19.07.05 (6 of 8)

98307-BAA

Project # 98307-BAA

RECEIVED
APR 1 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

SOLICITATION NO 52ABNF700049.

EXXON VALDEZ OIL SPILL RECOVERY
COMPUTER SYSTEM.
(EVOS)

1. USERS' GUIDE

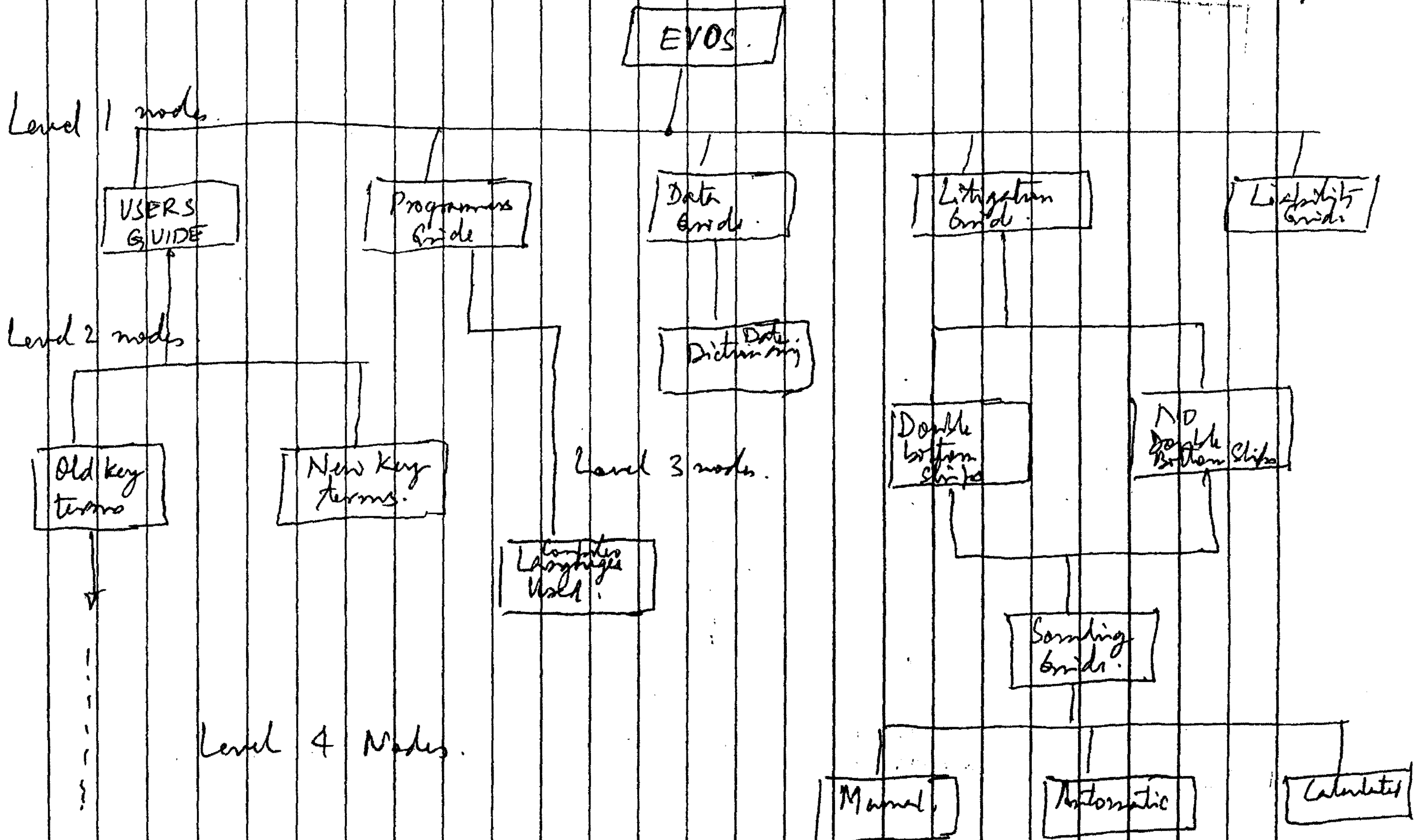
2. COMPUTER PROGRAMMERS GUIDE

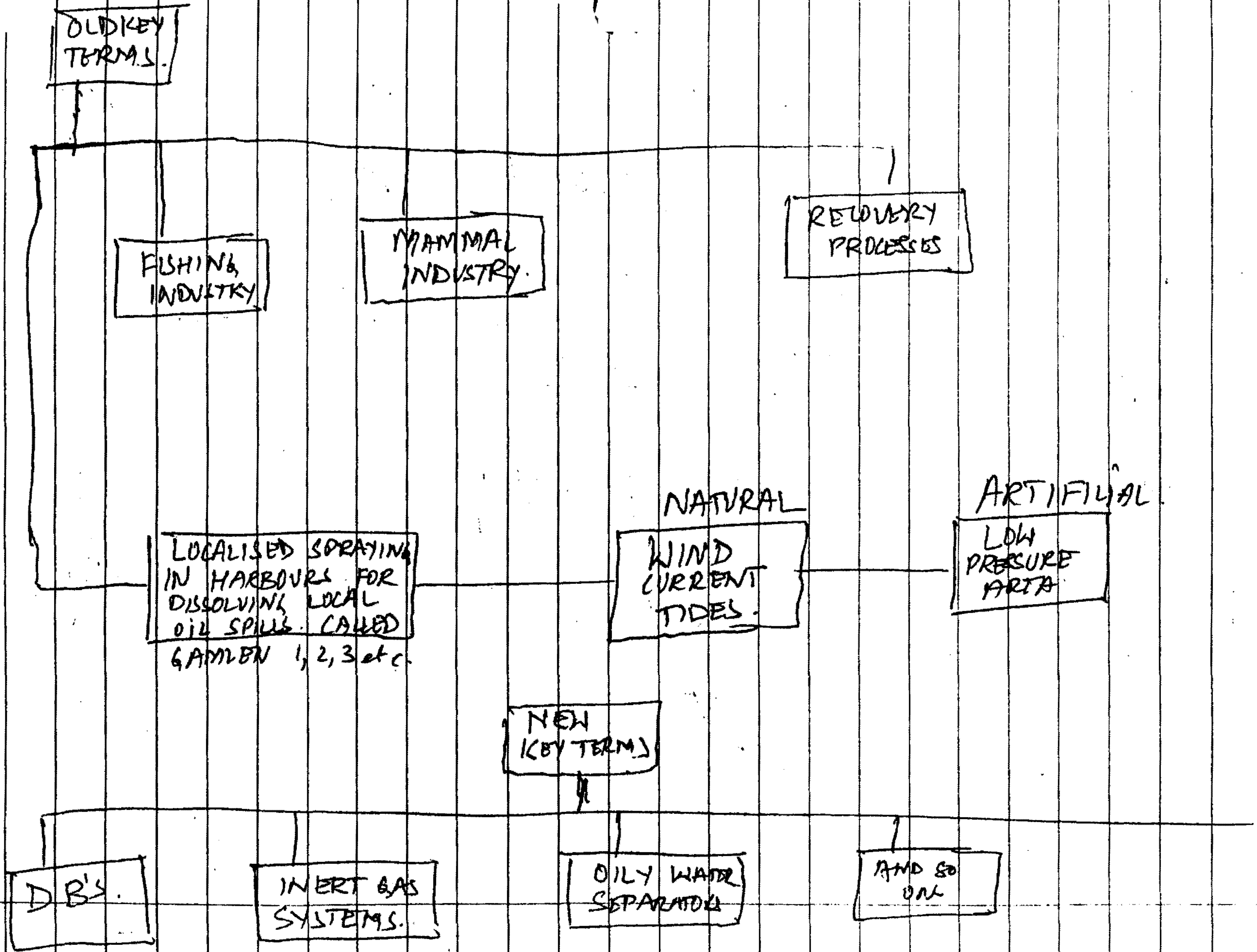
3. DATAS' GUIDE

4. LITIGATION GUIDES' &
LIABILITY,

BY RAO K. NUTI
114 BENEDICT STREET
WATERBURY, CT 06107.

NEURAL NETWORKS OF THE EVOS SYSTEM.




OLDKEY TERMS.
FISHING INDUSTRY
MAMMAL INDUSTRY.
RECOVERY PROCESSES
NATURAL
ARTIFICIAL
LOCALISED SPRAYING IN HARBOURS FOR DISSOLVING LOCAL OIL SPILLS CALLED
GAMLEN 1, 2, 3 etc.
WIND CURRENT TIDES.
LOW PRESSURE AREA
NEW KEY TERMS
DB's.
INERT GAS SYSTEMS.
OILY WATER SEPARATOR
AND SO ON

BUILDING THE COMPUTER SIMULATION MODEL

The matrices so prepared from these models will be multiplied and the result will be unitised vector.

$$\begin{bmatrix} m_{11} & & \\ & & \\ & & \end{bmatrix} \cdot \begin{bmatrix} m & & \\ & & \\ & & \end{bmatrix} = 1$$

$\{M_1\}$ old term mn.

$\{M_2\}$ new term pq.

Conditional matrices:

$$\left.\begin{aligned} \{M_1\}_{mn} \cdot \{M_2\}_{pq} &= 1 \\ &= 0 \\ &\;\;\vdots \\ &= n. \end{aligned}\right\} \text{Simulation model.}$$

$\neq 1$ Then [illegible] oil spill.

Vector multiplication yield certain definite & indefinite quantities. These quantities will then be used for the prediction of future disasters.
A historical database is to be built upon which one could or should evaluate the excesses of damage. Say, what are the excesses of damage — in this case oil only.

The skewing of the ~~past~~ parameters of the individual nation would yield results leading to certain predictive results.

National Oceanic and Atmospheric Administration,
Host Agency serving:
Bureau of the Census
Economic Development Administration
International Trade Administration
Minority Business Development Agency
Office of the Inspector General
Bureau of Export Administration

U.S. DEPARTMENT OF COMMERCE
Western Administrative Support Center
7600 Sand Point Way N.E.
BIN C15700
Seattle, Washington 98115-0070

WESTERN ADMINISTRATIVE SUPPORT CENTER
ACQUISITION MANAGEMENT DIVISION
SEATTLE, WA

BROAD AGENCY ANNOUNCEMENT

PROJECT NO

SOLICITATION NO: 52ABNF700049

TITLE: Broad Agency Announcement *EXXON VALDEZ* Oil Spill Trustee Council FY98 Work Plan

CLOSING DATE/TIME: 3:00 PM Local Time April 15, 1997

Offerors are required to submit proposals **in original and three (3) copies.** Only proposals submitted directly to NOAA's WASC Acquisition Management Division can be considered for award under this Broad Agency Announcement.

References: (1) April 1997. Vol 191, No 4 National Geographic
Oil on Ice
(2) 13 March 1997 Briefing Fisheries Science in troubled waters.

NOT A CLIMATE MODEL

BUILDING THE COMPUTER SIMULATION MODEL

KEY old Terms will be numbers

Key new terms will also be number.

The matrices so prepared from these models will be multiplied vectorially and the result will be rotated vector.

$$\begin{bmatrix} m_{11} & \cdots & \\ \vdots & \ddots & \\ & & m \end{bmatrix} \cdot \begin{bmatrix} M & \cdots \\ \vdots & \end{bmatrix} = 1$$

Indices of the matrix 01

$\{M_1\}$ old term mm

$\{M_2\}$ new term pq.

Conditional matrices.

$$\boxed{\{M_1\}_{mm} \cdot \{M_2\}_{pq} \left.\begin{aligned} &= 1. \\ &= 0. \\ &\;\vdots \\ &= n. \end{aligned}\right\} \text{Simulation model.}}$$

Vector - matrix multiplication would yield certain definite & indefinite quantities. These quantities will then be used for the prediction of the ~~scenar~~ future disasters. A historical definition is to be built upon whether we could or should evaluate the ~~excuses of~~ excuses of damage. Say, what are the excuses of damage - in this oil ay.

The skewing of the parameters of this individual matrices would yield results leading to certain prediction results.

98308-BAA

Salmon - Predator Interactions Model Validation Experiment, Submitted Under the BAA

Project Number:	98308
Restoration Category:	Research
Proposer:	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency: Cooperating Agencies:	NOAA
Alaska SeaLife Center:	
Duration:	First year, 3-year project
Cost FY 98: Cost FY 99: Cost FY 00: Cost FY 01: Cost FY 02:	\$ 349.4K \$ 270K \$ 170K \$ \$
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pink Salmon, commercial fishing

ABSTRACT

We propose to use closed-circuit rebreather scuba technology to conduct *in situ* model validation experiments in support of the SEA project Nekton Model. We will determine the occurrence and timing of movements and interactions of the Model's principal prey and principal predator species, pink salmon fry and adult pollock, respectively, for comparison with that predicted in the model. Direct observation will be used to solve the pink salmon "predation gap" that presently exists because of limitations imposed by the conventional techniques used to date.

INTRODUCTION

The *Exxon Valdez* Oil Spill Trustee Council funded ecosystem research project known as SEA (Sound Ecosystem Assessment) which grew out of public concern in 1993 at the failing production of pink salmon and Pacific herring in Prince William Sound, and produced numerical simulation models as one of its principal products. The simulation models are expected to improve our ability to predict survival of juvenile fishes which is a critical step in good management practices and will ensure post-spill restoration. These models need field data for initial conditions and additional data for model validation. An important aspect of the model simulation is fish behavior. Movements of the principal prey and predator species are predicted in the model. Methods that insure minimal methodological artifacts are needed to validate these predictions. Thus far the principal method has consisted of fish sampling using fishing vessels and by acoustics. From these observations predation and fish movements have been inferred. The model predicts that the predation occurs as concentrated events at certain times of the day. However, the model predictions correlate poorly with existing data. Only 3% of predation is accounted for because of inherent deficiencies in currently utilized research techniques. To address these weaknesses we propose to use closed-circuit rebreather scuba technology to conduct *in situ* model validation experiments in conjunction with the on-going SEA project in FY98. This project will expand upon research done in SEA which has employed other methods including use of fishing gear and stationary underwater video cameras.

RESULTS FROM PRIOR WORK

Predation upon salmon fry in the nearshore area has been hypothesized to be a major factor in controlling their recruitment in Prince William Sound, Alaska. The *Exxon Valdez* Oil Spill Trustee Council funded Sound Ecosystem Assessment (SEA) project is developing numerical models that predict predation on pink salmon fry in nearshore areas by pollock (Patrick et al. 1995 1996 1997), e.g., see Appendix 1. Model validation is accomplished by comparing model predictions with field observations. Since fishing techniques and underwater videos have provided inadequate model validation, alternative techniques must be used.

Evidence from stable isotope evidence and stomach content analysis (Willette et al. in prep. and K. Stokesbury pers. comm.), suggests only localized occurrence of piscivorous pollock. Pollock which are piscivorous are thus at trophic level (TL) ≥ 4, which was also found infrequently in PWS as determined by stable isotope analysis (Willette et al.). Adult pollock most often were at TL < 4, near the value "A" in Fig. 1. The value "B" in Fig. 1, the expected value of a juvenile herring and salmon consumer, was seen in the upper 25 percentile of adult pollock from Port Gravina near where some were found to have stomach contents consisting 100% of herring (K. Stokesbury, pers. comm.). Adult pollock from near the large salmon hatchery at Esther Island also had a higher TL (Fig. 1) suggesting a higher proportion of fish in the diet relative to other sites. These spatial variations in adult pollock TL suggest that predation may be localized. Thus salmon predation rate based on broad-scale surveys may have missed the majority of predation. The estimated biomass of adult pollock in Prince William Sound is 40,000,000 kg or about 40,000,000 fish (G.L. Thomas, pers. comm.). If 5% of the population is responsible for glut feeding, or 1,000,000 pollock, then each pollock would have to consume about 240 fish each to account for the mortality of pink salmon fry released from the AFK and WHN hatcheries. This amount could be accounted for, e.g., if they ate 12 salmon fry per daily glut feeding bout over 20 days. Because the predation is postulated to be so focused, an appropriate method must be used as a test. The method used must be able to locate and then quantify the fish behavior.

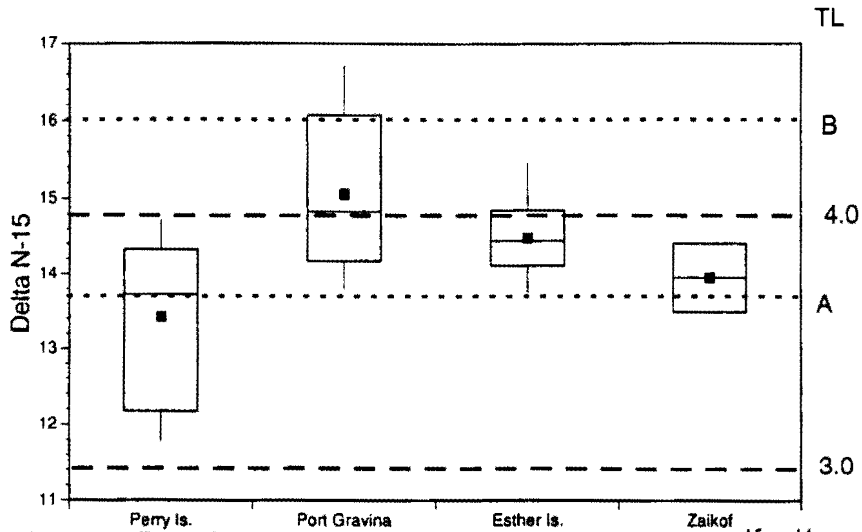


Figure 1. Trophic level (TL, right scale) determined from $^{15}N/^{14}N$ content (left scale) by the Kline and Paul (submitted for publication) method of adult pollock collected in June, 1995. A TL value of "A" was typical of PWS adult pollock (Willette et al. in prep.) whereas the value "B" was the value expected for a salmon or herring juvenile predator (from Willete et al. in prep.).

NEED FOR THE PROJECT

A. Statement of problem

One of the major problems for pink salmon recruitment in Prince William Sound (PWS) is very heavy predation during their early life history. Large number of salmon are vanishing as evidenced by their present very low survival (from release to return as adult), 0.36% to 0.38%, when survival has been as high as 10% (Willette et al. 1995A). There has to be some accountability for this change. Stomach content analysis of predators (principally pollock) sampled with mid-water trawlers only accounted for 3% of the salmon mortality, since salmon comprised only 1 to 5 % of the prey in their stomachs during the hatchery release period, and less later (Willette et al. 1995B). The trawler samples are probably biased since they were not able to capture fish in the immediate vicinity of the hatchery. The unaccounted for "predation gap" is hypothesized to occur in the nearshore area, especially in areas adjacent to where salmon are released from hatcheries. Addressing the gap has become a major concern for SEA. Proof of the process will have to come from observations using techniques that can be directed to the narrow spatial and temporal ranges where it is likely to occur. This project is directed at several needs, (1) accountability of losses to salmon populations, (2) determine the nature of the loss (identification of the principal predator species, if they exist), and (3) validate SEA nekton model predictions.

B. Rationale /Link to Restoration

We will be using closed-circuit rebreather scuba technology to conduct model validation experiments in conjunction with the on-going SEA project. The need for validation of the SEA nekton model has been pointed out by Trustee Council peer-reviewer Dr. George Rose. This project will provide data important for -

Management: The need to better manage fish stocks to achieve restoration depends on acquiring information that will enable good fisheries management decisions, especially with respect to harvest of predator species of salmon. For example, there is a commercial fishery on pollock, the suspected principal salmon fry predator that occurs in the pelagic area and probably an important predator in the littoral area (this latter point will be verified in the project being proposed). Observations by divers of significant predation behavior, such as glut feeding behavior, may suggest low cost alternatives which would reduce overall predation. For example, a solution might be to space fry release out through time, reducing the number of juvenile salmon available at any given time, thus having a much reduced chance of modifying predator behavior which takes advantage of large release quantities.

Predictive capability: The predictive capability being generated by the SEA models needs to be validated. Direct *in situ* observation will provide the strongest validation of the prey and predator movement and areas of predation occurrence predicted by the SEA nekton model.

Documentation: Documentation of predation, identification of predator species, and location of predation zones (for model validation) are the expected results. Data will be used by the Sound Ecosystem Assessment study. Specifically, data defining the zones of predation and species involved will be used in the SEA project's major modeling products. Long-term benefits of the SEA modeling will include better management since the role of multispecies interactions such predation will have been incorporated.

Real-time information: Real-time results (location of predators and predations) will be generated that will benefit on-going research projects and hatchery releases. Future applicability of the project's results includes use of *in situ* monitoring during fry releases by management enabling effective predation control or avoidance through change in salmon release strategy.

C. Location

Prince William Sound

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The Prince William Sound Aquaculture Corporation will provide support in terms of hatchery release information and will aid in field logistics (see attached letter) since the project will be carried out near the hatcheries.

The Alaska Underwater Science Foundation will be providing qualified scientific divers and equipment for this project (see attached letter). These divers will contribute their local knowledge as well as talents.

PROJECT DESIGN

A. Objectives

1. Validate occurrence of glut feeding, determine glut feeding consumption.
2. Answer basic questions on the nature of predation: A. when and where it occurs, B. primary species involved
3. Assess predation rate on salmon schools.

4. Determine frequency of feeding bouts by individual fish.

5. Estimate the daily predation quantity.

B. Methods

Hypotheses

Hypothesis: Predation on pink salmon takes place soon after release from - and in the vicinity of hatcheries (very close to the shoreline in shallow water when the fish are concentrated and very vulnerable (not able to escape predators because of their size (Willette et al 1995A)). We will determine if such predation exists in the nearshore by direct observation.

Hypothesis: Walleye pollock and possibly Dolly Varden (S. Jewett, Univ. Alaska Fairbanks, pers. comm.) are the principal predators of salmon fry following release from hatcheries. We will identify predators to species when making direct observation of predation events.

Hypothesis: Pollock are glut feeding then descending to depth. We will observe pollock movement using acoustics and divers. Divers will sample pollock during their descent for stomach content and stable isotope analyses. We will estimate predation rate from the stomach content and fish (pollock and salmon) school size data. The latter will be obtained from hatchery release, acoustic and direct observations. In year 2, we will determine whether individual pollock (or other predators) glut feed only once a day by following and observing acoustically-tagged fish.

Hypothesis: A small percentage of individuals of predator species are responsible for a large percentage of salmon predation. We will confirm by observation, samplings and comparisons with fishing boat sampling data.

Approach

In situ stealth approach

We plan to use *in situ* stealth technology using divers to observe and quantitatively assess the predation. Stealth technology is available through use of closed-circuit rebreathers (CCR). Although pollock have been found to be a predator of salmon, albeit small (Willette 1995B), we feel that pollock predation has been underestimated. We need direct evidence to demonstrate this. We will conduct two experiments to test the hypotheses.

Experiment 1 (follow the predators): Using the model predictions first and inferred behavior of predators from acoustical observations second, we will directly observe interactions between predators and salmon, by following the predators *in situ*. We will collect samples and data *in situ* using the protocols described below.

Experiment 2 (follow the prey): In this experiment we will follow a cohort of salmon from the hatchery *in situ* to determine when and where predators interacted with them, how many predators there were and the species identity. We will also collect predator samples *in situ* using the protocols described below.

Sampling protocols

Diel sampling strategy in relation to model prediction

There are ~20 hours of daylight at the time of the year (early May) when salmon fry are released which is when this project will be carried out. Thus we will only be light limited in our ability to make visual observations for a narrow window of time during which time we will use non-intrusive illumination (i.e., narrow wavelength). The dawn and dusk periods are predicted by the modeling to be when predation is most likely to occur. Accordingly, dives will be centered around these times. The working day will be based on the nocturnal cycle. Sampling strata will include dusk, dark, and dawn periods of three hours each. Since the daylight period is the longest and needs to be sampled the least for model validation, these strata will be five hours in length and sampled less frequently. Thus each day will be divided into three nocturnal and three diurnal strata (Table 1). We will sample sufficiently within each stratum to test the model for level of feeding with the diel cycle. The three-week duration of the research cruise will ensure replicated sampling within each stratum (Table 1). We anticipate having four-person dive teams being able to each make three dives of two-hour duration per day for 18 days of diving yielding 108 hours of dive time for a total of 432 hours of observation time. If warranted, we will reduce dive teams to two-person dives which will increase the number of dives shown in Table 1. and hours of dive time while conserving total hours of observation time.

Table 1. Distribution of sampling effort assuming four divers in water per dive.

Sampling Period	Time of Day	Effort (no. of 4-person dives)	
1. Dark	0000 - 0300	12	
2. Dawn	0300 - 0600	12	
3. Morning	0600 - 1100	6	
4. Mid-day	1100 - 1600	6	
5. Evening	1600 - 2100	6	
6. Dusk	2100 - 0000	12	
		54	Total

Acoustics

The PWSSC acoustics fisheries acoustics program will provide acoustics support as described. Acoustics information will be used to track predators to determine their spatial overlap with salmon fry. Acoustics data will be used to help place divers on predator schools (this is possible since CCR divers will not be generating interference bubbles). Acoustics will also be used to determine if predators are avoiding divers. Diver approach will be modified to minimize any behavior modification.

Predation rate

Predation rate estimates used for model validation will use the following data:

1. From stomach contents: We plan on linking predation events with rate. We will determine the number of salmon eaten during a glut feeding bout by capturing a predator departing the feeding arena. We need to first ascertain the general pattern of predation behavior so that a predator can be sampled at the termination of a glut feeding bout (or if, this even occurs). This way a limited sampling of stomachs, e.g., ~50, could tell us a lot more than many trawls worth of sampling where we had no certainty of how to relate the number of fish in the stomach to the predator's behavior.

2. From likelihood of predation events: The low incidence of pink salmon observed in predator stomachs when extrapolated for PWS only accounted for a small portion of the salmon loss. If we find evidence that predation occurs as concentrated events, then the previous extrapolation is invalidated (note the orders of magnitude differences, depending on assumptions):

The likelihood of a predation event is based on the assumption that predation is spread evenly through out the area used by hatchery salmon in PWS (~ 40 x 100 km) over the six week outmigration period (42 days) and a mortality of 240 million pink salmon (most of the output of the WHN and AFK hatcheries) is 60 per km^2-hour. Glut feeding is inconsistent with an even distribution of predation. The alternative, predation is concentrated in space and time, increases the likelihood of predation (in the areas where it is occurring) by orders of magnitude beyond this estimate. For example, if the predation is restricted to 100 km^2 near the hatcheries and the first 100 hours after release then the likelihood of a predation event is 24,000 per km^2-hour or 2.4 per 100 m^2-hour. Given our expected dive time (see above), we should see on the order 1000 predation events. This may be a conservative estimate as the fish may be more highly concentrated when most of the predation takes place. Thus the rate of predation observable within the limitations of diving should provide enough data to validate the model.

If the predation takes place in a very limited period and space, then accurate sampling will depend on making the best use of this critical period. Systematic observation parameters, such as a choice to do 50 m transects, will increase the number of transects per dive compared to longer transects. If water conditions prohibit the transect approach, alternatives based on the fish behavior will be developed, e.g., tracking a given school using acoustic guidance. We would then ascertain predator interactions with a given area or school of fish (the size of the school will be estimated or known - e.g., from hatchery release data and acoustical observation).

It is not inconceivable that glut feeding events are even more concentrated in both time and space. If we make the assumption that feeding is concentrated in 25 km^2, and within 24 hours of release, when salmon fry are most vulnerable, then a loss rate of 228,571/km^2-hour would be predicted - an amount of serious proportion.

3. From hatchery release info: Hatchery release information will be used to determine numbers of salmon in schools and used to calibrate observers. As discussed above, captured predators departing from a glut feeding bout will provide better estimates of predation. Being able to follow a given cohort from hatchery release in space and time will allow us to directly observe predator interaction and assess loss rate of the cohort.

4. Frequency of feeding bouts: To determine feeding bouts per day we would tag predators to track their behavior. Presently this is being done in another PWSSC project (Kline and Scheel 1996). A prototype diver-held receiver for sonic tags was shown to P.I. Kline at the recent Second World Fisheries Congress. This tool would facilitate relocation of tagged fish and repeated observations of feeding bouts by individual predators (each predator tag would have a unique frequency, making it possible to track several tagged fish). This experiment is planned for year 2 as we presently have insufficient information to use this tool with the greatest effectiveness. Year 1 would focus on determining if, when and where predation occurs. This information will be used to design a more effective sampling approach for both the predators (e.g., tags) as well as transect design, incorporating important parameters such as maximum diver swimming speed (Smith 1988).

Diving protocols

Divers will need to be able to rapidly identify the fish species, requiring a degree of expertise a naive observer may not be able to gain. The observer needs to be not only as qualified in fish biology and advanced scuba technology as the P.I.'s are, but also be able to function well in the adverse conditions that we expect to encounter. The P.I.'s have extensive experience and are capable of functioning well in spite of poor conditions. We plan on collaborating with scientific divers from the Alaska Underwater Science Foundation (AUSF) since they are familiar with the local biology and diving conditions, as well as the closed circuit rebreather technology which will greatly increase the probability of success in this project.

With conventional open-circuit (OC) scuba, a diver breathes compressed air from a tank. Exhalations are vented directly into the water. In contrast, CCR divers exhale back into closed-circuit rebreathers (CCR). The scrubber unit inside the CCR chemically removes the CO_2 and oxygen is replaced using various techniques depending on CCR design. The use of CCR is desired to avoid fish behavior modification and increase diver endurance through heat retention and gas mixture optimization. Closed-circuit scuba divers can approach mobile marine animals quite closely. These animals would otherwise be frightened by the bubbles of open-circuit scuba.

CCR diving requires a greater degree of discipline than OC diving (Richardson et al. 1996). Diver surveys would follow dive safety protocols established by the Chief Diver (co- P.I. Bozanic). Dive objectives include acquisition of predator and predation data (on salmon fry), and habitat classification including, (1) location (using the Dive Tracker device), (2) geomorphology, (3) nature of the water (clarity, currents, tidal cycle). Divers will estimate number of fry and predators in 50m, including the presence or absence of evidence of predation (actual observation of predation or observation of prey in mouth of predator). *In situ* data recording using the Dive Tracker device will enable geo-referencing of data points. Hand nets will be used for collections. Through a regular radio schedule and rendezvous, we will interact with the other projects and the hatcheries on observations.

We expect to conduct our observations from below fish schools. Salmon are extremely responsive to and avoid shadows projected onto the water surface (based on observations of migrating salmon, Kline unpublished data). For example, non-submerged observers would have to project a shadow in order to make the needed observations. It will probably be necessary for any in-water observers to be at or towards the bottom, so as not to cast shadows mid-water. We will determine the best location (depth and position relative to the school) to closely approach the fish as an initial goal. CCR use will facilitate from-below observations since they do not release bubbles.

Video transects may have reduced precision compared with visual transects (Davis and Anderson 1989). High-resolution still photography conducted with water-contact optics, as available on the Nikonos RS (Kline 1995), will be our primary tool for photo-documentation of our visual transects, which will be backed-up with digital underwater video.

Only through direct observation at close range (probably up to ~ 1 m), which is possible using a CCR based stealth approach, will many of the questions regarding salmon predation be answered. The following points justify our CCR use:

1. Presence of divers: Evidence in the form of disappearance of fish suggests that a lot of predation has not been observed, or "sensed." Although the physical presence of non-destructive sensors (e.g., divers) cannot be avoided, we feel that CCR equipped divers will have far less impact than either conventional OC scuba (" I question the validity of all fish behavioral studies done with scuba because of the demonstrated disturbing effects of the noisy bubbles" - Collette 1996), breathhold diving (extremely limited temporal scope - observation restricted to a few seconds at a time - from when the observed gets situated to make observations and before the observer goes for another breath and which is likely to disturb the subjects) or ROVs (they have their own noise and can create their own unique disturbance as well as that of the tether and its interaction with the water, kelp, rocks and light (shadows)). We feel that CCR will provide the greatest stealth. We will document and validate the stealth ability of CCR by tracking the fish acoustically when in contact with divers to ascertain whether avoidance is taking place. Bubble-free diving will also enhance the co-tracking of divers and the fishes since exhaust bubbles interfere with acoustics (pers. comm. J. Kirsch). Thus, use of acoustics to assess fish behavior modification by divers is a bonus only possible with CCR.

