in total returns of adult salmon to different areas of Prince William Sound and at different times of the season will be analyzed to measure the amounts of damage to salmon runs that were subject to different amounts of oil on the spawning grounds and while migrating to sea in the spring of 1989. Run reconstruction can also be used to determine if run timing is normal in the returning year.

[2]Council to make recommendation following review of detailed study plan; anticipated cost if continued - $50,000.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 29	Ecological and life History Model	Pending[2]		ADFG	-0-	($50,000)[2]

COMMENTS

In order to demonstrate the potential for long term harm to the salmon populations from the effects of oiling, it is necessary to sum up the impacts of a number of factors at a number of life history stages such as reduced growth of fry, mortality of eggs and fry, loss of spawning habitat, and overescapement. Such measures are being generated in the NRDA Fish/Shellfish studies 1-10. The magnitude of the overall loss in productivity for a salmon stock can best be understood by looking at survival at each life history state, (egg, fry, smolt, subadult, adult) over the life span of all fish of the same age, and over all age groups in the population. Such a bookkeeping program is necessary to take advantage of the NRDA data being already collected, and to integrate existing historical data into documenting the actual and potential damages due to oiling. The stocks and areas covered by this computer-based mathematical model are those included in the portions of Fish/Shellfish studies 1-10 as approved by the trustees for funding in 1990, plus any stocks which were observed to have suffered overescapement in 1989 as a result of the presence of oil. The work can start immediately using data from NRDA 1989 and from existing historical sources. The model is termed ecological, because interactions of salmon with other biological and physical components of the environment could be added as they are defined in other studes.

[2]Council to make recommendation following review of detailed study plan; anticipated cost if continued - $50,000.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 30	Salmon Database Management	Pending[2]		ADFG	-0-	($120,000)[2]

COMMENTS

Large quantities of data are being analyzed in order to demonstrate the fact and extent of injury to natural resources due to oiling. The purpose of this study is to make original data readily available to agency and non-agency personnel so that data analysis can be conducted, and so that all analysis can be accomplished faster and at less cost than is presently possible. The data to be placed under the database management system (DBMS) will be drawn from two categories; 1) historical data necessary to the interpretation and implementation of the results of NRDA studies, and 2) data resulting from NRDA studies. It is envisioned that the DBMS will be useable by any authorized person with access to a standard personal computer (IBM compatible, MS-DOS, 640K RAM, 20M hard disk) to readily and quickly structure data for CRT viewing, printing, and use by statistical, spreadsheet, and other analytic software. Structuring data required that original data in electronic form be retrieved and ordered according to user specified criteria of time, space, and selection of variables. Since readily available statistical software packages permit extensive compuational manipulation of data, it is not envisioned that the DBMS will possess extensive computational options. Rather it is proposed that the DBMS be constructed to meet the following criteria in order of priority; 1) completeness of contents, 2) speed of retrieval, and 3) ease of use in assembling primary data into data into data sets for further analysis by other software. Furthermore, the DBMS will take advantage of existing DBMS applications currently available in the Alaska Department of Fish and Game.

In addition to NRDA project data, examples of historic data include commercial catch and effort data for the species and areas targeted in the Fish/Shellfish studies 1-10, all relevant biological data on age, size at age, growth at age, stock identification, spawning escapements, and fry fingerling and smolt production.

* Reduced budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 30	Salmon Database Management					

COMMENTS

(-Page 2-)

Strategically it is logical that this study be broken into substudies by major species assemblages such as salmon and shellfish.

[2]Council to make recommendation following review of detailed study plan; anticipated cost if continued - $120,000.

* Reduce budgeted figures, not amount actually spent.

RESTORATION

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1	X		ADFG/EPA	$500,000	$1,700,000

COMMENTS

I. Introduction

The ultimate purpose of this project, Restoration Planning 1, is to identify actions that may be taken to restore the ecological health of the areas affected by the **Exxon Valdez** oil spill.

Although the 1989 Damage Assessment Plan had a budget of $500,000 for Restoration Planning, activities were not initiated until late in the year; no substantial funds were expended. The Project, however, is expected to continue in 1991 and beyond, as needed. At any time during this process, the Trustees may implement restoration measures demonstrated to be ecologically sound and cost effective, subject to the availability of funding.

II. Study Plan

As described Below, six major tasks will be carried out in 1990: (1) conduct a Public Restoration Symposium; (2) conduct local Public Scoping Meetings; (3) conduct a series of Technical Expert Workshops; (4) conduct a comprehensive Literature Collection/Review; (5) develop and conduct Feasibility Studies; and (6) prepare draft Restoration Methodology/Planning Process report.

* Indicate budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1					

COMMENTS

Restoration Symposium: A two-day public symposium will be held in Anchorage, March 26-27, 1990 to begin the scoping process. This meeting will disseminate information about the restoration planning process and invite public comments about restoration needs and opportunities. Alaska Natives, environmental groups, the fishing industry, and other interested constituencies will be invited to participate. Scientists and others who have experience with restoration of natural resources are being invited to make presentations. The meeting will be recorded, and a summary of comments and ideas presented at the symposium will be prepared for inclusion in the Restoration Methodology/Planning Process. Budget: $50,000.

Public Scoping Meetings: A series of six public meetings will be held in major communities directly affected by the spill: Cordova, Valdez, Whittier, Seward, Homer, and Kodiak. Persons directly affected by the spill will have the chance to express their opinions about restoration needs, methods, and priorities. The meetings will be recorded, and summarized for inclusion in the Restoration Methodology/Planning Process. Budget: $40,000.

Technical Expert Workshops: A series of closed meetings will be held to exchange ideas among damage assessment principal investigators, peer reviewers, and key scientists. The purpose of the workshops is to identify and evaluate the

* Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1					

COMMENTS

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feasibility and effectiveness of restoration projects, including those suggested by the Public. Because it will be necessary to discuss confidential Damage Assessment information, the workshops will be closed to the public. Budget: $200,000.

Literature Collection/Review: Drawing on existing bibliographies and new information, published and unpublished literature on the restoration of damaged natural resources will be collected and reviewed. Results of the literature review will serve as background for the Technical Expert Workshops and the entire restoration planning process. The results will be summarized in the Restoration Methodology/Planning Process. Budget: $90,000.

Feasibility Studies: Tasks 1-4 will identify a variety of restoration options. To determine whether or not some of these projects are technically feasible and cost effective, a series of carefully targeted studies may be necessary. These studies may include evaluations of both field restoration techniques and potential opportunities for replacement or acquisition of equivalent-value resources. In 1990 only limited feasibility studies will be undertaken, but in 1991 there will be increased emphasis on such studies. Budget: $500,000.

* Authority budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1					

COMMENTS

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Development of draft Restoration Methodology/Planning Process: Results from tasks 1-5, as well as well as other Damage Assessment studies, will be used in the development of the draft Restoration Methodology/Planning Process. An initial report will be completed by July 1, 1990, and distributed to the public; a second report will be completed prior to February 28, 1991. Each report will include a matrix of species, habitats, and other ecosystem components potentially affected by the oil spill, and corresponding restoration options to the extent that such options have been identified at that time. Each report will also summarize results of the scoping tasks (i.e. tasks 1-5 above). These summaries will also be published and distributed as separate documents. Plans for any Feasibility Studies to be conducted in 1990, will be presented in the first report. Reports that directly involve confidential Damage Assessment data will not be distributed to the public. Budget: $150,000.

III. Personnel and Organizations

The Restoration Planning Project is directed by the Trustee Council through the Restoration Planning Work Group, consisting of representatives from the Environmental Protection Agency, the Department of the Interior, the National Oceanic and Atmospheric Administration, the U.S. Forest Service, The U.S. Fish and Wildlife Service, and the Alaska Departments of Fish and Game, Natural Resources, and Environmental Conservation. Contract support will be necessary for conducting the symposium, public scoping meetings, literature review, feasibility studies, and report preparation.

* Outside budgeted figures, not amount currently spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1					

COMMENTS

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IV. Budget

*Estimated costs:

Symposium:	$50,000
Scoping Meetings:	$40,000
Technical Workshops:	$200,000
Literature Collection/Review:	$90,000
Feasibility Studies:	$500,000
Restoration Methodology/Restoration Plan Development:	$150,000
Salaries:	$600,000
Travel:	$70,000
TOTAL:	$1,700,000

* Overhead costs of 20% not included.

ARCHAEOLOGY

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Archeology 1	Archeological Impacted Sites	X		USFWS	$200,000	$1,000,000

COMMENTS

There may be as many as 10,000 archeological or historical (cultural) resource sites in the area impacted by the oil spill. Cultural resources are considered to have high value from a research, education, and intrinsic perspective. The objective of this study is to determine what significant cultural resource sites have been impacted by the spill and determine the type and extent of injury to the sites. Impacted sites are to be inventoried and classified according to site type, degree of oiling, significance, etc. based on available information from response effort records and other available sources, with any significant gaps in data filled in by field survey as necessary. Injury to sites is to be assessed by detailed field investigation and lab testing of a representative sample of sites in oiled and nonoiled areas for such effects as physical and chemical changes in the soil column relevant to radiocarbon age determinations, erosional changes, and vandalism. Assessment results are intended to provide information useful to establishing recovery potential, restoration methods, feasibility, and cost, and valuation of the extent of injury to sites.

* Revised budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Archeology 1	Archeological Impacted Sites					

COMMENTS

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* This study was included among the economic uses group of studies for 1989. For 1990, the inventory and injury assessment portions of the study, described above, have been segmented from this group, like other injury assessment studies that do not include economic valuation as a component , for more efficient performance of the study. The economic valuation portion of cultural resource damage assessment remains included in the economic uses group of studies.

** No work beyond preparation of a study plan and preliminary review of existing information regarding sites has been accomplished thus far, so little of the 1989 budgeted amount has been expended.

* Reflects budgeted figures, not amount actually spent.

ECONOMICS

(Pending)

COST SUMMARY

COST SUMMARY
EXXON VALDEZ NRDA STUDY RECOMMENDATIONS

CONTINUING STUDIES

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Birds					
1	Water Birds/Beached Birds	X		$ 258,000	$ 625,000
2	Census & Seasonal Distribution	X		$ 565,000	$ 470,000
3	Seabird Colony Surveys	X		$ 440,000	$ 250,000
4	Bald Eagles	X		$ 445,000	$ 500,000
5	Peregrine falcons	Pending		$ 43,000	$(200,000)[2]
6	Marbled Murrelets		X	$ 115,700	-0-
7	Storm Petrels		X	$ 135,000	-0-
8	Black-Legged Kittiwakes		X	$ 190,000	-0-
9	Pigeon Guillemots		X	$ 109,500	-0-
10	Glaucous-Winged Gulls		X	$ 73,000	-0-
11	Sea Ducks	X		$ 146,000	$ 100,000
12	Shorebirds		X	$ 166,000	-0-
13	Passerines	X		$ 59,000	$ 10,000
14	Migratory Birds		X	$ 10,000	-0-
Marine Mammals					
1	Humpback Whale	Pending		$ 226,000	($90,000)[2]

[1]Spill year is March 1 - February 28

[2]Cost of Study, if continued

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Marine Mammals					
2	Killer Whale	X		$ 200,000	$ 255,000
3	Cetacean Necropsy		X	$ 73,000	-0-
4	Sea Lion	X		$ 270,000	$ 161,000
5	Harbor Seal	X		$ 245,000	$ 135,000
6	Sea Otter Impacts	X		$ 763,000	$1,056,000
7	Sea Otter Rehabilitation	X		$ 108,000	$ 130,000
Terrestrial Mammals					
1	Sitka Black-Tail Deer	X		$ 87,000	$ 17,300[3]
2	Black Bear	X		$ 139,700	$ 10,
3	River Otter		Pending	$ 287,700	($300,000)[2]
4	Brown Bear	X		$ 162,700	$ 115,100
5	Carnivores/Small Mammals	X		$ 302,400	-0-
6	Mink Reproduction		Pending	$ 192,200	($139,000)[2]
Fish/Shellfish					
1	Salmon Spawning Area Injury	X		$ 144,800	$ 391,300
2	Salmon Eggs & Preemergent Fry	X		$ 149,100	$ 302,800
3	Salmon Coded Wire Tagging	X		$1,943,400	$1,943,400

[1]Spill year is March 1 - February 28

[2]Cost of study, if continued

[3]If the Trustee Council determines that further study is warrante after completion of the winter survey, the total 1990 budget will be $126,600

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Fish/Shellfish					
4	Early Marine Salmon Injury	X		$ 829,200	$ 630,000
5	Dolly Varden/Cutthroat Injury	X		$ 437,400	$ 290,000
6	Sport Fisher Harvest & Effort		X	$ 175,900	-0-
7	Salmon Spawning Area, Outside PWS	X		$ 320,300	$ 539,400
8	Egg & Preemergent Fry, Outside PWS	X		$ 111,400	$ 293,300
9	Early Marine Salmon, Outside PWS		X	$ 348,500	-0-
10	Dolly Varden/Sockey, Lower Kenai		X	$ 152,600	-0-
11	Herring Injury	X		$ 374,500	$ 400,000
12	Herring, Outside PWS		X	$ 60,000	-0-
13	Clam Injury	X		$ 86,200	$ 175,000
14	Crab Injury		X	$ 142,000	-0-
15	Shrimp Injury	X		$ 60,500	$ 65,000
16	Oyster Injury		X	$ 30,500	-0-
17	Rockfish Injury	X		$ 45,600	$ 73,000
18	Trawl Assessment	X		$ 738,800	$ 186,000
19	Larval Fish Injury		X	$ 413,400	$ 5,000
20	Underwater Observations		X	$ 550,100	-0-

[1]Spill year is March 1 - February 28

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Fish/Shellfish					
21	Clams, Outside PWS		X	$ 108,800	-0-
22	Crabs, Outside PWS		X	$ 111,500	$ 110,000
23	Rockfish, Halibut, Lingcod-Lower Kenai	X		$ 108,400	-0-
24	Trawl Assessment, Outside PWS	X		$2,495,800	$ 450,000
25	Scallop Resources Injury	X		$ 53,800	-0-
26	Sea Urchin Injury		X	$ 45,000	-0-
Coastal Habitat					
1	Comprehensive Assessment	X		$5,436,000	$6,300
Air/Water					
1	Geog. Extent/Temporal Persistence		X	$ 343,500	-0-
2	Injury to Subtidal Resources	X		$ 883,000	$ 800,000
3	Geog. & Temp. Dist. in Water Column	X		$ 595,500	$ 564,500
4	Injury to Deep Water		X	$ 378,900	-0-
5	Injury to Air		X	$ 106,500	-0-

[1]Spill year is March 1 - February 28

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Technical Services					
1	Hydrocarbon Analysis	X		$2,300,000	$2,000,000
2	Histopathology		X	$ 440,200	($75,000)[2]
3	Mapping	X		$ 670,000	$ 798,200
Restoration					
1	Restoration Planning	X		$ 500,000	$1,700,000
Archaeology					
1	Archaeological Survey	X			$1,000,000
Economics					
1	Economic Studies	Pending		$2,800,000	Pending
			Subtotal for Continuing Studies:		$22,851,300
			Subtotal for Pending studies (except economics):		$ 724,000

[1]Spill year is March 1 - February 28

[2]Cost of study, if continued

NEW STUDIES

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Air/Water					
6	Oil Toxicity Study	X		-0-	$ 870,000
Fish/Shellfish					
27	Sockeye Salmon Over-escapement		Pending	-0-	($572,000)[2]
28	Run Reconstruction		Pending	-0-	($50,000)[2]
29	Ecological and Life History Model		Pending	-0-	($50,000)[2]
30	Salmon Database Management		Pending	-0-	($120,000)[2]
				Subtotal for New Studies:	$ 870,
			Pending	Subtotal for New Studies:	$ 792,000

TOTAL COST

Pending Studies		Continuing Studies	
Subtotal (except economics):	$ 1,516,000	Subtotal for New and Continuing studies:	$23,721,300
Overhead (20%): (except economics):	$ 303,200	Overhead (20%):	$4,744,260
		Budget for summarizing data and writing reports on studies recommended to be discontinued:	$140,000
TOTAL COST:	$ 1,819,200	**TOTAL COST:**	$28,605,560

[1]Spill year is March 1 - February 28

[2]Cost of study, if continued

(3)

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TRUSTEE COUNCIL RECOMMENDATIONS TO THE TRUSTEES

Review of 1989 Natural Resource Damage Assessment for the Exxon Valdez Oil Spill and Proposals for 1990 Studies

February 26, 1990

TABLE OF CONTENTS

INTRODUCTION

Trustee Council Recommendations to the Trustees
Review of 1989 Natural Resource Damage Assessment for the Exxon Valdez Oil Spill and Proposals for 1990 Studies

Introduction

This report contains the recommendations of the Trustee Council regarding the Natural Resource Damage Assessment ("NRDA") Plan and Restoration Strategy for the Exxon Valdez Oil Spill ("EVOS"). It briefly reviews (1) studies conducted in the 1989 field season and (2) proposals for 1990 field studies (Note: Further description of the 1989 studies can be found in the 1989 plan and the detailed study plans completed last year. Detailed study plans for the 1990 studies will be completed by the end of March).

The Trustee Council analyzed each study in the 1989 study plan ("yellow book") from three perspectives. First, whether it allowed an estimation of population impacts resulting from the EVOS. Second, whether it showed evidence of "sublethal" impacts from the spill. Third, whether it showed injury to non-biological resources (e.g., air, land, and water). Our method of analyzing these three impacts is discussed in Section II. Section III contains our combined recommendations regarding the 1989 studies and the proposals for new studies. Section IV contains a summary description of the Restoration Planning activities for 1990. Section V contains a proposal to evaluate archeological and cultural injuries for the EVOS. Section VI, proposed Economic studies, has been reserved for further development. Section VII contains a summary of costs for all proposed studies.