Richard Pyle, of the Bishop Museum in Hawaii, has been using CCR for his studies of fish in tropical waters for the past two years. He has noted significant benefits in the use of CCR in his work, including the ability to work in close proximity to the fish under observation with minimal disturbance of their behavior. Pyle (1996, in press) has made numerous observations using CCR that were not otherwise possible. In two years of CCR use, Pyle has observed more fish behavior than his previous 20 years on OC scuba. Examples are: (1) Sixteen sandbar sharks were seen where never seen before and were approachable up to 0.5m. Pyle switched to OC and returned to the site - they were gone. Pyle went to the surface where he switched back to CCR and they were back when he returned. (2) He has been able to observed surgeonfish spawning behavior. He found that the fish perceived him as part of the natural rock formation and spawned right over him (they normally spawn over rocks using the turbulence to spread the gametes). (3) He was the first to observe lizzardfish spawning. His observations suggest that CCR divers blend in so well to the environment that fish ignore their presence and proceed with their normal behavior.

Duggins (Univ. Santa Cruz) has also used CCRs to approach marine mammals not approachable with OC scuba - sea otters in the Aleutian Islands (S. Jewett, Univ. Alaska Fairbanks, pers. comm.). Marty Snyderman (pers. comm. to J. Bozanic) has greatly increased his ability to approach marine mammals and fishes using CCR over OC scuba. CCR-divers studying cephalopod behavior have had greater success using CCR over OC scuba as well (Hanlon et al. 1982). Hanlon et al. (1982) found that CCR facilitated observations of interactions between species including commensal relationships. Based on these successes we believe that CCR-divers are highly likely to be able to observe predation on pink salmon and make observations that could lead to its solution.

2. *Diver endurance:* With fully-closed rebreathers, the amount of oxygen added equals the amount metabolized, hence CCR dive duration is depth independent. With OC scuba, only a fraction of the oxygen inhaled is metabolized, thus most of the gas transported with the diver is wasted. Furthermore, OC dive times decrease with depth since the number of molecules per unit volume inhaled increases because of pressure. Nitrox (OC scuba using air enriched with O_2, thus percentage $O_2 > 21$ and N_2 is < 79) and CCR use optimizes the breathing mixture reducing the deleterious effects of excess partial pressures of N_2 that result from using compressed air with conventional open circuit (OC) scuba at depth. With OC scuba, the $\%O_2$ and $\% N_2$ is fixed by the mixture provided in the scuba tank. This can be 21% and 79%, O_2 and N_2, respectively, when using compressed air or other mixture as defined by a particular nitrox blend. Nitrox use allows for greater endurance only at moderate depths (20 to 30 m) because of O_2 toxicity-dependent depth limitations. Breathing from a gas mixture fixed by the contents of a tank, i.e., the $\% O_2$ and $\%N_2$, results in a change in the partial pressure of each as with depth as described by Boyle's Law.

Mixed-gas (as opposed to pure O_2-CCR) CCR are designed to operate at a set partial pressure of oxygen by automatically varying the percentage of O_2 in the breathing mixture as a function of diver depth. The control of the partial pressures of gases in the breathing mix effects an optimization that minimizes the dangers that occur from excessive partial pressures of O_2 and N_2 encountered with other forms of scuba. The control of the gas mixture also allows for deeper and longer dives. CCR depth and time equipment limitations will allow for two-hour observations with the ability to follow schools without the severe depth limitations imposed by O_2-CCR, Nitrox or OC scuba.

In addition to optimization of breathing mixture, diver endurance is enhanced by CCR use since the breathing mixture is recycled (minus CO_2 which is chemically removed by the CCR scrubber). The re-circulated breathing mixture retains heat and moisture. Additionally, the chemical reaction that removes CO_2 in the CCR scrubber generates heat compensating for some conductive heat loss. Diver heat retention from CCR use in conjunction with use of argon for dry suit inflation will enable long duration dives (e.g., 2 hr) at the cold water temperatures (~ 0 to 5 °C) encountered in Prince William Sound.

3. Alternative technologies are discussed in comparison with CCR:

CCR vs. ROV

With respect to ROVs, autonomous divers are advantageous because of a capacity for greater spatial coverage in critical nearshore areas (salmonids tend to be surface and shoreline-oriented). Divers are less directly dependent on support vessel positioning. Support vessel positioning limits many PWS sites from even moderate sized vessels (e.g. 50 ft) because of safe anchorage needs. Tether management may also limit ROVs in PWS. The rocky nature of important salmon habitat in western PWS will limit use of an ROV because of the potential of umbilical entanglement. ROVs are ineffective in high relief habitat, such as found in PWS, because of snagging and the inability to maintain transects (O'Connell and Carlile 1994). We plan on using the Dive Tracker device which will enable us to determine and record positions of fish in 3-D as well as maintain transects. An ROV may be more limited by currents whereas divers can engage in drift dives when necessary as strong tidal currents are common in PWS.

Divers are fully autonomous and can follow any shallow topology while skiffs provide surface support. ROV technology has vision limitations (O'Connell and Carlile 1994). An ROV is video-dependent, whereas divers would use direct vision which enables more detailed observation such as species identification over a wider field of view (O'Connell and Carlile 1994). Reconstructed vision is limited by design and has poor resolution compared with human vision. Video excels only at low light levels given a system with enhanced low light level sensitivity. We plan on using non-intrusive artificial illumination which exploits the insensitivity of wavelengths > 600 nm (red) in fishes (Brett 1957, Munz 1964) to aid in diver vision when needed.

CCR vs. open circuit (OC) scuba

The primary advantage of CCR is the absence of bubble exhaust from the breathing apparatus. Bubble disturbance has a pronounced affect on animal behavior (Collette 1996). Closed-circuit scuba divers can approach mobile marine animals quite closely if the approach is taken slowly. These animals would otherwise be frightened off by the bubbles of OC scuba. For example, the P.I. was able to approach juvenile fishes by moving slowly while breath-hold diving (with weights to provide neutral buoyancy). Though the breath-hold approach works, it is difficult and very time-limited because of cold-water equipment (drysuit) encumbrances and the need to hold one's breath. It does demonstrate however, the need to not emit bubbles. Diving without a breathing apparatus, i.e., snorkeling, in addition to being severely limited in terms of available observation time which greatly reduces the potential for predation event observations, will more likely disturb schooling behavior compared with CCR (Hanlon et al. 1982).

CCR vs. fixed unmanned underwater still or video cameras

Unmanned cameras placed on the bottom or moored in the water column may not require the use of divers and can be set up to collect data continuously until the recording medium is exhausted. This approach is limited by spatial coverage that is dependent on (1) lens angle of view, (2) water transmissivity, and (3) the number of cameras/stations The deployment operation may also modify fish behavior. Furthermore, the desired observations may not occur frequently at a given deployment site (Willette, pers. comm.). Thus a large number of cameras may be needed to acquire enough data from which statistically valid conclusions could be drawn. Fixed video methods were used in the SEA project during 1996-7 and will be compared with CCR results.

CCR vs. fishing

It has already been shown that sampling with fishing gear has not accounted for the salmon loss. Fishing vessels and gear capabilities are excluded from much of the nearshore rocky habitat of western PWS. The intricate topology either excludes the fishing methods *per se* or allows fish to escape from the gear. *In situ* methods can, however, enable fish population data collections in otherwise unfishable rocky habitat (Mathews and Richard 1991). Additionally, direct observations may also reveal more realistic aspects of fish population structure not attainable by fishing (Yoklavitch et al. 1993).

CCR vs. submersible

Submersibles have a proven track record of successful *in situ* fish population assessment having advantages of depth accessibility and good transect maintenance which enables more precise quantification of the area observed compared with ROVs (O'Connell and Carlile 1994). Submersibles have current and visibility limitations (NURP 96) and may not be able to operate in confined spaces as well as divers. They are also much more expensive and require more expensive surface support. We think that much of the predation takes place very close to shore (Willette pers. comm.) in relatively shallow water which is easily accessed by divers, who are much more maneuverable.

SCHEDULE

A. MEASURABLE PROJECT TASKS for FY 98 (October 1, 1997 - September 30, 1998)

Year 1. (FY 98)

Dec. 1- Feb. 28:	CCR planning and training
Mar.1 - Apr. 30:	Cruise planning and vessel bidding
May 1 - May 21:	Research cruise
Jun. 1 - Nov. 30:	Data processing
Oct. 1 - Oct. 15:	Project review

Description of Major Tasks

Year 1

1. Pre-survey preparation: Selection of CCR system, CCR-specific training*, determination of specific dive site locations in consultation with Mark Willette, bidding of dive vessel.

* CRR training will include:

A. CCR-specific instruction from manufacturer (2 weeks travel) which will include classroom (4 days), pool (5 days), and open water sessions (5 days) for a total of 40 hours of required in water training.

B. Training dives under supervision of project Chief Diver and CCR instructor Bozanic which will include 1 week of confined openwater (in coldwater conditions) and 1 week of drills including practice research sessions testing out equipment and familiarizing personnel with protocols.

2. Dive survey: 18 days exclusive of mobilization (1.5 days to load and travel to sites) and demobilization(1.5 days).

3. Data analysis:

a. Identify predator species. Validate occurrence of glut feeding, determine glut feeding consumption.
b. Determine predator and predation zones (depths, distance from shore, which substrates favor predator or salmon as determined by their occurrence).
c. Assess losses of salmon populations.
c. Evaluate use of closed-circuit scuba for the above purposes.

4. Reporting results via scientific meetings (e.g., Annual Symposium of the American Academy of Underwater Science) and scientific publications.

B. Project Milestones and Endpoints

Objectives

Year 1	Validate occurrence of glut feeding, determine glut feeding consumption.
Year 1	Answer basic questions on the nature of predation: A. when and where it occurs, B. primary species involved.
Year 2	Determine frequency of feeding bouts by individual fish.
Year 2	Estimate the daily predation quantity.
Year 2-3	Assess predation rate on salmon.

Year 2. (FY 99)

Dec. 1 - Jan. 30:	Data synthesis, plan second field season
Mar.1 - Apr. 30:	Cruise planning and vessel bidding
Mar. 1 - Mar. 28:	Preparation and Dissemination of results at 1999 anniversary
May 1 - May 21:	Research cruise
Jun. 1 - Sept. 30:	Data processing

Oct. 1 - Oct. 15: Project review (?)

Year 3. (FY 00)
Dec. 1 - Jan. 30: Data synthesis
Dec. 1 - Jan. 30: Preparation and Dissemination of results at Annual Meeting
Feb. 1 - May 30: Final report preparation
Jun. 1 - Nov. 30: Final report revision

Year 2

Description of Major Tasks
After glut feeding is validated (year 1), then a frequency of feeding bouts by individual fish will be determined which will be used to estimate the daily predation rate. We will use sonic tags that will be surgically implanted. Kline has been involved with a study on the North Slope where similar sized (to the sonic tags) radio tags that were successfully implanted surgically into fish and used for tracking them upstream by plane.

1. Refine methods and objectives used in year 1 to improve results.

2. Conduct a 21 day cruise (~ 18 day sampling effort) using refined objectives and sonic tags.

3. Data analysis:
   a. Compare with analyses from year 1 (predator species, etc.)
   b. Determine glut feeding consumption from sonic tag data.
   c. Assess predation on salmon and population effects.
   d. Evaluate use of CCR.

4. Preparation for and dissemination of results.

C. Completion Date

30 November 2000

D. Budget Justification and Matching

In addition to funding provied by the Trustee Council, this project will use in-kind and matching support dedicated to this project. Greater than one-quarter of the total project support will be from in-kind or other resources.

Personnel:

The estimated effort for each task in months by project investigators is given below (additionally, there will two surface dive tenders/ zodiac drivers for the cruise, 1.5 person-months, and an acoustician: 1 month).

Personnel effort by month:

Task	Kline	Bozanic	Williams	Hicks	Arnold
CCR Planning	0.25	0.5			
CCR Training	1	1	1	1	1
Vessel Bidding	0.25				
Cruise Planning	0.5	1	1	0.5	0.5
Cruise Execution	0.75	0.75	0.75	0.75	0.75
Data Processing	0.75	0.75	2		
Quarterly Reports	0.25				
Annual Report	1	1	1		
Data Synthesis	1	1	1	1	1
Dissemination of Results	0.5	0.5		0.5	0.5
Project Review	0.5	0.5			
TOTAL EFFORT	6.75	7	6.75	3.75*	3.75*

* The effort contributed by Hicks and Arnold of the AUSF will be voluntary (matching estimated at $75,000).

Travel:

CCR Training
1 R/T CDV to lower 48 training site which will be determined by CCR chosen (Kline and Williams)
1 R/T to lower 48 training site which will be determined by CCR chosen will be contributed by Bozanic, Hicks, and Arnold (matching estimated at $ 5000)

Research Cruise, Data analysis and synthesis, Annual meeting, Annual Review
4 R/T LA to CDVor Anch. (Bozanic), 2 R/T Anch. to CDV (Hicks and Arnold)

Reporting
1 R/T AK to lower 48 (Kline),
1 R/T LA to lower 48 (Bozanic), Bozanic will contribute travel costs (matching estimated at $1000)

Services:

Vessel charter (dive support vessel) is estimated at $2000/day for 21 days in 1998 based on previous bidding experience.

Bozanic is paying for his rebreather instructors certification which will enable him to complete the training of project divers beyond that provided the manufacturer (matching estimated at $3000)

Camera equipment rental. Use of Kline's underwater still photographic equipment and Bozanic's underwater digital video equipment will have a $1200 and $900 per week rental value. This in-kind matching for the three-week field operation is $6300.

Personal dive gear used on the project will devalue about $1500 per week of use. This in-kind matching for the project will be $7500 (2 weeks of cold-water training and 3 weeks of field operations).

Equipment:

CCR
The cost of CCR is a significant barrier to their use for research (Hanlon et al. 1982) and may be a concern here. We are seeking funding from several sources (PADI Foundation, submitted; OSRI, in preparation for new RFP; NURP, in preparation for 1997 RFP) to finance this portion of the project. Though nine manufacturers of closed-circuit scuba have one or more rebreather models available or in development (Menduno 1995), only those meeting safety criteria set by Chief Diver Bozanic can be used. The CCR units that are applicable to our use must be adaptable to cold water use, which is determined by the design as well as the chemistry used in the CO_2 scrubber. We also have safety criteria greater than that used by the military and require built-in system redundancy and self-bailout. CCR units that are usable for this project have an estimated cost ~ $15K each. Since a dive team would consist of, as a minimum, two similarly-equipped divers per scientific diving protocols (AAUS 1996 Scientific Diving Standards), a minimal equipment investment of $30K would be required. We wish to have four operational CCR.

The CCR manufacturers provide unit-specific training. Training will be required for Kline and Williams. Co-P.I. Bozanic is undergoing formal rebreather instructor training. This training cost ($3000) is being absorbed by him as part of cost sharing. Training of Kline and Williams beyond that provided by the manufacturer will be done by Bozanic.

Dive Tracker
The Dive Tracker is a sonar based navigation and communication system. Navigation is accomplished through sonar triangulation techniques, supplemented with depth information from a pressure sensor on the Diver Station. This provides for position fixes with an accuracy of as good as +/- 0.15 m operating at ranges of up to 500 m. The Dive Tracker Diver Station (DS-1) lets divers obtain *3D position information*, determine range and bearing to waypoints, communicate with other divers and the support vessel (when using a surface unit), *record observations*, and monitor decompression status (including CCR use) and bottom time. The Diver Station provides the diver with multiple instrumentation capabilities in a single box.

E. Facilities

PWSSC Facilities
P.I. Kline will provide his underwater single lens reflex photographic equipment (three Nikonos RS 35mm camera bodies, four Nikonos RS water-contact lenses and two Hasselblad EL 70mm cameras in an underwater housings with compensating dome ports. Co-P.I. Bozanic's personal computer will be used to program, upload, and download the CCR and Dive Trackers each day(matching lease value of these items is estimated at $ 500).

AUSF Facilities
The AUSF facilities include the following : Air compressor, inflatable boats, OC breathing apparatus (lease value of these items is estimated at $ 5000)

AFK Facilities

PWSAC will allow us to use of the facilities at AFK for shore logistical support (matching in-kind support estimated at $2K/week) for the three week field portion of the project.

Matching: Total matching from volunteer time, facility and equipment usage is estimated at $110,300.00 each year.
We anticpate additional matching:
$15K from PADI Foundation (for purchase of a CCR)

PUBLICATIONS AND REPORTS

Quarterly and Annual reports to the Trustee Council as specified in the Invitation to Submit Restoration Proposals

Peer-reviewed scientific papers (Year 2)

PROFESSIONAL CONFERENCES

Annual Scientific Diving Symposium of the American Academy of Underwater Science (AAUS)

NORMAL AGENCY MANAGEMENT

None

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Sound Ecosystem Assessment (SEA)-Predator: We propose to employ divers using closed-circuit rebreathers (CCR) as a mobile *in situ* method to compliment by overcoming the limitations of, the stationary *in situ* approach being used in the predation project. The divers could also assist other on-going projects by locating predation events. The stationary video being used by SEA-Predator is capable of continuous sampling but is limited in spatial coverage because of the limited visual range of the system and the number of cameras employed compared to km of shoreline where the predation activity could be taking place. Furthermore, salmon move relatively rapidly along the littoral area on their migration to the open ocean reducing the opportunity to observe predation at any one fixed location. Location of areas of intense predation by divers could be used to place continuous observation platforms where they are more likely to be effective. The P.I. Willette has been consulted during this proposal preparation and will be consulted with during the data collection and analysis phase of the proposed project.

SEA-Data
The results of this project will be used directly by the modeling effort in SEA-Data. Investigators Patrick and Mason have been consulted during this proposal preparation and will be consulted during the data collection and analysis phase of the proposed project.

SEA-Fish
This project will involve use of acoustic support developed in the SEA-Fish project. SEA-fish personnel will conduct the acoustics portion of this project and have use of data collected. The P.I. Thomas has been consulted during this proposal preparation and will be consulted with during the data collection and analysis phase of the proposed project.

SEA-Food
Samples collected and analyzed for natural stable isotope abundances will be integrated into the stable isotope database generated in SEA-Food of which Kline is the P.I. The isotopic signatures of known glut feeders will be compared to those in the database which represent the overall population. This comparison may validate that glut feeding predators deviate from the population values which would explain why random samples failed to account for the losses of salmon that are known to occur.

Coordination with the other CCR projects
The projects using CCR we are proposing will occur at different times of the year. However the training and experience gained on this project would benefit the Rockfish Recovery Project 98269 since experience will enhance our ability to more fully use the capability of CCR (Pyle 1996).

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL and CO-PRINCIPAL INVESTIGATOR

Administration of the project will be the responsibility of the P.I., Kline. He will lead in the scientific tasks. Project Chief Diver will be co-P.I. Bozanic. Bozanic will be responsible for the technical aspects of research diving operations.

Kline is a Research Scientist and Diving Safety Officer (DSO)of the PWSSC Scientific Diving Program, C.V. attached. Kline is a Master Scuba Diver (NAUI) with nearly a decade of diving experience in Alaska. Bozanic is a member of the PWSSC Dive Control Board, is the DSO in two other diving research organizations among other qualifications (see attached C.V.), and has experience in teaching the use of closed circuit scuba as well as numerous other specialties. Bozanic is a past Director of NAUI as well as an instructor trainer (NAUI), cave diving instructor (NSS), and has extensive diving experience (>2400 dives) from Antarctica to Alaska. Both P.I.s have extensive experience in studying fishes underwater from the Arctic to the tropics. For example, Bozanic has conducted underwater surveys of seniorita fish in kelp forests and Kline has observed lakeshore salmon spawning on scuba. Underwater research studies conducted by Bozanic have resulted in the discovery of ~30 species of invertebrates including the naming of an amphipod, *Bahadzia bozanici*, a shrimp, *Agostocaris bozanici*, and a seastar, *Halacea bozanici*, after him by Holzinger (1992), Hindler (1996), and Kensley (1988), respectively.

T. Kline has been actively involved in stable isotope research since 1985. His use of stable isotopes has been in fish ecology with emphasis on salmonid fishes in northern, western, south central and southeast Alaska. His innovative use of the techniques has allowed him to quantify the effect of salmon carcass nutrient input to juvenile sockeye salmon production. This research has been the first to provide direct evidence for the importance of salmon carcasses for juvenile salmon production. He has generated stable isotope models that enable the quantification of different sources of production important in salmon ecosystems. Dr. Kline also led an investigation relating feeding strategies to growth forms in North Slope salmonids. His on-going efforts include collaborations with ADF&G, the North Slope Borough, and BPX. The results of these projects have been presented in numerous scientific papers as well as in public forums (speaking to local groups and classes). T. Kline initiated project 320I which has been the first comprehensive project using natural stable isotopes in Prince William Sound. Through this project he has developed new models and application of natural stable isotope abundance methods. He was the first to provide direct evidence of the importance of carbon from the Gulf of Alaska in Prince William Sound.

OTHER KEY PERSONNEL

Research Associate for project execution and data processing: Williams, PWSSC
J. Williams received his Masters degree in Fisheries from Texas A&M University in 1995. While earning his degree, he spent one year conducting field research in a remote area of Venezuela, successfully incorporating native fishermen in his survey of reservoir fish populations. His research has been presented in a variety of forums and is currently under review for journal publication. J. Williams is a certified Rescue Diver, Divemaster and has eleven years of diving experience. He is currently fulfilling a diver-in-training program for cold water research diving to expand his knowledge of diving further. Currently, J. Williams is tasked with sample and data processing and data management and actively contributes to data synthesis.

Affiliate Investigators: Hicks and Arnold, AUSF
Affiliate investigators R. Eldridge Hicks and Charles F. Arnold IV are the Chairman, Board of Directors and Executive Director of the Alaska Underwater Science Foundation,

Inc. (AUSF), respectively. Recent and current AUSF projects include a sea lion tagging project with the Alaska Department of Fish & Game, exploration of six submerged cave systems on Prince of Wales Island, Alaska under a grant from the U. S. Forest Service, completion of an unfinished survey of World War II wrecks in the Aleutian Islands (unfunded to date), and an exploratory expedition and survey across the Bering Land Bridge from Cape Prince of Wales, Alaska to Cape Deshnev, Russia. AUSF divers Hicks and Arnold will voluntarily contribute their time in execution of this project. Additionally, they will provide equipment for use on the project including scuba gear, inflatables and an air compressor.

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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$142.4						
Travel		$17.4						
Contractual		$63.1						
Commodities		$4.3						
Equipment		$64.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$291.2		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$58.2						
Project Total	$0.0	$349.4		$270.0	$170.0			
Full-time Equivalents (FTE)		23.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: $110.3K in matching for FY98 funding should be added to above budget, see DPD for matching breakdown. Additional funding from PADI Foundation $15K (proposal submitted).

1998

Project Number: 98308
Project Title: Salmon-Predator Interactions Model Validation Experiment
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

4/11/97

1998 EXXON VALDEZ TRUSTEE COUNC ROJECT BUDGET

October 1, 1997 - September 30, 1998

onnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
Kline	Principal Investigator	[redacted]	6.8	7.9		53.7
Bozanic	Co-P.I	[redacted]	7.0	6.9		48.3
Williams	Fish Biologist	[redacted]	6.8	4.1		27.9
TBD	Acoustician	[redacted]	1.0	6.9		6.9
TBD	Field Techs	[redacted]	1.5	3.7		5.6
		[redacted]				0.0
		[redacted]				0.0
		[redacted]				0.0
		[redacted]				0.0
		[redacted]				0.0
		[redacted]				0.0
		[redacted]				0.0
	Subtotal	[redacted]	23.1	29.5	0.0	[redacted]
					Personnel Total	$142.4

el Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
R/T CDV-L48 CCR training	0.8	2	28	122.0	5.0
car rental	0.0	0	14	50.0	0.7
Travel to CDV for cruise, meetings LA to CDV/Anch	0.6	4	20	141.0	5.2
Travel to CDV for cruise Anch to CDV	0.2	2	3	141.0	0.8
R/T L48 Meeting	0.8	1	7	122.0	1.7
R/T CDV-Anch Workshops , Review, Project meeting	0.2	6	20	141.0	4.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$17.4

1998

Project Number: 98308
Project Title: Salmon-Predator Interactions Model Validation Experiment
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

ared:

4/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Contractual Costs: Description	Proposed FY 1998
Photocopying	0.3
Shipping (including hazmat)	2.0
Communications	0.4
Exposure suit rental	0.9
Dive equip rental	0.9
PWSSC Newtwork Charge	0.5
CCR manufacturers training	4.0
Vessel Charter 21 days @2.5K	52.5
Underwater camera maintenance	0.6
Photo. processing	1.0
Contractual Total	$63.1

Commodities Costs: Description	Proposed FY 1998
hand nets (5 @ $100)	0.5
o rings etc	0.1
film	0.5
Sofnolime (CCR scrubber material)	1.0
Oxygen	0.5
Chemicals	0.3
FW gear	0.5
dry gloves	0.5
Rite in rain	0.1
office supplies	0.3
Commodities Total	$4.3

1998

Project Number: 98308
Project Title: Salmon-Predator Interactions Model Validation Experiment
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

Prepared:

4/11/97

1998 EXXON VALDEZ TRUSTEE COUI PROJECT BUDGET

October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
	0	0.0	0.0
Dive Tracker for multiple day use (see DPD)	1	19.0	19.0
Closed Circuit Rebreathers	3	15.0	45.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$64.0

Existing Equipment Usage: Description	Number of Units	

1998

Project Number: 98308
Project Title: Salmon-Predator Interactions Model Validation Experiment
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared:

4/11/97

Ecosystem Synthesis Model Validation Using Natural Stable Isotope Tracers

Project Number:	98309
Restoration Category:	Research
Proposer:	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	Year 1, 2 -year project
Cost FY 98:	$ 122.2K
Cost FY 99:	$ 91.0K
Cost FY 00:	$
Cost FY 01:	$
Cost FY 02:	$
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pink salmon and herring, Commercial Fishing

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

The output of the Ecopath mass-balance model (proposed to the Trustee Council by Pauly and Pimm as an ecosystem synthesis tool) includes the trophic level (TL) of each modeled component. We will validate the model by using nitrogen stable isotope ratio as an independent method to assess TL. We seek to expand upon the number of taxa that have had their TL determined from $^{15}N/^{14}N$ which have been limited to the scope of the SEA project. We expect to include representatives of taxa and TLs that will facilitate model validation and which will fill significant data gaps.

Prepared 4/11/97

INTRODUCTION

Stable isotope ratios of carbon serve as effective tracers of energy supply in the study area due to conservative transfer of carbon isotope ratios between the lower tropic levels (phytoplankton to zooplankton to forage fishes, etc.) of Prince William Sound and adjacent Gulf of Alaska waters up to the top consumers. Organisms acquire these isotope ratios in response to the importance of the food in bulk body tissues (muscle and fat). Isotope ratio analysis of these tissues can provide insight into both habitat usage and assist in quantifying amounts derived from various areas (Fry and Sherr 1984). Nitrogen isotope ratios, in turn, provide excellent definition of relative trophic level. The heavy isotope of nitrogen is enriched by about 0.3 % with each trophic level and thus can accurately indicate the relative trophic status of species within an ecosystem (Minagawa and Wada 1984, Fry 1988, Cabana and Rasmussen 1994, Kiriluk et al. 1995). Preliminary trophic level assessment suggests up to five trophic levels are present in PWS (Fig. 1). The Ecopath mass-balance model (proposed to the Trustee Council by Pauly and Pimm as an ecosystem synthesis tool) determines the trophic level of each modeled component as part of its output that we propose to validate using nitrogen stable isotope ratio as an independent technique. This will build upon the existing database (Fig. 1) by filling in data gaps.

NEED FOR THE PROJECT

A. Statement of Problem

The Problem: Declining Production Marine Birds and Mammals, Salmon, and Herring in PWS.

The availability of macrozooplankton forage for salmon, herring, and their predators varies in space and time because of changes in physical processes in PWS. This was a major focus in the SEA project where it was known as River/Lake. River/Lake shifts represent fundamental changes in the way the PWS ecosystem produces commercial species, i.e. herring and salmon. One effect of River/Lake known as prey-switching occurs when macrozooplankton are not available and macrozooplankton consumers are forced to switch prey which include important commercial fish species. This process occurs seasonally and to a greater or lesser degree among years. The variability in River/Lake affects the availability of carbon in the ecosystem and thus productivity. Long term shifts in fish abundances (Anderson and Blackburn, APEX) and isotopic signature (D. Schell, pers. comm.) suggest the occurrence of bottom-up shifts that could be captured using the mass-balance approach.

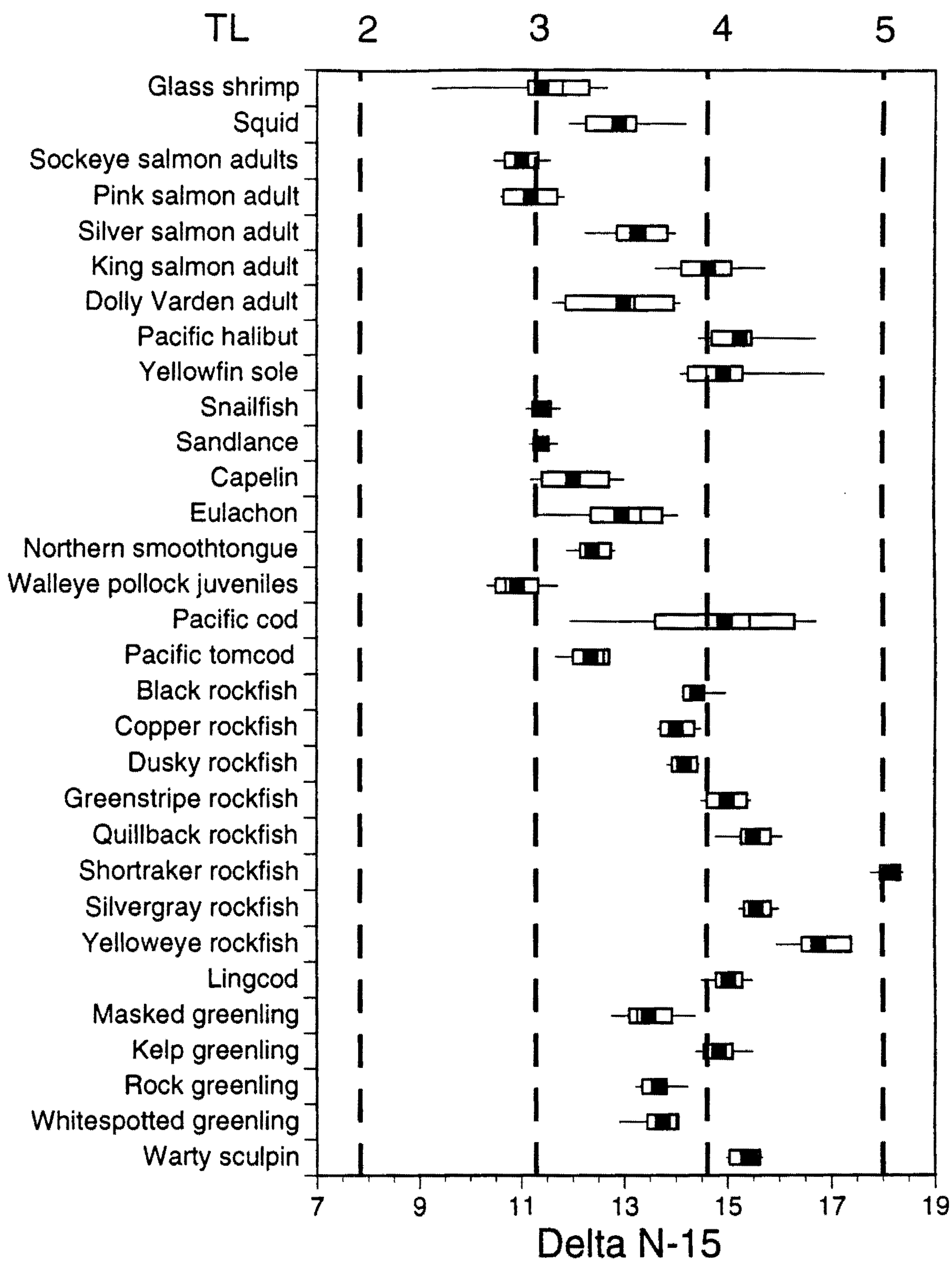

Figure 1. Trophic level (TL: top scale, integer values indicated by dashed lines) based on $^{15}N/^{14}N$ content (lower scale) using the method described by Kline and Paul (Appendix 1) of Prince William Sound biota (except sockeye salmon that were sampled in the Copper River) that were collected as part of the SEA project (from Kline and Pauly in prep.).

River) that were collected as part of the SEA project (from Kline and Pauly in prep.). Range in values indicated by box and whisker plots which indicate 10th, 25th, 50th, 75th, 90th percentiles and mean values (square symbol).