This report was prepared with the full participation and cooperation of legal and management representatives of all Federal and State agencies involved in the NRDA process. Our review was conducted over a 2 1/2 month period. During this time, meetings were held with experts retained by the State and Federal Governments ("Peer Reviewers") and Principal Investigators from the agencies conducting the studies. Except as noted below, all of the recommendations contained in this report represent the consensus of the Trustee Council. The following points must be emphasized:

1. Because the timeline for the review process did not allow the Management or Legal Team or the Peer Reviewers to examine detailed study plans for 1990 studies, further analysis of the costs of the 1990 studies is appropriate. We anticipate conducting this

review following submission of detailed 1990 study plans.

2. Some studies that were judged not to be valuable for the NRDA process may be valuable for other purposes, such as restoration planning. Our recommendations are based solely on the usefulness of the various studies for natural resource damage assessment.

3. The Council either did not reach consensus or there was insufficient information to make a recommendation on the following studies:

   Birds 5: Peregrine Falcons
   Marine Mammals 1: Humpback Whale
   Terrestrial Mammals 3: River Otter
   Terrestrial Mammals 6: Mink Reproduction
   Fish/Shellfish 27: Sockeys Salmon Overescapement
   Fish/Shellfish 28: Run Reconstruction
   Fish/Shellfish 29: Ecological & Life History Model
   Fish/Shellfish 30: Salmon Database Management
   Technical Services 2: Histopathology

4. For studies proposed to be discontinued, we recommend a budget of $140,000 be included to summarize the data and write final Study Reports.

5. The budget estimates contained in Section III do not include overhead for administrative expenses. We recommend that 20% overhead be budgeted. This recommendation is included as a separate line item in the summary table in Section VII of the report.

6. Public comments on the State/Federal Natural Resource Damage Assessment Plan and Restoration Strategy were considered in preparing these recommendations.

METHODOLOGY FOR ASSESSING NATURAL RESOURCE DAMAGES

II. Methodology for Assessing Natural Resource Damages

A. Population Impact Assessment

One of the primary impacts of the oil spill was the short and long term injury to populations occupying the affected area. These injuries stem from (1) the immediate death of animals due to oil exposure; and (2) a change in vital rates such as post-spill reproductive or survival rates which cause a population depression. The depression may be temporary, followed by subsequent recovery, or it may be permanent, depending upon ecosystem dynamics.

The next section describes theoretical models of population perturbations which underlie our population dynamics analysis. Section 2 sets forth four methodologies which may be used to estimate total population loss. In Section 3, the applicability of these four methodologies to the EVOS is discussed.

1. Population Response to Perturbation[1]

One of the simplest perturbation models of an oil spill impact is an immediate kill followed by gradual recovery of the population to the level it would have achieved absent the spill. This is shown in Figure 1. The natural resource injury suffered consists of (1) animals initially killed plus (2) the loss of population during the recovery period. The "hatched" area in the figure represents the losses during recovery. The population recovery may be delayed if there is a continued post-spill impact on the population due to reduced reproduction, growth, or survival, or due to additional mortality. In that case the recovery would take longer than recovery from an initial kill, as shown in Figure 2.

If the perturbation resulted in permanent loss of habitat, change in the community composition, or permanent changes in survival rates, a population may never recover to its pre-spill abundance. Under this scenario, depicted in Figure 3, the legal damages for the injury would include the cost of artificial restoration, replacement, or the acquisition of equivalent resources.

It is possible that a population may experience an initial decline from immediate exposure and then recover to a level above the pre-spill population, due to decreased competition after the

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[1] The models presented below are simplified and are offered for conceptual purposes only. Population response in nature is generally much more complicated due to the influence of a variety of factors not discussed here.

FIGURE 1

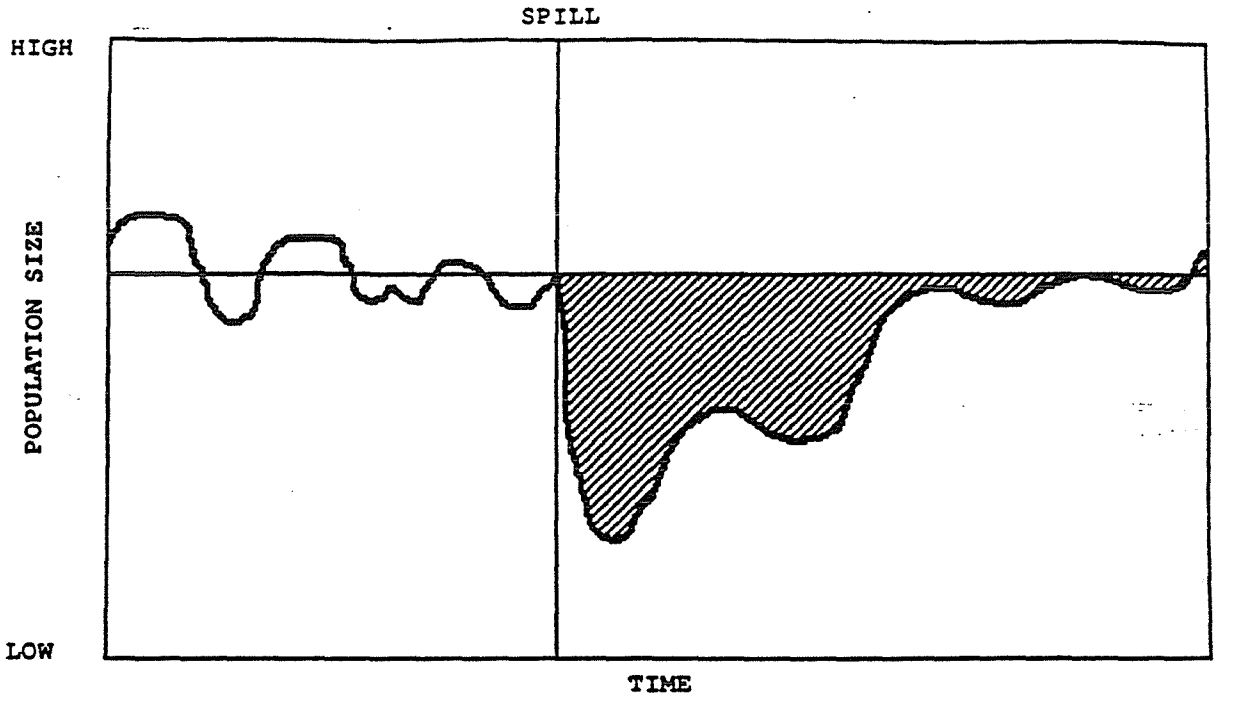


FIGURE 2

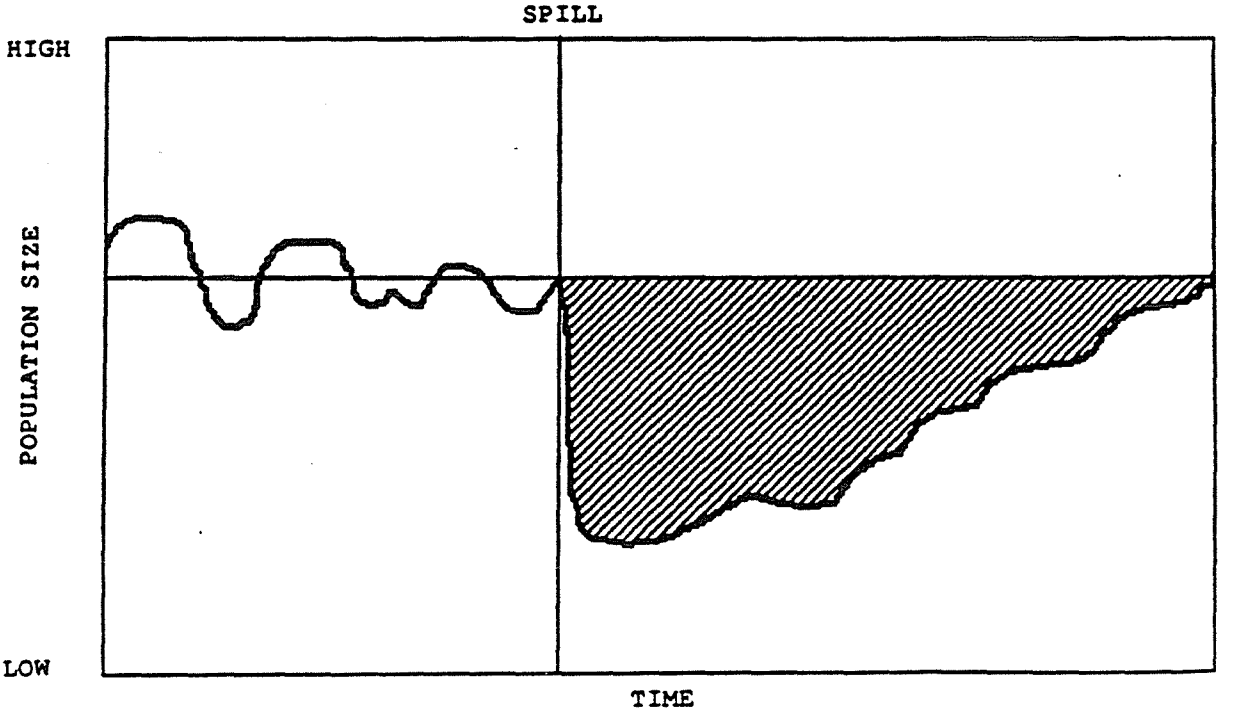


FIGURE 3

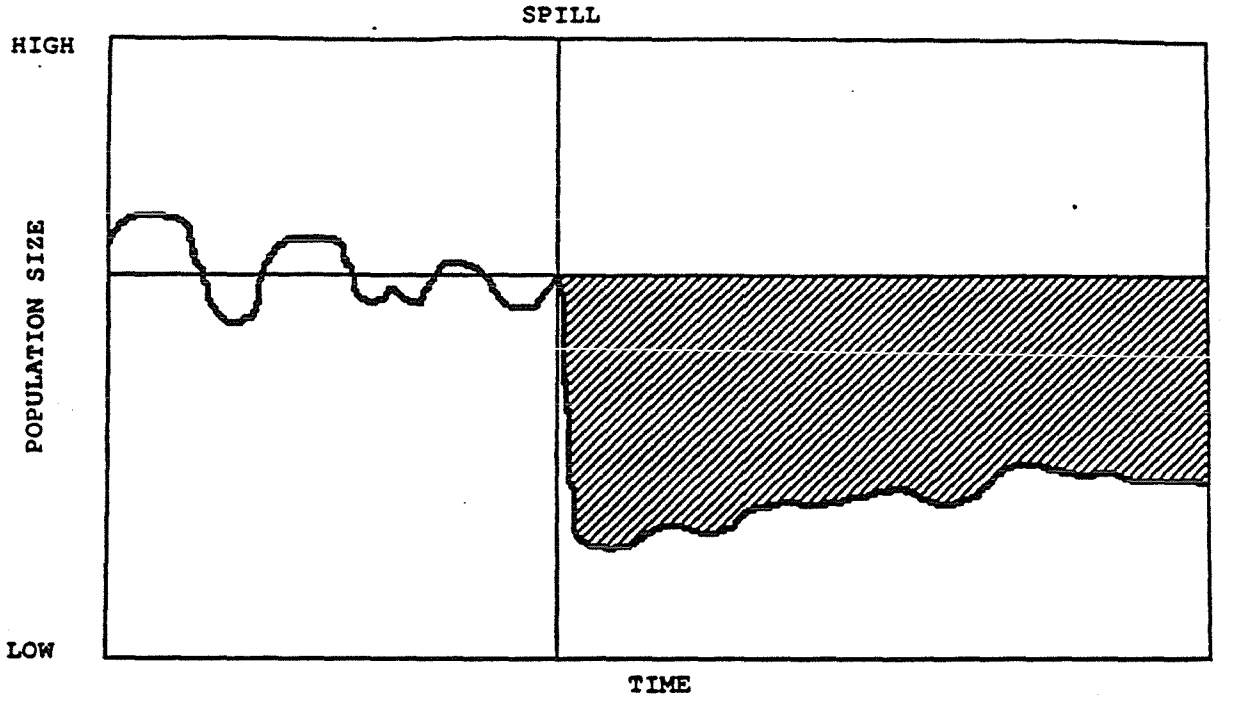
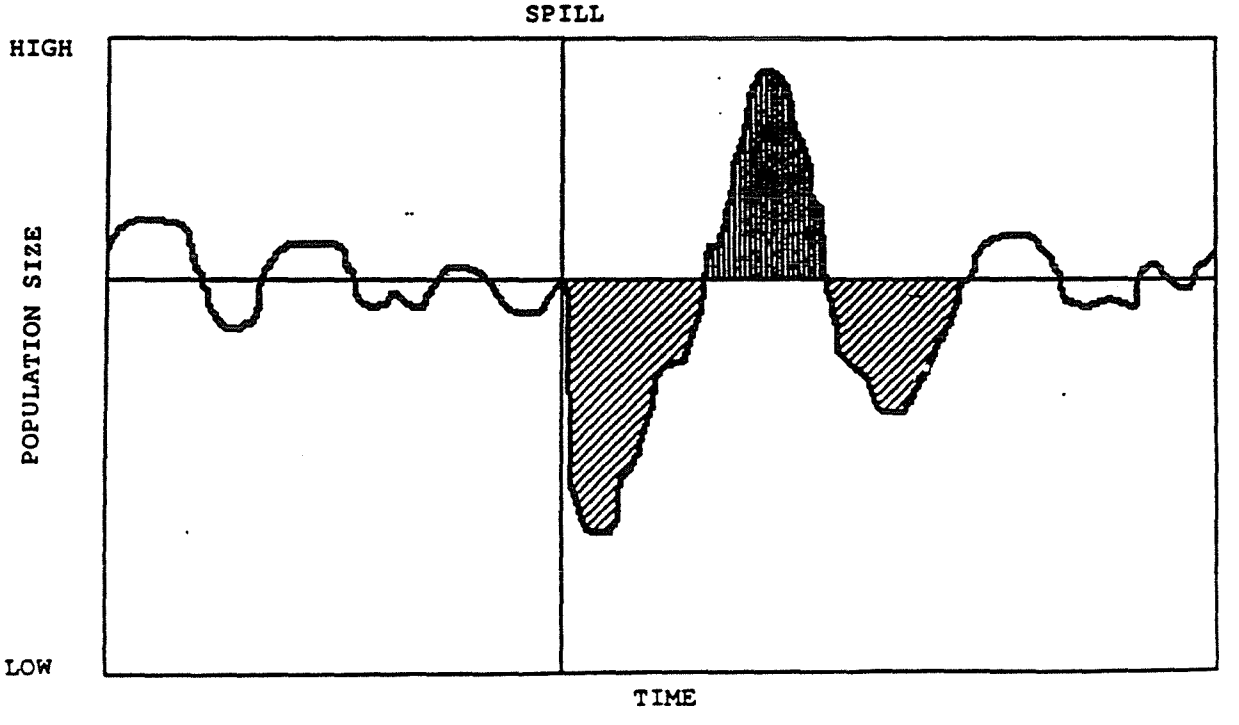


FIGURE 4



spill, a change in other pre-spill mortality factors such as commercial harvest rates, or some other permanent alteration of the ecosystem. Such a population "surge" may be followed by a significant decline prior to recovering to pre-spill levels. See Figure 4. Under this scenario, the injury would be the difference between the total population loss (represented by the diagonal lines) and the population surge (represented by the vertical lines).

2. Methodologies for Assessing Population Impacts

There are four general methodologies for assessing population impacts from an oil spill. The applicability of each methodology to a particular species will depend on whether the information needs of the methodology are available. The methodologies are:

a. Direct Mortality: Body Count and Enhancement

This methodology consists of determining the number of animals initially killed by the spill or the "immediate" impact. This is done by conducting an inventory of recovered carcasses, estimating what percentage of that number was killed by oil exposure, and estimating what percentage of the total population killed by oil was not recovered.

i. Recovered bodies

For some species, particularly birds and mammals, large numbers of dead animals have been recovered. A certain portion of those animals may have died of natural causes, while others probably died of exposure to oil. For each species, it will be desireable to determine what percentage of the recovered bodies were killed by oil.

ii. Estimated Total Immediate Deaths

The number of carcasses recovered after a spill usually represents only a fraction of the direct mortality. The proportion of total kill recovered may vary widely depending on the species, search effort, oil on the beach, scavenging, burying of carcasses, wind and current patterns, wave action, and other factors. When possible, an estimate should be made of what proportion of the total number of killed individuals were actually recovered. This may require establishing an experimental program to assess the wash-up rate of marked dead individuals, or simulating drift and recovery rates by some other method.

b. Temporal Comparisons of Population Sizes Before and After the Spill

When historical population data are available, comparison of pre- and post-spill numbers may be made to assess the change in population. Essentially, the pre-spill information can be used to forecast what the population would have been absent the spill. This may then be compared with the actual population as tracked after the spill. The statistical power of such a comparison will depend upon the reliability of the pre- and post-spill census methods, the natural variability of the population, the magnitude of change induced by the spill, and the total amount of data available for comparison.

c. Post-Spill Spatial Comparison of Population Size in Oiled and Unoiled Sites

When populations can be surveyed in otherwise comparable oiled and unoiled sites, it may be possible to assess the impact of the spill even when pre- and post-spill data are not available. Again, the power of this method will depend on the reliability of the census method, the natural variability from site to site, and the magnitude of the change induced by the spill.