B. Rationale/Link to Restoration

This proposal is submitted under the Ecosystem Synthesis initiative described on page 29 of the Invitation to Submit Restoration Proposals for Federal Fiscal Year 1998 (*Exxon Valdez* Trustee Council 1997). A better understanding, particularly a quantitative understanding, is a prerequisite to determining protocols for restoration and recovery of all PWS species. Shifts in trophic levels occurring as a result of variations in the physical environment represent fundamental changes in the way the PWS ecosystem supports important species. Because a quantitative understanding of these phenomena is a prerequisite to determining protocols for restoration and recovery of these species, these results will have direct application to all future rehabilitation and restoration efforts. The stable isotope approach is unique in its ability to integrate time and spatial scales at mesoscale levels. No other technique currently available can generate such results. The natural tracer aspects of the approach emulates artificial tracer experiments without the burden of needing to generate signals or experimental artifacts.

The effort to integrate the PWS ecosystem studies into synthesis includes the Ecopath modeling by Pauly and Pimm. The Ecopath model can be used to ascertain the level of productivity needed to sustain an ecosystem (Pauly and Christiansen 1995a and b). The Ecopath model can thus be used to assess variability in bottom-effects resulting from River/Lake. This modeling effort will require validation. Stable isotope analysis can be used to determine trophic level independently of Ecopath. Since Ecopath predicts trophic level as part of its output, the isotopic-based trophic level makes a good model validation.

Trophic level determinations should be made on a number of Ecopath model components to make an effective validation. Trophic level determination arising from the SEA project was necessarily focused on hypothesis testing with the project. Thus samples that were not important for hypothesis testing, had to be set aside or discarded. A number of samples were saved at the initiative of SEA investigator Kline in the hope that future funding would enable a more complete isotopic analysis of present taxa. Because a significant dataset does exists, analysis of these "extra" samples when integrated will lead to a more comprehensive picture. Furthermore, analysis of SEA samples suggested that 1995 was much more of a "River" year than 1994 or 1996. Thus effects of the primary bottom-up hypothesis for the PWS ecosystem could be expanded into taxa that were not the focus of SEA and incorporated into the Ecopath ecosystem model during an actual ecosystem shift. It is not certain whether River vs. Lake years are "good" or "bad." Such an assessment could be made using a criterion of carbon availability determined by Ecopath and validated using isotopically determined TL. Additionally River/Lake assessment using ^{13}C content as was done with the SEA samples could be made for additional taxa.

Monitoring strategy development is presently underway (Projects 98320, 98312). The demonstrated sensitivity of natural stable isotope abundance to ecosystem shifts in PWS suggests that this will be a good tool for long-term studies. Isotopic time-series data in conjunction with population and other studies will reveal the relationships between changes in oceanographic processes and fish productivity at decadal time scales where we have seen dramatic changes and which seem to correlate with sea temperature (Anderson and Blackburn, 1996 APEX Project). The later may be indicative of processes such as regional upwelling that affects productivity by varying nutrient input and cross-shelf zooplankton transport (Cooney 1988). Sampling goals for long term-studies that will capture decal shifts which are a pre-requisite for such studies will be a goal of this ecosystem synthesis effort.

C. Location

Prince William Sound

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

PROJECT DESIGN

Natural stable isotope abundances reflect (1) trophic level and (2) source of assimilated matter and are thus a proxy for the change in diet resulting from ecosystem shifts. The proposed study would build upon the existing data base (Fig. 1) and add new data to construct and test conceptual food webs supporting salmon and herring and higher trophic levels in Prince William Sound and their prey organisms. The goal is to determine the trophic positions and to define the natural history parameters accessible from isotope ratio data in light of the observed declines in their populations. These include changes in trophic level over the lives of fishes, habitat dependencies, seasonal energetics and trophic dynamics relative to other community organisms. As part of this goal, we will integrate our analytical work with the field and laboratory studies of other investigators looking at food web structure, productivity of lower trophic levels, and provide validation data for assessment of conceptual and quantitative models.

A. Objectives

1. Synthesize data on hand to match mass-balance model and identify data gaps
2. Retrospective analysis of sample inventory (see below) to fill data gaps
3. Acquire samples from other EVOS projects and samples of opportunity to fill remaining data gaps (see below)
4. Determine trophic levels of organisms being modeled using $^{15}N/^{14}N$ ratios.

5. Compare with model predictions of trophic levels
6. Assess discrepancies between model predictions and empirical determination of trophic level

The initial synthesis, collaboration with Pauly and Pimm, and the initial modeling workshop will facilitate the sample selection process. We will collaboratively prioritize analytical work. The 1997 Wakefield symposium will provide an opportunity for Kline and Pauly to identify important data gaps.

Inventory of samples from 1995-6 that are available:

	1995	1996
Amphipods	302	272
Euphausids	22	315
sm pel shrimp	11	8
pteropds	229	13
chaetognaths	298	32
Euchaeta	23	137
other zoops	632	3489*
Octopus		4
Pandalid shrimp	~400	102
smoothtongue	57	
sand lance	236	
stickleback	55	
squid	71	3
wolfish	114	
sablefish	16	
cottids	64	49
Heaxagrammids	34	4
Blennioids, Lipards & misc1. benth. fsh	175	1
Pleuronectids	127	116
Osmerids	351	89
Salmonids	349	34
Scorpaenids	62	10
Gadids	449**	98
Elasmobranchs	27	

* mostly copepods
** includes ~ 130 intermediate age (yearling through subadults) pollock from 4 sites which are in need of analysis (P. Peterson, pers. comm. Feb. 1997).

Prepared 4/11/97

Kline has been in contact with these sources for additional samples:

Jellyfish [Scyphozoa] (Purcell, APEX)
Decapods including Pandalid shrimps (Anderson, APEX)
Orcas (Matkin, Killer Whale project)
Birds: kittiwakes (Suryam, APEX)
Adult Salmonids (Dolly Varden/Cutthroat project)
Sablefish (Bechtol, ADFG groundfish)
Rockfishes (Bechtol, ADFG groundfish)

B. Methods

1. The goal is to determine the $^{15}N/^{14}N$ and $^{13}C/^{12}C$ of species collected from the Prince William Sound ecosystem with a focus on those components important to man or important in the food webs supporting these species. Biota collected from PWS will be matched with regional isotope abundances in prey species (zooplankton, forage fishes) to allocate food sources and to assess trophic levels in specific areas of the sound.

2. Synthesize the data obtained in context with conceptual food webs to validate mass-balance models and expand the natural history information.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

ADFG
NOAA

SCHEDULE

A. Measurable project tasks for FY 98 (October 1, 1997 - September 30, 1998)

Year 1 (Sample Acquisition, Processing and Laboratory Analysis)

Oct -Dec Synthesisize data on hand to match mass-balance model and identify data gaps
Nov Present preliminary modeling validation at Wakefield symposium
Dec-Sept Retrospective analysis from sample inventory to fill data gaps
Jan Attend annual meeting (travel already funded)
Jan-Jul Acquire samples from other EVOS projects and samples of opportunity to fill remaining data gaps
Feb Attend ecopath modeling workshop
Jun-Sep Determine trophic levels of organisms being modeled using $^{15}N/^{14}N$ ratios from retrospective samples.

B. Project Milestones and Endpoints

Year 1

Sample Acquisition, Processing and Laboratory Analysis
Ecopath PWS Model Specification Workshop

Year 2:

Data Analysis and Synthesis
Incorporation of synthesis into Ecopath model and products

Oct - Jan	Determine trophic levels of organisms being modeled using $^{15}N/^{14}N$ ratios
Jan	Attend Annual Meeting
Jan-Jun	Compare with model predictions of trophic levels
Mar-Apr	Attend final Ecopath workshop
Jun-Sept	Assess discrepancies between model predictions and empirical determination of trophic level

C. Completion Date

30 September 1999

PUBLICATIONS AND REPORTS

The following manuscripts are in preparation:

Mass-balance ecosystem model validation using $^{15}N/^{14}N$ data
T.C. Kline and D. Pauly.

In prep for the 15th Lowell Wakefield Fisheries Symposium: Fishery Stock Assessment Models for the 21st Century -- Combining Multiple Data Sources

A carrying capacity model for pelagic PWS production constrained by empirically-determined trophic levels and carbon source inputs using $\delta^{13}C$ and $\delta^{15}N$.

PROFESSIONAL CONFERENCES

Nov. 1997: 15th Lowell Wakefield Fisheries Symposium: Fishery Stock Assessment Models for the 21st Century -- Combining Multiple Data Sources

NORMAL AGENCY MANAGEMENT

None

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Ecosystem Modeling Workshops and meetings with other P.I.s will be conducted to facilitate collaboration and to direct analysis efforts. Results of the analyses will be exchanged at workshops where they will be incorporated into the model validation. Contacts with P.I.s from other project will also facilitate acquisition of samples not otherwise available to the P.I. These samples include but are not limited to jellyfish (J. Purcell, APEX), killer whales (C. Matkin), "groundfish" species such as sablefish, flatfishes, rockfishes,an gadids (B. Bechtol, ADFG), pandalid shrimps (P. Anderson, APEX), Dolly Varden and cutthroat trout (G. Reeves), kittiwakes (R. Suryam, APEX). The first modeling workshop will probably facilitate further sample acquisition collaborations. The P.I. will be collaborating with Pauly and Pimm on scientific papers using stable isotope data to validate mass balance models. A preliminary assessment of the approach is planned for the 1997 Wakefield symposium which will be published in the peer-review proceedings in 1998.

PROPOSED PRINCIPAL INVESTIGATOR

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tkline@grizzly.pwssc.gen.ak.us

PRINCIPAL INVESTIGATOR

T. Kline has been actively involved in stable isotope research since 1985. His use of stable isotopes has been in fish ecology with emphasis on salmonid fishes in northern, western, south central and southeast Alaska. His innovative use of the techniques has allowed him to quantify the effect of salmon carcass nutrient input to juvenile sockeye salmon production. This research has been the first to provide direct evidence for the importance of salmon carcasses for juvenile salmon production. He has generated stable isotope models that enable the quantification of different sources of production important in salmon ecosystems. Dr. Kline also led an investigation relating feeding strategies to growth forms in North Slope salmonids. His on-going efforts include collaborations with ADF&G, the North Slope Borough, and BPX. The results of these projects have been presented in numerous scientific papers as well as in public forums (speaking to local groups and classes). T. Kline initiated project 320I which has been the first comprehensive project using natural stable isotopes in Prince William Sound. Through this project he has developed new models and application of natural stable isotope abundance methods. He was the first to provide direct evidence of the importance of carbon from the Gulf of Alaska in Prince William Sound.

OTHER KEY PERSONNEL

Fish Ecologist: J. Williams, PWSSC. J. Williams received his Masters degree in Fisheries from Texas A&M University in 1995. While earning his degree, he spent one year conducting field research in a remote area of Venezuela, successfully incorporating native fishermen in his survey of reservoir fish populations. His research has been presented in a variety of forums and is currently under review for journal publication. J. Williams is a certified Rescue Diver, Divemaster and has eleven years of diving experience. He is currently fulfilling a diver-in-training program for cold water research diving to expand his knowledge of diving further. Currently, J. Williams is tasked with sample and data processing and data management for this project and actively contributes to data synthesis.

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1998 EXXON VALDEZ TRUSTEE NCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$114.2						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$114.2		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$8.0						
Project Total	$0.0	$122.2		$91.0				
Full-time Equivalents (FTE)		0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Project Number: 98309
Project Title: Ecosystem Synthesis Model Validation Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
11Ap97/wjh

4/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	FY 1997	FY 1998						
Personnel		$53.2						
Travel		$3.2						
Contractual		$35.8						
Commodities		$3.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$95.2		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$19.0						
Project Total	$0.0	$114.2		$85.0				
Full-time Equivalents (FTE)		0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared:

Project Number: 98309
Project Title: Ecosystem Synthesis Model Validation Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COL PROJECT BUDGET
October 1, 1997 - September 30, 1998

rsonnel Costs:						
Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
Kline	Principal Investigator		4.0	7.6		30.4
Williams	Fish Biologist		6.0	3.8		22.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	11.4	0.0	
					Personnel Total	$53.2

ravel Costs:					
Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Project Review, 1 R/T CDV-Anch	200.0	1	5	141.0	905.0
ECOPATH Workshop/ R/T CDV-Anch	200.0	1	5	141.0	905.0
Car rental			5	50.0	250.0
Wakefield modeling symposium 1/	200.0	1	5	141.0	905.0
Car rental			5	50.0	250.0
					0.0
1/ 15th Lowell Wakefield Fisheries Symposium					0.0
"Fishery Stock Assessment Models for the 21st Century -- Combining Multiple Data Sources"					0.0
'October 8-11, 1997 -- Anchorage, Alaska, USA					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.2

1998

Project Number: 98309
Project Title: Ecosystem Synthesis Model Validation Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

repared:

4/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Contractual Costs:		Proposed
Description		FY 1998
Photocopying		0.3
Shipping		0.2
Posters for annual workshops 4@ $200		0.8
Communications		0.4
Page charges/ 1 @ $400		30.0
Stable isotope freezedrying @ PWSSC	1200 @$25	3.6
Stable isotope analyitical @ UAF	1200 @$3	0.5
PWSSC Newtwork Charge		
	Contractual Total	$35.8

Commodities Costs:	Proposed
Description	FY 1998
Office and Computer supplies	0.4
Dye Sub materials 1 @$300 each	0.3
Miscl	0.3
Lab supplies : vials,blades, chemicals,dialyisis bags, etc.	2.0
Commodities Total	$3.0

1998

Prepared:

Project Number: 98309
Project Title: Ecosystem Synthesis Model Validation Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

4/11/97

v Equipment Purchases: scription	Number of Units	Unit Price	Proposed FY 1998
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
ose purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

sting Equipment Usage: scription	Number of Units	

1998	Project Number: 98309 Project Title: Ecosystem Synthesis Model Validation Using Natural Stable Isotope Tracers Name: Prince William Sound Science Center	FORM 4B Equipment DETAIL

pared:

Distribution and Turnover in Juvenile Herring Populations

Project Number:	98310
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	
Duration:	1st year, 3-year project
Cost FY 98:	$150,977
Cost FY 99:	$347,800
Cost FY 00:	$150,700
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific herring

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

Estimates of Pacific herring survival and population size are confounded by fish movement and migration. Results from this project will refine current EVOS research and the PWS stock definition. In FY 98, a pilot study using herring collected in 1995–1997 by SEA (320T) will be completed. Samples will be processed for size, fatty acid composition, and isotopes. Otoliths will be extracted for pattern and chemical analysis. These results, when combined with appropriate distribution and habitat data, will be interpreted as tracers if distinctive for each area. In the future, seasonal investigations, including tagging, will be done within a defined nursery region of PWS in order to properly interpret tracer results.

INTRODUCTION

This project will provide critical information needed to complete an analysis of recruiting processes, assist other researchers who are studying herring as prey, as well as help to redefine the stock model currently being used by Alaska Department of Fish and Game (ADFG) managers. Sound Ecosystem Assessment (SEA) is producing a herring recruitment dynamics model which relies on estimates of survival and growth rates from each of four bays. This work is embedded in investigations of sound-wide as well as bay distributions of juvenile herring. If daily and seasonal movements of juvenile herring within and between nursery areas were better known, both the estimates of survival and the model could be refined. In addition, other EVOS researchers using fatty acid composition in seal tissue as an indication of prey will be able to refine their understanding of prey type with the results of this study. Finally, ADFG is using a single stock model to manage the herring population in Prince William Sound (PWS). This assumes complete mixing of early life stages within the sound with a single larval retention area, and does not account for any immigration or emigration. If 1) there is more than one retention area within the sound, 2) rearing of juveniles in these areas is separate, and 3) recruitment occurs to discrete adult herring groups, it would be possible under the current management regime to over harvest one area and under exploit another. This could exacerbate recovery of the population. By focusing on juvenile herring movement, site fidelity, and mixing with the adult population, we can begin to explore the possibility that there are sub-stocks or meta-populations within the sound and recommend alternative management strategies to ADFG.

Current SEA research (97320T) reveals that although there is some overlap in spawning, juvenile nursery, adult summer feeding, and both juvenile and adult overwintering distributions, these distributions are largely distinct. The implications as to stock structure are unclear. Iles and Sinclair (1982) and Sinclair (1988) described unique areas used by different life stages of Atlantic herring. Others have defined herring stocks as a function of distribution of the life stages over time (Carlson 1980). Stocker (1993) described two types of herring populations in British Columbia (BC)—major migratory stocks and smaller resident stocks usually found at the heads of bays or inlets. Current SEA aerial and vessel surveys revealed minor spawnings in PWS that appear to be due to small local adult groups. These minor spawnings are separate from the major spawning recorded by ADFG and are later in the year, but could have large ramifications in terms of recruitment, herring as forage availability and population stability. The recurring use of the major spawning areas, the distance between these areas and difference in spawn timing with the minor spawning areas all point to the possibility of multiple stocks within PWS. Tagging studies on Pacific herring (*Clupea pallasi*) in BC reveal that discrete spawning populations can occur on the scale of approximately half of PWS (Hourston 1982; Stevenson 1955) with a range in homing between 64 and 87% (Hourston 1982). Wheeler and Winters (1984) report homing fidelity of spawning Atlantic herring at 90%. Other tools to separate stocks (genetics using electrophoresis and mitrochondrial DNA, morphology and meristics) have provided information valuable to discerning differences on a large scale (e.g. BC to PWS) but generally fail when trying to distinguish within an area the size of PWS (Schweigert 1981, 1990; Meng and Stocker 1984; Grant and Utter 1984; Schweigert and Withler 1990; Safford and Booke 1992). They also provide little information about movement and recruitment dynamics. Genetic homogeneity probably due to larval drift and dispersion (Hay and McCarter 1991) prevents discernment of the stocks at the scale needed to assess movement or occurrence of meta-populations.

New tools that could be used as tracers of fish on a smaller scale are now available. The analysis of otolith microstructure (Stenevik et al. 1996). otolith chemical composition (Severin et al. 1995), isotope (Kline and Paul, in prep.) and fatty acid composition (Iverson et al. in prep.) can distinguish between groups of fish most likely due to differences in prey, age, growth, and physical factors within the nursery sites. In otoliths, growth rings are deposited approximately daily as a result of circadian changes in metabolic activity (Thresher 1988) and increment spacing reflects the growth rate of an individual (Moksness and Wespestad 1989) providing a useful time-line of life history (Victor 1986). If compositional signals can be matched to particular geographic locations, it may be possible to get a geographic history of an individual by examining the otolith cross-section in detail. The degree to which these differences occur between sites and ages of herring may provide clues as to how much site fidelity and mixing occurs within PWS. For example, if samples of juveniles from opposite sides of the sound are different, but juveniles from a site in the middle are intermediate between the two, this may indicate mixing and habitat overlap. However, because we know very little about how the signals are formed in otoliths and tissues, caution should be used when interpreting them. *Interannual* variation in habitats could override *intraannual* variability between sites. Eventually, we will need information on tracer signal formation for proper interpretation. This will also aid current marine mammal researchers using fatty acid composition in seals (97064) to identify prey since area differences or similarities could confound their results.

Considering the current literature and this year's sample availability, we propose to conduct a pilot study in FY 98 documenting the differences in biological tracers in herring between nursery areas within the context of general population distribution. These are areas where juvenile herring recruit as larvae and leave as subadults (SEA, unpublished data). Data from these areas have a good possibility of revealing the degree of mixing that may confound estimates of survival as well as how, when and where juvenile herring recruit to the adult population. In addition, herring samples from these sites are accompanied by a host of habitat and population data including: prey composition, energetic content, water temperature, salinity, age structure, size at age, somatic growth, survival, and degree of overlap with adults and other fish species (SEA project 98320T) which will be critical to interpreting tracer signals. We plan to try several tracer tools (otolith pattern recognition, otolith chemical composition, tissue fatty acid composition and isotopes) in order to evaluate and compare the usefulness of each. We also plan to continue tracking the broadscale distribution of juvenile herring for two reasons: 1) the distribution of tracer signals occurs within the context of the population and therefore the relative importance of each signal varies, 2) adult distribution data, except during the summer, is readily available from ADFG, but juveniles are not counted. With no monitoring plan in place in FY 98 and since SEA herring projects are closing out field research (final season March 1998; 98320T), we are concerned about missing distribution information in 1998 critical to the interpretation of results for this study. However, since samples will be collected in 1997-98 by the SEA project (97-98320T) with funding already in place for vessels and field logistics, the costs for this project are minimal (needed only for summer 1998).

For future years, we plan to incorporate a finer scale study of a particular nursery area in order to directly link variability in the habitat, movement, and mixing to variability in the tracer signals. By that time, we will limit the tracer tools used to the ones which provide the best information to answer the questions posed, are the most cost-effective, or provide information to other studies looking at herring as food (e.g. 97064). In addition, we will add a tagging component, critical in evaluating the accuracy of the use of tracers in discerning different rearing groups. We may also want to add a lab component to examine tracer formation if necessary. Planning for future work is an iterative process and depends on results revealed by this pilot study.

NEED FOR THE PROJECT

A. Statement of Problem

Pacific herring are a key species in the marine ecosystem of Prince William Sound, the health of the apex predator community may depend on the magnitude of herring recruitment and condition of individual fish since herring are the key forage fish in the sound (Lew Haldorson, UAF, personal communication). The PWS herring population decline (Brown et al. 1996a and 1996b) has had serious and significant negative impacts on the commercial fisheries, subsistence food harvest patterns and distribution of wildlife in areas now devoid of herring spawning and feeding; the effects on oil–injured predators of herring are only beginning to be understood by other EVOS funded researchers. Eight years after the spill, Pacific herring are still listed by the EVOS Trustee Council as injured and not recovering. Direct restoration of this species is not practical. However, understanding and monitoring recovery is important in order to improve stock assessment for management of commercial fisheries. Recovery can only take place via successful recruitment of juvenile herring to the adult population.

B. Rationale/Link to Restoration

The research completed under this project combined with data from other SEA projects will help refine models describing processes controlling and regulating herring recruitment by enabling us to interpret juvenile herring survival estimates. This information will help to better understand the dynamics of the recovery of this species.

C. Location

This research is conducted solely in Prince William Sound. Cordova is the base for the departure of vessels and aircraft.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

We anticipate that since we are coordinated with SEA, this program will receive similar public involvement and support. Each year, SEA researchers hold public meetings in Cordova to answer questions from and concerns of local residents which we will attend. Residents will also be able to participate directly by bidding on future vessel charters. SEA has used traditional knowledge of herring distribution for the survey design. We anticipate hiring PWS and other Alaska residents as technicians, vessel owners, vessel crew, and pilots. Supplies, fuel, and equipment are purchased locally.

The use of traditional knowledge has not been directly incorporated into this project since we are focusing on current data. Results will be shared with local residents as mentioned above in whatever way is requested and logistically possible.

PROJECT DESIGN

A. Objectives

The main research questions for the scope of this study are:

1) To what degree and on what scale do age-0 through 2 juvenile herring move away from or into nursery sites after recruitment to the site as larvae?

2) How do tracers, such as otolith patterns and fatty acid and isotope composition, vary between nursery sites in PWS?

3) How are tracer signals affected by particular nursery habitat conditions as well as growth and age of the herring?

4) How and where does mixing of juvenile and adult herring occur and when does actual recruitment take place (point at which a juvenile joins a group of adults)?

In 1998 we will address questions 2 and 3 with the following objectives:

1) Process archived frozen juvenile and adult herring from four sites in PWS for fatty acid composition and isotope structure.

2) Prepare, section, and digitize images of archived otoliths of juvenile herring from several sites; determine the best cross-sectional view to use for analysis; conduct microstructure pattern analysis and chemical composition on each otolith.

3) Using aerial surveys during the summer of 1998, continue tracking distribution of juvenile herring; use net catches and video to validate and sample schools observed from the air.

4) Archive frozen and preserved samples from the summer of 1998 for future analysis of tracers and stomach contents as deemed necessary.

B. Methods

Archived Samples

In 1995, 1996, and 1997 whole herring were frozen and archived from each of at least four sites during each year. These sites represent areas in eastern, central, southwestern, northwestern and northeastern PWS. Whole herring archived in 1995 and 1996 were shipped to Kathy Frost (ADFG) and forwarded to Dr. Sara Iverson, Dalhousie University in Nova Scotia, Canada for fatty acid composition. Samples from 1997 are archived at the University of Alaska Fairbanks. Otoliths preserved from these same areas have been archived for all three years. Although not from the exact same fish, isotope structure has been analyzed from a subset of juvenile and adult herring from these same areas for 1995, 1996, and 1997. In summary, for at least four sites representing nursery areas of juvenile herring in PWS, there are archived samples or processed results available that have been collected during the same space and time strata. These most likely represent fish from the same group within a bay or nursery site.

Sample Processing

Otoliths from a subset of site, season, and year strata will be extracted from the frozen heads of juvenile herring. Each juvenile herring has been numbered so that weights, lengths and age can be linked to each otolith. They will be shipped to the ADFG otolith lab in Juneau for preparation and sectioning. Several different sections will be performed on a few otoliths and digitized in order to determine which section is likely to provide the best information. We will cooperate with the otolith lab to make this determination. Once the section is chosen, the remaining otoliths to be processed in the subset will be digitized. Optimus software (Peter Hagen, personal communication, ADFG, Juneau) will be used to digitize and analyze microstructure. We will travel to Juneau for training with section and digitizing images. Once the otolith image has been made, the otoliths will be shipped back to UAF to Dr. Ken Severin of the Geophysical Institute who will perform chemical composition on the same microstructures used in the pattern analysis. This will provide additional power to our ability to differentiate between rearing groups and will enable us to link the data to habitat conditions more accurately. Results from both otolith pattern analysis and chemical composition will be used in the analysis of site differences.

Data from fatty acid composition of herring processed from 1995 and 1996 samples by Sara Iverson will be gathered with her assistance. Using methods and processing equipment similar to Iverson et al. (in prep.), archived samples from each of four bays in 1997 will be processed at UAF (Kodiak or Fairbanks). It may also be possible that with new equipment currently being acquired by Dr. Don Schell (personal communication, UAF, Fairbanks) we will be able to run isotopes from the identical fish and perhaps individual fatty acids. If not, isotope data processed by the SEA project (97320T) from the same sites and dates, but not from the same fish, will be obtained from Dr. Tom Kline, Prince William Sound Science Center.

Analysis of Differences in Tracer Signals Between Sites

Analysis of the tracer data requires non-parametric multivariate statistical procedures because the points are not normally distributed—a function of the complexity of patterns in otoliths and fatty acids and the range of environmental variables in the analyses. For the fatty acid data, we will enlist the help of a fatty acid expert to assist with interpretation of the compositional patterns. For this procedure we will use S-plus programs used for classification and regression trees (CART) similar to those used by Iverson et al. (in prep.). The isotope data will come to us in a post-processed state normalized for lipid and carbon source (Kline and Paul, in prep.). If this tool proves to be useful in the analysis of movement and stock structure, we will enlist the help of an isotope specialist in future years. The otolith pattern analysis involves Fourier and discriminant function methods. After the identifying structures have been specified and summarized for each site (including site variability) and because of the form of the data, analysis will be similar to fatty acid composition data. However, we will enlist the help of both the otolith lab in Juneau (Pete Hagen, personal communication, ADFG, Juneau) and Ken Severin, UAF, Fairbanks for interpretation of microstructure and chemical patterns. Once the initial statistical procedures have been run for site-specific tracer results, we will incorporate the environmental data from each site as independent variables in order to interpret tracer signal differences or similarities. We will use multivariate procedures for this part of the analysis.

BROADSCALE SURVEYS AND NET SAMPLING

We will use aerial surveys to continue to assess the distribution of juvenile herring and net catches, and underwater videography to provide validation for sightings and additional samples in 1998. The methods used for collecting, processing and analyzing the data are identical to those reported by SEA (96320T, 1995 Annual Report; Brown and Norcross, in prep.). This will add a fourth year of juvenile herring broadscale distribution information, which is needed to assess interannual variability in distribution and relative abundance. A long-term data set on juvenile herring distribution will be useful in the evaluation of movement, especially if movement and stock mixing is density dependent. For net sampling and videography, a single seiner will be employed synoptically with aerial surveys. In direct communication with the aerial surveyor, a technician will deploy the camera using coordinates provided from the air. In addition, juvenile and adult herring will be sampled from sites representing the sound-wide distribution (with an emphasis on sites sampled previously) and archived for future analysis. For tracer analysis, 30 juveniles or adults will be frozen for fatty acid/isotope processing and heads will be removed and frozen from an additional 25 juvenile herring. Fifteen whole juvenile herring and 15 adult herring stomachs will be placed whole in 10% buffered formalin for future stomach contents analysis. Hydrography measurements (CTD) will be made wherever catches occur using a Seabird CTD.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Although there are no cooperating agencies, the lead agency, Alaska Department of Fish and Game, will be contracted to perform otolith processing.

Contracts under this proposal are for vessel charter (local PWS vessel owners) used to collect data in the field.

SCHEDULE

A. Measurable Project Tasks for FY 98 (October 1, 1997 – September 30, 1998)

November 30:	Complete inventory of all archived and processed data needed for this study Contract fatty acid expert
November 1 - February 28:	Send samples to appropriate labs for processing Decide on optimal otolith section for all samples
January 15-24 (3 of these days):	Attend EVOS workshop; share information gained to date
March 1 - May 31:	Set up databases and analytical programs for analysis of tracer data; work with expert personnel for tracer data Prepare annual progress report Prepare FY 99 proposal using information gained from pilot
June 1 - August 31:	Establish analytical procedure for tracer data and run analysis of processed samples Conduct two broadscale aerial/vessel surveys
September 30:	Run first cut tracer/habitat analysis; evaluate results Update progress report; prepare publication draft Plan and implement 1998–99 field season

B. Project Milestones and Endpoints

FY 98

March 31:	Initial set of samples processed; Objective 1
May 31:	Tracer pattern and compositional analysis complete for first set of samples; Objective 2
April 15:	Progress report and 1999 study plan complete
August 31:	Fourth year broadscale aerial survey complete; samples from summer 1998 archived; Objectives 3 and 4 Tracer analytical procedure set
September 30:	First run analysis done; analytical procedure set for incorporation of habitat information Draft of first publication completed

FY 99	
October 1:	Initiate fine-scale study with tagging and tracer sample collection
January 15 - 24:	Attend 10-year anniversary EVOS restoration workshop (3 of the days listed)
March 31:	Processing complete for 1998 samples
April 15:	Complete analysis for second set of tracer data; compare interannual results from identical sites Annual progress report complete Prepare final FY 00 close-out proposal; integrate with proposed monitoring plan
July - August:	Complete final field collections and tracer analysis
September 31:	First cut analysis of tagging results complete as well as second cut analysis of tracer/habitat data
FY 00	
November 30:	Processing of all remaining samples complete
January 15-24:	Attend annual EVOS restoration workshop (3 of the days listed)
February 28:	Analysis complete on final set of tracer data Analysis complete on tagging data
April 30:	Tracer analysis results integrated with tagging results and habitat data
August 31:	Integrated analysis complete; prepare draft publications
September 30:	Publications completed; Final Report complete

C. Completion Date

September 30, 2000

PUBLICATIONS AND REPORTS

The Annual Report due April 1998 will be a progress report, since only a small portion of the sample processing will be complete. We will relate how milestones are met and objectives addressed. We expect to complete a draft publication by the end of the fiscal year:

Evaluation in using otolith microstructure, otolith chemical composition, fatty acid and isotope composition of juvenile herring, *Clupea pallasi*, in meta-population differentiation on a seasonal and interannual basis in Prince William Sound, Alaska. Brown, Blanchard, Severin, Iverson, Hagen, Stokesbury and Norcross. Fishery Bulletin

PROFESSIONAL CONFERENCES

During FY 98 we do not anticipate attending any scientific conferences other than the Annual Restoration Workshop in January.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be closely coordinated with the SEA project (98320) since much of the archived samples, processed data, and herring habitat analysis will come from its investigators. We will also coordinate with the marine mammal researchers (98064; 98170; new harbor seal fatty acid project) sharing procedural and analytical methodology as well as herring distribution and tracer data. During the summer, we will coordinate, as in the past, with APEX (98163) and NVP (98025) when conducting aerial surveys; this information will be shared as well.

PROPOSED PRINCIPAL INVESTIGATORS

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PRINCIPAL INVESTIGATORS

Evelyn D. Brown
SS #379-54-5204

PROJECT RESPONSIBILITIES:

- Supervise project leader and review data collected
- Train data acquisition technician
- Assist researchers with quantifying traditional and local knowledge and incorporating data into current projects
- Assist with mapping
- Create archive database
- Analyze archive data for models
- Assist with report analysis and preparation of journal articles for submission

EDUCATION:

- B.S. Zoology and Chemistry, University of Utah, Salt Lake City, 1977
- M.S. Fisheries Biology and Aquacultural Engineering, Oregon State University, Corvallis, OR, 1980

EXPERIENCE:

- Research Associate, University of Alaska, Fairbanks, 1995–present
- Herring Research Biologist, Alaska Department of Fish and Game, Cordova, Alaska, 1988–1995
- Principal Investigator, Injury to Prince William Sound Herring, NRDA FS 11, 1989–1992
- Fisheries Biologist, Alaska Department of Fish and Game, Cordova, Alaska, sonar projects, stream surveys, aerial surveys, and net sampling, 1985–1987
- Commercial Fisherperson, various skippers, 1982-1984
- Fisheries Consultant, self-employed; contracts included Prince William Sound Aquaculture Corporation for fish tagging and stream surveys; Metlakatla Indian Community on Annette Island for salmon stream survey manual and estimate of production potential and for environmental impact statement for logging activity.
- Fisheries Biologist, Florida Department of Natural Resources, St. Petersberg, Florida; employed for one winter to conduct a hydroacoustic survey of mullet in the Manistee River and in Tampa Bay; also worked on a mullet tagging project encompassing the entire west coast of Florida, 1987–1988
- Fisheries Management Biologist, Metlakatla Indian Community, Annette Island, Alaska, completed an oyster culture feasibility study, provided management recommendations on shellfish harvests, participated in herring egg deposition survey and salmon management through the use of commercial fish traps, 1980–1982

CURRENT RESEARCH INTERESTS:

Juvenile herring population dynamics; interactions of biological and physical parameters at nursery habitats, distribution

Prince William Sound herring stock model

FIELD EXPERIENCE:

From 1978 to the present, I have participated in numerous field programs from ground surveys of streams out of skiffs, to aerial surveys of salmon streams and herring aggregations, to SCUBA surveys of herring egg deposition and shellfish resources, to open ocean cruises aboard large research platforms performing large scale fisheries oceanography surveys (R/V *Oshoro Maru*, 1983). I have operated fish weirs and fixed-site sonars from remote field camps and from trailers located in urban areas (Bradenton, Florida). I have repaired outboards, carried firearms for protection from dangerous animals (brown bears and wolves), and assisted in construction of structures including cabins and tent platforms. I have operated vessels ranging from 12 to 72 ft. by myself and assisted in skippering vessels up to 84 ft. (crabber out of Kodiak, Alaska). I have experience operating navigational equipment including GPS, Loran, Radar, Searchlight sonar and using nautical charts, compasses, parallels, etc.

PUBLICATIONS, CONTRIBUTED PUBLICATIONS AND REPORTS:

Final Reports Submitted to Trustee Council:

Biggs, E.D., and T.T. Baker. Studies on Pacific herring in Prince William Sound following the *Exxon Valdez* oil spill, 1989-1992 (former FS11 G-egg loss and H-fecundity are included with this report)

E.D. Brown, T.T. Baker, F. Funk, J.E. Hose, R.M. Kocan, G.D. Marty, M.D. McGurk, B.L. Norcross, J.W. Short. 1994. Injury to Prince William Sound Herring following the *Exxon Valdez* oil spill: Final Report for Natural Manuscripts on one file by end of Damage Assessment Fish/Shellfish Study No. 11

Baker, T.T. and E.D. Biggs. 1993. Measurements of the survival of Pacific herring eggs in the field following the *Exxon Valdez* oil spill, 1989-1991.

Journal Articles or Symposia

1. Brown, E.D., T.T. Baker, J.E. Hose, R.M. Kocan, G.D. Marty, M.D. McGurk, B.L. Norcross, and J. Short. 1996. Injury to the early life history stages of Pacific herring in Prince William Sound after the *Exxon Valdez* oil spill. Am. Fish. Soc. Symp. 18. pp. 448-462.
2. Brown, E.D., B.L Norcross, and J.W. Short. 1996. An introduction to studies on the effects of the *Exxon Valdez* oil spill on early life history stages of Pacific herring, [illegible] Prince William Sound, Alaska. Can J. Fish. Aquat. Sci. 53: 2337-2342
3. Brown, E.D. and E. M. Debeves. In press. Effects of the *Exxon Valdez* oil spill on in situ survival of Pacific herring (*Clupea pallasi*) eggs. Can J. Fish. Aquat. Sci.

4. McGurk, M.D., and E.D. Brown. 1996. Egg-larval mortality of Pacific herring in Prince William Sound, Alaska, after the *Exxon Valdez* oil spill. Can J. Fish. Aquat. Sci. 53: 2343-2354.
5. Hose, J.E., M. D. McGurk, G.D. Marty, D.E. Hinton, E.D. Brown, and T.T. Baker. 1996. Sublethal effects of the *Exxon Valdez* oil spill on herring embryos and larvae: Morphologic, cytogenetic, and histopathological assessments, 1989 - 1991. Can J. Fish. Aquat. Sci.
6. Kocan, R.M., J.E. Hose, E.D. Brown, and T.T. Baker. 1996. Pacific herring (*Clupea pallasi*) embryo sensitivity to Prudhoe Bay petroleum hydrocarbons: Laboratory evaluation and in situ exposure at oiled and unoiled sites in Prince William Sound. Can J. Fish. Aquat. Sci. 53: 2366-2375.
7. Norcross, B.L. , J.E. Hose, M. Frandsen and E.D. Brown. 1996. Distribution, abundance, morphological condition and cytogenetic abnormalities of larval herring in Prince William Sound, Alaska following the *Exxon Valdez* oil spill. Can J. Fish. Aquat. Sci. 53: 2376-2387.
8. Kocan, R.M., G.D. Marty, M.S. Okihiro, E.D. Brown and T.T. Baker. 1996. Reproductive success and histopathology of individual Prince William Sound Pacific herring three years after the *Exxon Valdez* oil spill. Can J. Fish. Aquat. Sci. 53: 2388-2393.
9. Marty, G.D., J.E. Hose, M. D. McGurk, E. D. Brown, and D. E Hinton. In press. Histopathology and cytogenetic evaluation of Pacific herring larvae exposed to petroleum hydrocarbons in the laboratory or in Prince William Sound, Alaska after the *Exxon Valdez* oil spill. Can J. Fish. Aquat. Sci.

Brenda L. Norcross
SS# 355-42-8879

PROJECT RESPONSIBILITIES:

Review survey design, data, and analysis
Review reports and publications

EDUCATION:

A.B., Biology, MacMurray College, Jacksonville, Illinois, 1971
M.S., Biology, St. Louis University, St. Louis, Missouri, 1976
Ph.D., Marine Science, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia, 1983

EXPERIENCE:

Associate Professor, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1996-present
Assistant Professor, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1989-1996
Assistant Professor, Division of Biological Oceanography and Fisheries Science, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia, 1986-1988

Assistant Professor, Computer Center, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia, 1984-1986

Research Biologist/Oceanographer, Ocean Research and Education Society, Inc., Gloucester, Massachusetts, 1984

TEACHING EXPERIENCE:

Fisheries oceanography seminar (MSL 692), 1991, 1993, 1994

Fisheries oceanography (MSL 640), 1990, 1993

Introductory oceanography (ORES/University of Massachusetts), 4 courses, 1984

CURRENT RESEARCH INTERESTS:

Fisheries oceanography, early life history of marine fish, fisheries ecology

FIELD EXPERIENCE:

28-foot skiff, Chief Scientist and Principal Investigator, Inshore fish and crabs, benthos and sediment (Kachemak Bay, 7 days), 1994

26-foot Boston whaler, Chief Scientist and Principal Investigator, Inshore fish and crabs. benthos and sediment (Kodiak Island, 12 days), 1994

24-foot skiff, Chief Scientist and Principal Investigator, Inshore fish, benthos and sediment (Afognak Island, 8 days), 1994

F/V *Maritime Maid,* Fisheries Scientist, Distribution of juvenile fishes (Aleutian Islands. 16 days), 1994

26-foot Boston whaler, Chief Scientist and Principal Investigator, Inshore fish and crabs, benthos and sediment (Kodiak Island, 9 days), 1993

F/V *Big Valley*, Chief Scientist and Principal Investigator, inshore fish, benthos, sediment, ROV and water samples (Kodiak Island, 14 days), 1992

24-foot skiff, Chief Scientist and Principal Investigator, Inshore fish, benthos, sediment and water samples (Kodiak Island, 6 days), 1992

21-foot Boston whaler, Scientist, Inshore fish (Auke Bay, 2 days), 1992

F/V *Big Valley*, Chief Scientist and Principal Investigator, Inshore fish, benthos, sediment and water samples (Kodiak Island, 7 days), 1991

24-foot skiff, Chief Scientist and Principal Investigator, inshore fish, benthos, sediment and water samples (Kodiak Island, 12 days), 1991

R/V *Alpha Helix*, Associate Investigator, Distribution of larval fish (Alaska to Hawaii, 17 days), 1991

R/V *Alpha Helix*, Associate Investigator, Distribution of larval fish (Gulf of Alaska, 3 cruises, 9 days), 1990

12-foot inflatable, Chief Scientist and Principal Investigator, Inshore fish and water samples (Kodiak Island, 10 days), 1990

R/V *Alpha Helix*, Chief Scientist and Principal Investigator (1 cruise), Associate Investigator (3 cruises), Distribution of larval fish, oil spill (Prince William Sound, 27 days), 1989

F/V *Jennie Girl*, Principal Investigator, Distribution of larval fish, oil spill (Prince William Sound, 10 days), 1989

NOAA Ship *John Cobb*, Chief Scientist and Principal Investigator, Distribution of larval fish, oil spill (Prince William Sound, 7 days), 1989

R/V *Little Dipper*, Chief Scientist and/or Principal Investigator, Distribution and transport of larval fish (Resurrection Bay, 4 cruises, 20 days), 1989

PUBLICATIONS:

Moles, A., S. Rice and B.L. Norcross. (In press.) Non-avoidance of hydrocarbon laden sediments by juvenile flatfishes. *Neth. J. Sea Res.*

Moles, A. and B.L. Norcross (In press.) Sediment preference in juvenile Pacific flatfishes. *Neth. J. Sea Res.*

Müter, F.-J., B.L. Norcross and T.C. Royer. (In press.) Do cyclic temperatures cause cyclic fisheries? *Can. Spec. Pub. Fish. Aquat. Sci.*

Feingold, L.E. and B.L. Norcross. (In press.) Temporal and spatial distribution of weakfish (*Cynoscion regalis*) spawning grounds and nursery areas defined by physical parameters. *Can. J. Fish. Aquat. Sci.*

Müter, F.-J. and B.L. Norcross. 1994. Distribution, abundance, and growth of larval walleye pollock (*Theragra chalcogramma*) in an Alaskan fjord. *Fish. Bull.* (U.S.) 92(3):579-590.

Norcross, B.L. and M. Frandsen. 1996. Distribution and abundance of larval fishes in Prince William Sound, Alaska, during 1989 after the *Exxon Valdez* oil spill. In S.D. Rice, R.B. Spies, D.A. Wolfe and B.A. Wright [eds.]. *Exxon Valdez* Oil Spill Symposium Proceedings. Am. Fish. Soc. Symp. 18: 463-486.

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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$34.8						
Travel		$3.7						
Contractual		$67.5						
Commodities		$4.5						
Equipment		$3.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$113.5	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated
Indirect		$28.4	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
Project Total		$141.8	$347.8	$150.7				
Full-time Equivalents (FTE)		0.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

Justification
Personnel: Much of PI time incorporated in related EVOS projects; main cost is for sample preparation (otolith extraction and inventory) and statistical assistance.

Travel: Anchorage trips - two are for EVOS related meetings and Juneau trips are for coordination with otolith lab. R/T to Canada is to bring fatty acid expert to Fairbanks, or for PI to travel and meet there.

Lab processing costs should be self-explanatory. Contract costs have been explained in the proposal.

We need a powerful computer with large screen for the processing and analysis of otolith patterns. We will purchase the Optimus software similar to what the otolith lab in Juneau uses. This computer will be dedicated to the analysis of tracer data and digitized images.

FY 98

Prepared: 04/10/97

Project Number: 98310
Project Title: Distribution and Turnover in Juvenile Herring Populations
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
DETAIL

1998 EXXON VALDEZ TRUST OUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:							
	Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
	E. Brown	Program Manger - PI		2.0	5.9		11.8
	Vacant	Statistician		2.5	5.7		14.3
	Vacant	Lab Technician		3.0	2.9		8.7
		Subtotal		7.5	15	0	
						Personnel Total	$34.8

Travel Costs:						
	Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
	Fairbanks–Anchorage -- Attend EVOS Meetings	150	2	6	125	1.0
	Fairbanks–Juneau -- Attend Otolith Meetings	350	1	4	100	0.8
	Fairbanks–Nova Scotia, Canada -- Meet Fatty Acid Analysis Expert	800	1	5	100	1.3
	Car Rental -- All trips	30	1	20		0.6
					Travel Total	$3.7

FY 98

Project Number: 98310
Project Title: Distribution and Turnover in Juvenile Herring Populations
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 04/10/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Fatty Acid Expert – Consulting	6.0
Otolith Sample Preparation; 200 @ $15/otolith	3.0
Otolith Chemical Composition: 200 @ $50/otolith	10.0
Fatty Acid Sample Processing: 100 @ $170.00/fish	17.0
Aircraft Charter; 25 hrs per survey, 2 surveys, $250/hr	12.5
Vessel Charter; summer only; 14 days @ 1200/day	16.8
Phone, fax	0.5
Printing and copying	0.2
Publication charges	1.5
Contractual Total	$67.5

Commodities Costs:	Proposed
Description	FY 1998
Chemicals and Lab Supplies	0.5
Optimus software	4.0
Commodities Total	$4.5

FY 98

Project Number: 98310
Project Title: Distribution and Turnover in Juvenile Herring Populations
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities
DETAIL

Prepared: 04/10/97

1998 EXXON VALDEZ TRUS' :OUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Pentium computer with large monitor dedicated for analysis of digitized images and pattern analysis	1	3,000	3.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$3.0

Existing Equipment Usage: Description	Number of Units	
Fax/Printer	1	
Copier	1	
Office Furniture	3	
Work Station – UAF	1	
Work Station Software with S-plus and CART (needed to analyze fatty acids)	1	
Laptop for field work – UAF	1	
Anchovy Seines	2	
Underwater Video – UAF		

FY 98

Project Number: 98310
Project Title: Distribution and Turnover in Juvenile Herring Populations
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 04/10/97

UNIVERSITY OF ALASKA BUDGET INFORMATION

The University of Alaska accounting system accumulates data according to an established system of accounts codes. This differs from the level or category of detail required on this proposal. Per the new Cost Accounting Standards Board (CASB) guidelines, costs are to be listed in a proposal only to the level of detail at which the subsequent expenditures may be tracked. Therefore, please note that supplies itemized on the budget form may be tracked to UA accounting system categories such as the following: 1) project supplies; 2) professional, technical and scientific supplies; 3) field camp supplies; and 4) hazardous materials. Service listings are also broad, but include specific categories such as duplicating, postage, toll charges, and software licensing. A complete list of University of Alaska Accounts Codes is available upon request.

98311

Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers

Project Number:	98311
Restoration Category:	Research
Proposer:	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	Year 1, 2-year project
Cost FY 98:	$ 119.3 K
Cost FY 99:	$ 80.6 K
Cost FY 00:	$
Cost FY 01:	$
Cost FY 02:	$
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific herring, Commercial Fishing,

RECEIVED
APR 1 1 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

The advective regime connecting the northern Gulf of Alaska (GOA) with Prince William Sound (PWS) may affect recruitment and nutritional processes in Pacific herring (*Clupea pallasi*). Research of the Sound Ecosystem Assessment (SEA) program has shown that herring have significant dependence on GOA carbon. Accordingly, herring are subject to changes in carbon flow occurring between GOA and PWS. The first step in understanding of how this fundamental environmental process affects herring recruitment is to isotopically analyze a time series of herring for which energetic data have been collected. This will expand upon the data series available from SEA providing a total four-year time period corresponding to one period in the cyclicity of herring population abundance in PWS.

INTRODUCTION

Stable isotope ratios of carbon, which have been shown to serve as effective tracers of energy supply in the Prince William Sound study area (Kline and Paul, MS submitted for publication, Appendix 1), is due to conservative transfer of carbon isotope ratios between the lower tropic levels (phytoplankton to zooplankton to forage fishes, etc.) of Prince William Sound and adjacent Gulf of Alaska waters up to the top consumers, and the naturally occurring gradient in ^{13}C between productivity generated in the Gulf compared with the Sound. Herring acquire these isotope ratios in response to the importance of the food in bulk body tissues (muscle and fat). Isotope ratio analysis of these tissues can provide insight into both habitat usage and assist in quantifying amounts derived from various areas. For example, Kline and Paul (Appendix 1) suggested a relationship between carbon source determined with $^{13}C/^{12}C$ and somatic energy content in relation to size of age-0 herring. Nitrogen isotope ratios, in turn, provide excellent definition of relative trophic level. The heavy isotope of nitrogen is enriched by about 0.3 % with each trophic level and thus can accurately indicate the relative trophic status of species within an ecosystem (Minagawa and Wada 1984, Fry 1988) and is useful for $^{13}C/^{12}C$ data modeling (Kline and Paul, Appendix 1).

RESULTS FROM PRIOR WORK

Juvenile herring and pollock are the dominant pelagic fishes in PWS and both consume zooplankton. Samples of juvenile herring and pollock collected between 1994 and 1996 shifted in $^{13}C/^{12}C$ content from which a change in carbon source dependency was inferred (Fig. 1) [data came from samples of opportunity in 1994, from Kline and Paul (Appendix 1), and samples collected during broadscale surveys in 1995 and 1996]. Although both species shifted in concert to greater GOA dependency in 1995 than 1994, pollock were consistently less dependent on GOA carbon. Juvenile pollock and herring occupy different levels in the water column, have different schooling behavior, and recruit from the larval stage at different times, effecting access to a different forage-base as confirmed by the data. This difference may not be reflected in the species composition of diet but instead the where and when of the production cycle is integrated into the isotopic signature which reflects the assimilated carbon pool in the fish. Pollock may be at an advantage since they metamorphose earlier and thus have first access to prey. The greater reliance on GOA-derived carbon in herring may reflect their dependence on carbon generated later in the season during the time when advection of GOA production was nearly the sole carbon source in 1995 as implied by the data (Fig. 1). The concordant shift to greater GOA dependency by both species in 1995 implies system-wide bottom-up effects permeating the whole ecosystem due oceanographic processes.

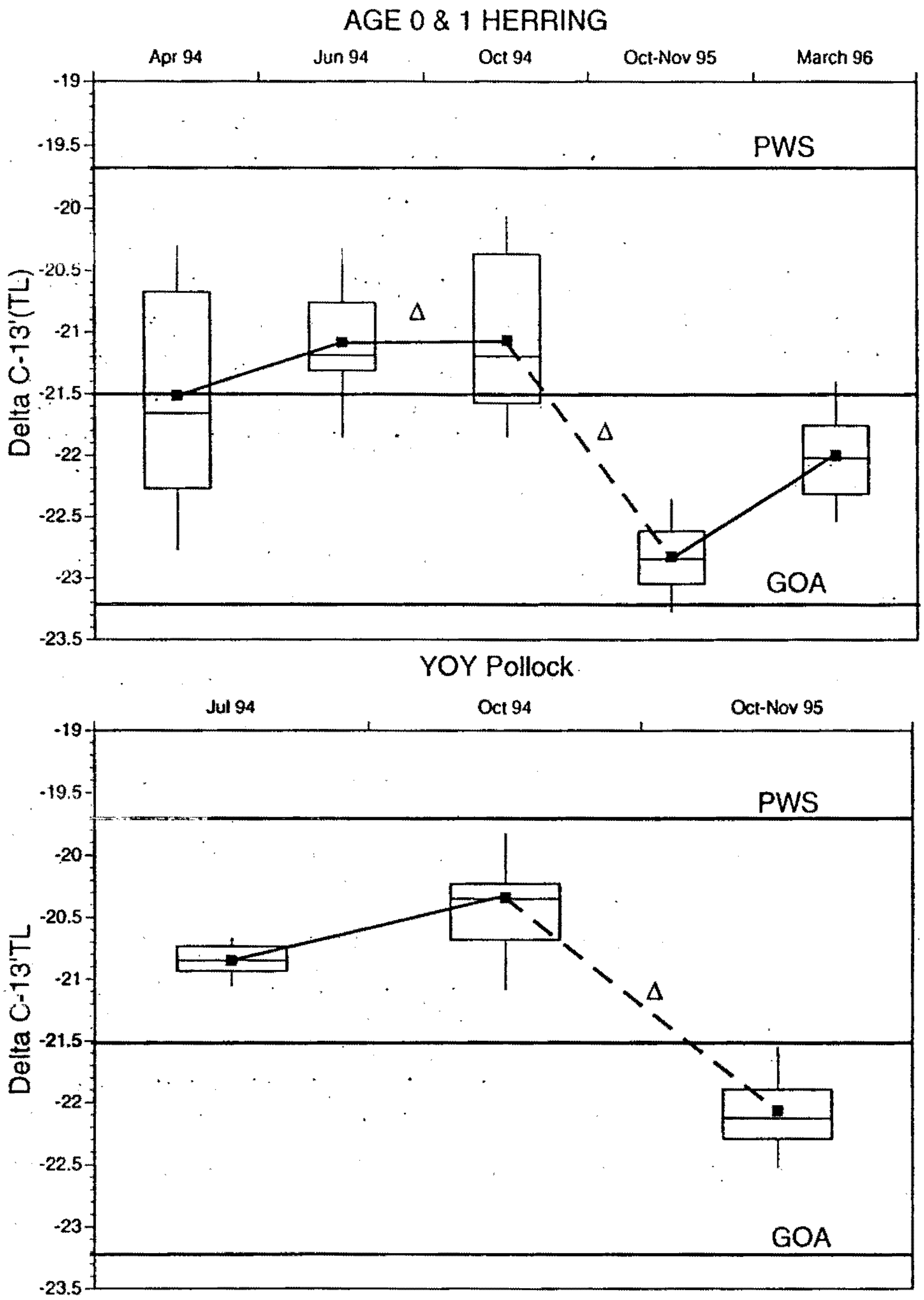

Figure 1. Shift in $\delta^{13}C$'TL and inferred change in Gulf of Alaska (GOA) vs. Prince William Sound (PWS) carbon dependency (see Kline and Paul, Appendix 1, for explanation of delta notation and method of data interpretation) of juvenile herring (above) and pollock (below) in 1994 - 6 (from Kline in prep.). The distribution of values are shown as box and whisker plots that denote the 10th, 25th, 50th, 75th, and 90th percentiles; means shown as symbols. The upper-case deltas indicate recruitment in and out of the juvenile populations. There was a large shift to greater GOA carbon dependency in 1995 for both species as indicated by the dashed lines.

NEED FOR THE PROJECT

A. Statement of Problem

The Problem: Declining Production of Herring in PWS.

The availability of macrozooplankton forage for herring varies in space and time because of changes in physical processes in PWS. Results from the SEA project suggest that interannual differences can be quite large. These differences, in the SEA context, are due to postulated Lake/River processes. The data suggest that 1995 was more of a "river" year than 1994. In 1994, when Gulf of Alaska carbon was apparently not transported into PWS to the same extent, there was more spatial variability than 1995. Herring were energetically in better condition in 1994 (A.J. Paul, pers. comm.). The relative poor condition of herring when Gulf carbon dominates parallels the existing downturn in Kittwake productivity in the Gulf area (APEX project results) that may be related to a regime shift phenomenon. Accordingly, when production in the Gulf improves, herring production when principally dependent on Gulf carbon may also improve.

B. Rationale/Link to Restoration

This proposal is submitted under the New Projects: Distribution and Turnover in Juvenile Pacific Perring Populations initiative described on page ten of the Invitation to Submit Restoration Proposals for Fedearl Fiscal Year 1998 (*Exxon Valdez* Trustee Council 1997). A better understanding, particularly a quantitative understanding, is a prerequisite to determining protocols for restoration and recovery of these species. The shifts in carbon flow occurring as a result in variations in the physical environment represent fundamental changes in the way the PWS ecosystem supports commercially important species. Because a quantitative understanding of these phenomena is a prerequisite to determining protocols for restoration and recovery of these species, these results will have direct application to all future rehabilitation and restoration efforts. The stable isotope approach is unique in its ability to integrate time and spatial scales at mesoscale levels. No other technique currently available can generate such results. The natural tracer aspects of the approach emulates artificial tracer experiments without the burden of needing to generate signals or experimental artifacts. Tracking the effect of Gulf carbon inflow on herring production that appears to vary between years will be used to resolve the question of how oceanographic process affect herring recruitment. The results obtained thus far indicate important temporal shifts in carbon source dependency in herring and their probable principal competitor, juvenile pollock. The level of sampling will be improved to resolve finer temporal shifts than shown in Fig. 1. Fewer sites with more frequent sampling will resolve when shifts occur particularly in the late summer to fall period. Energetic data form A.J. Paul (pers. comm.) suggest the continuation of material uptake until at least

December which may explain the large isotopic shift that occurred beween November 1995 and March 1996 (Fig. 1).

C. Location

Prince William Sound

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community involvement and traditional ecological knowledge was incorporated into the sampling regime developed by collaborator E. Brown used for acquisition of samples being analyzed in this work.

PROJECT DESIGN

Natural stable isotope abundances reflect (1) trophic level and (2) source of assimilated matter and are thus a proxy for the change in diet specified in the Lake/River and Predator/Prey Relationships hypotheses. Stable isotope ratios will thus be used as a biomonitor of salmon and herring production and shifts in predation as tests of the SEA hypotheses. Hypothesis tests using stable isotope data were presented in the SEA DPD. The proposed study will build upon our existing data base and add new data to construct and test conceptual food webs supporting herring (and other species dependent upon herring) in Prince William Sound. The goal is to determine the trophic positions and to define the natural history parameters accessible from isotope ratio data in light of the observed declines in their populations. These include changes in trophic level over the lives of herring, habitat dependencies, seasonal energetics and trophic dynamics relative to other community organisms. As part of this goal, we will integrate our analytical work with the field and laboratory studies of other investigators looking at food web structure, productivity of lower trophic levels, and provide validation data for assessment of conceptual and quantitative models.

A. Objectives

1. Analysis of archived samples
2. Analysis of new as they become available following SEC determination by AJ Paul
3. Data synthesis
4. Disseminate results

B. Methods

Hypothesis: Herring do better (i.e., have a higher somatic energy content, see Appendix 1) when carbon source is ~50% from GOA and PWS (this is the case based upon data from 1994-5, discussed above).

1. To determine the $^{15}N/^{14}N$ and $^{13}C/^{12}C$ of juvenile herring collected from the Prince William Sound, juvenile herring and pollock (when obtainable) will be matched with regional isotope abundances in zooplankton to allocate food sources and to assess trophic transfer efficiencies in specific areas of the sound.

Analysis of archived samples consisting of 100 fish samples each from 14 sampling periods from the four-bay time series collected in May, June, August, October, November, December 1996, March, May, July, August, October, November, December 1997, March 1998 for which energetic and AWL data are or will be available (AJ Paul, pers. comm.)

Time series data obtained from these samples will be compared with our existing database which starts in 1994 and includes samples of opportunity collected in April, June, and October and as part of the Herring Group sampling in October-November 1995, March 1996 (shown in Fig. 1).

2. Synthesize the data obtained in context with conceptual food webs to validate feeding models and expand the natural history information.

3. Contribute stable isotope results to formal tests of the Lake/River-driven prey switching hypothesis developed by SEA to explain herring production trends, and the hypothesis given above through collaboration with AJ Paul of the Herring Group.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

SCHEDULE

A. MEASURABLE PROJECT TASKS for FY 98 (October 1, 1997 - September 30, 1998)

Oct-Dec 1997: Preparation of archived samples for mass spectrometry
Jan-July 1998: Preparation of new samples for mass spectrometry as they become available following energetic determination by A.J. Paul
Jun-Sept 1998: Process new isotope data

B. Project Milestones and Endpoints

Oct-Dec 1997:	Preparation of archived samples for mass spectrometry
Jan-July 1998:	Preparation of new samples for mass spectrometry
Jan 1998	Attend Annual Restoration Workshop
Jun-Sept 1998:	Process new isotope data
Oct-Dec 1998:	Data, receipt (from mass spect lab), integration and synthesis
Jan-April 1999:	Preparation for and dissemination of results at 10th Anniversary
Symposium	
May-Sept 1999:	Data synthesis and assessment, final report preparation

C. Completion Date

September 1999

PUBLICATIONS AND REPORTS

The following manuscripts dealing with Pacific herring in Prince William Sound are planned in preparation (journals CJFAS= Canadian Journal of Fisheries and Aquatic Science, Fish. Ocean. = Fisheries Oceanography, TAFS = Transactions of the American Fisheries Society)

Fall isotopic and somatic energy signatures of young of the year Pacific herring at two sites in Prince William Sound Alaska: Implications for trophic studies.
T. C. Kline and A. J. Paul
for CJFAS
resubmitted following peer review

Spatial patterns of Gulf of Alaska carbon in Prince William Sound pelagic food webs determined by $^{13}C/^{12}C$. T. C. Kline.
for TAFS: *In* Brandt and Mason (eds) Spatial Patterns and Processes in Aquatic Environments
in prep

Interannual variability of the dependance of juvenile Pacific herring in Prince William Sound, Alaska on Gulf of Alaska shelf-derived secondary productivity
Kline
Fish. Ocean.
planned publication

Relationship between feeding regime, inferred from natural stable isotope abundance, and whole body energetics of Pacific herring in PWS.

Kline & Paul
CJFAS
outline conceptualized by authors, analytical work in progress

PROFESSIONAL CONFERENCES

1998: American Fisheries Society or American Society of Ichthyology and Herpetology

NORMAL AGENCY MANAGEMENT

None

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Herring Group workshops and meetings with other EVOS P.I.s will be conducted to facilitate collaboration and to direct analysis efforts. Results of analyses will be exchanged at workshops and by telecommunications. Preliminary analysis from the integrated effort will be used to direct retrospective analysis of archived samples.

Collaboration with AJ Paul will continue and facilitate relating carbon-source dependency with somatic energy content (Kline and Paul, Appendix 1).

PROPOSED PRINCIPAL INVESTIGATOR

Thomas C. Kline Jr., Ph.D.
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PRINCIPAL INVESTIGATOR

T. Kline has been actively involved in stable isotope research since 1985. His use of stable isotopes has been in fish ecology with emphasis on salmonid fishes in northern, western, south central and southeast Alaska. His innovative use of the techniques has allowed him to quantify the effect of salmon carcass nutrient input to juvenile sockeye salmon production. This research has been the first to provide direct evidence for the importance of salmon carcasses for juvenile salmon production. He has generated stable isotope models that enable the quantification of different sources of production important in salmon ecosystems. Dr. Kline also led an investigation relating feeding strategies to growth forms in North Slope salmonids. His on-going efforts include collaborations with ADF&G, the North Slope Borough, and BPX. The results of these projects have been presented in numerous scientific papers as well as in public forums (speaking to local groups and classes). T. Kline initiated project 320I which has been the first comprehensive project using natural stable isotopes in Prince William Sound. Through this project he has developed new models and application of natural stable isotope abundance methods. He was the first to provide direct evidence of the importance of carbon from the Gulf of Alaska in Prince William Sound.

OTHER KEY PERSONNEL

Fish Biologist: J. Williams. PWSSC. J. Williams received his Masters degree in Fisheries from Texas A&M University in 1995. While earning his degree, he spent one year conducting field research in a remote are of Venezuela, successfully incorporating native fishermen in his survey of reservoir fish populations. His research has been presented in a variety of forums and is currently under review for journal publication. J. Williams is a certified Rescue Diver, Divemaster and has eleven years of diving experience. He is currently fulfilling a diver-in-training program for cold water research diving to expand his knowledge of diving further. J. Williams is tasked with sample and data processing and data management for this project and will actively contribute to data synthesis.

LITERATURE CITED

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Fry, B. 1988. Food web structure on Georges Bank from stable C, N, and S isotopic compositions. Limnol. Oceanogr. 33:1182-1190.