Combining the temporal and spatial comparisons can provide the most powerful evidence of an impact, if such data are available. Such a "before and after" contrast of populations at oiled and unoiled sites controls for both spatial and temporal differences which are unrelated to the oiling. For example, it may be that the population of murres at an island which was heavily oiled has historically been approximately 15% lower than the population at one of the unoiled control sites. A post-spill comparison which indicates that the oiled site population is 30% lower than the unoiled, therefore, suggests that the spill caused a 15% population decline.

d. Measurement of Changes in Vital Rates and Prediction of Recovery Trajectory

Where populations have been sufficiently depressed or vital rates sufficiently impacted, it may take an extended period of time for the population to recover to the level it would have reached absent the spill. It may be necessary, therefore, to predict the recovery time using some type of model. In species where it is difficult to measure abundance, but vital rates can be measured, population dynamics models may provide the most useful tool for assessment of impacts. The standard models of population dynamics include:

i. the logistic growth model (Schaefer model) and its variations;

ii. the Leslie model of survival and fecundity; and

iii. the Beverton-Holt age structured models, with assumptions about recruitment and density dependent stages.

Where the relevant vital rates can be measured, they may be used in these population dynamics models to predict the future trajectory of the population.

3. Applicability of Population Dynamics Methodologies to Individual Species or Categories of Species

An analysis of population impacts for each species under consideration may include one or more of the four approaches described above. For some species counting dead bodies may not be possible, but it might be quite feasible to measure a change in survival rates. For other species, the data available may be sufficient to apply all four methodologies. Set forth below is a brief analysis of how relevant each methodology is for assessing population impacts on the species. Additional discussion of the appropriateness of these methodologies is contained in the specific comments for each study (Part III of the Report).

a. Finfish

Very few fish carcasses have been collected in connection with the EVOS. The only form of direct mortality that may be relevant to finfish is a change in egg or fry survival resulting from the spill. In the case of pink salmon, sockeye salmon, and herring, sufficient historical data are available to permit pre- and post-spill comparisons of population size. Post-spill spatial comparisons of oiled and unoiled sites are also possible for pink salmon, sockeye salmon, herring, Dolly Varden char, and cutthroat trout. Spatial comparisons for sockeye salmon and herring, however, would require several years of study given that it takes them 4-5 and 5 years respectively to be reared, migrate to sea, and then return to spawn.

A number of vital rates can be measured for pink salmon, including eggs produced per female, spawning success and egg retention, egg survival, fry to adult survival, fry to adult growth rates, and growth in the first few weeks of marine life. Differential rates between oiled and unoiled streams can be used in a life history model to estimate damage due to oiling. Similar comparisons can be made for sockeye salmon and herring.

1. Shellfish

Few if any shellfish carcasses were collected following the EVOS. Direct mortality estimates, therefore, are not available. In addition, pre-Spill data is not available for most of the shellfish studied.

Spatial comparisons between oiled and unoiled sites is possible and was undertaken for the brown king crab. Many of the shellfish populations, however, demonstrate a high degree of natural spatial variability, making it difficult to demonstrate impacts through oiled/unoiled comparisons.

Population impacts on clams and scallops could theoretically be assessed by analyzing changes in growth rates, as the shells for these species conveniently document seasonal growth patterns. The populations of dungeness crabs and sea urchins in affected areas were too small, however, for any spill impact to be detected by any of the population dynamics methodologies.

C. Marine Mammals

Of the marine mammals studied, only sea otter carcasses were found in any significant numbers. The carcasses collected can be analyzed to determine the general age structure of the population immediately impacted by the spill and the reproductive status of the females killed. It may be possible to use this information in turn to assess population recovery periods through the application of age structure models. The strength of any model prediction will depend, however, on whether we are able to adequately assess post-spill growth rates.

In general, for the other marine mammals studied, pre- and post-spill as well as spatial comparisons between oiled and unoiled sites represent the most feasible techniques for assessing population impacts.

d. Birds

All four methodologies are potentially relevant to a population dynamics damage assessment for birds. Heavily oiled birds came ashore in large numbers during the first months following the spill, and carcasses continued to wash up on beaches for much of the year thereafter. It will be desireable to sample some of the bodies recovered to determine what percentage actually died from exposure to oil. Typically, the number of bird carcasses recovered after a spill represents only from 5 to 60% of the direct mortality. Field studies and computer modelling designed to determine the rate of carcass loss can be used to arrive at an estimate of total immediate kill.

A comparison of pre- and post-spill population sizes requires a baseline set of data taken before the spill, and a replicate set of data collected after the spill. Colony and at-sea populations for seabirds are highly variable, however, and the historical data are, for the most part, insufficiently precise to be able to demonstrate limited die-offs for most seabird species. Generally, population changes less than 20% will be undetectable, and for some species it will be difficult to detect changes of less than 50% or more. In cases where a difference can be demonstrated, comparisons of populations in oiled and unoiled sites may be highly useful for inferring an oil spill impact.

Demonstrating long-term projections of population changes would require developing population models for the major species affected by the spill. Two basic kinds of data are required for such a model: survivorship rates and fecundity measured in terms of nesting, hatching, and fledgling success. Historical data on fecundity are available for some of the species involved, but survivorship data are generally lacking for birds in Prince William Sound and Alaska in general.

e. Terrestrial Mammals

Very few terrestrial mammal carcasses were found last field season which could be linked to the spill. Many of the animals studied spend more time in upland areas than on beaches and, therefore, their carcasses would be hard to locate even if many died of oil exposure. In addition, pre-spill data are lacking for all species studied. The most feasible methodologies for analyzing population impacts on terrestrial mammals, therefore, are spatial comparisons at oiled and unoiled sites and projecting population changes based on a change in vital rates.

Post-spill spatial comparisons between oiled and unoiled sites can be done through direct observation, by studying fecal droppings, and by tracking mammals fitted with radio transmitters. Data on mortality rates and productivity also can be collected through radio tracking and used in projecting population changes. It may not be feasible, however, to instrument enough animals in oiled and unoiled areas to provide statistically valid comparisons. The reasonableness of pursuing either of these methodologies will depend on the size of the populations at issue and the economic value which may be assigned to a population loss.

B. Methodologies for Assessing Sublethal Effects.

The preceding section described methodologies for quantifying the lethal effects of the EVOS. "Sublethal" impacts are effects at the organism, community, and ecosystem level that do not result in acute mortality of organisms.

1. Assessing Injury At The Organism, Community, And Ecosystem Level

Injury to the natural environment can be identified at organism and community levels and can be inferred to apply at the ecosystem level under certain assumptions. The potential exists for identifying and quantifying injury through direct observations and measurements or by inference from field and laboratory data or scientific literature. It is possible to translate injury at the organism level to injury at the community level in two ways: (1) when injury at the organism level is determined to be pervasive and the role of the organism is known to be prominent in strong ecological interactions (e.g., plant-herbivore, predator-prey, competitors); and (2) by manipulation of certain components or elements of the community to test the response to disruption of these ecological interactions. Extrapolation to the ecosystem level requires reliable knowledge of the extent, concentration, and form of the insult, the organisms' response, and the distribution of the community in the system.

2. Complementary Assessment Strategies.

The sublethal effect of the EVOS can be analyzed using four complementary strategies:

(1) statistically precise, unambiguous descriptive studies;
(2) field experiments;
(3) dose-response evidence based on field and laboratory measurements that relate injury to doses of petroleum and its derivatives; and,
(4) use of risk assessment methods to project injury based upon empirical relationships developed under the first three strategies, and on the use of scientific literature.

These strategies can be used to develop a cause-and-effect chain of evidence to demonstrate damages from oil contamination. Each of these strategies should, if possible, be focused primarily upon elements of the ecosystem and their interactions with ecological networks[2] of organisms that are both economically important and likely to have come in contact with oil and that are representative of the estuarine and marine communities that predominate in the affected ecosystem. This approach provides a "template" upon which each of the strategies, both singly and in concert, can be implemented in the most productive and defensible manner.

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[2] Ecological networks are defined as the complex web of linkages among species--typically food web linkages, but they may also involve competitive, inhibitory, or synergistic interactions.

In developing and implementing statistically precise descriptive studies, one must take into account natural variability and other characteristics of the areas affected by the spill (e.g., differences in exposure of intertidal communities, mainland, and island sites because of low salinties from freshwater run-off , and exceptionally cold temperatures before the spill). In many instances, effective selection of paired treatment sites (oiled/nonoiled, pre-/post-spill, or both) or field manipulative experiments (using techniques such as transporting oiled rocks between beaches to assess oil effects on recruitment) can be used to eliminate or minimize the influence of confounding factors.

Producing strong empirical or experimental results showing pervasive, long-term changes in communities which can be unambiguously tied to the EVOS is the ultimate goal. In many instances, however, direct evidence of such changes will probably not be available. As a viable alternative, studies that generate data in support of exposure and dose-response relationships with respect to the effects of petroleum (and its conversion products) on growth, reproduction, and behavior can be used to provide strong evidence demonstrating damage from oil contamination.

The first step in this cause-and-effect chain of evidence is to examine dose, i.e. (1) whether there are hydrocarbon derivatives in the immediate environment of the organism and (2) whether the organism accumulates hydrocarbons or their environmentally-formed derivatives. The most basic type of evidence in this regard is whether the oil physically contacted the species of interest. Photographs and records of visual observations can be effectively used in this case as supportive evidence. The other kind of basic evidence is whether hydrocarbon derivatives were measured in the environment of the organism. Measurements of concentrations of oil derivatives in the water, in sediments, in porewater, on rocks, or in the food of the species of interest are used to establish this link. If hydrocarbons or metabolites of oil components are detected in the organism, then the causal link to damage becomes stronger.

Since many species metabolize hydrocarbons, it is likely that analyses of tissues will either not detect the parent compounds or the concentrations will not be representative of the magnitude of exposure. It is therefore necessary to perform other analyses, such as to measure the levels of metabolites in the organism to estimate the degree of exposure or to measure the activity or concentration of enzymes that metabolize hydrocarbons. Since certain enzymes are inducible with exposure, measurement of these enzymes provides a surrogate estimate of dose that is indicative of exposure, usually for days to weeks. Another useful aspect of enzyme measurement is that the products of metabolism include some

toxic compounds. Therefore enzyme assays are a measure of potential for injury as well as an indication of exposure.

Other examples of biochemical changes associated with oil exposure include adducts formed by the reaction of aromatic hydrocarbon metabolites with DNA or proteins, interference with lipid metabolism, and alterations of steroid metabolism. The consequence of exposure responses on higher levels of organization, i.e., at the tissue, organ, or integrative physiological level, can be shown in many ways. For example, disruption of membranes can indicate accumulation of hydrocarbon derivatives (e.g., metabolites) in the lipid layer of the membrane. Lipid accumulation in vacuoles can indicate effects of hydrocarbon derivatives on lipid metabolism. Narcosis may indicate the interference of hydrocarbons derivatives with the transmission of nerve impulses. Alteration of the number of eggs produced by females or in their viability may indicate that some aspect of reproduction, perhaps mediated by hormones, has been impaired. Hydrocarbon derivatives can also impair the efficiency of cellular immune responses so that the organism becomes more susceptible to disease.

The next link in the chain of cause-and-effect is to show population changes. For example, change in embryo viability, abundance of young, or in recruitment may be a direct effect of some impairment of reproduction. These alterations can then be manifested as a change in absolute abundance of the population or as a shift in the age structure of the population due to poor recruitment of larval survival. Controlled laboratory experiments can be conducted under conditions that mimic or partially adopt field conditions, and can assist in identifying damages to organisms that can be translated to population effects (i.e., effects on reproductive success, etc.). For example, pink salmon eggs and fry could be removed from oiled and unoiled redds (spawning grounds) to the laboratory for further monitoring of egg/alevin development and mortality, genetic abnormalities, and the induction of hydrocarbon-metabolizing enzymes, all of which are a measure of exposure to oil. The loop of causation as it affects populations is closed at this stage of ecosystem effect.

A complete ecosystem study and approach to the EVOS has been suggested by some public committees, but we find that it is scientifically impractical and therefore undesirable. The best way to achieve the goal of demonstrating ecosystem effects is to identify "ecological networks" (organisms linked by strong interactions such as plant-herbivore, predator-prey, competitor, parasite, etc.) known to be important in Prince William Sound and other ecosystems affected by the Oil Spill, and to identify key organisms in these networks upon which to focus studies and experiments. If sublethal effects can be clearly identified or predicted, some level of modeling can also be employed to estimate

community-ecosystem effects. Reduced growth or reproduction, or behavioral adjustments that can modify distribution or abundance, even acting in the absence of mortality, can produce important system-wide consequences.

In addition to the above strategies for demonstrating damage, various risk assessment methodologies can be used. The objective of an ecological "risk assessment" is to quantify injury. The magnitude and extent of injury are measured on the basis of a select set of ecological endpoints (i.e., death, growth, etc.) that are considered reasonable indices of the status of biological populations and communities.

Predicting injury through a "risk assessment" strategy broadens the legal and scientific basis for assessing injury and establishing costs associated with lost use and recovery. This is especially true in cases where injury to resources are obfuscated in the field.

The procedures for injury assessment discussed above are not unique. They are, in fact, similar in principal to approaches currently being used in ecological risk assessments for hazardous waste sites. Using the above-described strategies, one can develop an interlocking picture evidencing cause and effect of oil contamination on organisms and their ecosystem.

C. Methodologies for Identifying and Quantifying Impacts to Non-Biologic Resources

A group of studies in the 1989 Plan, particularly Air/Water Studies Nos. 1-5 and the Coastal Habitat study, were used to assess damages to non-biologic resources (surface water, water column, beaches (intertidal sediments), subtidal sediments and air) as well as to demonstrate exposure of biologic resources to hydrocarbons and by-products from the spill.

The strategy of the 1989 Studies was to locate and quantify hydrocarbons from the spill in the various compartments of the environment over space and time.

1. Impacts to water.

a. Surface water. Two methodologies for identifying and quantifying impacts to surface water were used in 1989: mapping of descriptive observations, and sample analysis for hydrocarbon components.

i. Descriptive observations (mapping). As part of its spill response function in 1989, the Alaska Department of Environmental Conservation (ADEC) tracked the spread of the spill by aerial overflights. Maps of the path of the slick are being

prepared based on ADEC's aerial overflight data (Air/Water Study No. 1). These maps show the location of the large mass of oil on the surface relatively early in the spill. They do not show smaller quantities such as tarballs, oily debris, etc. on the surface of the water.

ii. Analysis for hydrocarbon components. The University of Alaska-Fairbanks (UAF) collected offshore surface water samples in Prince William Sound over the first three weeks of the spill for analysis for volatile hydrocarbons. In the nearshore zone, ADEC collected surface water samples at 22 moderately and heavily oiled sites in Prince William Sound in the fall of 1989. These studies were done as parts of Air/Water Study No. 3.

b. Water Column. Impacts to the water column were evaluated in 1989 by analysis of water samples taken at various locations, depths, and times, and using several techniques. Except where indicated below, these were done in Air/Water Study No. 3.

i. Analysis for hydrocarbon components. The National Marine Fisheries Service (NMFS) collected water samples from depths of one and five meters in Prince William Sound during the first five weeks after the spill. Concentrations of petroleum hydrocarbons were found to be generally below the detection limit of the screening technique (1 mg/l.). As part of its response function, outside the NRDA process, ADEC collected numerous water column samples during five cruises inside and outside Prince William Sound during the summer of 1989. The data require extensive review, however, to determine if they may be suitable for use in the NRDA process. ADEC also collected samples of water in the beach matrix for analysis for hydrocarbon components as part of its Air/Water No. 3 study.

ii. Deployment of mussel cages. Mussels bioaccumulate hydrocarbons in the water column and can indicate ongoing low-level contamination below the detection limits of water sample analyses. NMFS deployed mussel cages at 30 locations inside and outside of Prince William Sound to measure the presence of low level hydrocarbons.

iii. Analysis of sediments collected in sediment traps. Sediment traps are designed to collect sediments and associated hydrocarbons that are transported through the water column. ADEC deployed sediment traps subtidally in Prince William Sound as part of its 22-site study referred to above. The UAF also deployed sediment traps early in the spill, outside the NRDA process.

iv. Microbiological studies. The presence and metabolic activity of hydrocarbon-degrading bacteria provide a fairly inexpensive indication that hydrocarbons persist and natural degradation is not complete. As part of Air Water Study No. 2,

ADEC enumerated hydrocarbon-degrading bacteria in the nearshore water column and interstitial water and evaluated their ability to degrade hydrocarbons.

v. Toxicity analysis. Analysis of the toxicity of water that may contain hydrocarbons or oxidation by-products is another method of showing impacts to water. Continuing toxicity may occur in the water flowing through and off of beaches containing residual oil. This type of analysis is not presently being done, but could be useful in demonstrating ongoing injury to the intertidal environment. It would involve laboratory simulations and exposing organisms to the runoff water or laboratory exposure of organisms to water collected in the field.