Minagawa, M., and E. Wada. 1984. Stepwise enrichment of ^{15}N along food chains: Further evidence and the relation between $\delta^{15}N$ and animal age. Geochim. Cosmochim. Acta 48:1135-1140.

1998 EXXON VALDEZ TRUSTEE (ICIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$111.5						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$111.5		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$7.8						
Project Total	$0.0	$119.3		$80.6				
Full-time Equivalents (FTE)		0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared:
10Ap97/wjh

1 of 5

Project Number: 98311
Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/10/97

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$53.3						
Travel		$2.3						
Contractual		$35.0						
Commodities		$2.3						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$92.9		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$18.6						
Project Total	$0.0	$111.5		$80.6				
Full-time Equivalents (FTE)		0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998	Project Number: 98311 Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers Name: Prince William Sound Science Center	FORM 4A Non-Trustee SUMMARY

Prepared:

4/10/97

1998 EXXON VALDEZ TRUSTEE C__..CIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
Name	Position Description					
Kline	Principal Investigator		4.0	7608.5		30,434.0
Williams	Fish Biologist		6.00	3804.2		22,825.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	11412.7	0.0	
					Personnel Total	$53,259.2

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Description					
Herring Review / R/T CDV-Anch	200.0	1	5	141.0	905.0
Herring Group Workshop/ R/T CDV-Fbx	400.0	1	5	141.0	1,105.0
Car rental			5	50.0	250.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2,260.0

1998

Prepared:

Project Number: 98311
Project Title:Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

4/10/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:		Proposed
Description		FY 1998
Stable Isotope Analytical Services @ UAF	1200 2 $25	30000
Freeze-drier use	1200 @ $3	3600
Photocopying		250.0
Shipping		250.0
Posters for annual workshops 1@ $200		200.0
Communications		300.0
Page charges/ 1 @ $400		400.0
	Contractual Total	$35,000.0

Commodities Costs:		Proposed
Description		FY 1998
Lab supplies (vials, scalpels, blades, chemicals, etc.)		1,500.0
Office and Computer supplies		350.0
Dye Sub materials 1 @$300 each & miscl.		450.0
	Commodities Total	$2,300.0

1998

Prepared:

Project Number: 98311
Project Title:Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

4/10/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	

1998	Project Number: 98311 Project Title:Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers Name: Prince William Sound Science Center	FORM 4B Equipment DETAIL

Prepared:

4/10/97

98312

Monitoring Shifts in Prince William Sound Food Webs Using Natural Isotope Tracers: A Time Series Approach, Submitted Under the BAA

Project Number:	98312
Restoration Category:	Research and Monitoring
Proposer:	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency:	NOAA
Cooperating Agencies:	ADFG
Alaska SeaLife Center:	
Duration:	First year, multi-year project
Cost FY 98:	$ 166.6K
Cost FY 99:	$ 125K
Cost FY 00:	$ 135K
Cost FY 01:	$ 145K
Cost FY 02:	$ 155K
Geographic Area:	Prince William Sound
Injured Resource/Service:	Herring, pink salmon, birds, and marine mammals, commercial, recreational and subsistence Fishing and other recreational uses

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TRUSTEE COUNCIL

ABSTRACT

Time-series measurements of natural stable isotopes of fishes and their forage when combined with pertinent data on fish populations and oceanographic measurements being collected in sibling projects will enable a new understanding of how fundamental environmental processes affect fish recruitment and interaction. The large herbivorous copepods of the genus *Neocalanus* ,which have had distinctive $^{13}C/^{12}C$ signatures when sampled in the northern GOA compared to those from PWS, will be used as a carbon source proxy. Validation of the signature gradient will enable us to assess shifts in the source of carbon of fishes, as well as shifts in source signatures in the long-term. Analyses of $^{15}N/^{14}N$ and C/N of fishes will be determined and used to remove effects of fat content and food chain length on their $^{13}C/^{12}C$ signature, so that the affinity of PWS fishes with GOA or PWS carbon can determined. Shifts in GOA carbon affinity will be tracked with fish recruitment and oceanographic processes to assess the effects on fishes at interannual and decadal time scales.

INTRODUCTION

Decadal cycles of fish and shellfish populations have had dramatic effects on fisheries in the Gulf Coast region of Alaska (McDowell et al. 1979). Effects of fluctuations in Gulf of Alaska (GOA) production on Prince William Sound (PWS) fish populations is poorly understood. The advective regime connecting the northern GOA with PWS, which affects nutritional processes in fishes demonstrated by using natural stable isotope tracers, provides direct evidence of GOA links in the PWS study area (Kline and Paul submitted manuscript, Appendix 1). These natural tracers involve differing ratios of the two types of carbon [C] and two types of nitrogen [N] that are distinguished by their number of neutrons and known as stable isotopes. The large herbivorous copepods of the genus *Neocalanus*, used as a carbon source proxy, have distinctive $^{13}C/^{12}C$ signatures when sampled in the northern GOA compared to those from PWS. These signatures enable us to identify the origins of carbon in different fishes [since "you are what you eat"]. Analyses of $^{15}N/^{14}N$ and C/N of fishes when used to remove effects of fat content and food chain length on their $^{13}C/^{12}C$ signature, made it possible to determine the affinity of PWS fishes with GOA or PWS carbon. Results from project 320I suggest that these affinities range from total dependency on PWS carbon to significant input of carbon from the GOA and that these affinities vary with the fishes' life history stages. Fishes dependent on GOA carbon are subject to changes in carbon flow that result from physical oceanographic processes [e.g., currents, temperature and salinity gradients] that connect GOA with PWS. Fishes wholly dependent on PWS are more likely to be directly affected by internal PWS processes. Increased competition for PWS carbon by all species, however, may occur if GOA carbon is less available to those that normally use it. Shifting to increased dependency on PWS carbon by species with normal affinity for GOA carbon during years of poor GOA carbon availability would provide evidence of competition for a limited carbon supply by the increasing overlap in their $^{13}C/^{12}C$ signature. Increased competition for PWS carbon by all species, however, may occur if GOA carbon is less available to those that normally use it. Time-series measurements of natural stable isotopes in fishes combined with data on fish populations and cogent oceanographic measurements will enable a new understanding of how basic environmental processes affect fish recruitment and interaction.

Stable isotope ratios of carbon can serve as effective tracers of energy supply in the study area due to conservative transfer of carbon isotope ratios between the lower tropic levels (phytoplankton to zooplankton to forage fishes, etc.) of Prince William Sound and adjacent Gulf of Alaska waters up to the top consumers. Fishes acquire these isotope ratios in response to the importance of the food in bulk body tissues (muscle and fat). Isotope ratio analysis of these tissues can provide insight into both habitat usage and assist in quantifying amounts derived from various areas (Fry and Sherr 1984).

RESULTS FROM PRIOR WORK

The isotopic gradient which exists between the northern GOA shelf and PWS (Fig. 1) will be used to differentiate carbon sources of PWS fishes (Kline and Paul submitted for publication, Appendix 1). Isotopic signatures reflect phytoplankton growth regimes (Schell pers. comm., Laws et al. 1995, Fry 1996) which are postulated to change over time in accordance with the long-term productivity cycles (Schell pers. comm., Anderson and Blackburn APEX). We hypothesize that these changes, which occur in cycles in accordance with oceanographic processes, will be reflected by concordant changes in isotopic signatures of pelagic biota of PWS. Isotopic shifts are expected to be similar to those that have been detected within the short timeframe reflected in our present database shown below.

Transport of zooplankton

The isotopic composition of diapausing copepods can vary significantly between years (Fig. 2). The distribution of $^{13}C/^{12}C$ in most copepods in PWS in the fall of 1995 (lower panel of Fig. 2) was quite different than those found feeding within PWS prior to diapause but similar to those found in the northern GOA (Fig. 1). We ascribe this difference to the transport of copepods into PWS during the diapause recruitment period that follows the spring bloom and coincides with the timing of deepwater renewal in PWS (Niebauer et al. 1994). The interannual differences in isotopic composition of diapausing copepods in PWS may reflect differences in either or both the relative strength and timing (relative to the copepod bloom) of deepwater renewal or the relative strength of the copepod bloom inside and outside of PWS. Accordingly, appropriate physical and biological observations will be required to unravel this complexity.

Shifts in carbon source dependencies in commercially important fishes

Herring

Samples of juvenile herring and pollock collected between 1994 and 1996 shifted in $^{13}C/^{12}C$ content from which a change in carbon source dependency was inferred (Fig. 1) [data came from samples of opportunity in 1994, from Kline and Paul (Appendix 1), and samples collected during broadscale surveys in 1995 and 1996]. Juvenile herring and pollock are compared since they are the dominant pelagic fishes in PWS (based on recent acoustic surveys, G.L. Thomas and L. Haldorson pers. comm.) and both consume zooplankton (A. J. Paul pers. comm.). Although both species shifted in concert to greater GOA dependency in 1995 than 1994, pollock were consistently less dependent on GOA carbon. Juvenile pollock and herring occupy different levels in the water column, have different schooling behavior, and recruit from the larval stage at different times, effecting access to a different forage-base which was confirmed by the data. This difference in food base may not be reflected in the species composition of the diet, but instead in the where and when of the production cycle that is reflected by the carbon isotope signature.

Pollock may be at an advantage since they metamorphose earlier and thus have first access to prey. The greater reliance on GOA-derived carbon in herring may reflect their dependence on carbon generated later in the season during the time when advection of GOA production can become nearly the sole carbon source, as suggested for 1995.

Pink salmon

Up to a half billion salmon fry enter Prince William Sound each year (Cooney 1993) and like herring and pollock juvenile forage primarily on zooplankton. Unlike herring and pollock, salmon have large eggs that provide nutrition for the entire larval development period, and concomitant conservative isotopic signature (Kline et al. 1990). The temporal isotopic shift of salmon from the natal signature is complete by the end of June (Fig. 4). Salmon are short-term residents leaving PWS by the end of summer. Accordingly salmon respond to and will reflect isotopically fluctuations in GOA in a narrow window of time (June to September). Thus spatial effects of GOA carbon (Fig. 4), may be more important than sub-annular shifts. Although there will be limited overlap between herring and pink salmon due to the non-concordance in their distribution in PWS, we will nevertheless be able to compare spatial variability among species through comparison of each with zooplankton basemaps developed using the Generic Mapping Tools computer program as shown in Fig. 1 (Smith and Wesel 1990, Wesel and Smith 1995).

Time integrators (subadult and adult fishes)

As fish growth slows, there is a concomitant decrease in turnover rate so that isotopic signature reflect longer integrations (Hesslein et al. 1993). Thus older fish, with long turnover rates, make effective integrators of whole growing seasons. Furthermore these fish may have high economic value, thus their consideration facilitates integration of bottom-up effects to species important to man. Thus stable isotopes will improve our understanding of processes leading up to population fluctuations.

Pollock

The dominance of PWS carbon in pollock (Willette et al. in prep.) may reflect relative strength of PWS at present because of the postulated contemporary poor production levels in the Gulf. As GOA production increases, relative increases in importance of GOA in all species including pollock will increase.

Other species

Response to changing GOA production cycle may affect each species differently, thus a comprehensive understanding will only come about through sampling a cross section of pelagic taxa. Such sampling that could otherwise be expensive, could be effected through port sampling, particularly when other parties have need for such data. We have collaborated with the Department of Fish and Game and North Pacific Processors, in Cordova for such sampling.

Significance of parallel isotopic shifts among several species

As has been pointed out by Dr. Phil Mundy, shift in the isotopic composition of fishes in PWS could come about through immigration of fishes from outside PWS. To validate that this is not the process causing the isotopic shift, multiple species should be monitored. The likelihood that shifts are due to immigration decrease with the number of species undergoing parallel shifts as shown in Fig. 3. Parallel shifts in 10 species would have to be explained by simultaneous immigration. Additionally, larger immigrating fish would have an increased retention of their originating signature since they would be turning it over slower. Although this was the pattern seen in young of the year herring in 1994 (Kline and Paul, Appendix 1), this was not the case in 1995 (Kline and Paul in prep.). Thus collections of fishes of differing metabolic rate as well as different species provide essential data.

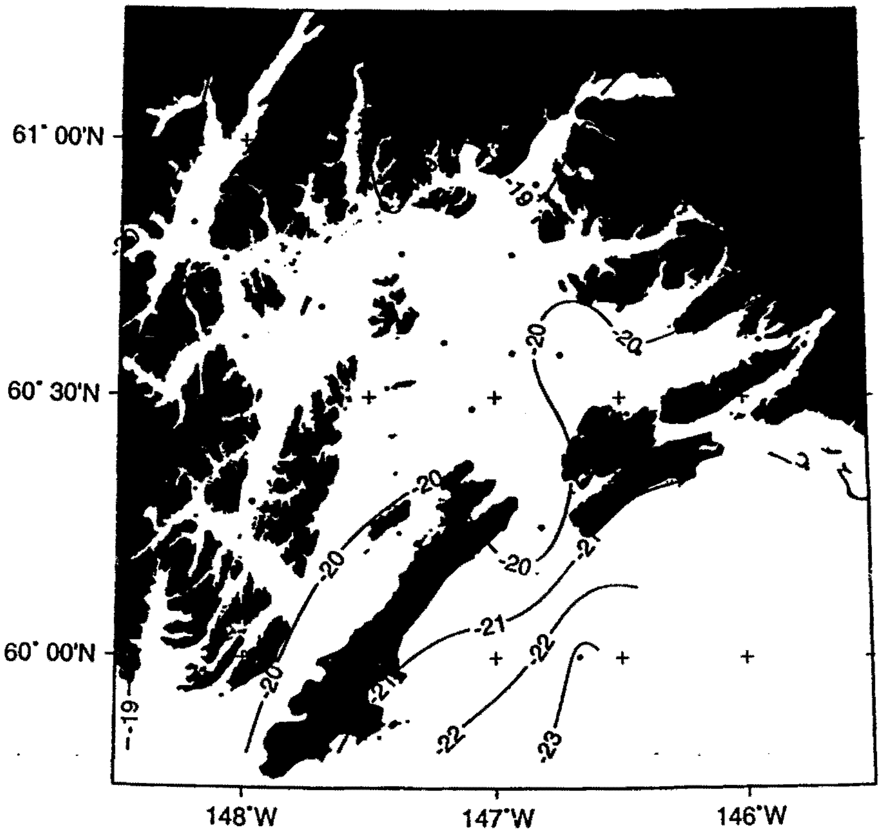


Figure 1. A large gradient in $^{13}C/^{12}C$ exists between production in PWS and the adjacent northern Gulf of Alaska (from Kline and Paul, Appendix 1).

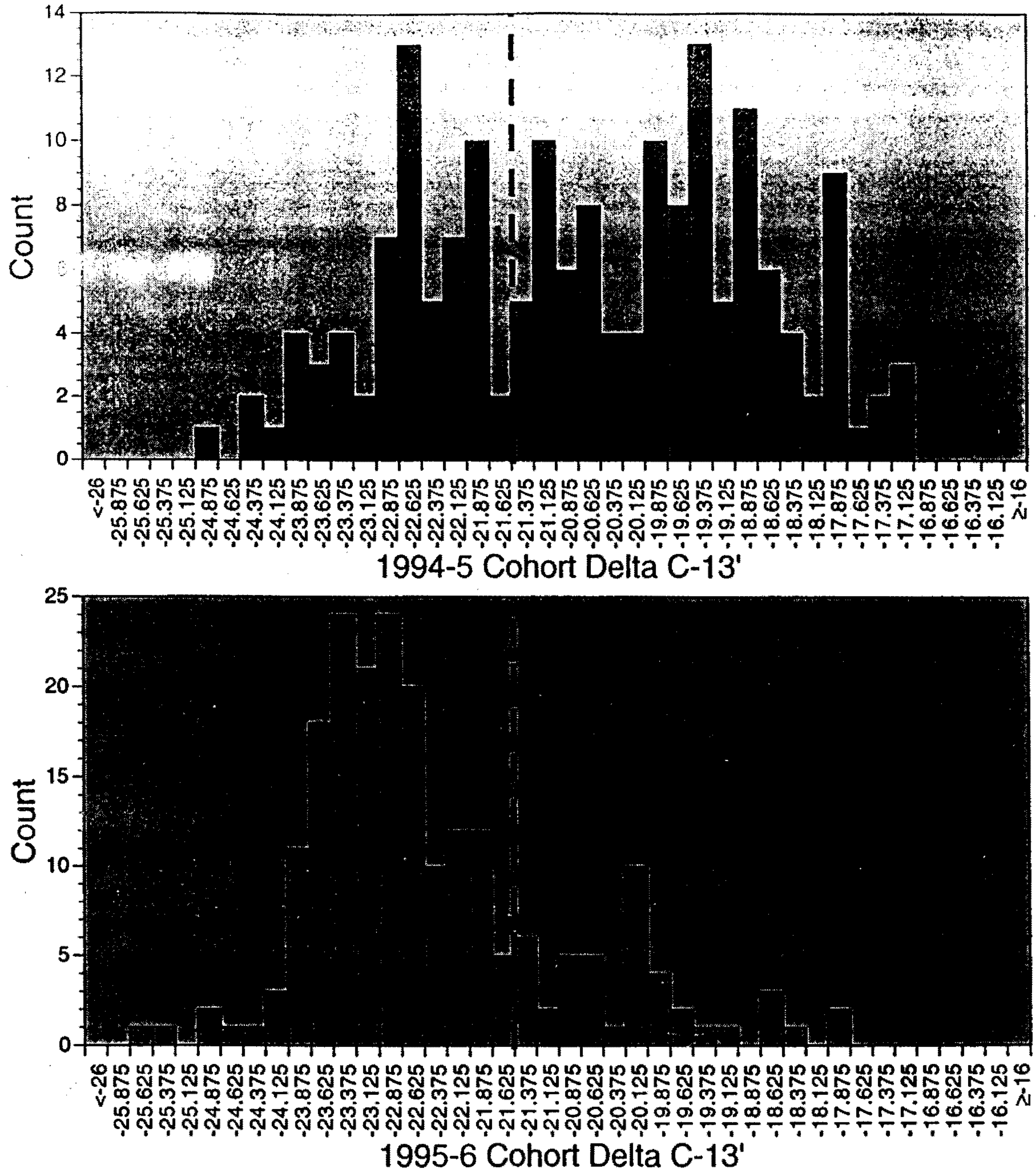


Figure 2. (from Kline in prep.) Shift in the $^{13}C/^{12}C$ composition (using international delta units) of *Neocalanus cristatus* diapausing in Prince William Sound (PWS) derived from the 1994 (top) and 1995 (bottom) spring blooms implying a greater extent of zooplankton transport in to PWS in 1995 than 1994. $\delta^{13}C'$ values < -21.5 reflect Gulf of Alaska carbon (left of dashed line) whereas $\delta^{13}C'$ values > -21.5 reflect PWS carbon (right of dashed line), figure from Kline (in prep.).

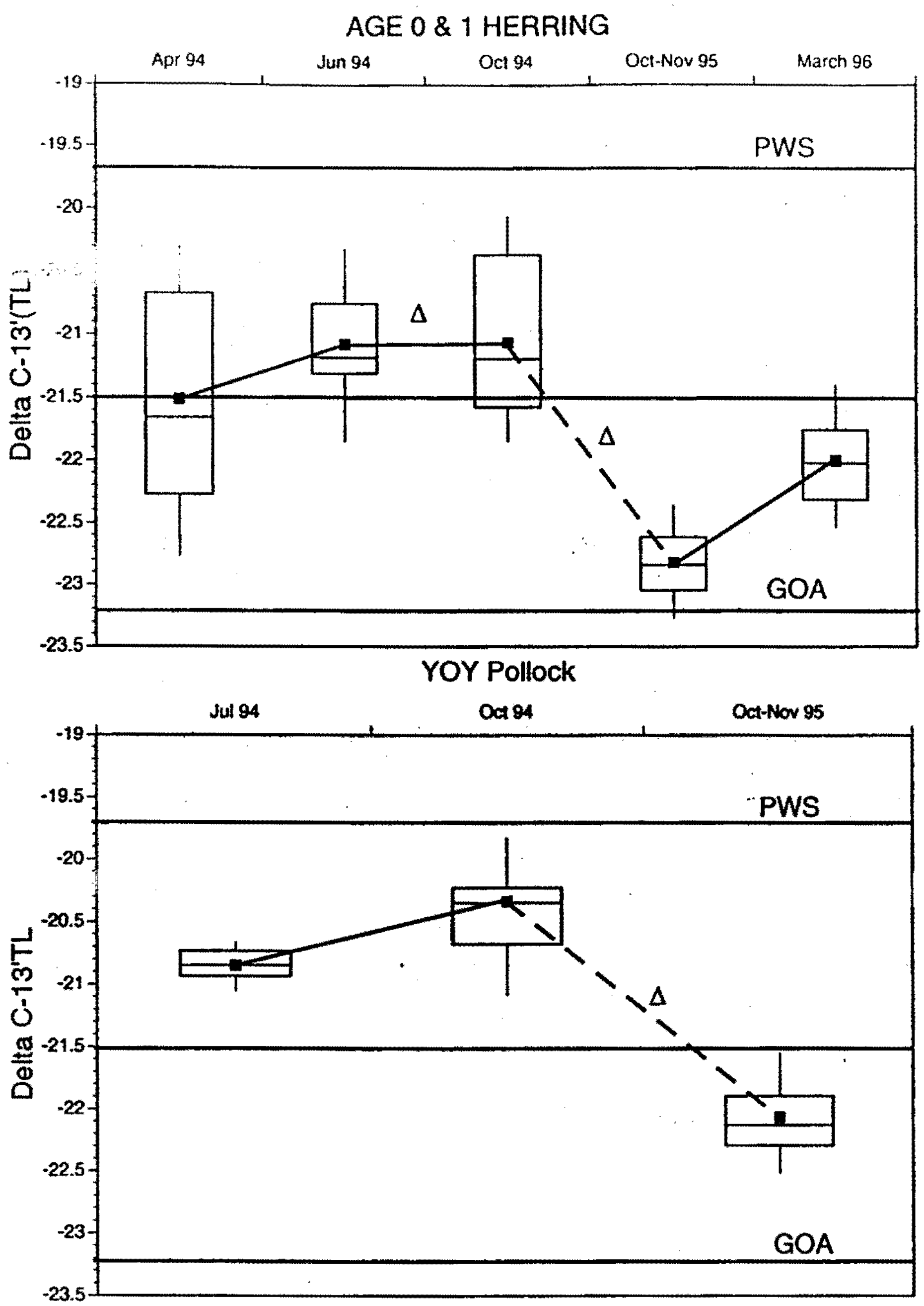
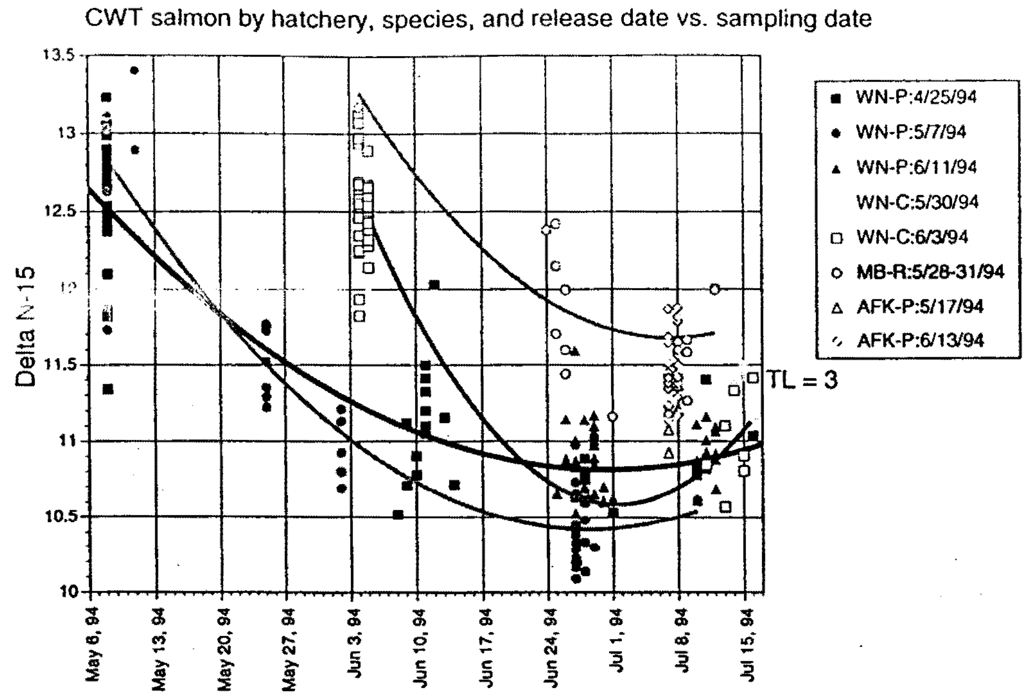


Figure 3. Shift in δ^{13}C'TL and inferred change in Gulf of Alaska (GOA) vs. Prince William Sound (PWS) carbon dependency (see Kline and Paul, Appendix 1, for explanation of delta notation and method of data interpretation) of juvenile herring (above) and pollock (below) in 1994 - 6 (from Kline in prep.). The distribution of values are shown as box and whisker plots that denote the 10th, 25th, 50th, 75th, and 90th percentiles; means shown as symbols. The upper-case deltas indicate recruitment in and out of the juvenile populations. There was a large shift to greater GOA carbon dependency in 1995 for both species as indicated by the dashed lines.



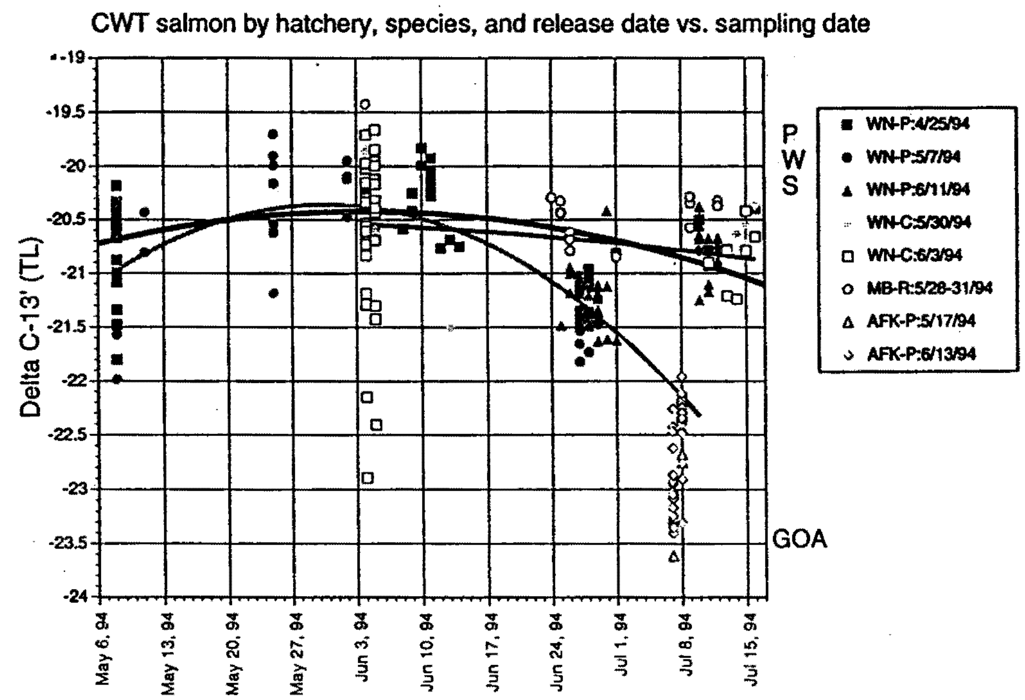


Figure 4. Shift in isotopic signatures, $^{15}N/^{14}N$ (above) and $^{13}C/^{12}C$ (bellow), of salmon fry released from hatcheries in PWS as a function of date. The natal isotopic signature had turned over by late June as indicated by the large differences in $^{15}N/^{14}N$ between salmon soon after release and later dates (upper plot). A difference in GOA carbon dependency was seen in salmon from the AFK hatchery compared with the others suggesting a significant spatial effect on GOA dependency (lower plot). Figure from Kline et al. (in prep.).

NEED FOR THE PROJECT

A. Statement of Problem

The Problem: Declining Production of Birds, Marine Mammals, Salmon and Herring in PWS

The availability of macrozooplankton forage for salmon, herring, and their predators varies in space and time because of changes in physical processes in PWS, known as the Lake/River processes in the SEA project. When macrozooplankton are not available, macrozooplankton consumers are forced to switch to prey that includes juvenile fishes. These shifts represent fundamental changes in the way the PWS ecosystem produces species with commercial, recreational (including aesthetic), and subsistence values.

B. Rationale/Link to Restoration

A better understanding, particularly a quantitative understanding, is a prerequisite to determining protocols for restoration and recovery of PWS pelagic biota. The shifts in predator-relationships occurring as a result of variations in the physical environment represent fundamental changes in the way the PWS ecosystem supports important species. For example, changes in oceanographic condition have been linked to rockfish recruitment (Norton, 1986). Because a quantitative understanding of these phenomena is a prerequisite to determining protocols for restoration and recovery of these species, these results will have direct application to all future rehabilitation and restoration efforts. The stable isotope approach is unique in its ability to integrate time and spatial scales at mesoscale levels. No other technique currently available can generate such results. The natural tracer aspects of the approach emulates artificial tracer experiments without the burden of needing to generate signals or experimental artifacts.

Decadal population cycles are an enigma that requires a long-term process study for comprehension. Thus far we know that there are also temperature cycles in the GOA. The mechanism that links temperature cycles with population cycles is not understood. Temperature cycles may be a manifestation of cyclical changes in slow upwelling occurring on a planetary scale. Changes in upwelling rate affects isotopic fractionation resulting in changing signatures that are passed up the food chain. Upwelling variability may regulate cross-shelf transport of zooplankton into PWS (Cooney 1988, Cooney and Coyle 1996). We will thus establish and verify a relationships between processes that vary at interannual and decadal time scales. We will accomplish this by comparing a long time series of isotopic signatures of various biota with coordinated oceanographic measurements.

C. Location

Prince William Sound and adjacent Gulf of Alaska

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The fishing communities will become involved in this project through their roles as samplers of fish. The local processors, particularly North Pacific Processors, in Cordova, have and will continue to facilitate much of the sampling. PWSAC hatcheries have been used as field support bases. Additionally, they will facilitate sampling of salmon.

PROJECT DESIGN

A. Objectives

Natural stable isotope abundances reflect (1) trophic level and (2) source of assimilated matter and are thus a proxy for the change in diet resulting from ecosystem shifts. The proposed study would build upon the existing data base (Fig. 1) and add new data to construct and test conceptual food webs supporting salmon and herring and higher trophic levels in Prince William Sound and their prey organisms. The goal is to determine the trophic positions and to define the natural history parameters accessible from isotope ratio data in light of the observed declines in their populations. These include changes in trophic level over the lives of fishes, habitat dependencies, seasonal energetics and trophic dynamics relative to other community organisms. As part of this goal, we will integrate our analytical work with the field and laboratory studies of other investigators looking at food web structure, productivity of lower trophic levels, and provide validation data for assessment of conceptual and quantitative models.

1. Determine yearly, the isotopic gradient occurring in zooplankton during the vernal bloom
2. Determine yearly, the proportion of diapauing copepods in PWS originating from the GOA using stable isotopes
3. Determine yearly, the dependency of juvenile PWS herring on GOA food sources using stable isotopes
4. Determine yearly, the dependency of juvenile PWS salmon on GOA food sources using stable isotopes
5. Determine yearly, the dependency of a systematic representative sample of PWS fishes on GOA food sources using stable isotopes

B. Methods

1. To determine the $^{15}N/^{14}N$ and $^{13}C/^{12}C$ of species collected from the Prince William Sound ecosystem with a focus on those components important to man or important in the food webs supporting these species. Biota collected from PWS will be matched with regional isotope abundances in prey species (zooplankton, forage fishes) to allocate food sources and to assess trophic levels in specific areas of the sound.

2. Synthesize the data obtained in context with conceptual food webs to validate ecosystem models (e.g. Patrick et al. 1995 1996 1997 , Pauly and Chritensen 1995a and b) and expand the natural history information.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Port Sampling (as defined by ADFG) will provide a source for some of the sampling which involves cooperation with ADFG, Groundfish (Bechtol, Blackburn); ADFG Sportfish (Meyer), NOAA (Anderson)

SCHEDULE

A. Measurable Project Tasks for FY 98 (October 1, 1997 - September 30, 1998)

Under the BAA, we expect that FY 98 funding will commence on 1 December 1997 and end 30 November 1998 and have scheduled accordingly:

Since this project is designed to run continuously, measurable tasks are given in relation to each objective which are each timed differently within the calendar year.