2. Impacts to sediments.

a. Beaches and intertidal sediments. Impacts to intertidal sediments were evaluated in 1989 by descriptive surveys, sampling for hydrocarbon components, and analysis of microbial activity. Other methodologies that could be used include volumetric analysis to determine the total volume of hydrocarbons in the sediments, analysis of toxicity of sediments, and beach transecting to obtain more detailed observational data on oiling at a particular location.

i. Descriptive surveys (mapping). ADEC conducted aerial overflights to determine the extent of oil on the beaches in 1989 as part of its response function. The data from these surveys are being compiled on maps showing the surface distribution of oil in the areas impacted by the spill (Technical Services Study No. 3). These maps show the degree of oiling based on the surface coverage of the beach by oil. They do not reflect the thickness of oil or the depth of penetration into the sediments. More precise maps will be prepared using data from ADEC's walking survey ("walk-a-thon") of all moderately and heavily oiled areas conducted in September, 1989. This survey provides the most detailed and comprehensive view of oiling, although it was conducted late in the season when some of the oil may have been removed.

ii. Analysis for hydrocarbon components. Impacts to beaches and intertidal sediments are being evaluated by sampling for hydrocarbon components. NMFS took samples of intertidal sediments at 29 locations in Prince William Sound and 25 sites outside the Sound as part of Air/Water Studies Nos. 2 and 4. The Coastal Habitat Study group also took sediment samples at 111 study sites that are to be analyzed for hydrocarbon components. Finally, ADEC collected sediment samples in its 22-site study referred to above.

iii. Toxicity testing. NMFS tested the toxicity of intertidal and subtidal sediments collected in the Air/Water

Studies Nos. 2 and 4, using a Microtox bioassay to test the inhibition effect of sediment extracts on the bioluminescence of a species of bacteria. Other standard bioassay methodologies, such as using fish larvae, bivalve larvae, or amphipods as test organisms, are not being done.

iv. Microbiological studies. NMFS evaluated the hydrocarbon degrading potential of bacteria in intertidal and subtidal sediments and enumerated the numbers of hydrocarbon degrading bacteria in Air/Water Study No.4, as discussed above.

v. Analysis to determine the volume of oil in sediments. This is not presently being done. As part of its 1989 response effort, ADEC collected sediment samples from the intertidal zone at approximately 120 locations inside and outside Prince William Sound. The ADEC samples were collected for analysis of the amount of oil in the sediments and are presently archived.

vi. Beach transecting. This was done on a large scale by NOAA and ADEC as part of their 1989 response functions. The methodology involves establishing a beach transect perpendicular to the shoreline, diagramming the beach composition, elevation, and degree of oiling along the transect, and collecting samples for hydrocarbon analysis. It provides more detailed oiling descriptions than could be obtained from the aerial overflights and could be used to calibrate overflight data. ADEC evaluated some 120 such transects in Prince William Sound and NOAA evaluated additional transects in their response capacities. ADEC continued its program in conjunction with its study of 22 sites in Prince William Sound referred to above.

b. Subtidal sediments. Impacts to subtidal sediments have been evaluated by chemical and microtox sampling, as discussed above. Several different agencies have sampled the subtidal zone.

i. Analysis for hydrocarbon components. NMFS and ADEC collected subtidal sediments for analysis for presence of hydrocarbon components.

ii. Analysis for toxicity. NMFS analyzed subtidal sediments for toxicity using the Microtox method as part of Air/Water Studies Nos. 2 and 4.

3. Impacts to Air

a. Modelling of air impacts. Given the short duration of any impacts to air and the lack of direct measurements of such impacts, modelling is the only feasible methodology of evaluating impacts to air. A model is being developed under Air/Water Study No. 5.

4. Synthesis of Impacts to the Non-Biologic Resources.

An additional methodology for evaluating overall impacts to the non-biologic resources that is not presently being utilized is to synthesize the data on particular impacts into a mass-balance "budget" or accounting of the spill over time. Such a budget, which also is referred to as a mass balance or box model, can provide a comprehensive (quantitative and qualitative) description of the location of the oil and its degradation by-products in all major compartments of the environment over time, including, for example, amount evaporated, amount in intertidal sediments and toxicity, amount in water column and toxicity, amount in subtidal sediments and toxicity.

This type of synthesis can be developed using empirical data, as distinguished from purely theoretical predictive models. It can be used to make predictions based on the data to date as well as to present an integrated explanation of the fate of oil up to the present.

NATURAL RESOURCE INJURIES STUDIES

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Birds						
1	Water Birds/ Beached Birds	X		USFWS	$258,000	$625,000

COMMENTS

This is one of the most important bird studies from a population dynamics perspective. Approximately 36,000 dead birds were recovered in the 1989-90 field season. This number provides a minimum estimate of bird mortality caused by the oil spill. The process of carcass loss both at sea and on the beach is poorly understood but is critical to the estimate of total mortality. The study should be modified in the 1990-91 field season to determine the mechanisms and rate of these processes and should include: (1) analysis of the recovered carcasses to determine what percentage of the 36,000 died from oiling rather than natural causes; (2) development of a model to estimate the potential total kill -- i.e. to estimate what percentage of birds killed by oil did not wash up on beaches. The general approach is to apply a hindcast model to work backwards from the place where the animals died to the beach where the carcasses were recovered; and (3) field experiments to support the modelling effort which will document oiled bird floatation times, drift, and survival rates once beached. In addition, documentation (photos and/or notes) of birds in oil at sea should be collected -- especially for birds under-represented in the beach counts.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
~~Birds~~ 2	Census & Seasonal Distribution	X		USFWS	$565,000	$470,000

COMMENTS

The shoreline boat survey documented a decline in several species. To the extent that these are breeding birds which normally demonstrate site fidelity, population loss would be the most reasonable explanation if birds fail to return to pre-spill abundance in 1990. Boat surveys should be continued in 1990 with increased coverage of oiled areas in PWS and the Kodiak area. Survey design should be reviewed by statistical consultants. Aerial surveys of waterfowl use should be repeated for all spill affected coastlines in Feb/March and Spring 1990 and again in Jan. 1991 if effect on seaducks is severe. It is essential to conduct winter and spring surveys by aircraft as well as long-term boat surveys. The 1990 survey should be comparable to the 1989 pre-spill survey.

[illegible] budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Birds 3	Seabird Colony Surveys	X		USFWS	$440,000	$250,000

COMMENTS

This study is highly valuable to a population dynamics assessment, as it indicates there was a substantial die-off of murres (up to 60-70% of murres breeding on Barren Island). Body count evidence corroborates the hypothesis that missing murres were probably killed by oil (74% of beached birds were murres). Another census should be conducted in 1990 for murres and kittiwakes. In addition, an effort should be made to link murre reproductive failure to oil, including conducting hydrocarbon tests on eggs and old and new nest material in oiled and un-oiled areas. Also, investigators should attempt to gather evidence showing murre numbers had not declined before the spill. The status of other colony nesting seabirds should be evaluated as various locations are visited.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
4	Bald Eagles	X		USFWS	$445,000	$500,000

COMMENTS

Last year's study revealed that the oil spill resulted in significant mortality and a decline in productivity of bald eagles. Nest failure rates were significantly higher along heavily and moderately oiled beaches than along lightly and un-oiled beaches. This study is highly valuable to completion of a population assessment of oil spill effects.

Aerial surveys of the eagle population should be completed in spring 1990 to assess whether the population has declined since the April 1989 pre-spill count. If this survey indicates a significant decline, it could be used to project a much higher population effect than the 153 recovered carcasses. Additionally, comparisons of eagle reproduction rates should be made in oiled and comparable oil-free areas. Prey samples should be collected in the 1990 survey. Results of hydrocarbon analysis of prey, blood samples, and eggs will be important for linking productivity changes to oil contamination. Blood samples should be assayed for hemolytic anemia. Tracking of radio-tagged eagles should continue to determine if the birds are foraging in oil-contaminated areas.

*Agency budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
5	Peregrine Falcons		Pending	USFWS	$43,000	($120,000)[2]

COMMENTS

The population of falcons inhabiting PWS and the coastal Kenai Peninsula is estimated at 40-60 pairs. The 1989 survey demonstrated lower numbers of occupied nests and lower numbers of young produced per successful nest than historical rates in Queen Charlotte Islands, the Western Aleutians and Norton Sound.

Objectives of this study would be to: 1) test the hypothesis that nest site occupancy and productivity are lower in the project area as a result of EVOS than in other populations; 2) test the hypothesis that the quantities of vanadium and nickel in peregrine feathers are the same for birds nesting in oiled and non-oiled areas; 3) count and identify prey remains collected at eyries in oiled and non-oiled areas; 4) test the hypothesis that pesticide contamination of egg clutches in the project area are less than contamination levels reported in scientific literature as causing reproductive failures in peregrine falcons; and 5) identify methods of restoration where injury has occurred.

[2]Council did not reach agreement. State of Alaska feels this study should go forward at $120,000. DoI, USDA, and NOAA recommend to discontinue.

* Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
6	Marbled Murrelets		X	USFWS	$115,700	-0-

COMMENTS

This study will not produce substantial useful information if continued as originally planned. All 1989 hydrocarbon samples should be analyzed, and murrelets should be observed as part of the 1990 survey for Bird Study #2.

*Exclude budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
7	Storm Petrels		X	USFWS	$135,000	-0-

COMMENTS

No measurable population impact was demonstrated by the 1989 study. No significant difference was found in reproductive success. Analysis of stomach oils, eggs, and dead chicks for hydrocarbons should be completed, as the results could demonstrate contamination that would be useful in painting a picture of broad ecological damage.

* Indicates budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
~~Birds~~ 8	Black-Legged Kittiwakes		X	USFWS	$190,000	-0-

COMMENTS

Approximately 1220 dead kittiwake carcasses were collected after the spill as part of the beached bird count. An estimated 40,000 of these birds nest in 30 colonies in Prince William Sound. Of the 24 colonies studied, 10 were oiled. The USFWS has an ongoing base-funded project on kittiwakes in PWS. Information from these studies will be made available to the NRDA process.

* Budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
9	Pigeon Guillemots		X	USFWS	$109,500	-0-

COMMENTS

This study will not provide further useful information if continued. Boat surveys conducted under study #2 should observe pigeon guillemots to assess population trends.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds 10	Glaucous-Winged Gulls		X	USFWS	$73,000	-0-

COMMENTS

This study focused on the reproductive biology of gulls nesting on Egg Island, outside Prince William Sound, and demonstrated no population injury.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
11	Sea Ducks	X		USFWS	$146,000	$100,000

COMMENTS

Preliminary analysis of results indicates that harlequin ducks which forage in the intertidal area are in poorer condition than those sea duck species which forage farther offshore. This study has potential, therefore, to provide evidence of either a decline in food sources in near-shore oiled areas or direct hydrocarbon contamination of intertidal-feeding ducks. The study does not support a population dynamics analysis, since it focuses on habitat and species contamination and does not provide an estimate of the number of sea ducks killed by the spill. It has value, however, in a sublethal analysis, particularly in demonstrating food chain impacts.

We recommend that the study focus on the status and food habits of harlequin ducks and golden-eyes.

Objectives of this study are to: 1) test the hypothesis that the prevalence of petroleum hydrocarbons in gut samples from collected sea ducks is higher in the oil spill areas than in the control area; 2) test the hypothesis that the prevalence of petroleum in tissues of collected sea ducks is significantly higher in the two spill areas than in the control area; 3) from evidence of histopathology, estimate the ingested petroleum hydrocarbon effects on morbidity, mortality, and reproductive potential; and 4) Identify restoration methods where injury has occurred.

* Reflects budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
12	Shorebirds		X	USFWS	$166,000	-0-

COMMENTS

Black Turnstones: This study described the use of staging and foraging areas by migrant shorebirds, in particular black turnstones and surfbirds, and provided information on turnstone reproduction on the Yukon-Kuskokwim Delta. No useful information will be gained if this study is continued.

Oystercatchers: Study showed reduced chick survival and reduced food intake rates in oil-contaminated areas. Value to population dynamics assessment is low, however, given the relatively small number of chick mortalities involved. The consensus among the Peer Reviewers was that the oystercatcher study was well designed and well executed, but unlikely to provide substantial further information.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Birds						
13	Passerines	X		USFWS	$59,000	$10,000

COMMENTS

Onshore behavioral surveys of the shoreline should continue to record passerine observations in the intertidal zone, at a reduced level from what was proposed in 1989. Oiled versus unoiled areas will be visited and species composition and activity recorded. This work will be carried out by outside contract.

* Actual budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
~~Birds~~ 14	Migratory Birds		X	USFWS	$10,000	-0-

COMMENTS

This study was not done in 1989 and has not been proposed for continuation in 1990.

Call. Marilyn Baldwin

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
1	Humpback Whale		Pending[2]	NOAA	$226,000	($90,000)[2]

COMMENTS

This study did not detect a decline in the population of humpback whales in Prince William Sound, but it did find the apparent reproductive rate for these whales to be at its lowest in eight years. Results from 1989 suggest a re-distribution of whales within Prince William Sound, possibly in response to increased levels of vessel traffic associated with cleanup activities. It may not be possible to conduct a chemical analysis for sublethal effects. Observations on humpback whales would be coordinated with the Killer Whales study #2 to see if there is any significant change in the Humpback Whale population. Laboratory research/literature regarding known oil effects on baleen whales will be assessed prior to any field effort.

Continuation of the survey portion of this study is contingent upon review and approval of the detailed study plan by the Trustee Council, and results of laboratory/literature review.

[2]Council did not reach consensus; DoI, USDA recommend to dincontinue, NOAA and State of Alaska recommend to continue at $90,000.

* Authority budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
2	Killer Whale	X		NOAA	$200,000	$255,000

COMMENTS

Seven individuals from one pod (the A/B pod) as well as members from several other pods were found to be missing this year. If these seven whales do not appear in 1990, the 1988-89 mortality rate would be 19.4%. If confirmed, this mortality rate would result in an unprecedented mortality rate for killer whales based on 24+ years of killer whale research in the eastern North Pacific Ocean. Second year field studies are required to determine if the missing whales are dead or if they return in 1990. Good data from earlier years exists. If the missing whales fail to appear again next year, continued observation and tracking of the whales seems worthwhile. The main reason for continuing this study is the high visibility that killer whales maintain within the public eye and the high value they might correspondingly be assigned should an impact be demonstrated.

* Budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
3	Cetacean Necropsy		X	NOAA	$73,000	-0-

COMMENTS

This study found a number of stranded whale carcasses, but was unable to sample most of the decomposing carcasses for tissue analysis. It is unlikely that samples taken from cetaceans will be fresh enough for histological examination. Even if obtained in a timely manner, it is unlikely that any causal relationship could be established. The samples should be held but not analyzed at this time.

* Reflects budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
4	Sea Lion	X		NOAA	$270,000	$161,000

COMMENTS

Results of aerial surveys and pup counts in 1989 failed to document an oil spill effect. The major decline overshadowed any possibility of detecting losses due to the oil spill. However, exposure to oil during 1989 may deleteriously affect the reproductive capability of female sea lions during 1990. The effects may be magnified by increased rates of abortions or premature births during 1990. The magnitude of premature pupping will be documented by placing biologists at two rookeries during March and April at a location near the oil spill (Cape St. Elias) compared to one far from the spill (Chirikof Island) where the rate is expected to be lower.

Additional population dynamics analysis of sea lions is not recommended as results from 1989 did not demonstrate significant body counts or significant difference between pre- and post-spill populations. This may be due in part to the fact that variances on aerial counts of these marine mammals is quite high, making it difficult to detect changes in distribution and abundance, and the sea lion population in Prince William Sound and the Gulf of Alaska has been in decline over the last 30 years. In addition, sea lion mobility confuses oiled and unoiled comparisons, and modelling population impacts and recovery rates using changes in vital rates would be very difficult to do.

Nevertheless, we believe sea lions are worth studying as part of a sublethal analysis. This study should focus on analyzing whether there has been a change in premature pupping, reproductive rates, and behavior, which could indirectly suggest population changes. Scientists should also collect the placentas for tissue analysis for mixed function oxidaze (MFO) on surviving and non-surviving pups.

Objectives of this study are to: 1) test the hypothesis that numbers of sea lions using ~~keries and hauling areas from Cape St. E~~ ~~s to Chowiet Island are lower during the~~

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals 4	Sea Lion					

COMMENTS:

(-Page 2-)

breeding season and test the hypothesis that lower numbers are due to EVOS; 2) test the hypothesis that premature pupping occurs at a higher rate at a hauling area nearer EVOS; 3) test the hypothesis that pup production is lower in the vicinity of EVOS; 4) estimate hydrocarbon levels in tissues and test the hypothesis that tissue damage has occurred.

* Reduced budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
5	Harbor Seal	X		NOAA	$245,000	$135,000

COMMENTS

Results of 1989 field work indicated that over 70% of the seals in oiled areas were oiled. Carcasses of 39 seals were necropsied and sampled, but sample analysis is not complete. Investigators for this study were able to conduct a pre- and post-spill comparison of oiled and unoiled sites. This comparison revealed a greater-than-expected population decline in oiled areas. Aerial surveys of haul-outs and rookeries, therefore, should be continued to monitor population numbers and estimate adult to pup ratios. The investigator should also continue taking a full range of samples for toxicology and histopathology analyses from any animals that are collected. However, no additional live seals should be collected under existing federal collection permits unless positive evidence of oil contamination and related physiological changes are found in existing samples and until investigators have received approval from the Trustee Council. Toxicology and histopathology tests should be completed as soon as possible, especially those taken from collected animals. As feasible, the investigator should collect information on reproductive behavior, pup growth rates, and food habits.

Objectives of this study are to: 1) describe the characteristics and persistence of oiling of pelage that resulted from contact with oil; 2) test the hypothesis that harbor seals found dead in the EVOS area died due to oil toxicity; 3) test the hypothesis that the levels of hydrocarbons and incidence of pathological changes in tissues from visibly oiled seals are higher than from seals that are not visibly oiled; 4) test the hypothesis that the proportion of harbor seals on the trend count route during pupping and molting decreased, relative to other years, in the area affected by EVOS and associated activities; 5) test the hypothesis that the abundance of harbor seals decreased in oiled portions of PWS as compared to unoiled areas; 6) test the hypothesis that pup production was lower in oiled portions of PWS as compared to unoiled areas; and identify restoration methods where injur[illegible] has occurred.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals						
6	Sea Otter Impacts	X		USFWS	$763,000	$1,056,000

COMMENTS

This study is very important given the number of sea otters in nearshore areas directly impacted by the spill (over 1000), the potential for estimating recovery rates, and the relatively high economic value that is likely to be assigned to sea otters. In addition, it appears that otters in off-shore areas may also have been impacted. If this is substantiated by additional study, it could dramatically increase mortality estimates.

Tests on beached carcasses should be completed to determine what percentage died from oiling and to determine the age of the otters killed. These data may allow projection of population recovery rates. A carcass search should be conducted in early spring to supplement the body count. A drift experiment should be undertaken as well to determine wash-up rates.