For Objective 1

May 5-20	Conduct a two-week-long area-wide oceanographic survey to sample feeding stage copepods, including the major basins of PWS and the adjacent GOA area to the continental slope near Middleton Island in collaboration with other monitoring projects (G.L. Thomas et al.).
Jun- Aug	Process copepods prior to stable isotope analysis
Sept-Apr	Stable isotope analysis (at UAF)
May-Oct	Data analysis
Oct-April	Data synthesis and reporting

For Objective 2

Sept-Nov	Conduct a week-long oceanographic survey to sample diapause stage copepods in PWS in collaboration with other monitoring projects (G.L. Thomas et al.).
Dec- Feb	Process copepods prior to stable isotope analysis
Feb-Sept	Stable isotope analysis (at UAF)
Oct-Apr	Data analysis
Apr-Oct	Data synthesis and reporting

For Objective 3

Jul-Nov	Sample juvenile herring systematically in four regions of PWS in collaboration with other monitoring projects (G.L. Thomas et al.).
Aug-Mar	Herring samples at Seward undergoing SEC analysis
Sep-Apr	Following SEC analysis samples sent to PWSSC
Oct-May	Process herring samples prior to stable isotope analysis
Dec-nextDec	Stable isotope analysis (at UAF)
Jan-Jun	Data analysis
Jul-Dec	Data synthesis and reporting

For Objective 4

Jul-Aug	Sample salmon fry systematically in three regions of PWS in collaboration with other monitoring projects (G.L. Thomas et al.).
Aug-Dec	Parallel set of samples at Seward undergoing SEC analysis
Aug-Dec	Process salmon samples prior to stable isotope analysis
Jan-Aug	Stable isotope analysis (at UAF)
Sept-Mar	Data analysis
Mar-Sep	Data synthesis and reporting

For Objective 5

Feb-Oct	Sample fishes systematically in PWS in collaboration with ADFG port sampling, acoustic surveys, and other monitoring projects (G.L. Thomas et al.).
Aug-Dec	Process fish samples prior to stable isotope analysis
Jan-Aug	Stable isotope analysis (at UAF)
Sept-Mar	Data analysis
Mar-Sep	Data synthesis and reporting

B. Project Milestones and Endpoints

Synthesis products will consist of scientific publications and presentations. These activities will take place on a continuous basis during the funded period.

C. Completion Date

30 November 1998

PUBLICATIONS AND REPORTS

This project will produce:
(1) peer-reviewed papers on an *ad lib* basis
(2) annual reports

PROFESSIONAL CONFERENCES

American Geophysical Union and American Society of Limnology and Oceanography or the American Fisheries Society

NORMAL AGENCY MANAGEMENT

none

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Vessel Charters
Funding for vessel charters is not being requested in this proposal. It is requested that vessel charters be undertaken by an independent project the sole purpose of which would be to coordinate this for all monitoring projects in consultation with P.I.s in order to meet the projects needs.

PROPOSED PRINCIPAL INVESTIGATOR

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907-424-5820 (f)
tkline@grizzly.pwssc.gen.ak.us

PRINCIPALINVESTIGATOR

T. Kline has been actively involved in stable isotope research since 1985. His use of stable isotopes has been in fish ecology with emphasis on salmonid fishes in northern, western, south central and southeast Alaska. His innovative use of the techniques has allowed him to quantify the effect of salmon carcass nutrient input to juvenile sockeye salmon production. This research has been the first to provide direct evidence for the importance of salmon carcasses for juvenile salmon production. He has generated stable isotope models that enable the quantification of different sources of production important in salmon ecosystems. Dr. Kline also led an investigation relating feeding strategies to growth forms in North Slope salmonids. His on-going efforts include collaborations with ADFG, the North Slope Borough, and BPX. The results of these projects have been presented in numerous scientific papers as well as in public forums (speaking to local groups and classes). T. Kline initiated project 320I which has been the first comprehensive project using natural stable isotopes in Prince William Sound. Through this project he has developed new models and application of natural stable isotope abundance methods. He was the first to provide direct evidence of the importance of carbon from the Gulf of Alaska in Prince William Sound.

OTHER KEY PERSONNEL

Fish Biologist: J. Williams. PWSSC. J. Williams received his Masters degree in Fisheries from Texas A&M University in 1995. While earning his degree, he spent one year conducting field research in a remote are of Venezuela, successfully incorporating native fishermen in his survey of reservoir fish populations. His research has been presented in a variety of forums and is currently under review for journal publication. J. Williams is tasked with sample and data processing and data management for this project and will actively contribute to data synthesis.

The following are indirectly involved as extra-project collaborators by providing samples for analysis. Furthermore we will be collaborating by seeking management applications from the results obtained.

Ken Roemhildt, North Pacific Processors, Cordova
ADFG Groundfish, Bill Bechtol
ADFG Sport fish, Scott Meyer
NOAA, Paul Anderson

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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$53.2						
Travel		$5.5						
Contractual		$35.5						
Commodities		$3.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$97.2		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$19.4						
Project Total	$0.0	$116.6		$125.0	$135.0	$145.0	$155.0	
Full-time Equivalents (FTE)		10.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: subsequent annual funding based on conserving the program and incorporate expected minimal cost increases

1998

Prepared:

Project Number: 98312
Project Title: Monitoring Shifts in Prince William Sound Food Webs Using Natural Stable Isotope Tracers: A Time Series Approach
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

4/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:						
Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
Kline	Principal Investigator		4.0	7.6		30.4
Williams	Fish Biologist		6.0	3.8		22.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	11.4	0.0	
					Personnel Total	$53.2

Travel Costs:					
Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Project Review, annual meeting, workshop 1R/T CDV-Anch	0.2	3	15	0.141	2.7
Car rental	0.0	0	15	0.050	0.8
National meeting	0.8	1	7	0.122	1.7
Car rental	0.0	0	5	0.050	0.3
	0.0	0	0	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.5

1998

Project Number: 98312
Project Title: Monitoring Shifts in Prince William Sound Food Webs Using Natural Stable Isotope Tracers: A Time Series Approach
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared:

4/11/97

Contractual Costs: Description		Proposed FY 1998
Photocopying		0.3
Shipping		0.2
Posters for annual workshops 1@ $200		0.2
Communications		0.3
Page charges/ 1 @ $400		0.4
Stable isotope freezedrying @ PWSSC	1200 @$25	30.0
Stable isotope analyitical @ UAF	1200 @$3	3.6
PWSSC Newtwork Charge		0.5
	Contractual Total	$35.5

Commodities Costs: Description	Proposed FY 1998
Office and Computer supplies	0.4
Dye Sub materials 1 @$300 each	0.3
Miscl	0.3
Lab supplies : vials,blades, chemicals,dialyisis bags, etc.	2.0
Commodities Total	$3.0

1998

Project Number: 98312
Project Title: Monitoring Shifts in Prince William Sound Food Webs Using Natural Stable Isotope Tracers: A Time Series Approach
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

1998	Project Number: 98312 Project Title: Monitoring Shifts in Prince William Sound Food Webs Using Natural Stable Isotope Tracers: A Time Series Approach Name: Prince William Sound Science Center	FORM 4B Equipment DETAIL

Prepared:

4/11/97

98314

HOMER MARINER PARK HABITAT ASSESSMENT & RESTORATION DESIGN PROJECT

RECEIVED
APR 9 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project Number:	98314
Restoration Category:	Intertidal Community, Recreation and Tourism
Proposer:	City of Homer
Lead Trustee Agency:	Alaska Department of Natural Resources
Cooperating Agencies:	Alaska Department of Fish and Game Department of Interior, Fish and Wildlife Service
Alaska SeaLife Center:	No
Duration:	1 year
Cost FY 98:	$95,350
Geographic Area:	Kenai Peninsula, Homer
Injured Resource/Service:	Intertidal Organisms, Recreation and Tourism

ABSTRACT

In its present state, Mariner Park is a highly stressed marine habitat in decline. The area is experiencing a dramatic reduction in marine biota and shorebird population while incompatible and environmentally destructive human uses flourish. From the results of a comprehensive feasibility study that includes botanical, biological, and hydrological field studies coupled to community information it is possible to develop a comprehensive habitat restoration and enhancement plan. This plan will establish the optimal hands-on restoration program to increase and diversify the intertidal fauna; which, in turn, will benefit migrating shorebirds and promote recreationally compatible use of the area by residents and tourists.

INTRODUCTION

Kachemak Bay is the premier marine ecosystem in Cook Inlet. It is important for its fertile intertidal, nearshore, and subtidal waters. These estuarine areas support a richly diverse biosystem. In particular, the Bay nurtures a thriving marine bird habitat by providing important feeding, nesting, rearing, and migratory staging throughout the year. Central to this critical habitat, as an ecosystem and a destination for resident and non-resident recreational visitors, is Homer Spit.

Located at the base of the Spit and east of the Sterling Highway (Spit Road), is Mud Bay. This bountiful habitat is one of the most biologically diverse and active areas in the spectrum of northeast Pacific shallow-water estuaries, [Shimek, 1979]. From a biological perspective, Mud Bay is a classical thriving northern mud flat site. It is home to a collection of worms, bivalves, crustaceans, and other intertidal life. These organisms are food for birds, crabs, and fish. Once an integral part of Mud Bay with all of the important habitat characteristics of its host ecosystem, the area west of the road, referred to in this proposal as Mariner Park, redefined itself.

Mariner Park, a 109 acre parcel of which 71 acres are owned by the Alaska Department of Natural Resources, 32 acres by the City of Homer, and 6 acres in private hands, faces west toward Cook Inlet. Approximately fifty years ago, prior to the construction of the Homer Spit Road and Airport, Mariner Park was contiguous with the habitat rich, Mud Bay. Today, Mud Bay, (a.k.a. Coal Bay), continues as a productive estuary, a fate not shared by its estranged neighbor, Mariner Park.

Once a mudflat, Mariner Park, emerged as a sand beach ecosystem with a complex intertidal habitat. It consists of a high tide line saltwater wetlands, inshore tidal lagoon, and protective sand berm. Outer Kachemak Bay water enters the lagoon through a breach in the protective sand berm via a tidal stream. Since most of the lagoon area is relatively high, actual flooding occurs for short periods only during high tides; consequently, water exchanges are infrequent and the area is submerged only briefly. As a consequence Mariner Park has lost most of its diversity and density of infaunal organisms. It has become far less attractive for migratory shorebirds and folks who frequent the Spit to enjoy recreational opportunities. This decline in the vitality of the habitat was exasperated by protective actions taken in response to the *Exxon Valdez* Oil Spill *(EVOS)* incident.

During the *Exxon Valdez* incident the tidal stream inlet to Mariner Park was raised to lessen the potential for oil to enter the habitat. The tidal stream, which supplied critical nutrients to the intertidal lagoon and marsh was, per governmental directive, dammed to protect the intertidal wetlands from oil. During the closure the wetlands dried and biota rich portions of the habitat were greatly reduced. With the inability of the intertidal community to sustain itself the area was unable to effectively support migrating shorebirds. Correlationally, the dry area attracted inappropriate use by residents and visitors. This human disturbance, which included trampling of vegetation by off-road vehicles, removing drift wood from the storm berm, and deforming the protective sand barrier, translated into a loss of nesting area for Common Eiders, harassment of shorebirds during migration, disturbance to shorebirds and sparrows nesting in the dunes area, and the over-all degradation of the habitat.

The effort encumbered in this proposal is to perform a feasibility study for a project to restore the intertidal community injured by *EVOS*. The study, in the form of a National Environmental Policy Act (NEPA)-Environmental Assessment (EA), will delineate the feasibility of a follow-on construction project to restore and enhance the intertidal wetland community in Mariner Park. With botanical, biological, and hydrological studies, coupled to community and historical information, providing the foundation of the EA, predictions are that a comprehensive restoration construction program will return the area to the rich wetland status it once was. The eventual enhancement potential is to provide, preserve, and protect intertidal feeding habitat for migrating shorebirds, which in turn will help restore recreation and tourism services injured by *EVOS*.

NEED FOR THE PROJECT

A. Statement of Problem

Historically, as the head of Mud Bay, Mariner Park was a classical northern mud flat. The contiguous area supported a diverse biomass with dominant organisms to include polychaete worms and small bivalves. The small organisms were food for larger, transient organisms: shorebirds, crabs, and fish. The density of infaunal organisms at this site was high; consequently, even a small portion of habitat was a productive location supporting a relatively large number of important organisms.

While Mud Bay continues to prosper in intertidal and avian diversity, Mariner Park has not faired as well. With excavation of the area for fill used to construct the airport and the road segregating the area from its naturally connected ecosystem, Mariner Park's habitat has morphased into an intertidal area with complex sedimentary and biological relationships.

Mariner Park's sedimentary characteristics now resemble a sand beach versus mud flat ecosystem. Sediment carried via long-shore transport was deposited in the intermittently flooded lagoon area. Generally, the soil profile is sand, to a depth as shallow as four feet, over silty clay. Higher elevations have coarser sediment than lower areas. The subtidal cobble area is partially covered by moving patches of sand. The tidal stream habitat is composed of sandy gravel with cobbles and the saltwater marsh area, being farthest from the current flow, contains finer sediments. [USF&W, 1991 and Land Design North, 1980]

The site consists of a high tide line saltwater wetlands and lower inshore area which behaves as a tidal lagoon. The lagoon is separated from the outer Kachemak Bay by a storm berm. Historically, a tidal stream breaches the storm berm. Since most of the lagoon area is relatively high, it fills only at high tides, during which actual flooding occurs for short periods. Frequently, water becomes trapped in the lagoon area for long periods because the tidal stream channel is not sufficiently deep and the inshore lagoon too high to permit frequent exchange of water. The only remaining vegetation is located at the base of the bluff, which is primarily private property.

The areas above mean high tide line on both sides of the Spit Road are covered with grasses. These areas are interlaced with tidal channels and occasional tidal basins which are classified as saltwater wetlands, [Kenai Peninsula Borough Coastal Management Program, 1990]. Vegetation of the small saltwater marshes at the base of the Spit are mainly Lyngbye sedge and arrow grass, with alkali grass at the lower tidal levels. These marshes are prime feeding habitats for the less common shorebirds as well as secondary feeding and loafing areas for the principal shorebird migrants. [ADF&G, 1992 and West, 1990]

Not only has natural sediment transport processes affected Mariner Park, but consequences due to human use have depleted the habitat. As Homer grew the Spit became a very desirable recreation and tourist area. To address the demands for Spit development, in the late 1970's through the early 1990's, various proposals to address the ever growing need for campground and recreational areas on the Spit were written. It was the belief of various proposers, as a consequence of their site investigations, that the area at the base of the Spit and west of the road be partially filled and made into a park. The proposals suggested allowances be made to protect the saltwater lagoon and tidal stream. [Land Design North 1980, Dames & Moore 1981, and City of Homer 1984, 1990]

Responding to various ideas expressed in the proposals, in 1985, a phased development of a portion of the site was begun. Specifically, to support open space/recreational use, approximately 20,000 cubic yards of fill material was placed in a 2.6 acre area south of the tidal stream by 1989. The area, Phase I of a three phase park concept, was partially filled, graded, and safety/sanitation upgrades made. It was during this period that Mariner Park got its name.

Concurrent with the Park's development, a chorus of concerned Homer residents voiced their opposition while extolling the virtues of habitat protection. In 1985 a petition against filling the area gathered 400 signatures. After the *Exxon Valdez* incident which caused the closure of the tidal lagoon, in 1990 the residents of property adjoining Mariner Park signed a joint letter to the US Army Corps of Engineers (COE) expressing their continued opposition to the development of Mariner Park and encouraging its prompt return to a natural habitat.

In response to the degraded habitat in Mariner Park, the City of Homer's Spit Campground Task Force, in 1990, revised the partially implemented 1984 park development plan. The Task Force proposed a scaled-down development plan that incorporated a lagoon flushing and enhancement program for the area. Further development of the area, to include the filling of an additional 2.0 acres adjacent to Phase I was withdrawn by the City of Homer. Subsequently, as a consequence of the *EVOS* incident, community sentiment, and concerns voiced by recreational users of the area to preserve and enhance the habitat, the COE denied a permit application to continue development of Mariner Park.

With the partial reopening of the breach in 1992, the tidal stream resumed transport, at lower levels, of nutrients into the intertidal lagoon. The refreshed lagoon and raised gravel plain attracted a small number of waterfowl and cranes. The breach was again closed in 1994 during a severe storm and was partially re-opened in 1996. As a consequence of the tidal stream closures, Mariner Park has experienced a noticeable increase in the rate of habitat degradation.

B. Rationale/Link to Restoration

As a protective measure against oil entering Mariner Park's wetlands during the *Exxon Valdez* incident, the tidal stream inlet was closed. The result of the closure was that critical nutrients were prevented from entering the intertidal lagoon. By cutting-off the stream from the outer bay and tides, the saltwater lagoon and marshes dried, thus, biologically rich portions of Mariner Park were not able to sustain themselves.

With the inability of Mariner Park to sustain a vibrant intertidal community, the feeding habitat for shorebirds was injured. This transformed a once thriving habitat viewing area into an unattractive and unavailable tourist and recreation destination.

In addition to directly restoring the injury caused by the response to *EVOS* (i.e., closing the tidal stream inlet), this proposal is also justified as replacement for, and enhancement of, injured intertidal resources. Intertidal wetlands on the Homer Spit must be protected, as much as reasonably possible, if we are to maintain a healthy and productive ecosystem for populations of shorebirds and provide residents and tourists unique wildlife experiences.

C. Location

The environmental assessment project will be undertaken in Homer, Alaska. The flora, fauna, and hydrological studies will be conducted at the base of Homer Spit to include both sides of the Spit Road, (Mariner Park and the nearshore portions of Mud Bay).

The project will directly benefit the Homer area. Additionally, given the international interest in the ecosystem of Kackemak Bay, the environmental assessment will provide invaluable information to the scientific community on the integration of wetland restoration in high use areas. An eventual product of a restoration project is increased tourism to observe the unique habitat and shorebird migration. This will benefit the Cook Inlet region, specifically, and the State, generally.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

This project is a collaborative venture. Its success is predicated on a collegial relation where the interests of individuals, community groups, and governmental bodies are woven with scientific findings and Trustee Council concerns into tapestry for an optimal restoration outcome which is in the best interest of Homer and the environment. Frequent, open, and candid dialogue is the effective mechanism to achieve this goal.

While scientific information will shape the technical elements of the habitat restoration design, the program will only be effective if placed in a community context. It is incumbent and expected that the project will solicit community involvement and draw upon local resources for input to the planning, scheduling, assessment, and design efforts. A major objective of the project coordinator's scope of work is to communicate with residents, in non-technical terms, on all aspects of the project. It is the project's responsibility to establish and implement procedures for collecting technical, local, and traditional ecological knowledge as well as investigating the issues and concerns raised by the public.

Homer is a community blessed with residents who possess a broad spectrum of knowledge and represent a myriad of talents. It is assumed the project will call on this talent to provide project support. For example, Homer is home to renowned biologists who have studied the intricacies of the bio-diverse Kachemak Bay and the effects of change on ecosystems and habitats. These respected "birders" have intimate knowledge of the area which translates into project effectiveness and cost savings. They are expected to be an integral component of the planning, assessment, and design team. As to the nuts 'n bolts issues of the project, depending on availability, the assessment team will use local labor and resources, such as equipment and vessels, to assist in collecting data.

PROJECT DESIGN

A. Objectives

The eventual restoration goal, for which this proposal is a critical element, is to restore the intertidal community. The principal objective of this project proposal is to develop a National Environmental Policy Act - Environmental Assessment that will provide a feasible project to restore the intertidal community of Mariner Park. In turn, the restoration project is to restore and rehabilitate the area in such a way as to increase, preserve, and protect a diverse feeding habitat for migrating shorebirds. Correspondingly, due to the fact that Mariner Park is on the flight approach to the airport, the plan will address the issue of how to discourage geese and cranes from frequenting the area, (i.e. inhibit the growth of submergent and emergent vegetation). Additionally, the plan establishes mechanisms to enhance the recreational use of the area in an environmentally compatible manner.

The restoration construction project, the topic of a follow-on proposal to the Trustee Council, is meant to enhance the spectacle of the spring shorebird migration. This translates into increased resident and tourist interest in the area especially during the annual Kackemak Bay Shorebird Festival. With the implementation of an optimal restoration design, Mariner Park will be a show case of wetlands rehabilitation in a high use area.

To meet the proposal objectives, scientific and testimonial information is gathered to develop comprehensive restoration alternatives. These alternatives are compared and a preferred restoration alternative is tendered.

The objectives of the project are addressed by, but are not limited to, the tasks listed below.

1. Conduct a review of past documentation to establish an historical perspective for the comparison of past to present community related information and technical data.

2. Collect traditional and local information on prior and expected use of the area in relation to economic, social, and environmental issues. Solicit comments on issues and concerns relative to the impact on resources and services from a restoration project.

3. Measure the diversity, frequency, and abundance of flora and fauna in Mariner Park.

4. Determine the geophysical characteristics of Mariner Park and the head of Mud Bay.

5. Develop restoration design alternatives and conduct a comparative study to identify the preferred restoration project design.

6. Write a National Environmental Policy Act - Environmental Assessment.

B. Methods

The feasibility project being proposed involves collecting biological, botanical, hydrological, and community data that is used to produce an EA. Coordination and management of the project are the responsibilities of a representative for the City of Homer. Field, analytical, and formal EA efforts are to be developed and performed by consultant(s) hired by the City. The consultant(s) will formulate the details and methods for field studies. Generally, the elements of the project are as follows:

1. Research past biological, botanical, and hydrological studies of the area in order to develop a catalogue of historical data and information.

2. Conduct field studies to catalogue the flora and fauna presently in Mariner Park. The data will establish a baseline for comparing historical data in an effort to delineate changes in the project area.

3. Conduct a hydrological study of Mariner Park and Mud Bay. Perform hydraulic, soil classification (test hole), and sediment transport studies.

The information acquired from the technical and community studies will provide the basis for determining the optimal restoration program. Production of the EA will follow NEPA guidelines.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The City of Homer is the sponsoring, coordinating, and responsible agency for this project. The lead Trustee agency is the Alaska Department of Natural Resources (ADNR). Aside from providing technical expertise on environmental restoration issues, as property owner of a significant portion of the project area, the ADNR has land use interests in the Mariner Park. Additionally, during discussions with ADNR and ADF&G it was suggested that the project may best be served if the agencies act in the role of co-lead Trustees. This is a viable option that would facilitate the efficient prosecution of the project.

A restoration project in Mariner Park directly impacts and interfaces with several state and federal agencies. Of the many agencies touched by the project, the primary Trustee cooperating agencies are the Alaska Department of Fish and Game (ADF&G) and the US Department of Interior, Fish and Wildlife Service (USF&WS). Both agencies have technical knowledge and vested interest in projects that purport to restore and protect habitat. By providing key insight on biological relationships, the agencies can provide valuable support during the analysis of field data, the developing of restoration alternatives, and the selection of the preferred alternative.

With respect to the USF&WS role, it is expected they will provide expertise and review functions during the environmental assessment phase of the project. The EA is the primary planning and permitting document for the project. As such, it is a primary tool for communicating the merits and options for follow-on restoration activities at the site and its consequence on neighboring facilities and habitats.

The Alaska Department of Transportation and Public Facilities (ADOT&PF), US Army Corps of Engineers (COE), and Federal Aviation Administration (FAA) possess significant technical knowledge of the area. Additionally, these agencies have vested interest in a Mariner Park restoration construction project because the area is in proximity to their spheres of influence and responsibility: the Homer Spit Road is an ADOT&PF facility, the airport is the privy of FAA, and the COE is a permitting agency representing coastal water concerns. Other agencies with peripheral interest are the Alaska Department of Environmental Conservation (ADEC - State Water Quality Certification) and the Alaska Office of Management and Budget: Division of Governmental Coordination (Certification of Consistency with the Alaska Coastal Management Program). In all cases, the EA will provide a basis for understanding the relationship of the project to the environment and be a mechanism to critique the potential of the project in meeting the established restoration goals.

When appropriate, the project will attempt to contract with local talent and resources for specific project services. In some cases experts from outside the Homer area may best meet the objectives of the project. Expectations are to contract with private consultants for biological, botanical, and hydrological studies.

SCHEDULE

A. Measurable Project Tasks for FY 98

October 1 - November 15:	Collect and review historic information and data. Develop contract proposals for consultant(s) effort, advertise for cost proposals, and evaluate proposals. Conduct community involvement, (education and information gathering), component of project.
November 15 - December 1:	Analyze proposals.
December 10:	Award contracts.
December 11 - January 1:	Assist contractors in logistics for field efforts.
January 1 - March 27:	Assist with winter field surveys. Analyze historic information and data. Prepare portions of EA.
January 15 ~ January 24:	Attend Annual Restoration Workshop, (3 day workshop).
February 1 - March 15:	Conduct community involvement component of project.
March 16 - April 14:	Prepare annual report of activities to date.
April 15:	Submit annual report.
April 15 - September 30:	Consultant(s) conduct spring, summer, and fall field efforts and analyze data. Conduct formal community involvement component of project. Produce EA.

B. Project Milestones and Endpoints

December 1:	Collect and analyze historic data.
January 15:	Initiate EA process.
September 1:	Complete EA field studies and analysis of data..
September 30:	Submit EA and Report of Project to Trustee Council.

C. Completion Date

Substantial completion of the project is September 30, 1998. The principal objective to be completed by this date is the production of a NEPA-EA. Elements encumbered by this objective are historic and community perspectives, field studies, restoration design alternatives, no action alternative, comparative study of alternatives, preferred alternative, and final draft of the environmental assessment document.

PUBLICATIONS AND REPORTS

The project does not, at this writing, plan to submit manuscript(s) for peer-reviewed publication(s) in FY 98.

The project will submit to the Council an annual progress report on April 15, 1998 and a final project report on September 30, 1998.

PROFESSIONAL CONFERENCES

The project does not plan to present at professional conferences in FY 98.

NORMAL AGENCY MANAGEMENT

N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The location and nature of this project requires close local, state, and federal agency coordination. During the formulation of this proposal substantive discussions have taken place with community organizations, local authorities, and state/federal agencies: ADNR, ADF&G, ADOT&PF, COE, USF&W, and FAA. As the project unfolds it is expected that the coordination effort will expand.

Interested parties from the public, private, and government sectors are encouraged to engage the project during planning, design, implementation, and review processes. Similarly, the project will share data from the field efforts and welcomes feedback on its analyses, conclusions, and recommendations.

At present, the project addressed by this proposal has not solicited matching funding. This does not preclude such; rather, it is expected the project will take advantage of complimentary work undertaken by other entities, (i.e. shorebird counts and COE projects scheduled for the Spit).

It is planned that the follow-on restoration construction project will vigorously seek matching funding from non-Trustee Council sources. Potential sources for matching funds are the COE "Project Modifications for Environmental Improvement, Section 1135" and ADNR restoration grants.

EXPLANATION OF CHANGES IN CONTINUING PROJECT

N/A

PROPOSED PRINCIPAL INVESTIGATOR

The City of Homer plans to employ a Project Coordinator to manage the EA process. At present, the City does not know who will fill the Coordinator position.

PRINCIPAL INVESTIGATOR

Not Known

OTHER KEY PERSONNEL

Eileen Bechtol, Planning Director, City of Homer
Technical resource person and responsible party for City

Poppy Benson, U. S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge
Technical resource person

Mike Bennet, Alaska Department of Natural Resources, Division of Lands
Technical resource person

Ruth Carter, Alaska Department of Transportation and Public Safety, Coastal and Harbor Engineering Section
Hydrology and engineering resource person

Geno Del Frate, Alaska Department of Fish and Game, South-central District
Technical resource person

Larry Dugan, U.S. Fish and Wildlife Service, Ecological Services
Technical resource person

Ken Eises, U.S. Army Corps of Engineers, Coastal Engineering
Technical resource person on engineering design and hydrology issues

Dave Erikson
Biology resource person

William Hauser, Alaska Department of Fish and Game, Habitat Restoration Division
Representative of Cooperating Agency and technical resource person

Mac Humphrey, Federal Aviation Administration, Airports: Environmental Division
Technical resource person on FAA environmental concerns

Don McKay, Alaska Department of Fish and Game, Habitat Restoration Division
Representative of Lead Trustee Agency and technical resource

Mary Lynn Nation, U.S. Fish and Wildlife Service, Ecological Services
Representative of Cooperating Agency and technical support on NEPA-EA

Harvey Smith, Alaska Department of Transportation and Public Safety, Coastal and Harbor Engineering Section
Hydrology and engineering resource person

Art Weiner, Alaska Department of Natural Resources, Wetlands Restoration
Representative of Lead Trustee Agency

George West, Birchside Studios
Biology resource person

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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FFY 1997	Proposed FFY 1998						
Personnel		$14,400.0						
Travel		$2,710.0						
Contractual		$60,000.0						
Commodities		$0.0						
Equipment		$2,350.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$79,460.0		Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect		$15,890.0						
Project Total	$0.0	$95,350.0						
Full-time Equivalents (FTE)		12.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

The Indirect Cost multiplier for this project is 20%. The Indirects include, but are not limited to: utilities, phones, copying, office supplies, administrative and finance functions, and mail service.

1998

Prepared:

Project Number: 98
Project Title: Homer Mariner Park Habitat Assessment & Restoration Design Project
Name: City of Homer

FORM 4A
Non-Trustee
SUMMARY

4/4/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:				Months	Monthly		Proposed
	Name	Position Description		Budgeted	Costs	Overtime	FFY 1998
	Vacant	Project Coordinator		12.0	1200.0	0.0	14,400.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		12.0	1200.0	0.0	
						Personnel Total	$14,400.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FFY 1998
	Project Coordinator: meetings and research in Anchorage	130.0	3	8	100.0	1,190.0
	Official(s) of the City of Homer: meetings in Anchorage	130.0	4	10	100.0	1,520.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$2,710.0

1998

Project Number: 98
Project Title: Homer Mariner Park Habitat Assessment & Restoration Design Project
Name: City of Homer

FORM 4B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FFY 1998
Consultant(s) Firm to design and produce EA. Work includes biologic, botanical, and hydological field studies	56,000.0
Survey	2,000.0
Printing and Photographs	2,000.0
Contractual Total	$60,000.0

Commodities Costs:	Proposed
Description	FFY 1998
Cost associated with office materials, postage, utilities, etc. are addressed in the indirect rate.	
Commodities Total	$0.0

1998

Prepared:

Project Number: 98
Project Title: Homer Mariner Park Habitat Assessment & Restoration Design Project
Name: City of Homer

FORM 4B
Contractual &
Commodities
DETAIL

4/4/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1998
Computer (IBM: price per COMP USA)			1,800.0
Fax/copier/printer (HP: price per COMP USA)			550.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$2,350.0

Existing Equipment Usage: Description	Number of Units	

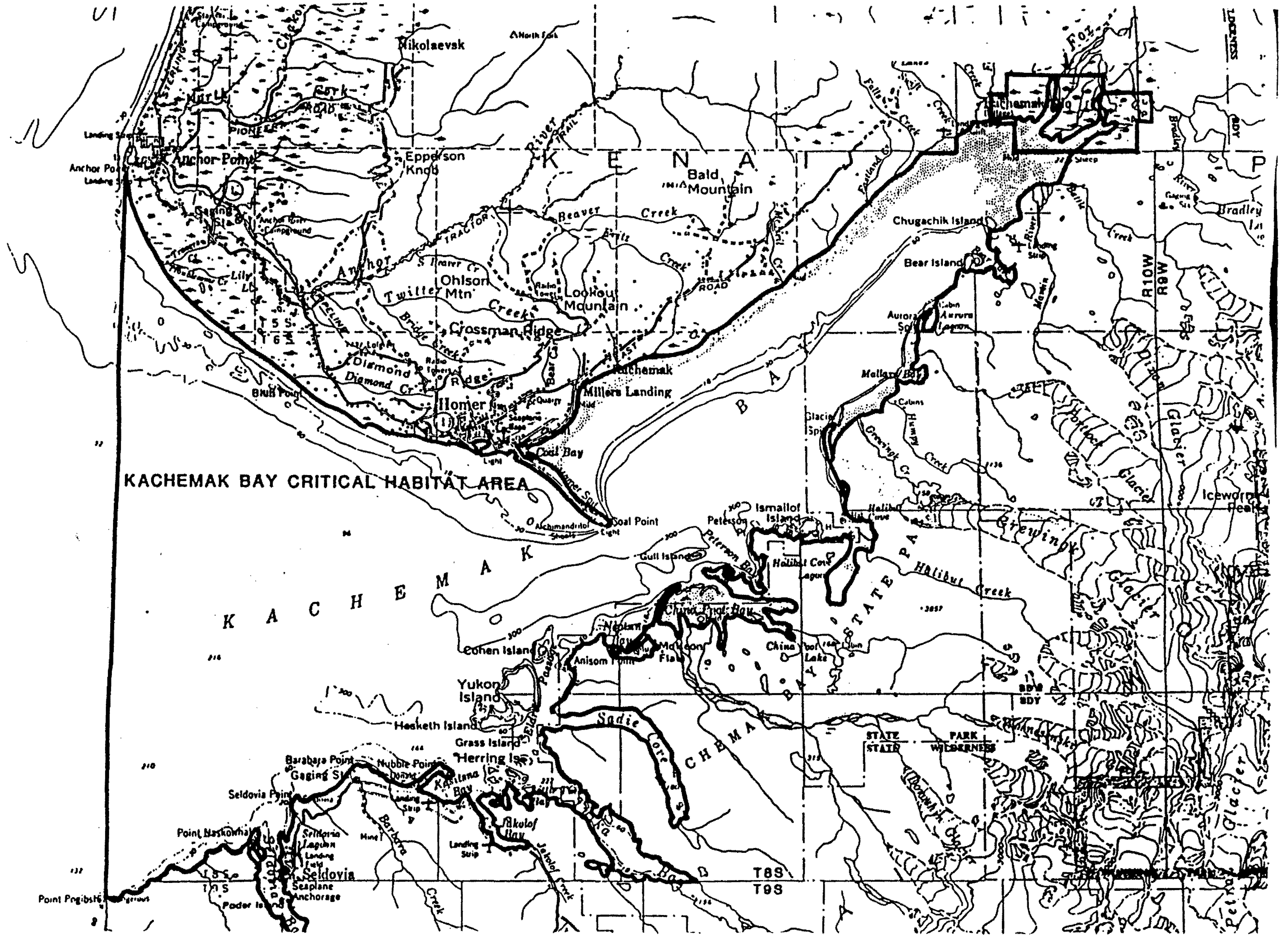
1998

Project Number: 98
Project Title: Homer Mariner Park Habitat Assessment & Resroration Design Project
Name: City of Homer

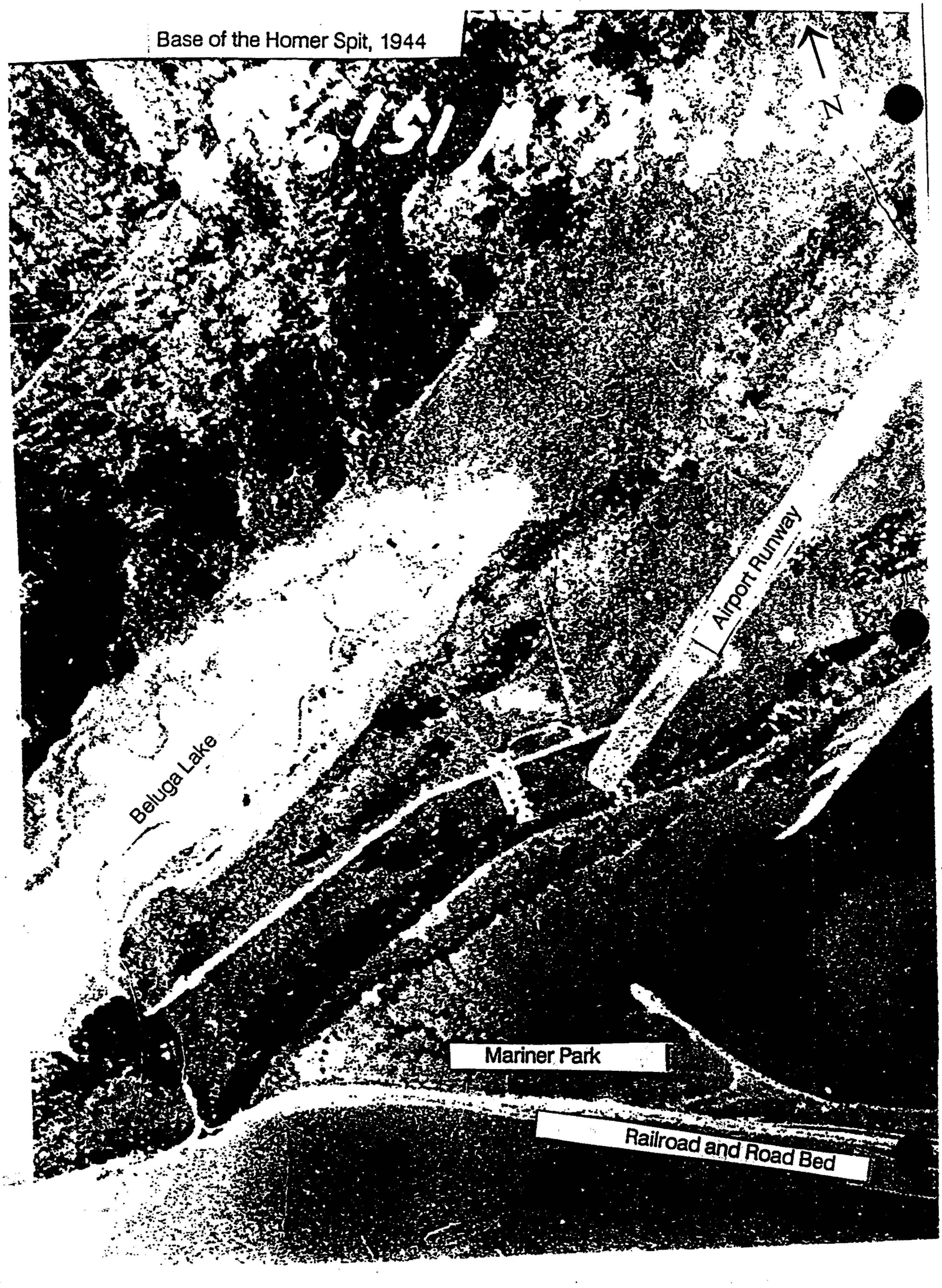
FORM 4B
Equipment
DETAIL

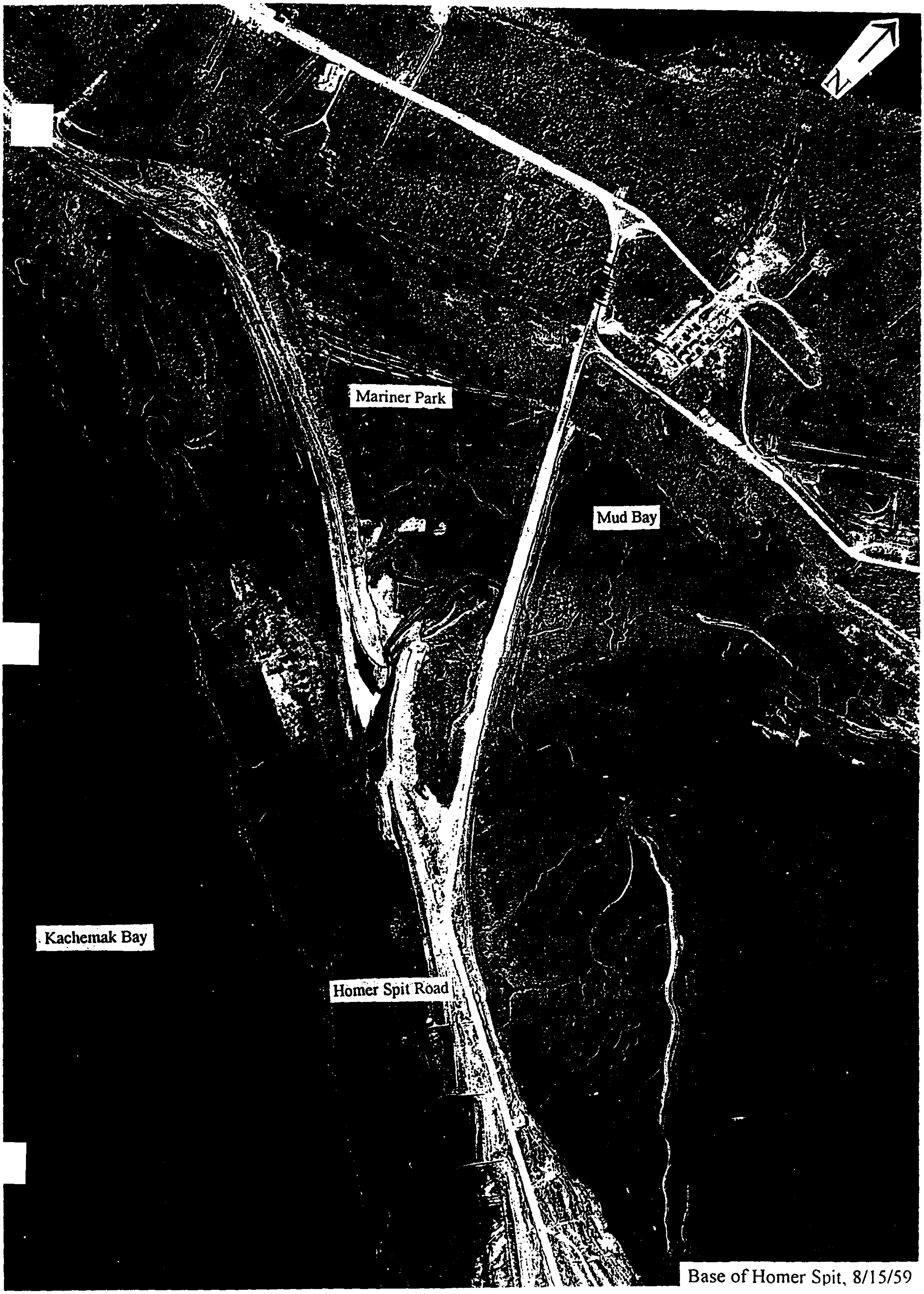
Preparec'

/97



KACHEMAK BAY CRITICAL HABITAT AREA
Nikolaevsk
Anchor Point
Epperson Knob
K E N A I
Bald Mountain
Beaver Creek
Ohlson Mtn
Lookout Mountain
Twitter Creek
Crossman Ridge
Diamond Ridge
Diamond Cr
Homer
Kachemak
Millers Landing
Bluff Point
Coal Bay
Homer Spit
Coal Point
Chugachik Island
Bear Island
Aurora Spit
Mallard Bay
Glacier Spit
Ismailof Island
Peterson Bay
Gull Island
Halibut Cove
China Poot Bay
Cohen Island
Anisom Point
Yukon Island
Hesketh Island
Grass Island
Herring Is
Barabara Point
Nubble Point
Kasitsna Bay
Seldovia Point
Point Naskowhak
Seldovia
Seaplane Anchorage
Point Pogibshi
Jakolof Bay
Sadie Cove
K A C H E M A K
B A Y
STATE PARK
STATE WILDERNESS
Grewingk Glacier
Halibut Creek
Portlock Glacier
Dixon Glacier
Iceworm Peak
Bradley
Fox
R10W
R9W
T8S
T9S


Base of the Homer Spit, 1944
N
Beluga Lake
Airport Runway
Mariner Park
Railroad and Road Bed



Base of Homer Spit, 8/15/59

Base of Homer Spit, 6/6/96

98315

Qutekcak Native Tribe
P.O. Box 1467
Seward, Alaska 99664
907-224-3118
907-224-5874 (fax)

RECEIVED
APR 14 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

April 14, 1997

Molly McCammon, Executive Director
Exxon Valdez Oil Spill Trustee Council
645 G Street, Suite 401
Anchorage, AK 99501-3451

Dear Ms. McCammon:

Letter of Proposal Assistance Request

The Qutekcak Native Tribe is requesting assistance to develop a proposal concept for Federal Fiscal Year 1998. The Qutekcak Tribal Council recognizes that detailed project descriptions are necessary for the Trustee Council work plan development process and asks that Restoration Office staff work with the Qutekcak tribal staff to address its role in the restoration of resources and services within the Chugach Region. Through this initial request, Qutekcak proposes to facilitate a major shellfish conference (and related follow-up) to increase the potential for clam and oyster production and harvesting in the region.

While little scientific research has shown direct resource damage in the Seward area as a result of the Exxon Valdez oil spill, the effects are present. The lack of confidence in subsistence resources, both within the community and at remote hunting and fishing areas has affected Seward and all of the oil spill impacted region. The residual effects on the region as a whole require that the communities must work together to restore resources and services.

Current project activities at the Qutekcak Shellfish Hatchery are a positive example of partnering efforts. While Qutekcak does not directly administer a restoration grant from the Trustee Council, it has served as the laboratory for Chugach Regional Resources Commission's research and growth of clam and oyster spat for later outplanting in the villages. Both the restoration and production for clam and oyster harvesting are favorable projects to the oil spill impacted communities as a means to restore services lost.

The Qutekcak Native Tribe proposes to convene a major shellfish conference involving regional, statewide, national and international participants in Seward for the express purpose of coordinating and enhancing research and growth of shellfish. To date, a great deal of experimentation has been conducted at the hatchery with minimal resources. Bringing together shellfish growers and hatchery experts and academic and industry specialists (date - March 1998), this will enable a greater understanding of the growth and seeding process, and thus, harvesting within the communities at a quicker rate. Also our process will be unique in that there will be integrated into our efforts an "action fund" to implement recommendations and necessary follow-up activities in a coordinated and timely manner.

Tremendous resources are being developed in Seward with the Alaska Sealife Center. Other agencies in Seward, such as the Institute of Marine Science and the Department of Fish and Game's presence at the Qutekcak Shellfish Hatchery provide additional support for this effort. This is an opportune time to increase coordination between research organizations and agencies. The facilitation of a shellfish conference at this date can speed the process of restoring subsistence services through the exchange of information and action concerning the latest techniques.

Qutekcak Native Tribe anticipates that the conference will cost $750,000 ($250,000 to convene conference process and $500,000 set aside funding to respond to scientific recommendations forthcoming from this unique effort). Yet given the limited resources available at the tribal level, assistance is necessary to fully develop this proposal concept.

Thank you in advance for your technical expertise to develop a detailed project description for FFY 98.

Sincerely,

Edgar Blatchford
Tribal Administrator
Qutekcak Native Tribe

cc: Martha Vlasoff, Community Involvement Coordinator

BIOLOGY OF TWO INTERTIDAL CRUSTACEANS: AN ISOPOD (Idotea wosnessenskii) AND A LITHODID CRAB (Hapalogaster krebnitzkii).

Project Number: 98319

Restoration Category: Research

Proposer: Dr. Bradley G. Stevens, NOAA/NMFS

Lead Trustee Agency: NOAA

Cooperating Agencies: None

Alaska SeaLife Center:

Duration: First year, 1 yr project.

Cost FY 98: $47,879

Cost FY 99: $6642

Cost FY 00:

Cost FY 01:

Cost FY 02:

Geographic Area: Kodiak

Injured Resource/Service: Intertidal Communities

RECEIVED
APR 1 4 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

Intertidal communites were heavily impacted by the Exxon Valdez Oil Spill. Lack of knowledge concerning the biology of intertidal organisms hampers assessment of their recovery from the EVOS or future disturbance. We propose to study the biology of two common intertidal crustaceans (an isopod and a lithodid crab) which are good indicator species because they live in close association with understory substrates. Monthly sampling and selective videography will be used to determine size at maturity, fecundity, reproductive season, and a range of "normal" behaviors including mating and foraging. Results will enable assessment of population differences between impacted and non-impacted populations.

INTRODUCTION

Intertidal ecosystems are some of the most productive on earth, and may equal or exceed tropical rain forests in total carbon fixation rates. Besides hosting a large variety and biomass of organisms, such ecosystems may serve as nursery grounds for many commercially valuable species, including rockfish, salmonids, flounder, halibut, king and dungeness crabs. In March 1989, oil from the Exxon Valdez oil spill (EVOS) wreaked havoc on the intertidal communities of Prince William Sound (PWS) and Shelikof Strait. Exposed capes suffered heavy oiling; at Sukoi Peninsula near Cape Douglas, oil covered 70-100% of beach rocks and gravel, and penetrated the sand 15 cm to underlying bedrock (Suchanek 1994). Unfortunately, impacts of the EVOS on faunal populations in PWS could not be adequately determined because few pre-spill studies had been conducted in the area (Estes 1992).

Detection of human-induced changes in natural communities is notoriously difficult, and requires multiple samples before and after impact events, at multiple control and impacted sites (Green 1979, Underwood 1991, Underwood 1992), and it is rarely possible to know the locations of impacts before they occur. Studies of community structure and change require enormous efforts to adequately sample all species comprising the community, and acute sampling strategies (i.e. one time, or annually) are often inadequate for detecting changes, or differentiating between short and long term changes. Information on demography, behavior, reproduction or growth rates of individual species is usually not obtained or utilized, although such information may provide better clues to changes in the local environment. The important aspect of pollution impact is not the mortality of organisms, but the fate of the survivors (Clark 1989).

Another approach to this task is to identify and study specific indicator species with regular sampling. Detailed knowledge of their life history, obtained prior to human disturbance, can be a very efficient and effective way to evaluate such disturbance. Changes in fecundity, size at maturity, and population structure, among others, are indicative of environmental stress. Such changes may occur after exposure to pollutant concentrations which are not detectable visually.

The isopod Idotea wosnessenskii is a common intertidal resident throughout the Gulf of Alaska (Rafi and Laubitz 1990, Suchanek 1994). It is abundant in many intertidal sites around Kodiak Island (authors personal observations) and is a common food item for intertidal fishes (Morris et al 1983). The lithodid crab Hapalogaster krebnitzkii (commonly called the fuzzy crab) is also abundant intertidally on Kodiak Island. Both of these species could serve as a valuable indicators of human impacts to intertidal areas. Pollutant induced mortality of juveniles and larvae has much greater impact on organisms with low fecundity and slow growth (e.g., most crustaceans), than on those with high fecundity and growth (e.g., bivalves)(Clark, 1989). In addition, the fuzzy crab might also be valuable as a "lab rat", or model/proxy species for studies on red king crab, which is commercially valuable, but difficult to study because of its remote habitats and large size. Unfortunately, very little information exists on the biology of either of these two crustaceans (see below).

We propose to conduct basic life history and ecology studies on Idotea and Hapalogaster spp. in intertidal ecosystems adjacent to Kodiak Island which have not been impacted by the EVOS. Determination of "normal" population parameters can be used to assess the consequences of future human disturbance, or compared to populations in impacted areas such as PWS.

NEED FOR THE PROJECT

A. Statement of the Problem

Except for occasional acute studies which have been conducted in the past, there has been no direct effort to establish basic biological information for intertidal organisms in PWS or the Kodiak archipelago. Such information is critical for deterimining the impacts of human disturbance. For instance, in February 1989, severe weather caused widespread mortality of mussels throughout intertidal areas from Washington state to Alaska. As much as 50% of the intertidal mussels were killed in Kodiak (authors personal observation). Without prior knowledge of this mortality, it might have been attributed to the EVOS, which occurred one month later. Overall, this natural mortality event may have been more catastrophic than the EVOS. Kodiak is also important overwintering habitat for birds which feed intertidally, such as black oystercatchers and harlequin ducks, which may be affected indirectly by changes in prey populations.

Kodiak is one of the top three major fishing ports in the United States, and home to the largest Coast Guard Base in the U.S. As a result of the large volume of ship traffic, and its proximity downstream from Prince William Sound, it is highly likely that Kodiak will suffer a major spill of petroleum or other contaminants at some time in the future. Indeed, the west side of Kodiak was directly affected by the EVOS event in 1989, and even Cape Chiniak, on the east side of Kodiak, received some oil (Suchanek 1994).

B. Rationale and link to Restoration

The isopod Idotea wosnessenskii and the lithodid crab Hapalogaster krebnitzkii are common intertidal residents around Kodiak Island (authors personal observations). They are important prey items for intertidal fishes, and probably birds, and because of their close association with understory substrates (see below), can serve as excellent indicator organisms for environmental disturbance. However, basic biology and ecology of these species is essentially unknown. Once that information has been obtained, Kodiak populations can serve as a reference for comparative studies on impacted populations in PWS.. If a future spill of oil or other contaminants occurs in the study area, basic biological information can be used to determine its impact on these index species.

C. Location

The study would take place at (at least) two sites in Kodiak, both of which are accessible from the Kodiak road system. Information obtained would be applicable at least to the northeast quadrant of Kodiak Island, and possibly to the entire Gulf of Alaska. There are two major advantages to conducting this study in Kodiak. One is that local populations were not impacted by the EVOS, so biological parameters should be closer to "normal" than those from impacted sites in PWS. The second is that both sites are accessible from the Kodiak road system, so sampling can be conducted year-round on a monthly basis with few interruptions due to weather, and without use of expensive charter vessel time.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

This project would not involve hiring local people, or use of local resources. All work would be conducted by personnel of the National Marine Fisheries Service Kodiak Laboratory. Information about the project would be disseminated by public lectures in Kodiak, and via University of Alaska classes taught by the P.I.

PROJECT DESIGN

A. Objectives.

The objectives of the project are to determine basic biological and ecological information concerning the isopod Idotea wosnessenskii (isopod) and the lithodid crab Hapalogaster krebnitzkii (fuzzy crab), as follows:

1. Determine the common intertidal habitats of isopods and fuzzy crabs.

2. Determine the breeding periods, size at maturity, and fecundity of both target species.

3. Determine major food sources for both species.

4. Determine "normal" foraging and mating behavior in natural habitats (in-situ).

B. Methods

1. (Un)Known Biology: Morris et al (1983) reported that Idotea wosnessenskii reproduces in July, but we have observed ovigerous females as early as January in Kodiak. Samples of Idotea collected in January, February, and March 1994 included ovigerous females in all three months, and brood size was about 100 (author's unpublished data). At low tide, isopods can be found on the undersides of rocks which are wet but not in contact with sand. No detailed ecological studies have been conducted on I. wosnessenskii, but sutdies have been done on the congeners Idotea emarginata (Naylor 1955) and I. baltica, (Jormalainen and Tuomi 1989, Salemaa 1979) in northern Europe. The latter species lives in similar environments to I. wosnessenskii , but males typically spend more time on Fucus (the main food source) than females, which remain hidden during the reproductive period, ostensibly to reduce predation.

   There is little information available concerning Hapalogaster, although Knudsen (1964) reported some biological aspects of the related species H. mertensii, from Puget Sound. Crabs occur on the sand substrate below rocks. Crabs and isopods often occur under the same rocks, though the distribution of isopods typically extends higher in the intertidal zone than crabs (personal observations).

2. Sampling:Preliminary work by the author has identified four easily accessible sites where both crabs and isopods can be studied. Crabs and isopods would be sampled at two of these sites: (1) Phinney Reef, a semi-protected site near the NMFS Kodiak Lab, and (2) Spruce cape, an open, exposed headland. A third site, Miller Point (Fort Abercrombie State Park) may be included if either of the first two sites are inadequate. Samples would be collected monthly at low tides for one year. Large crabs would be measured and released in the field, but small and female crabs, and isopods would be returned to the Kodiak NMFS lab for measurement and examination. For crabs, sex, shell condition, carapace length (CL), chela height (males only), or egg stage (females) would be recorded. Representative samples of egg clutches would be removed and counted to determine fecundity. For isopods, sex, total length, and reproductive stage would be determined, and numbers of eggs or larvae would be counted on ovigerous females. A minimum of 50-100 individuals would be examined during each sampling period, if possible.

Food habits and reproductive behavior would be studied by observation of animals in the field, and by laboratory analysis. Food items of crabs can be identified to higher taxonomic levels after consumption (Stevens et al. 1982), although it is probably not possible to do so for isopods.

Behavioral observations would be made using a small (2 x 3 inch) waterproof video camera to observe both species under natural conditions. The camera would be placed near a group of animals, and a cable run to the recorder in a waterproof housing; video observations would consist of short (30-120 minute) periods, during which the animals would be undisturbed. Observations would be made during both day and night, and high and low tides. These observations would be used to determine the range of "normal" behaviors, whether behavior differs between sexes, light, and tide conditions, when mating occurs, and to give an index of motility (within the field of view), and timing of foraging bouts. Videotapes would be analyzed at the NMFS video laboratory, using The Observer Videotape Analysis System. This program was designed specifically to analyze behavior, and allows coding of behavioral events, and capture of occurrence time from the video tape. We have used this system effectively since 1992 for studying in-situ behavior of crustaceans.

The advantage of using video to study organisms is that, quite often, scientists do not recognize important behavior when it is first observed, and do not record it until after they have seen repeated occurrences or aberrations of this behavior. Such data includes interactions with other species (e.g., prey or predators) which may be too brief to be observed by occasional visual observation. In addition, there is usually much more information on a videotape than one expects, or can record concurrently. Video tape can be re-viewed at a later time to glean additional data, or to look for information missed on the first viewing. Video equipment would be used for data recording and analysis (Hi-8), archival storage (S-VHS), and production of demo tapes for scientific presentations.

3. Hypotheses: The majority of this study is descriptive and designed to answer specific questions rather than hypotheses, but some can be formulated. Those questions, for both

species, are:

1. What is the minimum and mean size at sexual maturity for both sexes?
2. What is the normal breeding season?
   Ho_1: Breeding has no distinct seasonality.
3. What is average fecundity?
4. What are the proportions of juveniles, adults, and breeding adults?
5. What are the common habitats?
6. What do they eat?
7. Do they have diurnal or tidally-related behavior?
   Ho_2: Foraging behavior and activity level does not differ between sexes or tide levels.
8. Ho_3: Biological parameters do not differ between the two sampling sites.

Although there are many more questions that could be asked, these are the basic questions which must be answered before further research can be done. This project will not attempt to determine population abundance, because habitats are not adequately known, and sample sizes and confidence levels therefore cannot be predicted.

4. Additional Research: In October 1998, we expect to move into a new research laboratory on Near Island. That lab will contain running seawater, in which live animals could be kept for study. If this project is funded, we may propose a second year of work, which would include bringing animals into the lab to study substrate use, egg incubation time, and behavior of larvae and juveniles.

SCHEDULE

A. Measurable Project Tasks for FY 98.

1997:

October:	Sample intertidal crustaceans.
November:	Sample intertidal crustaceans.
December:	Sample intertidal crustaceans.

1998

January:	Sample intertidal crustaceans.
February:	Sample intertidal crustaceans.
March:	Sample intertidal crustaceans.
April:	Sample intertidal crustaceans.
May:	Sample intertidal crustaceans.
June:	Sample intertidal crustaceans. Make in-situ video of behavior.
July:	Sample intertidal crustaceans.

	In-situ behavior studies.	
August:	Sample intertidal crustaceans.	
	In-situ behavior studies.	
September:	Sample intertidal crustaceans.	
October-December:		Analyze data.

1999

January:	Attend Annual Restoration Workshop
February-March:	Analyze data.
April:	Submit Annual Report.
May:	Prepare for publication.

B. Project Milestones and Endpoints.

Objectives requiring monthly sampling will be completed in September of 1998. In-situ behavioral studies will be conducted during June, July, and August of 1998. All field work will be completed by October 1998. One month of salary time (BGS) will be incurred in 1999 for report writing.

C. Completion Date.

Data analysis will begin in October 1998, and will take approximately 6 months, due to other obligations. We hope to have a preliminary manuscript prepared by June 1999.

PUBLICATIONS AND REPORTS

Manuscripts will be prepared and submitted to peer-reviewed journals. At least one manuscript concerning each of the two target species will be prepared. An annual report will be submitted in April 1999.

PROFESSIONAL CONFERENCES

Results of the project will be presented at professional conferences in 1999 or 2000.

NORMAL AGENCY MANAGEMENT

It is within the mission of the NMFS to study intertidal organisms, and the Kodiak lab has special expertise in crustacean biology. However, Agency policies and economic considerations channel the efforts of NMFS scientists towards studies on commercially valuable species. In addition, budget constraints have prohibited the acquisition of equipment necessary to observe, record and analyze relevant data. For these reasons, the proposed study would not be pursued without outside funding.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Initial studies on impacts of the EVOS to intertidal ecosystems in PWS were conducted by M. Stekoll and R. Highsmith at UAF. J. Rice et. al (NMFS, Juneau) are presently conducting studies on contamination of intertidal bivalves in PWS. All of these authors have been contacted and we plan to work closely with them during the project. We are slso willing to cooperate with any other investigators who may have research interests in this geographic location.

PROPOSED PRINCIPAL INVESTIGATOR

Dr. Bradley G. Stevens
National Marine Fisheries Service
P.O. Box 1638
Kodiak, AK 99615
Phone: (907) 486-5961
FAX: (907) 486-5960
email: bstevens@afsc.noaa.gov

PRINCIPAL INVESTIGATOR

Dr. Stevens has conducted research on ecology and life history of crustaceans since 1978, and has numerous publications on crustaceans of the North Pacific (see attached C.V.). He has experience in the use of underwater videography, and the interpretation of behavior by videotape analysis. Every year since 1989, he has taught a class in Intertidal Ecology at Kodiak College, University of Alaska. Recent research activities include: Mating behavior and size at maturity of Tanner crabs (Chionoecetes bairdi), impacts of fishwaste dumping on subtidal megafaunal communities, settling behavior of king crab larvae, substrate preferences of juvenile king crabs, and impacts of ghost fishing on king and Tanner crabs. Dr. Stevens received funding from the National Undersea Research Program in 1991, 1992, 1994, 1995, and 1997 (deferred), which has resulted in four publications to date.

OTHER KEY PERSONNEL

One additional person (not yet identified) would probably be assigned to this project.

LITERATURE CITED

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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$16,468.0						
Travel		$4,335.0						
Contractual		$250.0						
Commodities		$0.0						
Equipment		$24,338.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$45,391.0		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$2,487.7						
Project Total	$0.0	$47,878.7		$6,642.0				
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared: 4/10/96

Project Number: 98319
Project Title: Biology of Intertidal Crustaceans
Agency: NOAA/NMFS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
B. G. Stevens	Principal Investigator	GS-13	2.0	6642.0		13,284.0
Unknown	Biologist	Gs-9	1.0	3184.0		3,184.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.0	9826.0	0.0	
					Personnel Total	**$16,468.0**

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Technical Review Session, Anchorage, 1998	316.0	1	2	141.0	598.0
Annual Restoration Workshop, Anchorage, Jan 1999	316.0	1	3	141.0	739.0
International Crustacean Symposium, Amsterdam, July 1998	1500.0	1	7	214.0	2,998.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					Travel Total | **$4,335.0**

1998

Prepared: 4/10/97

Project Number:
Project Title: Biology of Intertidal Crustaceans
Agency: NOAA/NMFS

FORM 3B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Surveying of Intertidal sites and marking elevations	250.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$250.0

Commodities Costs:	Proposed
Description	FY 1998
Commodities Total	$0.0

1998

Prepared: 4/10/96

Project Number:
Project Title: Biology of Intertidal Crustaceans
Agency: NOAA/NMFS

FORM 3B
Contractual &
Commodities

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Sony TR910 Video camera and "Stingray" underwater housing	1	3500.0	3,500.0
Sony EVO-9720 Hi-8 professional video editing machine - price from Camera World (Portland)	1	5700.0	5,700.0
Panasonic 20" Hi-res video monitor (Camera world price).	1	380.0	380.0
Sony SVO-9600 Professional S-VHS Video tape recorder	1	2450.0	2,450.0
Compaq computer (Pentium 200 Mhz, 32 MB, SCSI hard disk, removable disk, 8X CD ROM)	1	2300.0	2,300.0
Video board for computer processing: Targa 2000 Pro (MSR Price)	1	3400.0	3,400.0
Video Editing Software: Adobe Premiere (Catalog price)	1	470.0	470.0
HP 6MP Laser Printer (catalog price)	1	900.0	900.0
The Observer Videotape Analysis System (upgrade, Mfr. price)	1	1350.0	1,350.0
Misc. Video equipment (tape, tripod, cables, etc)	1	1000.0	1,000.0
Iomega Jaz removable hard drive (for video data storage) plus two disks	1	740.0	740.0
Micro SeaCam 1050 (underwater camera) Retail price	1	2020.0	2,020.0
Cable for SeaCam, 160 ft.	160	0.8	128.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$24,338.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1998

Project Number:
Project Title: Biolog of Intertidal Crustaceans
Agency: NOAA/NMFS

FORM 3B
Equipment
DETAIL

Prepared:

98320

Sound Ecosystem Assessment (SEA)

FY98 Proposal

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Letters of Submittal

FY 98 Single Integrated Detailed Project Description (DPD)

Appendix I. Sound Ecosystem Assessment (SEA): Individual Project Budgets

Submitted under the NOAA BAA

98320-I Stable Isotopes
98320-J Information Systems and Model Development
98320-M Physical Oceanography
98320-N Nekton and Plankton Acoustics

Submitted to Alaska Department of Fish and Game

98320-E Salmon Predation
98320-G Phytoplankton and Nutrients
98320-H The Role of Zooplankton
98320-R Trophodynamic Modelling and Remote Sensing
98320-T Juvenile Herring Growth and Habitats
98320-T Supplement – Herring Traditional Ecological Knowledge
98320-U Somatic Energetics
98320-Z SEA Synthesis and Integration

Appendix II. Workplans for the FY 98 SEA Model Subgroups

Ocean State and Plankton Dynamics
Pink Salmon Recruitment Dynamics
Herring Recruitment Dynamics

Sound Ecosystem Assessment (SEA): An Integrated Science Plan for the Restoration of Injured Species in Prince William Sound, Alaska Submitted (in part) under the Broad Agency Announcement

Project Number:	98320
Restoration Category:	Research
Proposer:	Alaska Department of Fish and Game University of Alaska Fairbanks Prince William Sound Science Center
Lead Trustee Agency:	ADFG
Cooperating Agency:	NOAA
Alaska SeaLife Center:	
Duration:	5th year, 5-year project
Cost FY 98:	$ 2,436.0
Cost FY 99:	$ 770.1 (Budget details among projects and between fiscal years are summarized on a separate spreadsheet. wjh)
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pink salmon and Pacific herring

ABSTRACT

Project 320 is an integrated, multi-component study of processes influencing the annual survival of juvenile pink salmon and herring rearing in the Sound. An emerging understanding of mechanisms of loss at this life stage is being captured by linked numerical simulations of ocean state, plankton dynamics, fish energetics and prey/predator relationships. This proposal requests funding for the final fully-funded year of SEA, a period of reduced field work but accelerated data analysis and application of results to management models. These activities must be completed so the program can close-out with nominal funding in FY99.