Sublethal impacts should also be studied as blood samples show potential liver and kidney damage. We recommend investigators apply DNA and hemoglobin adduct analyses to samples from the tagging study and existing samples, examine tag/recaptured animals for cataracts, ensure histopath analysis is double blind random. We strongly recommend a high priority be placed on body burden sample analysis, especially on tagged individuals (30-40 animals from Fall '89). Investigators should attempt to gather corroborating data on behavior, especially weanlings which can be linked to chemical analyses and fresh carcasses. The PIs should be given guidance on sampling invertebrates for toxic dose information. Further comments: 1984-85 baseline data exists; female-pup ratio data not available over time but comparable over space; use weanling mortality as a prime indicator of habitat change.

* Estimate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals 7	Sea Otter Rehabilitation	X		USFWS	$108,000	$130,000

COMMENTS

This study should continue as designed for the same reasons cited in comments to Study #6.

* Budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals 1	Sitka Black-Tail Deer	X		ADFG	$87,000	$17,300*

COMMENTS

Systematic counts of dead deer were proposed as one of the major methods for assessing spill effects on Sitka Black-Tailed deer. However, a pilot study conducted two months after EVOS occurred found no deer mortality that could be linked directly to oil exposure. Therefore, the counts were suspended until results of aerial surveys conducted along oil contaminated beacheds during January through April are available. if deer concentrate on oiled beaches, and if there are indications of oil toxicity, a systematic gound count is proposed. We recommend that investigators complete the winter aerial survey at a budget level of $17,300. The viability of systematic ground counts should be based on those aerial survey results and should proceed only upon approval of the Trustee Council with funding of $109,300.

Objectives of this study are to: 1) test the hypothesis that deer on heavily oiled islands have tissues and rumen contents contaminated by oil; 2) test the hypothesis that deer found dead have rumen contents in their lungs; 3) estimate the number of dead deer per unit area on both a heavily oiled and non-oiled island in PWS; and 4) identify restoration methods where injury has occurred.

Now recommended to discontinue based on lack of signif. mort.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals						
2	Black Bear	X		ADFG	$139,700	$10,000

COMMENTS

Principal investigators were not able to use helicopters to capture bears for marking and therefore had to discontinue the project in 1989. Investigators propose to undertake a limited literature search in 1990 to determine whether prior studies have demonstrated that black bears are impacted when denied their preferred food source. We recommend this literature search receive funding.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals						
3	River Otter	Pending[2]		ADFG	$287,700	($300,000)[2]

COMMENTS

Preliminary analysis indicates that the rate of mink fecal deposition rates between oiled and unoiled areas is approximately the same. Investigators propose to complete the radio-tagging of 40 river otter in 1990 to compare population size, food habits, and habitat use in oiled and unoiled areas. Very little data was collected in 1989 because most of the effort was devoted to establishment of study areas and development of techniques. However, 40% of the radio collared river otters are now emitting signals indicating probable death.

Objectives of this study would be to: 1) determine cause of death for river otters recovered from oiled areas; 2) test for higher hydrocarbon levels in river otter in oiled versus unoiled areas; 3) estimate population sizes of river otter on oiled and control areas; 4) estimate rate of fecal deposition for river otter; 5) test for lower survivorship of river otter on oiled versus control areas; 6) test for difference in food habitats of river otter before and after EVOS on the oiled study area; 7) test for differences in food habits of river otters on oiled and control areas; 8) test for differences in activity patterns (foraging) of river otters between oiled and control areas; 9) test for differences in habitat selection in river otters between oiled and control areas; 10) identify restoration methods where injury has occurred.

[2]Council did not reach consensus; will make recommendation following review of detailed study plan; cost estimated at $300,000 if continued.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals 4	Brown Bear	X		ADFG	$162,700	$115,100

COMMENTS

Thirty brown bears were captured and fitted with radio collars in the oiled study area along the Katmai coast. They were relocated at 2-3 day intervals until entering winter dens. No mortalities were observed among radioed animals. Most aspects of this project were planned to yield results beginning in autums 1990. Investigators propose to maintain a fall total of at least 30 bears with radio-collars and follow them for three years to obtain mortality, population, and hydrocarbon contamination data. The results will be compared with a similar study now being conducted in the unoiled Black Lake area. Since brown bears are a high profile species that are endangered or threatened in all states other than Alaska, we recommend the study be continued.

Objectives of the study are to: 1) test the hypothesis that radio-collared brown bears in the oiled area ingested hydrocarbons at higher concentrations than radio-collared bears in an unoiled area; 2) test the hypothesis that natural mortality rates of female bears in the oiled area is higher than in unoiled areas for a period of 3 years following EVOS; 3) test the hypothesis that some natural mortality of brown bears in the oiled area can be attributed to the physiological affects of ingesting hydrocarbons; 4) estimate the adult brown bear population density of the study area to obtain a coefficient of variation on the degree of petroleum exposure; and 5) identify restoration methods where injury has occurred.

*Reflects budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals 5	Carnivores/ Small Mammals		X	ADFG	$302,400	-0-

COMMENTS

This study has not been proposed for continuation.

* Revised budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Terrestrial Mammals						
6	Mink Reproduction	Pending[2]		ADFG	$192,200	($139,000)[2]

COMMENTS

This study is designed to determine if short and long-term ingestion of weathered Prudhoe Bay crude oil by captive ranch mink affects female reproduction. The reproductive variables to be studied would include breeding behavior, number of kits per litter, kit survival, kit growth and maturation, and histology of adult and kit reproductive traits. Observations would continue until weaning, when animals would be euthanized and necropsied. While the study itself is well designed, there is no demonstrated connection between the lab experiments and the actual exposure animals are receiving in the environment. Given the relatively high cost of this study, the lack of any data to suggest the actual mink mortality caused by the spill was significant, and the relatively low value likely to be assigned mink, we recommend this study be discontinued.

Objectives of this study would be to: 1) identify the concentration of weathered Prudhoe Bay Crude (WPBC) oil in mink feed that does not produce clinical illness or significantly reduce palatability; 2) determine the total mean retention time of oil within the mink alimentary tract; 3) test the hypothesis that short-term low level ingestion of WPBC oil during pre-estrus, diapause, gestation, or lactation does not produce a significant difference in female mink reproduction; 4) test the hypothesis that continual, low-level ingestion of WPBC oil starting during pre-estrus and continuing through to weaning of kits does not produce a significant difference in female mink reproduction.

[2]Council did not reach consensus; will make recommendation following review of detailed study plan; cost estimated at $139,000 if continued.

*note budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 1	Salmon Spawning Area Injury	X		ADFG	$144,800	$391,300

COMMENTS

This study is an integral part of any pink salmon population impact assessment in Prince William Sound. It supplements the existing escapement database and will contribute to a pre- and post-spill comparison of population size, a post-spill spatial comparison in oiled and unoiled sites, and in measuring changes in vital rates between oiled and unoiled streams.

A survey of the distribution of oil contamination was completed for 441 intertidal salmon spawning streams in Prince William Sound during the 1989 field season. Nearly all streams surveyed were aerial photographed, the intertidal areas of oiled streams were mapped, and the type and extent of oil contaminatino were recorded. Mussel samples were collected for hydrocarbon analysis at all streams where escapement ground surveys were conducted. Pink and chum salmon escapements for 1989 were enumerated by tidal zones for 138 streams. In order to provide a time series of pre- and post-spill pink and chum salmon escapements in Prince William Sound, an analysis of the historical data base must be completed and post-spill escapement surveyes must be validated.

This project is also designed to document oil contamination of intertidal spawning habitat.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 2	Salmon Eggs and Preemergent Fry	X		ADFG	$149,100	$302,800

COMMENTS

This study has already demonstrated oil spill population impacts by revealing a substantial increase in egg mortality. It supplements the existing egg deposition and pre-emergence data, particularly by including more oiled sites in the sample. The results could provide direct mortality data by comparing egg survival rates in oiled and unoiled areas. In addition, the study will contribute data relevant to pre- and post-spill population comparisons, post-spill population comparisons, post-spill spatial comparisons, and to measuring changes in vital rates.

The study also could provide valuable information for an analysis of sublethal impacts. We recommend expansion of studies with field experiments to assess long-term and sublethal effects of spawning habitat contamination, including transplanting (in baskets) of fertilized (hatchery) eggs into streams with varying degrees of contamination, followed by regular monitoring of egg development and survival. Investigators should do MFO measurements in field-collected eggs, larvae and fry. In laboratory studies, investigators should measure egg membrane disruption, cytogenetics, and growth behavior.

This study is designed to assess possible changes in pink and chum salmon egg to preemergent fry survival in intertidal and upstream areas relative to oil contamination.

*Includes budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
~~Fish~~ ~~Shellfish~~ 3	Salmon Coded Wire Tagging	X		ADFG	2,049,000 ~~$1,943,400~~	2,049,000 $1,943,400

COMMENTS

Catch and survival rates of pink salmon released from four Prince William Sound hatcheries in 1988 were estimated for 1989 recoveries. Almost 1.4 million tagged pink, chum, sockeye, and coho salmon were released from five hatcheries in 1989. Future catches will be scanned for these marked fish. Marine survival of each stock will be calculated when they return. Tagged pink and coho salmon will return in 1990. Chum and sockeye salmon will begin returning in significant numbers in 1991, and recovery efforts will continue through 1992 to encompass the majority of adult returns from the 1989 release. Based on results from Fish/Shellfish Study 1 and 2, six streams have been chosen for pink salmon tagging and measurement of outmigration in 1990. Tag recoveries from harvest and stream surveys in 1991 will provide estimates of survival rates. Over 90 thousand sockey smolts were tagged at Eshamy and Coghill Rivers in 1989.

This study provides information useful to a population dynamics analysis. The coded wire tagging allows investigators to analyze survival rates for fish released into oiled versus unoiled hatcheries and wild streams. This information primarily contributes to an analysis of vital rate changes, although differences in survival can be thought of as body counts. The coded wire tag (CWT) fish will also be used to analyze early marine distribution and growth in study #4.

* Reduce budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET: 1989 BUDGET*	OIL YEAR BUDGET: 1990 BUDGET
Fish Shellfish						
4	Early Marine Salmon Injury	X		ADF&G/NOAA	$829,200	$630,000

COMMENTS

This study found different migration patterns for fry released in oiled vs. oil-free areas. Growth rates were also significantly lower in oiled than in unoiled areas. Both juvenile pink and chum salmon were also more abundant in non-oiled areas, but corroboration of this resulting from oil exposure requires analysis of tissues for levels of hydrocarbons.

This study should be redesigned to focus on elements relevant to a sublethal analysis. The study should consists solely of laboratory and/or field manipulative experiments, with priority on field manipulative experiments measuring growth using otoliths/diet composition/consumption. This study should be further reviewed to determine if pens are the best means to analyze effects.

*Costs budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 5	Dolly Varden/ Cutthroat Injury	X		ADFG	$437,400	$290,000

COMMENTS

Of all of the finfish species, Dolly Varden char and cutthroat trout are the most exposed to the oiled marine environment. Oil contamination may affect growth and survival. There is, however, no background data on either species. In 1989, emigrating fish were counted, measured, aged, and tagged in several systems, including oiled and unoiled areas. In 1990, investigators propose to sample the fish tagged in 1989 to determine growth and survival rates. Re-sampling during the 1991 field season may be necessary for reliable survival estimates. Post spill spatial comparisons constitute the only possible population dynamic assessment technique for these species. The experimental design is such that comparisons are almost sure to detect differences if they exist. This study provides the data needed to conduct this assessment.

* Reduces budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 6	Sport Fishery Harvest & Effort		X	ADFG	$175,900	-0-

COMMENTS

This is an economic study.

Sport harvested fish were examined for signs of oil contamination including oxganoleptic tests and residues of oil in the digestive tracts. The sport harvest was then apportioned to percentage of oil contaminated fish in the catch.

Study objectives were also to determine recreational catch and harvest of salmon, rockfish, halibut, cutthroat trout, and Dolly Varden char. Angler effort and temporal and spatial distribution and location of origin for angler effort identified

The Resurrection Bay area near Seward was documented as experiencing the lowest Sport Fishing angler effort ever recorded.

*Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 7	Salmon Spawning Area, Outside PWS	X		ADFG	$320,300	$539,400

COMMENTS

Overescapement caused by closure of the fisheries is felt to be the major oil spill impact on pink salmon in the Kodiak area (7b). The first component of this study supplements the existing escapement database and is essential to estimating overescapement impacts on pink salmon. Damage from overescapement may include a decline in average egg survival as a function of spawning density. Published studies on overescapement can be used to determine the effect of overescapement on vital rates. Escapement counting methods used for the Kodiak area will need to be validated.

A second component of this study takes place in Lower Cook Inlet (7a), and parallels the project being conducted within Prince William Sound under study #2.

Pink and chum salmon escapements for 1989 were enumerated by tidal zones for 9 streams within the Lower Cook Inlet/Kenai Fjords area. Survey stream was aerial photographed, the intertidal areas of each oiled stream was mapped, and the type and extent of oil contamination was recorded. Mussel samples were collected for hydrocarbon analysis at all streams where escapement ground surveys were conducted. Preliminary estimates of numbers of pink and chum salmon spawning within four oiled and five unoiled streams have been made. Differences in the distribution of both pink and chum salmon have been documented between oiled and unoiled streams, however one or more additional years of study are needed to evaluate the cause of these differences. In order to provide a time series of pre- and post-spill pink and chum salmon escapements in the Lower Cook Inley/Kenai Fjords area, an analysis of the historical data base must be completed and the post-spill escapement surveys must be repeated for several more years.

* Include budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 8	Egg & Preemergent Fry, Outside PWS	X		ADFG	$111,400	$293,300

COMMENTS

This study has 2 components, one in Lower Cook Inlet (8a) and the other in the Kodiak area (8b). It supplements the existing egg deposition and pre-emergence data, particularly by including more oiled sites in the sample. The results could provide direct mortality data by comparing egg survival rates in oiled and unoiled areas. In addition, the study will contribute data relevant to pre- and post-spill population comparisons, post-spill spatial comparisons, and to measuring changes in vital rates.

Sampling of eggs and early preemergent fry was successfully completed at nine streams in the Lower Cook Inlet/Kenai Fjords area during the fall of 1989. Estimates of mortality from the egg to preemergent stage for progeny of 1989 brood year spawning of pink salmon within the study streams will be made following the completed of data collection in the spring of 1990. It may not be possible to make similar estimates for chum salmon, since few chum salmon eggs were collected in 1989.

These studies will supplement the existing egg deposition and preemergence data and could provide direct mortality data by comparing egg survival rates in oiled and unoiled areas. In addition, they will contribute data relevant to pre- and post-spill population comparisons, post-spill spatial comparisons, and to measure changes in vital rates.

Reflects budgeted figures, not assessed activity costs.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 9	Early Marine Salmon Outside PWS		X	ADFG	$348,500	-0-

COMMENTS

This study was not scheduled to begin until 1990.

This study would not provide any meaningful information for assessing the impact of overescapement. In addition, in the absence of coded-wire tag fish, it does not assist in assessing growth or migration patterns in oiled and unoiled sites outside of PWS.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 10	Dolly Varden/ Sockeye, Lower Kenai		X	ADFG	$152,600	-0-

COMMENTS:

Field work was not scheduled to begin for this study until 1990. We do not believe, however, that the study will produce meaningful information for a population or sublethal impact assessment.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
11	Herring Injury	X		ADFG	$374,500	$400,000

COMMENTS

Direct mortality of adult spawning herring, eggs, and larvae due to oil contamination was measured in 1989. Although the majority of the petroleum hydrocarbon samples that were collected in this study have yet to be analyzed, preliminary findings seem to indicate strong evidence of egg/larvae impacts. The proposed 1990 study will expand the 1989 data base and further quantify impacts to the Prince William Sound herring population. In addition, since herring are an integral part of the food chain, there is evidence that oil contamination of herring could impact predators such as shore birds, sea birds, marine mammals and other marine fish species.

This study includes intensive spawn sampling and special egg mortality studies. Data gathered will be valuable for a population dynamics assessment. With regard to a sublethal analysis, no petroleum hydrocarbon sample results are available but there is seemingly strong evidence of egg/larvae impacts. We recommend (1) MFO on existing archived samples; (2) analyses for body burden; and (3) specific laboratory studies (if not available in literature) of dose-response relationship.

Specific objectives for this study are: (1) to estimate the abundance of herring using spawn deposition studies, age-weight-sex and fecundity data, and aerial survey data; (2) document the occurrence of herring spawning in oiled and unoiled areas and validate the oiled sites with quantified oil level information: (3) collect hydrocarbon samples to determine the level of contamination in adults, larvae, and eggs; (4) evaluate egg mortality and egg loss; and (5) rear herring eggs and larvae from Prince William Sound and Southeast Alaska under laboratory conditions and compare differences in egg mortality, hatch success, viable hatch, occurrence of abnormalities, growth, and larval feeding.

* Estimate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
12	Herring, Outside	PWS	X	ADFG	$60,000	-0-

COMMENTS

Aerial surveys to determine the location of spawning areas and the magnitude of herring spawn, and to document the occurence and biomass of stocks on Kodiak Island and the Alaska Peninsula were limited due to a late beginning, lack of available charter aircraft, and poor weather. No direct herring mortality was observed, and an influx of juvenile herring (age 1 and 2) was noted in many bays of the Kodiak Area. Historical data on herring length at age, from age-weight-length-sex (AWL) samples taken during the sac roe fishery, 1981-1989, are being compiled and analyzed to test against future samples for year, area, and oil spill effects on herring growth.

No significant departures have been made from the objectives of this study. They are:

1. Document the occurence of herring stocks and spawn in oiled and non-oiled areas of the Kodiak Archipelago and the Alaska Peninsula.

2. Estimate the injury to herring eggs and larvae by directly applying results from Prince William Sound Injury assessment studies.

3. Test the hypothesis that incremental growth by age is independent of oil impacts.

*where budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
13	Clam Injury	X		ADFG	$86,200	$175,000

COMMENTS

To date 20 clam hydrocarbon samples (sediments and tissues) have been submitted for analysis, 10 samples from within Prince William Sound (PWS) and 10 from outside PWS. Results from these hydrocarbon samples have not been received yet, however it is expected that clams from the heavily oiled beaches will show a high level of contamination. Additional hydrocarbon analyses and histopathology analyses can be conducted once the initial sample results are received. Length measurements for clams inside and outside PWS were recorded. Findings from this study are expected to make a valuable contribution to sublethal/ecosystem damage assessment.

The value of this study, therefore, appears to be in the contribution it would make to a sublethal/ecosystem damage assessment. We recommend sampling Protothaca, Saxidomus, and Siliqua under a balanced oiled and unoiled, clean and not cleaned design, and expanding growth analyses to include analysis of shell microstructure and an oil "stress check." We suggest conducting reciprocal transplants with indigenous clams and with a common, clean source of clams. This is a substantial redesign of the 1989 studies. Our recommendation is to combine former studies 13 and 21 into a single clam study including selected areas outside PWS.

* Budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
13	Clam Injury					

COMMENTS

(-Page 2-)

This study is designed to determine injuries to little neck clams, butter clams, razor clams and their habitats that have been impacted by the Exxon Valdez oil spill, both within and outside Prince William Sound. Specific objectives for this study are: (1) determine the level of hydrocarbon in these sites; (2) evaluate the effect of oil contamination on the tissue and organs of calms; (3) measure growth rates and determine the effect of oiling on growth; and (4) study changes in numbers of young-of-the-year clams on unoiled, oiled, and mechanically cleaned beaches.

*Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
14	Crab Injury		X	ADF&G/NOAA	$142,000	-0-

COMMENTS

Insufficient numbers of Dungeness crabs exist in western PWS to test for oil effects. Lack of baseline data on brown king crabs precludes population change detection for that species. Not enough samples were taken in unoiled sites to permit a statistically reliable comparison of oiled and unoiled areas. Also, there is no definite evidence of subtidal contamination. We recommend, therefore, that this study be discontinued.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Fish Shellfish 15	Shrimp Injury	X		ADFG	$60,500	$65,000

COMMENTS

Sampling conducted in 1989 suggested lower catch-per unit effort in oiled areas and higher mortality of eggs (which are held externally) in oiled areas. These shrimp are relatively immobile. Adult shrimp usually inhabit deep water (20-120 fathoms) areas with near-shore rocky terrain. Since oil at depth is more likely to occur after the oil has hit the adjacent beach and been picked up in sand and debris particles, this study will provide information on damage at depth as opposed to damage at or near the surface of the water.

This study addresses effects of oil on spot shrimp growth and reproduction. Sampling conducted in 1989 suggested lower catch-per-unit effort in oiled areas and higher mortality of eggs (which are held externally) in oiled areas. These shrimp are relatively immobile, near shore, and relatively deep. Oil at depth is probably more likely sometime after the oil has hit the adjacent beach and picked up in samd and debris particles. This study would provide information on damage at depth as opposed to damage being a near surface phenomenon.

There will be problems applying results to the population at large by the relatively low costs associated with this project make it worthwhile.

* Reflects budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
16	Oyster Injury		X	ADFG/NOAA	$30,500	-0-

COMMENTS

Analysis of oil spill impact cannot be made based on the results of the 1989 study. A new study could be designed using before and after spill data at the three existing oyster farms to assess whether oil affected oyster mortality or growth. Such a project may cost around $30,000. Since oysters are not a native species, however, the value of such a study to the natural resource damage assessment process is highly limited. In addition, the oyster studies are largely redundant of mussel studies.

* Projected budgeted figures, not allowed authority spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
17	Rockfish Injury	X		ADF&G	$45,600	$73,000

COMMENTS

Oil spilled from the Exxon Valdez killed demoreal rockfish in Prince William Sound in 1989. Of 20 dead demoreal rockfish brought to collection centers in Valdez and Cordova from sites of reported fish kills, five were sampled and crude oil was found to be the cause of death. Eleven of 36 bile samples analyzed from oiled areas, six weeks after the March 24 oil spill in Prince William Sound, were exposed to oil within two weeks prior to sampling. Bile is continually being produced in a rockfish's gall bladder, and the local volume of bile is replaced every two weeks. Therefore, it is apparent that oil contamination persisted in the environment well after oiling and that oil contamination has extended to benthic habitate. To date, these reports from the public and the demoreal rockfish sampled in response to these reports are the only direct evidence of death to finfish as a result of exposure to crude oil from the Exxon Valdez in Prince William Sound. Result of hydrocarbon analysis from later sampling trips will help determine how long hydrocarbons persist in the environment and the food chain.

In light of the 1989 findings of oil impacts on rockfish populations, continued study is warranted to determine the extent of oil contamination to shallow reef habitats. This study will help determine if is oil being transported to subsurface habitats and it will help determine if it is oil being transported to subsurface habitats and it will quantify the extent to which these residual hydrocarbons persistence in the environment. Continued studies will also help determine long term histopathological effects of oil contamination on rockfish and affects on the quality for human consumption.

The peer review committee suggest that this study sould be reoriented to provide evidence of the geographic extent or spill impacts on the reef community. The modified study should include (1) capturing recently recruited rockfish for age, growth, and contamination analyses; (2) sampling sessile invertebrates (e.g. suspension feeders such

*Actuals budgeted figures, not amount initially spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 17	Rockfish Injury					

COMMENTS

(-Page 2-)

Reef and the Lower Kenai Peninsula should be included in the study. Compile and interperate historical data on reef communities in Prince William Sound and the Lower Kenai Peninsula. This new study design will provide useful data for population dynamics assessment.

Continued studies of demersal rockfish populations is warranted to determine the extent of oil contamination to shallow reef habitats. Specific objectives include: (1) determine the presence or absence of hydrocarbons in demersal rockfish, benthic prey species, benthic suspension feeders, and sediments from paired oiled and unoiled sites in Prince William Sound; (2) determine the feasibility of using otolith microstruction to evaluate depressed growth as a result of oil contamination; and (3) determine the feasibility of using histopathological evaluations of gonads and pituitary glands to ascertain effects of oil contamination on growth and reproduction.

* Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish						
18	Trawl Assessment	X		NOAA	$738,800	$186,000

COMMENTS

This trawl assessment surveys for finfish other than salmon, herring, Dolly Varden char, cutthroat trout, or rockfish. These "other" finfish live their entire lives in the marine environment. Little is known about the spacial movements of some of these fish, making it difficult to determine whether any change in abundance is due to redistribution, recruitment, or survival. In addition, it is difficult to measure vital rates of these fish. Realistically, because of the high natural variability of the species, lack of data points, and uncertainty in migration patterns, there is little possibility of detecting population dynamics impacts.

Preliminary sampling, however, indicates that some fish from the first year trawl had abnormally high levels of contaminants in their bile. We recommend, therefore, a continuation of this study but at a substantially reduced level.

Representative samples of offshore trawl species should be processed for body burden. If evidence of burden exists, investigators should follow up by analyzing corresponding histopath samples, i.e. gonadal material. Investigators need to coordinate fish sample analyses with sediment sample analyses to confirm hydrocarbon source. In addition, investigators need to analyze stomach contents and literature for representative prey and to sample benthic prey for contamination (especially nearshore).

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 19	Larval Fish Injury		X	ADF&G	$413,400	$5,000

COMMENTS

This study will not prove useful in any population dynamics assessment. We recommend that he 1989 samples be archived.

* Funding will be necessary to archive samples and to complete study.

* Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 20	Underwater Observations		X	ADF&G	$550,100	-0-

COMMENTS

It is not recommended that this study continue, as no oil was observed in 1989 at any of the sites surveyed.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
~~Fish Shellfish~~ 21	Clams, Outside PWS		X	ADF&G	108,800	-0-

COMMENTS

See comments for study #13

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
~~Fish Shellfish~~ 22	Crabs, Outside PWS		X	NOAA	$111,500	$110,000

COMMENTS

In the fall, the 1989 study lacked adequate control sites to determine whether a statistically significant population difference existed between oiled and unoiled sites. No growth data were taken. Tissue hydrocarbon data were collected but cannot be readily related to growth. This study documented the occurrence of Dungeness crabs in oiled environments in the Kodiak area and collected both crabs and sediments for hydrocarbon analysis. Only one female Dungeness Crab was captured in the fall, so a fecundity analysis was impossible. This study will be completed with a spring sampling cruise to conclude its analysis of oil effects on crab fecundity.

~~Reduce budgeted figures, not amount actually spent.~~

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 23	Rockfish, Halibut, Lincod - Lower Kenai		X	ADFG	$108,400	-0-

COMMENTS

It was felt that this study be discontinued because the study would not address population dynamics and is not likely to demonstrate impacts.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	ONE YEAR BUDGET 1989 BUDGET *	ONE YEAR BUDGET 1990 BUDGET
Fish Shellfish 24	Trawl Assessment Outside PWS	X		NOAA	$2,495,000	$450,000

COMMENTS

Preliminary sampling indicates that some fish in nearshore areas outside Prince William Sound have abnormally high levels of hydrocarbon metabolites in their bile. Continued exposure of these fish to hydrocarbons in the nearshore environments can cause long-term biological effects, such as reproductive dysfunction and histopathological lesions. The final decision to continue the second years' sampling is pending approval of a detailed study plan for 1990. We recommend continuing this study, but limiting it to nearshore areas outside Prince William Sound and with a reduced effort.

* Indicates budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 25	Scallop Resources Injury		X	ADFG	$53,800	-0-

COMMENTS

The field experiment should be discontinued because of the difficulty in correlating natural scallops and aquaculture situations.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 26	Sea Urchin Injury		X	ADF&G	$45,000	-0-

COMMENTS

Any population impact, if detected, would not be large because the geographic overlap of oiled areas and green urchin distribution is so small. Moreover, the sampling protocol prevents a quantitative analysis of oil impacts for those limited areas where urchins were present. Also, other interactions may confound interpretation of any density differences. We recommend, therefore, that this study be discontinued.

*Include budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Marine Mammals						
6	Sea Otter Impacts	X		USFWS	$763,000	$1,056,000

COMMENTS

This study is very important given the number of sea otters in nearshore areas directly impacted by the spill (over 1000), the potential for estimating recovery rates, and the relatively high economic value that is likely to be assigned to sea otters. In addition, it appears that otters in off-shore areas may also have been impacted. If this is substantiated by additional study, it could dramatically increase mortality estimates.

Tests on beached carcasses should be completed to determine what percentage died from oiling and to determine the age of the otters killed. These data may allow projection of population recovery rates. A carcass search should be conducted in early spring to supplement the body count. A drift experiment should be undertaken as well to determine wash-up rates.

Sublethal impacts should also be studied as blood samples show potential liver and kidney damage. We recommend investigators apply DNA and hemoglobin adduct analyses to samples from the tagging study and existing samples, examine tag/recaptured animals for cataracts, ensure histopath analysis is double blind random. We strongly recommend a high priority be placed on body burden sample analysis, especially on tagged individuals (30-40 animals from Fall '89). Investigators should attempt to gather corroborating data on behavior, especially weanlings which can be linked to chemical analyses and fresh carcasses. The PIs should be given guidance on sampling invertebrates for toxic dose information. Further comments: 1984-85 baseline data exists; female-pup ratio data not available over time but comparable over space; use weanling mortality as a prime indicator of habitat change.

* Agency budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Marine Mammals 7	Sea Otter Rehabilitation	X		USFWS	$108,000	$130,000

COMMENTS

This study should continue as designed for the same reasons cited in comments to Study #6.

* Budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment	X		USFS	$5,436,000	$6,300,000

COMMENTS

GENERAL RESULTS/ACCOMPLISHMENTS THRU 2/28/90

The overall objective of this study is to determine the effects of various degrees of oiling on the quantity (abundance nad biomass), quality (reproduction, condition, and growth rate), and in composition (diversity and proportion of population) of key species in the critical trophic levels of coastal communities. These data will provide the evidence of damage to the overall health and productivity of these critical coastal habitats, and provide information necessary to successfully analyze the more species-specific studies on the effects of the oil spill on important terrestrial and marine mammals, marine birds, and fish and shellfish.

INITIAL RESULTS

1. Intertidal data analysis is still proceeding from 78 sampling sites involving over 4 tons of samples. Initial analysis of some samples from Prince William Sound indicate: (1) reduced glycogen production in mussels which is essential for reproduction; (2) gills of intertidal fishes from heavily oiled sites are deformed as compared to unoiled sites (these fish provide an important food link to may important predators such as bald eagles and others); and (3) other detailed findings are found in the interim report prepared 1/15/90

2. Shallow subtidal work found a "dead zone" where many fish (pacific cod, flatfish, and others) and invertebrates (squid, starfish, etc.) were found dead (see report prepared 1/15/90)

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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SPECIFIC CHANGES FROM 1989 TO 1990

1. To reduce data analysis and costs but still maintain a statistical design capable of extrapolation to entire spill area: (1) greatly reduce the supratidal work, limiting it to the Alaska penninsula with some limited ruminent analysis for support to terrestrial mammals; (2) drop estuarine and fine testured replicate sites in Prince William Sound (this would reduce the total sites by 20, leaving 30 sites in coarse textured, sheltered, and exposed rocky shores); and (3) drop exposed rocky shores in Cook Inlet/Kenai Fiords area (reducing number of sites by 10, leaving 40 in estuarine, sheltered rocky, fine testured, and coarse textured beaches).

2. Increase emphasis on direct biological effects involving recolonization, growth rates of survivors, reproductive success by increasing the number of sites visited in-part by adding 5-10 new sites in each of the Cook Inlet and Alaska Penninsula/Kodiak areas to correspond to previous work conducted by NPS at 49 sites, responding to PR comment #2.

3. Differentiate the effects of beach clean-up from the effects of MOD/heavy oiling, concentrating the activity in one location in Herring Bay in PWS (further analysis is still needed).

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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SPECIFIC COMMENTS

1. Scale back supratidal field study. Focus on particular beaches where damage is likely, such as beaches wehre winter storms force oil onto supratidal areas. Coordinate supratidal study with terrestrial mammal studies to provide information required. Continue small 1990 sampling effort on how oiling affects digestibility of key forage species (especially Elmius) in one-step and two-step digestion processes in the supratidal. Consider using walkathons to obtain information on scope of oiling. Should develop standardized procedures for photography of oiled areas.

2. First priority in intertidal habitat study should be to utilize existing "before and after" data bases to test whether oil had any biological effects on intertidal communities, and the magnitude of any such effects. An experiment-oriented scientist shuch as Highsmith should choose those data sets that represent the appropriate and rigorous contrast of control (unoiled) and oiled sites before and after oiling, using sites that were initially biologically similar. The National Park Service's quantitative quadrat data, especially the data collected by Dr. David Duggins, may be the best data for this purpose. The photographic transect data collected by the NOAA Auke Bay coastal habitat study may also be suitable, depending on whether it includes both oiled and unoiled stations, incorporates replication, contains photographs taken at exactly repeated quadrats, utilized a scale of photographs that allows sufficient discrimination of organisms, and includes oiled and unoiled sites that were initially similar biologically. All photographs that can be used in a rigorous before/after

* Indicate budgeted figures, not assumed subsidy spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1990 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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contrast should be analyzed to obtain biological data, and those data should be analyzed statistically and interpreted.

3. The major effort of the Coastal Habitat Study in Prince William Sound should be directed towards rocky intertidal and coarse textured biota on sheltered and exposed shores. This focus is a result of the extensive exposure of these areas to oil, and the importance of these areas to oil, and the importance of these areas to the foold chain. Key food chains include (1) mussels to sea otters, ducks, surf birds, and subsistence users, (2) limpets to oystercatchers and surf birds and (3) seaweeds (Fucus, etc.) to amphipods and small snails to fishes and others. Mussels are particularly important as organizing species within the rocky intertidal community and as forage species. There is a substantial ecological literature on the impact of mussels on other organisms.

4. The statistical design, which provides for sampling at random within habitat types in order to permit inductive extension to entire geographic areas, is appropriate. It must be supplemented, however, by selection of some non-random, deliberately selected, control and oiled sites. Sampling of lightly oiled sites should be scaled back. Should consider experimental study to determine effects of light vs. moderate/heavy oiling.

The problem of providing control sites with similar geographical, biological and salinity characteristics must also be addressed. Although the statistical framework is elegant, it should be maintained only for the intertidal study habitats and even for those the overly ambitious work schedule may prevent the use of this statistically elegant approach.

* Indicates budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Coastal Habitat						
1	Comprehensive Assessment					

COMMENTS

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5. The major problem with the study is how to reduce the balance of the work load of the biologists with the analytical resources so that results can be obtained in a timely fashion. Either sites must be reduced or more lab sorters hired. Data collection and analysis for the summer 1990 field season should be completed by January 31, 1991.

6. The oiling status used to classify intertidal sites and to extrapolate to basin-wide effects cannot be based solely upon the September walkathon, because there had been significant decreases in oiling at some sites by September. The study should use observational data, plus all available historical data pertaining to the study sites. The Department of Environmental Conservation will provide a geomorphologist for each sampling area that will accompany the field sampling crew to document the amount of oil along each sampling transect, as well as, the horizontal, vertical, and penetration.

7. All possible information on cleanup efforts must be assembled and compared against each study site to insure that cleanup has not caused an improper assignment of oiling status at any study site.

8. For rocky intertidal sites, and perhaps for some other intertidal habitat categories, some of the seven set-aside areas where no oil cleanup was performed should be utilized to assess the biological impact of oiling as separate from cleanup activities. This is important both to show effects separtately and for future management of oil spill response activities. A study to separate effects of oil and cleanup requires careful

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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pairing of some oiled set-aside areas with nearby presumably ecologically analogous unoiled sites and oiled-but-cleaned sites. Since several different cleanup methods wereemployed, this design could become rather elaborate and extensive but limited information on the exact mode and intensity of cleanup activity probably precludes an elaborate design.

9. The 1990 study of intertidal areas should include explicit attempts to assess recovery rates of oiled systems. These should include some studies of recolonization rates on oiled vs. unoiled plots and should incorporate the necessary statistical designs to permit powerful tests of effects of oiling on recruitment of key rocky intertidal species. If any long-lived species or species with limited dispersal abilities appear affected by oiling, some attention to their site of recruitment and recovery should be made. Such species include certain starfish, soft corals, coralline algae, tunicates, etc.

10. Larval recruitment of barnacles, limpets and possibly benthis algae could be measured by matching rocks of similar composition from heavily oiled and totally unoiled sites, cleaning half of each rock chemically, stabilizing the rocks in intertidal areas both that retain oil and are free of oil. The design has four treatments, control for the chemical treatment site affects, and will permit a quantitative assessment of recruitment. The same design using fibrous materials such as hemp or polyester rope could be used to study recruitment of mussels.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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11. Reestablishment of soft botton benthos could be studied by constructing bottomless and topless boxes of some inert material such as plexiglass, filling half with oiled sediment and half with clean sediment, after removing most or all of the resident fauna. Replicated pairs are placed in unoiled and oiled environments, perferably in low energy areas.

12. Annual or daily growth rates, corrected for individual size of bivalves, fish or benthic algae should be compared on a before-and-after or on an oiled vs. unoiled basis to provide information on whether the presence of oil is correlated with impaired biological performance.

13. Shallow subtidal studies should focus on three habitat types: nereocystis, laminarian and eelgrass beds. A limited number of sites (approximately 6) should be selected to represent heavily oiled and control sites with appropriate comparisons for each of the three habitat types and enclosed embayments and more exposed shores.

Sufficient replication to allow statistical application to the entire affected areas is not feasible. Comparisons must be made between selected oiled sites and appropriate controls on a pair-wise basis. This means that there are no compelling reasons to continue the spatial coupling of intertidal and shallow subtidal studies.

* Reflects budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Coastal Habitat 1	Comprehensive Assessment					

COMMENTS

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Rather, the following criterial should be used (in order of importance) to guide the selection of sampling sites: (1) Representative of targeted habitat types coupled with appropriate controls; (2) consideration of sites sampled in 1989; (3) Tie in with subtidal sediment sampling; (4) Tie in with intertidal sampling.

It is critical to limit the extent of these studies such that they may be feasibly completed by January 31, 1991. Accordingly, consideration should be given to limiting quadrat size and the depth ranges sampled. Additionally, experimental studies and observations contributing to the sublethal effects assessment of key species should be integrated with the field studies and performed at the same locations. In this regard, sampling at the subtidal habitat sires may be conducted twice during the field season at selected sites, allowing the deployment and recovery of field experiments. Attention should be directed to the sampling of epiphytic crustaceans which are important preyitems for a variety of resource species.

In developing the detailed study plan, investigators should consider taking one sampling in 1990 rather than two out of concern for cost and ability to analyze samples.

*Authors budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air Water						
1	Geog. Extent Temporal Persistence		X	ADEC	$343,500	-0-

COMMENTS

A report will be available in late February consisting primarily of an atlas of maps showing the type and location of oil from all aerial tracking performed by ADEC with confirming data where available from NOAA overflights. Satelite observational data, analyzed by the University of Alaska at Fairbanks, will also be available, showing location and extent of oil on days where satelite imagery was available. This study has been subsumed in large part by proposed Air/Water Study #6. We recommend, therefore, that it be discontinued but that $25,000 be allocated to complete maps and reports (included in wrap-up costs).

The objective of this study is to document the location and extent of oil sheens in the water.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
~~Air Water~~ 2	Injury to Sub-tidal Resources	X		NOAA/ADEC	$883,000	$800,000

COMMENTS

A total of 1,160 sediment samples were collected from the inter-tidal and near shore sub-tidal regions of PWS and the Gulf of Alaska. No final results are available because analyses have not been completed. However, preliminary analysis of about 800 samples using the ultra-viloet fluorescence spectrophotometry indicates that, in bays where oil heavily contaminated the intertidal region, subtidal sediments may have suffered injury.

We recommend this study continue as "Injury to Intertidal and Subtidal Sediment Resources" with emphasis on determination of degradation rates for the higher molecular weight components typical of residual oil.

Objectives of this study are to: 1) determine occurrence, persistence, and chemical composition of petroleum hydrocarbons in subtidal marine sediments; 2) Provide marine sediment data to assist agencies in mass balance calculations on the fate of oil in the marine environment; 3) Relate subtidal oil concentrations to adjacent intertidal concentrations and other studies; and 4) Identify restoration methods where injury has occurred.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
~~Air~~ ~~Water~~ 3	Geog. & Temp. Distrib. in Water Column	X		NMFS	$595,500	$564,500

COMMENTS

Water samples were collected in 1989 to measure the levels of water column contamination by dissolved aromatic hydrocarbons. Mussels were deployed in cages to document the longer-term presence of hydrocarbons in these waters.

Surface water was sampled for analysis of voltaile aromatic hydrocarbons at ten locations and interstitial water was sampled for broader hydrocarbon analysis and microbial studies at twenty-four sites. In surface water, detectable concentrations of aromatic hydrocarbons were found in 7 of 22 samples. For interstitial samples, hydrocarbon analysis has not been completed. However, preliminary microbial studies suggest that populations on impacted shorelines are responding to oiling by shifting towards greater numbers of hydrocarbon degraders and that these degraders possess the ability to mineralize the relatively persistent and toxic polynuclear aromatic hydrocarbon fractions in situ.

Continue with the following modification: 1) Terminate water quality cruises; 2) expand deployment of mussel cages to test for the presence and bioavailability of petroleum hydrocarbons in the water column; deployment sites should focus on areas of heavy intertidal contamination and sites representative of degrees of intertidal and subtidal oiling, substrate type, and type of exposure; 3) delete interstitial water sampling component, since technique does not accurately gauge injury to interstitial water; 4) ADEC should review its 1989 water quality data in conjunction with Technical Services No. 1 investigators for possible incorporation into study (separate database); this is important as it is key evidence of early acute exposures in the water column; and 5) obtain 1989 sediment trap data from UAF and incorporate as separate data base if QA/QC standards are met.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air / Water 3	Geog. & Temp. Distrib. in Water Column					

COMMENTS

(-Page 2-)

Objectives of this study are to: 1) document water column hydrocarbon concentrations at a range of depths, locations, and times; 2) quantify injury to water resources; 3) Relate water injury to biological injury; 4) evaluate trends in ambient water quality using biological indicators as surrogates for chemical measurements; and 5) identify restoration methods through assessment of natural microbiological capacity to mineralize petroleum.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Air Water 4	Injury to Deep Water		X	NOAA	$378,900	-0-

COMMENTS

We recommend that this study be combined with Air/Water No. 2 and that Air/Water No. 4 be discontinued.

Objectives of this study were to: 1) estimate exposure of benthic resources to petroleum; 2) determine and quantify injury to the benthic infaunal resource; 3) determine persistence of injury to benthic resources; and 4) identify restoration methods where injury has occurred.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1990 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air Water						
5	Injury to Air		X	ADEC	$106,500	-0-

COMMENTS

A contract for completion of this modeling study has recently been awarded, therefore, no results are available at this time. We recommend that work in process be completed and that no additional work be undertaken.

Objectives of this study are to: 1) model loss rate of VOCs from crude oil; 2) model the ambient VOC concentrations as a function of time and distance from Bligh Reef; 3) Establish "zones of concentration" from predicted VOC concentration isopleths for levels of health-related injury; and 4) Evaluate "zones of concentration" for risk assessment impacts on the environment.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Technical Services 1	Hydrocarbon Analysis	X		NOAA/USFWS	$2,300,000	$2,000,000

COMMENTS

This study implemented the hydrocarbon quality assurance/quality control programs and directed the analyses of all hydrocarbon-matrix samples through qualified contractor laboratories. Analysis of all 1989 samples is not complete and will continue into 1990

Continue with the following modifications: 1) establish an ultraviolet fluorescence (UVF) screening procedure for 1990 sediment analyses and provide collection and handling procedures to PIs; this will allow prioritization of samples for GC/MS and provide a quick indicator of sediment contamination; 2) review ADEC and NOAA response data and any other available data and incorporate into data base if QA/QC standards are met, establishing separate data base(s) for unprivileged and less reliable data; 3) institute bar coding of samples for more efficient sample tracking; 4) review and approve all analytical QA/QC plans (e.g. for DNA adduct analyses); 5) prepare brief quarterly report showing type and number of samples that have been analyzed, are being analyzed or awaiting analysis, and showing the number of replicates and samples to be archived; and 6) continue training investigators in proper procedures.

* Authority budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Technical Services						
2	Histopathology	Pending[2]		ADFG	$440,200	($75,000)[2]

COMMENTS

Some samples have been archived and are available for analysis, as needed. The State of Alaska will provide a budget to archive existing histopathological samples and any samples taken in 1990.

Objective:

A) Measure the incidents of histopathological conditions, and external lesions in selected species of birds, mammals, finfish, and shellfish collected in collaboration with relevant biological field investigations.

[2]Pending review and development of recommendation by Management Team regarding future storage of samples; anticipated cost if continued $75,000.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Technical Services						
3	Mapping	X		ADNR/USFWS	$670,000	$798,200

COMMENTS

Continue to QA/QC all maps. Coordinate with resource specific studies.

This project provides geographic mapping of all resource inventory data and related damage statistics and models statistical questions against this database such as, "How may miles of State tidelands were oiled, plot the average animal and plant kilil statistics sampled over these lands, and determine an injury amount by projecting these field conclusions over all State tidelands that could not be sampled due to const constraints and the remote nature of the affected coastline miles." Specifically, this project provides the following services:

1) Capture and manage the base resource inventory data needed to conduct damage assessment work, which includes uplands land status (ownership), ecological shoreline classifications, and the degree of oil impact over the extent of the spill. These data are being fully qutomated on the oil spill computer subsystem and integrated to a common coastling model.

2) Upon this common resource inventory base, combine the following damage statistics:
   a) The locations and values of all chemical point samples collected by researchers at both NOAA and ADEC.
   b) The locations and values of ecosystem impacts collected by the Coastal Habitat Study Group headed by USFS and ADF&G.
   c) The locations and values of injury statistics compiled by the Fish/Shellfish, Marine Mammals, and Birds study groups

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Technical Services 3	Mapping					

COMMENTS

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d) The locations of all State land resources to include their usage designations. These data will include locations of shore fishery leases, anadromous stream locations, and lands designated with recreational uses.

3) Provide the study group with maps and statistical reporting that represent unique combinations of the data relevant to thier study conclusions of total damage assessed. For example, the Coastal Habitat Study Group designed a stratified sample using groupings of ecological shoreline classifications and oil impact. As of August 1998, over 250 individual map products have been generated and distributed to this study group.

4) Provide rigorous data repository and archival services to the State and CERCLA litigation teams. Insure documentation of all data standards and procedures, and project audit trails to meet standards of data admissibility.

5) Provide models of selected combinations of collected data that are appropriate to specific damage assessment problems. For example, provide volume estimates of oil moving into selected resource environments relative to State civil fine statutes.

*Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Technical Services 3	Mapping					

COMMENTS

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6) Work cooperatively with ADEC, ADF&G, and the Attorney General's office to provide geographic information computer support. Work cooperatively with the federal agencies coordinated through the CERCLA Trustee Council.

7) Provide map products and statistical reports to upper level decisionmakers for public presentation and congressional/legislative review.

* Reduced budgeted figures, and amount actually spent.

NEW STUDIES

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air Water						
6	Oil Toxicity	X		NOAA	-0-	$870,000

COMMENTS

I. Introduction

The rationale for this study is simply that there is no existing program that will supply all the needed data on the geographical spread, chemical characteristics and toxicity of oil remaining in Alaskan waters from the Exxon Valdez spill. The proposal presents a coordinated plan for obtaining such information. It will generate data that will be used to assess the geographical extent and degree of damage to the environment from residual oil. The data from this proposed study can be used to counter the argument that weathering and degradation have rendered the remaining oil non-toxic. It is expected that elements of this project will require at least two years of study.

Study Plan

There are four main components to the program; (1) a mass balance or oil budget, (2) assessment of toxicity of environmental samples of oil in a standard bioassay, (3) assessment of the toxicity and chemical characteristics of oil degradation products, (4) assessment of the toxicity of weathered oil in laboratory studies using sensitive early life history stages of marine animals (e.g. larval fish). Some data from existing studies can be used, for example many of the G.C./M.S. analyses of weathered oil in sediments for various studies can be used to support this present study. Nonetheless, a substantial amount of new effort will be required to provide useful information for the case. A preliminary mass balance model is anticipated to be constructed with one year's expenditure, and if necessary can be modified to provide more detail as determined to be necessary. Data from toxicity studies will be analyzed on an ongoing basis to determine the need for continued study.

* Indicates budgeted figures, not amounts actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air Water 6	Oil Toxicity					

COMMENTS

(-Page 2-)

The mass balance study will estimate the amount of oil in the water, on the beaches and in the air at several times after the spill and continuing past 1991. Some new information will be required but much of the currently available data would be used to provide even rough estimates of where the oil has gone. Based on these preliminary results, it may be desirable to undertake a more comprehensive mass-balance program. That effort needs further refinement and is not budgeted in this proposal.

The assessment of toxicity of oil remaining in the environment will be based on sampling at 15-20 sites, spread over a large geographical area and assessed using a standard toxicity assay, such as microtox. These sites will be sampled every six months and assayed. As deemed appropriate chemical analyses of environmental samples will be done to correlate with the results of the bioassays. Samples from the supratidal, intertidal and subtidal areas of each site will be screened initially with UV fluorescence to eliminate samples inappropriate for further analysis. Emphasis will be placed on testing sand, gravle and cobble samples. In heavily oiled beaches interstitial water samples will be tested. The 15-20 sites will be selected to cover a wide geographic range and deliberately placed at sites most likely to show continuing effects.

The assessment of the toxicity and chemical characteristics of oil degradation products will also be based on environmentally collected samples from heavily oiled beaches. Large volumes of interstitial water and smaller volumes of variously weathered oil residues will be chemically fractionated using standard techniques of column chromatography. A polar fraction will be eluted from the column for each sample.

* Reduce budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air Water						
6	Oil Toxicity					

COMMENTS

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A small number of selected samples will then be subjected to further analyses by mass spectrometry, gas chromatography, liquid chromatography, infrared spectrophotometry and nuclear magnetic resonance spectrometry to determine its composition. Subsamples of these fractions will be tested in simple assays to determine their toxicity. Microtox and fish cell assays are appropriate for toxicity testing on small volume samples of this sort. Based on the results of detailed characterization of these samples of degradation products and their toxicity, the study will either be expanded or curtailed.

The laboratory studies will test the toxicity of weathered oil to sensitive early life history stages of marine organisms. Columns of beach cobble and gravel coated with oil will be flushed with sea water on a periodic basis and the resultant effluent used to expose larval stages of animals. Various lethal and sublethal endpoints will be measured. In addition this will be closely coordinated with the studies of oil degradation products. It is suggested that pink salmon and herring be used as study species to provide cooroborative evidence for initial findings of damage to these species in 1989.

II. Personnel and Organizations

Not all aspects of this study can be carried out by the same organization, but they should be coordinated by one scientist with some experience in hydrocarbon chemistry, toxicology and microbiology. Properly qualified individuals in each case should carry out the research. Most of the chemical analysis can be done under the current technical

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Air Water 6	Oil Toxicity					

COMMENTS

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services components of the NRDA studies. The bioassay of environmental samples would probably be best done by a commercial laboratory experienced in running the microtox assay. The assessment of oil degradation products could be let as a contract to a university research laboratory. The laboratory exposures of eggs and larvae could be done by an existing laboratory, e.g. Auke Bay laboratory. Scientific coordination should be done by a designated scientist in consultation with a small working group of peer review scientists.

III. Budget

Estimated costs.

Mass Balance	100K
Bioassays of environmental samples	250K
Degradation products	120K
Laboratory toxic experiments	250K
Logistics	150K
TOTAL COST	870K

* Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Fish Shellfish 27	Sockeye Salmon Overescapement	Pending[2]		ADFG	-0-	($589,300)[2]

COMMENTS

In 1989, excessive over-escapement of sockeye salmon occured in upper Cook Inlet (Kenai River), Chignik, and in Kodiak associated with extensive fishery closures due to oil from the Exxon Valdez Spill. As a result, the number of sockeye salmon entering four important sockeye producing lake systems exceeded levels that are thought to produce maximum sustained yield.

These sockeye systems are thought to be rearing limited where very large spawning escapements produce more fry than can be supported by the lake's productivity. When the fry abundance greately exceeds the lake's carrying capacity, prey resources are cropped to the extent that very reduced growth, increased freshwater mortality, poor qualiyt smolts, increased carryover percentage, and increased marine mortality occur.

This project will examine the effects of large 1989 spawning escapements on the resulting progeny for a selected subset of the above mentioned sockeye producing lake systems. This project will yield information on the loss of future sockeye salmon products from this large 1989 overescapement.

For each of the 4 lake systems identified, the following will be conducted:

1. A hydroacoustic/townet survey will be conducted during the summer (late June) and fall (September) of 1991 and 1992, to estimate abundance, size, and age composition of the juvenile sockeye population.

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 27	Sockeye Salmon Overescapement					

COMMENTS

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2. Fyke net or inclined plane trap sampling will be conducted during 1991 and 1992 to estimate age and size composition of the outmigrating smolt population.

3. For Kenai/Skilak lake, the abundance of the 1991 and 1992 outmigrating smolt population will be estimated with a mark/recapture study using inclined plane traps.

[2]Council to make recommendation following review of detailed study plan; anticipated cost if continued - $572,000.

*[illegible] budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 28	Run Reconstruction		Pending[2]	ADFG	-0-	($50,000)[2]

COMMENTS

It is expected that a number of the Fish Projects being conducted on salmon in Prince William Sound, Cook Inlet and Kodiak will demonstrate the causes of damage due to the Exxon Valdez oil spill. The ability to quantify the amount of damage may rest heavily upon an assessment of the returning adults. Using the tools developed under Fish 30 Database Management and Fish 28 Ecological/Life History Modelling and the recaptures from the coded wire tag experiments, various combinations of catch and escapement can be calculated that will be used to estimate the total return (catch plus escapement). The differences in total returns of adult salmon to different areas of Prince William Sound and at different times of the season will be analyzed to measure the amounts of damage to salmon runs that were subject to different amounts of oil on the spawning grounds and while migrating to sea in the spring of 1989. Run reconstruction can also be used to determine if run timing is normal in the returning year.

[2]Council to make recommendation following review of detailed study plan; anticipated cost if continued - $50,000.

* Budget figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 29	Ecological and life History Model		Pending[2]	ADFG	-0-	($50,000)[2]

COMMENTS

In order to demonstrate the potential for long term harm to the salmon populations from the effects of oiling, it is necessary to sum up the impacts of a number of factors at a number of life history stages such as reduced growth of fry, mortality of eggs and fry, loss of spawning habitat, and overescapement. Such measures are being generated in the NRDA Fish/Shellfish studies 1-10. The magnitude of the overall loss in productivity for a salmon stock can best be understood by looking at survival at each life history state, (egg, fry, smolt, subadult, adult) over the life span of all fish of the same age, and over all age groups in the population. Such a bookkeeping program is necessary to take advantage of the NRDA data being already collected, and to integrate existing historical data into documenting the actual and potential damages due to oiling. The stocks and areas covered by this computer-based mathematical model are those included in the portions of Fish/Shellfish studies 1-10 as approved by the trustees for funding in 1990, plus any stocks which were observed to have suffered overescapement in 1989 as a result of the presence of oil. The work can start immediately using data from NRDA 1989 and from existing historical sources. The model is termed ecological, because interactions of salmon with other biological and physical components of the environment could be added as they are defined in other studes.

[2]Council to make recommendation following review of detailed study plan; anticipated cost if continued - $50,000.

* Reduce budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	1990 BUDGET
Fish Shellfish						
30	Salmon Database Management		Pending[2]	ADFG	-0-	($120,000)[2]

COMMENTS

Large quantities of data are being analyzed in order to demonstrate the fact and extent of injury to natural resources due to oiling. The purpose of this study is to make original data readily available to agency and non-agency personnel so that data analysis can be conducted, and so that all analysis can be accomplished faster and at less cost than is presently possible. The data to be placed under the database management system (DBMS) will be drawn from two categories; 1) historical data necessary to the interpretation and implementation of the results of NRDA studies, and 2) data resulting from NRDA studies. It is envisioned that the DBMS will be useable by any authorized person with access to a standard personal computer (IBM compatible, MS-DOS, 640K RAM, 20M hard disk) to readily and quickly structure data for CRT viewing, printing, and use by statistical, spreadsheet, and other analytic software. Structuring data required that original data in electronic form be retrieved and ordered according to user specified criteria of time, space, and selection of variables. Since readily available statistical software packages permit extensive compuational manipulation of data, it is not envisioned that the DBMS will possess extensive computational options. Rather it is proposed that the DBMS be constructed to meet the following criteria in order of priority; 1) completeness of contents, 2) speed of retrieval, and 3) ease of use in assembling primary data into data into data sets for further analysis by other software. Furthermore, the DBMS will take advantage of existing DBMS applications currently available in the Alaska Department of Fish and Game.

In addition to NRDA project data, examples of historic data include commercial catch and effort data for the species and areas targeted in the Fish/Shellfish studies 1-10, all relevant biological data on age, size at age, growth at age, stock identification, spawning escapements, and fry fingerling and smolt production.

* Indicate budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Fish Shellfish 30	Salmon Database Management					

COMMENTS

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Strategically it is logical that this study be broken into substudies by major species assemblages such as salmon and shellfish.

[2]Council to make recommendation following review of detailed study plan; anticipated cost if continued - $120,000.

* Indicate budgeted figures, not amount actually spent.

RESTORATION

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1	X		ADFG/EPA	$500,000	$1,700,000

COMMENTS

I. Introduction

The ultimate purpose of this project, Restoration Planning 1, is to identify actions that may be taken to restore the ecological health of the areas affected by the Exxon Valdez oil spill.

Although the 1989 Damage Assessment Plan had a budget of $500,000 for Restoration Planning, activities were not initiated until late in the year; no substantial funds were expended. The Project, however, is expected to continue in 1991 and beyond, as needed. At any time during this process, the Trustees may implement restoration measures demonstrated to be ecologically sound and cost effective, subject to the availability of funding.

II. Study Plan

As described Below, six major tasks will be carried out in 1990: (1) conduct a Public Restoration Symposium; (2) conduct local Public Scoping Meetings; (3) conduct a series of Technical Expert Workshops; (4) conduct a comprehensive Literature Collection/Review; (5) develop and conduct Feasibility Studies; and (6) prepare draft Restoration Methodology/Planning Process report.

* Outlook budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1					

COMMENTS

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Restoration Symposium: A two-day public symposium will be held in Anchorage, March 26-27, 1990 to begin the scoping process. This meeting will disseminate information about the restoration planning process and invite public comments about restoration needs and opportunities. Alaska Natives, environmental groups, the fishing industry, and other interested constituencies will be invited to participate. Scientists and others who have experience with restoration of natural resources are being invited to make presentations. The meeting will be recorded, and a summary of comments and ideas presented at the symposium will be prepared for inclusion in the Restoration Methodology/Planning Process. Budget: $50,000.

Public Scoping Meetings: A series of six public meetings will be held in major communities directly affected by the spill: Cordova, Valdez, Whittier, Seward, Homer, and Kodiak. Persons directly affected by the spill will have the chance to express their opinions about restoration needs, methods, and priorities. The meetings will be recorded, and summarized for inclusion in the Restoration Methodology/Planning Process. Budget: $40,000.

Technical Expert Workshops: A series of closed meetings will be held to exchange ideas among damage assessment principal investigators, peer reviewers, and key scientists. The purpose of the workshops is to identify and evaluate the

* Reflects budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1					

COMMENTS

feasibility and effectiveness of restoration projects, including those suggested by the Public. Because it will be necessary to discuss confidential Damage Assessment information, the workshops will be closed to the public. Budget: $200,000.

Literature Collection/Review: Drawing on existing bibliographies and new information, published and unpublished literature on the restoration of damaged natural resources will be collected and reviewed. Results of the literature review will serve as background for the Technical Expert Workshops and the entire restoration planning process. The results will be summarized in the Restoration Methodology/Planning Process. Budget: $90,000.

Feasibility Studies: Tasks 1-4 will identify a variety of restoration options. To determine whether or not some of these projects are technically feasible and cost effective, a series of carefully targeted studies may be necessary. These studies may include evaluations of both field restoration techniques and potential opportunities for replacement or acquisition of equivalent-value resources. In 1990 only limited feasibility studies will be undertaken, but in 1991 there will be increased emphasis on such studies. Budget: $500,000.

* Outside budgeted figures, not amount authority sought.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1					

COMMENTS

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Development of draft Restoration Methodology/Planning Process: Results from tasks 1-5, as well as well as other Damage Assessment studies, will be used in the development of the draft Restoration Methodology/Planning Process. An initial report will be completed by July 1, 1990, and distributed to the public; a second report will be completed prior to February 28, 1991. Each report will include a matrix of species, habitats, and other ecosystem components potentially affected by the oil spill, and corresponding restoration options to the extent that such options have been identified at that time. Each report will also summarize results of the scoping tasks (i.e. tasks 1-5 above). These summaries will also be published and distributed as separate documents. Plans for any Feasibility Studies to be conducted in 1990, will be presented in the first report. Reports that directly involve confidential Damage Assessment data will not be distributed to the public. Budget: $150,000.

III. Personnel and Organizations

The Restoration Planning Project is directed by the Trustee Council through the Restoration Planning Work Group, consisting of representatives from the Environmental Protection Agency, the Department of the Interior, the National Oceanic and Atmospheric Administration, the U.S. Forest Service, The U.S. Fish and Wildlife Service, and the Alaska Departments of Fish and Game, Natural Resources, and Environmental Conservation. Contract support will be necessary for conducting the symposium, public scoping ›etings, literature review, feasibility studies, and report preparation.

* Includes budgeted figures, not amount actually spent.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Restoration Planning 1	Restoration Planning 1					

COMMENTS

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IV. Budget

*Estimated costs:

Symposium:	$50,000
Scoping Meetings:	$40,000
Technical Workshops:	$200,000
Literature Collection/Review:	$90,000
Feasibility Studies:	$500,000
Restoration Methodology/Restoration Plan Development:	$150,000
Salaries:	$600,000
Travel:	$70,000
TOTAL:	$1,700,000

* Overhead costs of 20% not included.

* Reflects budgeted figures, not amounts actually spent.

ARCHAEOLOGY

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Archeology 1	Archeological Impacted Sites	X		USFWS	$200,000	$1,000,000

COMMENTS

There may be as many as 10,000 archeological or historical (cultural) resource sites in the area impacted by the oil spill. Cultural resources are considered to have high value from a research, education, and intrinsic perspective. The objective of this study is to determine what significant cultural resource sites have been impacted by the spill and determine the type and extent of injury to the sites. Impacted sites are to be inventoried and classified according to site type, degree of oiling, significance, etc. based on available information from response effort records and other available sources, with any significant gaps in data filled in by field survey as necessary. Injury to sites is to be assessed by detailed field investigation and lab testing of a representative sample of sites in oiled and nonoiled areas for such effects as physical and chemical changes in the soil column relevant to radiocarbon age determinations, erosional changes, and vandalism. Assessment results are intended to provide information useful to establishing recovery potential, restoration methods, feasibility, and cost, and valuation of the extent of injury to sites.

* Actual, budgeted figures, not amounts initially agreed.

EXXON VALDEZ NRDA
STUDY RECOMMENDATIONS

STUDY NO.	STUDY TITLE	RECOMMENDATION: CONTINUE	RECOMMENDATION: DISCONTINUE	LEAD AGENCY	OIL YEAR BUDGET 1989 BUDGET*	OIL YEAR BUDGET 1990 BUDGET
Archeology 1	Archeological Impacted Sites					

COMMENTS

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* This study was included among the economic uses group of studies for 1989. For 1990, the inventory and injury assessment portions of the study, described above, have been segmented from this group, like other injury assessment studies that do not include economic valuation as a component , for more efficient performance of the study. The economic valuation portion of cultural resource damage assessment remains included in the economic uses group of studies.

** No work beyond preparation of a study plan and preliminary review of existing information regarding sites has been accomplished thus far, so little of the 1989 budgeted amount has been expended.

* Reflects budgeted figures, not amount actually spent.

ECONOMICS

(Pending)

COST SUMMARY

NEW STUDIES

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Air/Water					
6	Oil Toxicity Study	X		-0-	$ 870,000
Fish/Shellfish					
27	Sockeye Salmon Over-escapement		Pending	-0-	($572,000)[2]
28	Run Reconstruction		Pending	-0-	($50,000)[2]
29	Ecological and Life History Model		Pending	-0-	($50,000)[2]
30	Salmon Database Management		Pending	-0-	($120,000)[2]
			Subtotal for New Studies:		$ 870
			Subtotal for Pending New Studies:		$ 792,000

TOTAL COST

Pending Studies		Continuing Studies	
Subtotal (except economics):	$ 1,516,000	Subtotal for New and Continuing studies:	$23,721,300
Overhead (20%): (except economics):	$ 303,200	Overhead (20%):	$4,744,260
		Budget for summarizing data and writing reports on studies recommended to be discontinued:	$140,000
TOTAL COST:	$ 1,819,200	**TOTAL COST:**	$28,605,560

[1]Spill year is March 1 - February 28

[2]Cost of study, if continued

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Technical Services					
1	Hydrocarbon Analysis	X		$2,300,000	$2,000,000
2	Histopathology		X	$ 440,200	($75,000)[2]
3	Mapping	X		$ 670,000	$ 798,200
Restoration					
1	Restoration Planning	X		$ 500,000	$1,700,000
Archaeology					
1	Archaeological Survey	X			$1,000,000
Economics					
1	Economic Studies	Pending		$2,800,000	Pending
			Subtotal for Continuing Studies:		$22,851,300
			Subtotal for Pending studies (except economics):		$ 724,000

[1]Spill year is March 1 - February 28

[2]Cost of study, if continued

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Fish/Shellfish					
21	Clams, Outside PWS		X	$ 108,800	-0-
22	Crabs, Outside PWS		X	$ 111,500	$ 110,000
23	Rockfish, Halibut, Lingcod-Lower Kenai	X		$ 108,400	-0-
24	Trawl Assessment, Outside PWS	X		$2,495,800	$ 450,000
25	Scallop Resources Injury	X		$ 53,800	-0-
26	Sea Urchin Injury		X	$ 45,000	-0-
Coastal Habitat					
1	Comprehensive Assessment	X		$5,436,000	$6,300
Air/Water					
1	Geog. Extent/Temporal Persistence		X	$ 343,500	-0-
2	Injury to Subtidal Resources	X		$ 883,000	$ 800,000
3	Geog. & Temp. Dist. in Water Column	X		$ 595,500	$ 564,500
4	Injury to Deep Water		X	$ 378,900	-0-
5	Injury to Air		X	$ 106,500	-0-

[1]Spill year is March 1 - February 28

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Fish/Shellfish					
4	Early Marine Salmon Injury	X		$ 829,200	$ 630,000
5	Dolly Varden/Cutthroat Injury	X		$ 437,400	$ 290,000
6	Sport Fisher Harvest & Effort		X	$ 175,900	-0-
7	Salmon Spawning Area, Outside PWS	X		$ 320,300	$ 539,400
8	Egg & Preemergent Fry, Outside PWS	X		$ 111,400	$ 293,300
9	Early Marine Salmon, Outside PWS		X	$ 348,500	-0-
10	Dolly Varden/Sockey, Lower Kenai		X	$ 152,600	-0-
11	Herring Injury	X		$ 374,500	$ 400,000
12	Herring, Outside PWS		X	$ 60,000	-0-
13	Clam Injury	X		$ 86,200	$ 175,000
14	Crab Injury		X	$ 142,000	-0-
15	Shrimp Injury	X		$ 60,500	$ 65,000
16	Oyster Injury		X	$ 30,500	-0-
17	Rockfish Injury	X		$ 45,600	$ 73,000
18	Trawl Assessment	X		$ 738,800	$ 186,000
19	Larval Fish Injury		X	$ 413,400	$ 5,000
20	Underwater Observations		X	$ 550,100	-0-

[1]Spill year is March 1 - February 28

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Marine Mammals					
2	Killer Whale	X		$ 200,000	$ 255,000
3	Cetacean Necropsy		X	$ 73,000	-0-
4	Sea Lion	X		$ 270,000	$ 161,000
5	Harbor Seal	X		$ 245,000	$ 135,000
6	Sea Otter Impacts	X		$ 763,000	$1,056,000
7	Sea Otter Rehabilitation	X		$ 108,000	$ 130,000
Terrestrial Mammals					
1	Sitka Black-Tail Deer	X		$ 87,000	$ 17,300[3]
2	Black Bear	X		$ 139,700	$ 10,
3	River Otter		Pending	$ 287,700	($300,000)[2]
4	Brown Bear	X		$ 162,700	$ 115,100
5	Carnivores/Small Mammals	X		$ 302,400	-0-
6	Mink Reproduction		Pending	$ 192,200	($139,000)[2]
Fish/Shellfish					
1	Salmon Spawning Area Injury	X		$ 144,800	$ 391,300
2	Salmon Eggs & Preemergent Fry	X		$ 149,100	$ 302,800
3	Salmon Coded Wire Tagging	X		$1,943,400	$1,943.400

[1]Spill year is March 1 - February 28

[2]Cost of study, if continued

[3]If the Trustee Council determines that further study is warrante after completion of the winter survey, the total 1990 budget will be $126,600

COST SUMMARY
EXXON VALDEZ NRDA STUDY RECOMMENDATIONS

CONTINUING STUDIES

STUDY No.	STUDY TITLE	RECOMMENDATION: CONTINUE	DISCONTINUE	SPILL YEAR[1] 1989	SPILL YEAR 1990
Birds					
1	Water Birds/Beached Birds	X		$ 258,000	$ 625,000
2	Census & Seasonal Distribution	X		$ 565,000	$ 470,000
3	Seabird Colony Surveys	X		$ 440,000	$ 250,000
4	Bald Eagles	X		$ 445,000	$ 500,000
5	Peregrine falcons	Pending		$ 43,000	$(200,000)[2]
6	Marbled Murrelets		X	$ 115,700	-0-
7	Storm Petrels		X	$ 135,000	-0-
8	Black-Legged Kittiwakes		X	$ 190,000	-0-
9	Pigeon Guillemots		X	$ 109,500	-0-
10	Glaucous-Winged Gulls		X	$ 73,000	-0-
11	Sea Ducks	X		$ 146,000	$ 100,000
12	Shorebirds		X	$ 166,000	-0-
13	Passerines	X		$ 59,000	$ 10,000
14	Migratory Birds		X	$ 10,000	-0-
Marine Mammals					
1	Humpback Whale	Pending		$ 226,000	($90,000)[2]

[1]Spill year is March 1 - February 28

[2]Cost of Study, if continued