INTRODUCTION

The SEA program (320) was designed in 1993 and funded in April 1994, as a five-year, multi-project investigation of factors influencing the production of pink salmon and herring in Prince William Sound, Alaska. The herring and salmon literature suggested at the time that most of the mortality occurs in the earliest life stages of these species, the larval and juvenile forms. During this time, both species are resident in the region, are sustained primarily by energy arising from plankton populations, and are believed to undergo high rates of loss associated primarily with predation and starvation. SEA argued that any understanding of the dynamics of recovery for these important commercial and ecological components of the Prince William Sound ecosystem must account for the combined affects of oil-induced change and limits placed on production by oceanographic and other variability in the marine environment. In the absence of substantial knowledge about how historical trends in pink salmon and herring production reflect environmental limitation, SEA developed a multi-year program of study to define the process of loss in juvenile populations of pink salmon and herring. The intent of the research is to provide information about these processes so that the Alaska Department of Fish and Game might better enhance, manage or otherwise restore pink salmon and herring production in the region.

The life histories of pink salmon and herring exhibit similarities and differences. Both species spawn demersal eggs in intertidal or coastal freshwater systems. Pink salmon are fall spawners and females deposit about 1,500 eggs each in the gravels of hundreds of short streams and small rivers that enter the periphery of Prince William Sound. A substantial percentage of females also deposit eggs in the intertidal reaches of these streams and rivers. Depending on water temperature, the large, yolky eggs incubate for a few weeks after which the larval salmon or alevins hatch and move deeper into the sediments of the natal areas. Both eggs and alevins are vulnerable in the fall when coastal storms generate sufficient rainfall to cause creek bed scouring, resulting in losses of embryos and larvae by washout. Surviving alevins encounter cooling water temperatures as the season progresses from fall into winter. Depending on winter temperatures, fluctuations in stream flow may cause dewatering, reduced oxygen and possibly freezing conditions with attendant mortalities to alevin populations. By late winter, the energy reserves of the non-feeding larvae are nearly exhausted. In March, a metamorphosis to the juvenile body form is completed for some and the annual fry out-migration into near-shore waters begins. Fry emergence into Prince William Sound generally occurs from late March through early June. Juveniles leave their natal habitats at approximately 30 mm in length and weighing 0.3 g.

Young pink salmon quickly adopt a pelagic feeding strategy, ingesting small, medium and large-sized copepods and other crustaceans as they school in shallow edge-zone nursery areas. Growth is influenced strongly by water temperature and modified by food availability, so rates of growth accelerate as the Sound experiences seasonal warming. During this life stage, fry are vulnerable to bird, fish and marine mammal predation. Later in the summer, at lengths between 50 and 70 mm, survivors begin migrating away from edge zone habitats into deeper passages. Pink salmon are bound by a strict two-year life history, so juveniles have little latitude to vary from their programmed migration to shelf and open ocean feeding grounds. By mid-July and early August, a time when adults from the previous brood year are returning to spawn, the juveniles begin leaving the region. Most have departed Prince William Sound by late September. SEA hypothesizes that the number of surviving juveniles leaving the region in late summer and early fall will be highly predictive of the following year's adult return.

In contrast, Pacific herring are spring spawners, depositing large clusters of small demersal eggs on intertidal and shallow subtidal vegetation in April. Each female is capable of spawning between 15,000 and 30,000 eggs, some of which immediately become food for birds, fish and local mammals. Egg masses are also vulnerable to late season freezing and erosion from the [illegible] by intense storm activity. In some cases, unusually heavy spawning can produce thick layers of eggs causing oxygen transport problems for some embryos. The historical data from Prince William Sound suggest that most herring spawning is restricted to a few locations in the region, although our preliminary observations indicate lesser spawning over a much broader area.

In the seasonally warming edge-zone environment, tiny (6–10 mm), weakly swimming yoke-sac larvae begin emerging from egg masses in early to mid-May. This timing generally corresponds to a transitioning from strong coastal downwelling to stabilization or weak coastal upwelling in the northern Gulf of Alaska and may be an adaption to minimize the chance of washout from the region. As the larvae disperse from the natal habitats they immediately become vulnerable to a host of small, planktonic carnivores. Survivors have only a few days to adopt active feeding after yoke-sac absorption or they will starve. Egg mortality and losses of larvae to predation, starvation and washout from the region probably account for 95-99 percent of the "mortality" of a year-class.

Survivors of this "critical period" metamorphose to the juvenile form 60–90 days later and begin appearing in schools in shallow near-shore habitats. At present, it is not clear whether most of these juveniles re-invade the shallows following a deep-water drift or are remnants of populations that remain in the shallow water environments after hatching. These small fish (30–60 mm in length) continue to be food for other fish, birds and marine mammals.

Unlike pink salmon, surviving juvenile herring remain in Prince William Sound until they mature at age 2 or 3. This strategy requires survival during at least two winter periods of food deprivation and cold temperatures. Rather than putting energy into size (like pink salmon), herring commit to energy storage, presumably a strategy to address predictably varying seasonal forage resources. The degree to which the juveniles are prepared to successfully bridge the winter season probably reflects local growth conditions experienced during the previous summer and fall. Fall measurements of the whole-body energy content for juveniles in Prince William Sound demonstrate clear differences in pre-winter condition within schools and between years and locations. Based on these observations and laboratory studies, SEA investigators believe that winter starvation represents a significant survival risk for juveniles. Post-winter energy levels demonstrate significant draw-down on reserves. As an additional problem, it is possible that a delayed plankton bloom in the spring (observed in the SEA data) may extend the period of elevated risk for winter survivors whose weakened condition make them increasingly vulnerable to predation just prior to the production of seasonal food. Much of the present work focuses on defining factors of loss during the "winter season". Once the surviving juveniles mature, they enter a multi-year class spawning population and may contribute to production for 10–12 years.

These differences in life history between pink salmon and herring have dictated very different approaches to understanding variability in losses to juvenile populations. Studies of salmon mortality have focused primarily on the April–July period of juvenile residence, with predation hypothesized as the major factor of loss. Correspondence between the timing of the salmon fry out-migration and the peak of a consistent early season zooplankton bloom points toward food and predation sheltering as an evolutionary adaptation. Subsequent studies have demonstrated that springtime macrozooplankton does serve as a food source for many species that also prey on juvenile pink salmon like juvenile and adult walleye pollock, adult herring, juvenile Pacific cod, and tom cod. Evidence is building that levels of zooplankton can modulate a kind of prey switching that impacts losses in juvenile pink salmon populations each year. Unusually high macrozooplankton stocks in April and May can apparently shelter small fish from larger fish by providing an energetically more attractive forage base for the larger predators. Conversely, weak macrozooplankton stocks can leave the juveniles more vulnerable to predation. This general picture is complicated by interannual differences in springtime water temperatures and the composition and abundance of predator stocks. Plankton populations and water temperatures are tied to the oceanography of the region and vary from year to year in response to Gulf of Alaska–scale meteorological events driven by global weather. Local zooplankton production, seeding from the adjacent shelf, and flushing from the Sound all play roles in regulating planktonic forage stocks for consumers each year. Understanding the relative importance of these interacting factors under a variety of different conditions remains the principal focus of SEA juvenile pink salmon studies.

Because they represent a major forage resource for many consumers in Prince William Sound, juvenile herring populations are also impacted heavily by predators. However, if these losses are generally consistent from year to year, other factors could be responsible for regulating the overall recruitment of juveniles to the adult population. Overwintering mortalities driven by oceanographic conditions affecting food and growth during the summer, and winter temperatures may be significant in some years. Also, the degree to which massive larval populations are either retained or washed from the system each spring could set levels of recruitment independent of predation and starvation. It seems likely that these factors, individually or acting in concert, establish recruitment levels.

As the SEA program enters its last fully funded year, sufficient information is on hand to begin a serious exploration and testing of the ideas that originally led to the creation of the study. The validation of all models is expected to be completed by late FY97 or early FY98, so these products can be used to develop survival scenarios under a variety of "experimental conditions" (including historical weather patterns) in attempts to recreate the trends observed in time-series of herring and salmon production before and after the spill. To do this, most investigators will emphasize data analysis, interpretation, and application to the modelling (testing or validation) as the principal tasks in FY98.

Since the present SEA herring program began its efforts in FY95 but did not become fully functional until FY96, it is likely that some of the herring work (including aspects of the management models) will have to be pursued under a new program beginning in FY99. That eventuality is being examined under a set of plans that may include a future merger of SEA herring studies with APEX. Also, the management model products being developed for ADF&G (pink salmon and herring) will need to be initialized each year for numbers of juvenile pink salmon and herring and their predators (large pelagic gaddids, herring, and others) as well as tuned to seasonally changing oceanography. This will have to be accomplished through a nominal monitoring program, also under development for support beginning in FY99. To assist with the application of results, SEA established a formal liaison with the regional office of ADF&G (Dr. James Brady) in September 1996 to stimulate interchange between the research, modelling and potential management applications of the 5-year program and the management of these species. This relationship is expected to define the interface between the long-term monitoring program and the management, enhancement, and restoration applications of the SEA models to pink salmon and herring in Prince William Sound.

NEED FOR THE PROJECT

A. Statement of the Problem

Injured and non-recovering pink salmon and herring populations in 1993 suggested that something other than oil might be constraining the recovery. SEA proposed that some aspect of ocean climate, perhaps temperature and/or food for juveniles might be responsible, or that an oil induced shift or other change in the composition of large fish predators was cause for prolonged reduced production. These conditions can only be examined comprehensively within the framework of a multi-disciplinary program designed specifically to define the processes of loss to juvenile pink salmon and herring populations in relation to bottom–up (oceanographic) and top–down (predation) control each year.

Even though pink salmon is now listed as a recovering species, that process is not yet complete. Pacific herring continues to be listed as non-recovering, but signs of growing stock size warranted a harvest in the spring of 1997. These signs point to the eventual overall recovery of both species, although the process is likely to be slow. Only the bald eagle has been declared fully recovered by the EVOS Trustee Council, eight years after the spill.

B. Rationale/Link to Restoration

The SEA approach to pink salmon and herring restoration is to formulate a series of interacting numerical models designed to simulate the dynamic processes influencing the survival of juvenile pink salmon and herring rearing in Prince William Sound each year. Because pink salmon and herring populations are managed for a commercial fishery, there is a proactive means for manipulating stock size each year in response to levels of production and the commercial and substance needs of the region. SEA models will ultimately assist the managers of these important fisheries to understand how environmental factors affect production from year to year and on decadal-level time scales. Because they encompass both food-web dynamics and atmospherically forced ocean physics, these simulations will also allow retrospective analyses of past stock performance, now-casting (current status of juveniles in the system), and improved forecasting. By more fully understanding the factors that regulate juvenile herring and pink salmon survival, appropriate levels of harvest can be applied to allow stock response in the face of ever changing natural conditions. In its maturation process, the work initiated by SEA in 1994 will transition from research (the development of management tools), to monitoring (the operation of management tools), and finally to general restoration (the application of management tools) to assist the recovery and improve the long term health of pink salmon and herring populations in Prince William Sound.

C. Location

The SEA program is being conducted in Prince William Sound and adjacent shelf and ocean waters.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Program 320 grew out of active regional community involvement which continues to the present time. Part of the study originates from the Prince William Sound Science Center, Cordova, Alaska and requires local services in that community. Prince William Sound vessels have been routinely charted for much of the SEA research. Each year SEA provides the citizens of the region with an update of research findings and current and planned studies. During the first two years of the program, SEA circulated a newsletter of accomplishments. Commercial fishermen in the region also learn about SEA results through a lecture series sponsored by the Prince William Sound Science Center. In FY97, SEA expanded the herring work to include incorporation of traditional ecological knowledge for this species (97320-T supplement).

PROJECT DESIGN

A. Objectives

1. Develop an ecosystem-level understanding of factors and mechanisms constraining the production of pink salmon and herring in Prince William Sound.

2. Use this information to create a series of numerical tools and a nominal monitoring program to assist with increasingly informed management, enhancement, and restoration of pink salmon and herring resources.

3. Establish a comprehensive database of SEA results for management and continuing scientific needs in the region.

B. Methods

Field and modelling activities in SEA have been designed to address a series of hypotheses about ecosystem function believed to be controlling the production of pink salmon and herring populations in Prince William Sound:

a. *The survival of juvenile pink salmon and herring is determined primarily by losses to bird, fish and marine mammal predators.*

b. *Predation losses are modified by the numbers and kinds of predators, and by the numbers, kinds and distributions of alternative prey for these predators. Macrozooplankton serves as alternative prey during some years and seasons.*

c. *Zooplankton stocks are established by local reproduction in relation to the timing and magnitude of the annual phytoplankton production and modified by currents that both flush and seed the region from adjacent shelf and oceanic populations.*

d. *Herring recruitment dynamics are driven primarily by larval retention, losses to predation, and winter survivals.*

e. *Larval herring retention is established each year in response to late spring flushing rates and transport relationships between near-shore natal areas and offshore currents.*

f. *Herring losses to predators and overwintering survivals are determined primarily by the size and somatic energy content of juveniles set by growth conditions each spring, summer and fall.*

g. *Pink salmon recruitment dynamics are driven primarily by the numbers of surviving juveniles leaving the sound each summer.*

SEA is a fully integrated, interdisciplinary, multi-component study. Methods used by each of the projects were described previously in the SEA95 DPD and other submissions on file with the EVOS Trustee Council, Alaska Department of Fish and Game, and NOAA as the result of previous proposals. Each SEA component project is required to submit an individual DPD to its appropriate sponsor for contracting purposes. These documents contain refinements to methods previously described (above).

In FY96, SEA organized internally to create a closer coupling between field and modelling studies in response to reviewer comments and an increasing need for internal focus. The new structure identifies three groups whose primary tasks are to create, through collaborations, the major SEA management numerical simulations (Appendix II). These groups are now working effectively alone, but will soon begin working together as the separate modelling efforts merge to address the ecosystem-level questions being pursued by SEA.

The **Ocean State and Plankton Dynamics workgroup** has responsibility for creating the simulations that model physical and lower trophic-level responses, both to flow fields (vertical and horizontal) and to physically constrained (light and mixing) local primary productivity. The SEA ocean state model has been tuned for seasonal wind and tidal forcing (manuscripts submitted), and the final refinement will involve the incorporation of freshwater input, a significant forcing factor in coastal Alaska. The present 1-dimensional plankton model is scheduled to be integrated with the 3-dimensional ocean state simulation to provide time/space plankton fields (phyto and zoo) as input to both the herring and pink salmon recruitment models. Investigators working on these products include Drs. Vince Patrick, Chris Mooers, and Jai Wang (320-J SEA modelling), Dr. Shari Vaughan (320-M Physical Oceanography/Optical Plankton Counting), Dr. David Eslinger (320-R Biophysical Modelling), Dr. Peter McRoy (320-G Phytoplankton) and Dr. Ted Cooney (320-H Zooplankton). Additional input comes from Dr. Tom Kline (320-I Isotopes) and Dr. Gary Thomas (320-N Acoustics). This subgroup will be responsible for the formal testing of hypotheses relating early spring zooplankton population levels to seeding and flushing rates, and local production—the original "lake/river" conjecture.

The **Pink Salmon Recruitment Dynamics subgroup** focuses field and modelling studies on processes of loss affecting the survival of juveniles during their short stay in Prince William Sound. Contributing investigators include Drs. Vince Patrick and Doran Mason (320-J Modelling), Dr. Shari Vaughan (320-M Physical Oceanography), Dr. Ted Cooney (320-G Zooplankton), Dr. Tom Kline (320-I Isotopes), Dr. Gary Thomas (320-N Acoustics) and Mark Willette (320-E Predation). Emphasis in this group is on understanding and simulating mechanisms that promote coupling or decoupling of salmon fry and their predators. This subgroup and its numerical products establish the framework for formal tests of SEA's original "prey switching" hypothesis. A fully functional pink salmon recruitment model is expected to provide managers of this valuable resource with new information about annual juvenile survivals and forecasted levels of returns one year in advance of the fishery.

The **Pacific Herring Recruitment Dynamics subgroup** formed to coordinate field and modelling activities that will eventually provide formal tests of the larval retention hypothesis and the juvenile overwintering hypothesis—factors critical to the process of adult recruitment and production in Prince William Sound. Studies include investigating modelled larval drift, and measured juvenile summer growth and energy storage, overwintering bioenergetics, starvation, and predation. Investigators leading this effort include Drs. Brenda Norcross and Kevin Stokesbury (320-T Herring Habitats), Drs. Vince Patrick and Doran Mason (320-J Modelling), Dr. A. J. Paul (320-U Energetics), Dr. Tom Kline (320-I Isotopes), Dr. Shari Vaughan (320-M Physical Oceanography) and Dr. Gary Thomas (320-N Acoustics). A fully functional herring model will track and predict levels of juvenile recruitment to adult populations as a function of both bottom–up and top–down influences.

The numerical products arising from the activities of these three groups will be linked (as needed) to provide estimates of pink salmon and herring recruitment strength to fishable stocks, to evaluate fluctuations in stock production caused by interannual and decadal-scale fluctuations in ocean climate, and to explore opportunities for investigating the effects of different management strategies on modelled populations. These kinds of numerical tools are not routinely available to managers of fisheries anywhere. Their use is expected to substantially improve the information available to the stewards of pink salmon and herring resources in Prince William Sound.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Program 98320 is one of three ecosystem approaches sponsored by the EVOS Trustee Council in Prince William Sound. The integrated SEA study is administered by two agencies - ADF&G for projects housed at the University of Alaska Fairbanks and within ADF&G, and NOAA for projects conducted from the Prince William Sound Science Center, Cordova, Alaska.

SCHEDULE

A. Measurable project tasks for FY 98 (October 1, 1997 – September 30, 1998)

October 1 - December 31:	• Analyze data collected from the FY97 field season Continue herring field studies Apply results to model formulation and hypothesis testing
January 15-24:	Attend the Annual Restoration Workshop
February 1 - April 10:	Prepare the FY99 DPD and FY97 Annual Report
April 15:	Submit the FY99 DPD and FY97 Annual Report
April 15 - September 30:	Collaborative research, model formulation, hypothesis testing.

B. Project Milestones and Endpoints

1. Complete the validation of coupled ocean state and plankton dynamics models.

2. Complete the final validation of the coupled juvenile pink salmon survival model.

3. Test a preliminary model of juvenile herring overwintering survivals with linkages to summer growth conditions.

4. Simulate losses of larval herring from the region under different conditions of springtime flow fields and temperatures in Prince William Sound.

5. Undertake and complete formal tests of the "lake/river" hypothesis. Describe the most probable causes for fluctuations in local macrozooplankton populations driven by the interacting processes of trophic coupling to phytoplankton and flushing and seeding to and from the adjacent Gulf of Alaska.

6. Undertake and complete formal tests of the "prey switching" hypothesis. Describe the most probable causes for fluctuations in fry survival under different conditions of predator species composition and abundance, alternative prey for predators, and temperature and food modulated growth of juvenile pink salmon.

7. Complete arrangements by which Alaska Department of Fish and Game interacts with the completed SEA management models and database to enhance the management of pink salmon and herring in the region.

8. Design the components of a nominally-funded, long-term, model-based monitoring program for implementation in FY99.

9. Design the components of continuing ecosystem-level herring studies in Prince William Sound with ties to the SEA models for implementation in FY99.

C. Completion Date

Program 320 is scheduled for closure of all field work at the end of FY98. The Trustee Council will provide nominal funding to prepare a final report/synthesis of the 5-year SEA study in FY99. Continuing herring studies and a model-based monitoring study will be proposed as new programs in FY99 under new names or affiliated with other ongoing ecosystem-level studies at that time.

PUBLICATIONS AND REPORTS

SEA will be responsible for submitting a single, integrated FY97 Annual Report and FY99 DPD by April 15, 1998. In addition, SEA investigators will all be actively publishing the results of research completed during FY97 and extending into FY98. These single-authored and collaborative manuscripts are expected to be used, in part, to assist with the preparation of a final SEA synthesis in FY99. The overall synthesis will include research completed in FY98, and draw upon all results since the program was established in 1994. The synthesis will focus on the resolution of hypotheses driving the SEA program since 1994.

PROFESSIONAL CONFERENCES

SEA will participate in the EVOS annual public workshop and program review in January 1998. Most principal investigators and many staff will also present invited and contributed papers to national and international science conferences such as those sponsored by the American Association for the Advancement of Science, the American Fisheries Society, the Society of Limnology and Oceanography, and the American Geophysical Union.

NORMAL AGENCY MANAGEMENT

Ecosystem-level studies of pink salmon and herring pursued in Prince William Sound, Alaska, are investigations of phenomena not normally conducted by the Alaska Department of Fish and Game or NOAA in this region.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

SEA program efforts are coordinated by a Lead Scientist (Ted Cooney) with assistance from an executive committee composed of David Eslinger, Vince Patrick, and Mark Willette. Each of the SEA modelling subgroups is chaired by a principal investigator with responsibility for coordination and integration within and between subgroups. SEA interacts with other EVOS-sponsored studies through collaborative research and analysis of data arranged primarily at the investigator level.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

The work proposed by SEA for FY98 represents a continuing shift in emphasis away from field collections to analyses and the application of results to hypothesis resolution and model formulation and application. These activities are consistent with plans signaled to the EVOS Trustee Council in FY95 in alignment with projected levels of funding and a closure data for SEA at the end of FY98. The only change to that agreement has been the willingness of the Council to fund a nominal synthesis effort for SEA in FY99 as a formal close-out task.

PROPOSED PRINCIPAL INVESTIGATOR

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Fairbanks, AK 99775-7220
Phone: 907-474-7407
Fax: 907-472-7204
E-mail: cooney@murre.ims.alaska.edu

PRINCIPAL INVESTIGATOR

Robert (Ted) Cooney serves as the Lead Scientist for SEA. Dr. Cooney has extensive experience with zooplankton in the Gulf of Alaska and Prince William Sound. His studies began in 1976 in response to questions from the local aquaculture corporation about the carrying capacity of the region to support enhanced populations of pink and other salmon species. He initiated a program of Cooperative Fisheries and Oceanographic Studies (CFOS) prior to the *Exxon Valdez* oil spill that yielded important information to initiate SEA studies of juvenile pink salmon survival. Dr. Cooney is professor of Marine Science at the University of Alaska Fairbanks, and an affiliated scientist with the Prince William Sound Science Center, Cordova.

OTHER KEY PERSONNEL

The interdisciplinary aspects of the FY98 SEA program are led by the following principal investigators:

Mark Willette – Alaska Department of Fish and Game, Cordova.
Peter McRoy – Institute of Marine Science, University of Alaska Fairbanks
Ted Cooney – Institute of Marine Science, University of Alaska Fairbanks
Brenda Norcross – Institute of Marine Science, University of Alaska Fairbanks
David Eslinger – Institute of Marine Science, University of Alaska Fairbanks
A. J. Paul – Institute of Marine Science, University of Alaska Fairbanks, Seward
Vince Patrick – Prince William Sound Science Center, Cordova
Gary Thomas – Prince William Sound Science Center, Cordova
Thomas Kline – Prince William Sound Science Center, Cordova
Shari Vaughan – Prince William Sound Science Center, Cordova

These investigators are assisted by staff personnel and students in Fairbanks, Cordova, and Seward, and at several institutions outside Alaska.

APPENDIX I.

Sound Ecosystem Assessment (SEA): Individual Project Budgets

A. Individual project budgets being submitted under the NOAA Broad Agency Announcement

Prince William Sound Science Center

98320-I	Stable Isotopes
98320-J	Information Systems and Model Development
98320-M	Physical Oceanography
98320-N	Nekton and Plankton Acoustics

B. Individual project budgets being submitted to Alaska Department of Fish and Game

Alaska Department of Fish and Game

98320-E	Salmon Predation

University of Alaska Fairbanks

98320-G	Phytoplankton and Nutrients
98320-H	The role of Zooplankton
98320-R	Trophodynamic Modelling and Remote Sensing
98320-T	Juvenile Herring Growth and Habitats
98320-T	Supplement – Herring Traditional Ecological Knowledge
98320-U	Somatic Energetics
98320-Z	SEA Synthesis and Integration

APPENDIX I–A

Individual project budgets being submitted under the NOAA BAA

98320-I

Stable Isotopes

Prince William Sound Science Center

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$123.8						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$123.8		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$8.7						
Project Total	$0.0	$132.5		$0.0				
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This Budget includes two major components:
FY 1998 "Remaining": $53.1K -project cost plus $3.7K GA = $56.8K
FY 1999 "Closeout": $70.7K -project cost plus $ 4.9K GA = $75.6K

Total: $132.4K

1998

Prepared: Prepared: 4/15/97
14Ap 97/wh

Project Number: 98320-I
Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the PWS Ecosystem Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$74.2	$91.1						
Travel	$10.4	$7.8						
Contractual	$11.0	$2.8						
Commodities	$2.1	$1.5						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$97.7	$103.2	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect	$19.5	$20.6						
Project Total	$117.2	$123.8						
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget is for NOAA CY98: February 1, 1998 – January 31, 1999.

Due to close out the deliverable final report on this project will not be completed until approx. September 30, 1999.

The close-out of this project will extend beyond a 12 mo. contract year.

FY 98

Project Number: 98320-I
Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the Prince William Sound Ecosystem Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
T. Kline	Principal Investigator		7.6	7.6		57.8
J. Williams	Fish Biologist		7.6	4.4		33.3
	Subtotal		15.2	12.0	0.0	
					Personnel Total	$91.1

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Cordova - Anchorage EVOS annual meeting	200	2	10	141	1.8
Cordova - Fairbanks SEA Workshop	400	3	15	141	3.3
Car rental			15	50	0.7
Cordova - San Diego Ocean Sciences Meeting	800	1	7	122	1.7
Car Rental			5	50	0.3
				Travel Total	$7.8

FY 98

Project Number: 98320-I
Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the Prince William Sound Ecosystem Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

Contractual Costs:	Proposed
Description	FY 1998
Photocopying	0.2
Shipping	0.3
Posters for annual workshops 4 @ $200	0.8
Communications	0.3
Page charges 3 @ $400	1.2
Approx titles of Pubs; (see DPD for more details):	
Spatial patterns of Gulf of AK carbon in PWS pelagic food webs determined by 13C/12C. - Trans. Amer. Fish. Soc	
'Fall isotopic and somatic energy signatures of young of the year Pacific herring at two sites in PWS - Can. J. Fish. Aquat. Sci.	
Trophic relations and carbon sources of the pelagic community of PWS/natural stable isotope - Can. J. Fish. Aquat. Sci.	
Evidence for the flow of zooplankton into PWS from the northern GOA - for Limol. Oceanogr.	
Contractual Total	$2.8

Commodities Costs:	Proposed
Description	FY 1998
Office and computer supplies	0.7
Dye Sub materials 2 @ $300 each	0.6
Miscellaneous	0.2
Commodities Total	$1.5

FY 98

Project Number: 98320-I
Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the Prince William Sound Ecosystem Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

February 1, 1998 - January 31, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

FY 98	Project Number: 98320-I Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the Prince William Sound Ecosystem Using Natural Stable Isotope Tracers Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

98320-J

Information Systems and Modelling

Prince William Sound Science Center

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$439.3						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$439.3		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$30.8						
Project Total	$0.0	$470.1		$0.0				
Full-time Equivalents (FTE)		1.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This Budget includes two major components:
FY 1998 "Remaining": $203.8K -project cost plus $14.3K GA = $218.1K
FY 1999 "Closeout": $235.5K -project cost plus $16.5K GA = $252.0K

Total: $470.1

1998

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: Prepared: 4/15/97
14Ap 97/wh

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$205.4	$142.6						
Travel	$25.5	$21.5						
Contractual	$204.6	$188.0						
Commodities	$5.3	$5.5						
Equipment	$2.0	$8.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$442.8	$366.1	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect	$88.6	$73.2						
Project Total	$531.4	$439.3						
Full-time Equivalents (FTE)		1.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget is for NOAA CY98: February 1, 1998 – January 31, 1999.
Due to close out the deliverable final report on this project will not be completed until approx. September 30, 1999.
The close-out of this project will extend beyond a 12 mo. contract year.

FY 98

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
V. Patrick	Principal Investigator	[redacted]	2.4	7.8		18.7
J. Allen	Tech. Project Manager/Data Manager		4.0	5.4		21.6
S. Bodnar	Systems Specialist		4.0	5.5		22.0
D. Mason	Fish Ecologist					
R. Nochetto	Numerical Analyst					
V. Patrick 99 Close-out	Principal Investigator		4.0	8.2		32.8
J. Allen	Tech. Project Manager/Data Manager		4.0	5.7		22.8
S. Bodnar	Systems Specialist		2.4	5.7		13.7
D. Mason	Fish Ecologist		1.0	4.9		4.9
R. Nochetto	Numerical Analyst		0.8	7.6		6.1
	Subtotal		22.6	50.8	0.0	
					Personnel Total	$142.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
CDV-FBKS (data management)	456	1	2	140	0.7
CDV-Baltimore ((UMD) fish model collaboration)	1100	1			1.1
CDV-conference (AGU/ASLO)	800	1	4	97	1.2
Baltimore-CDV (database development) (no per diem)	1100	1	10	103	2.1
Car rental			26	30	0.8
CDV-FBKS (final model coordination)	456	1	5	140	1.2
CDV-Baltimore ((UMD) fish model: wrap-up collab.) (no per diem)	1100	1			1.1
Baltimore-CDV (2, database: database wrap-up; EVOS review)	1100	2	30	103	5.3
CDV-Miami ((RSMAS) Circulation model: wrap-up) (no per diem)	1300	1			1.3
CDV-ANC (3 PIs, EVOS January review)	224	3	15	170	3.2
Madison-CDV (2, Fish model: wrap-up; EVOS review)	700	2	20	103	3.5
				Travel Total	$21.5

FY 98

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

Contractual Costs:			Proposed
Description	99 Remain	99Close-out	FY 1998
Telephone, facsimile	3.0	1.5	4.5
Copying	0.8	0.8	1.6
Shipping, mail	1.1	1.6	2.2
Software maintenance, support, licenses: AVS, IDL, AutoPLAN, Publisher, utility items	1.0	6.0	7.0
Computer systems maintenance	10.0	2.9	2.9
Wide & Local Area Networks: telecommunications charges, Internet access, LAD circuits, maintenance		6.4	16.4
Software: database licenses, clients and servers		5.0	5.0
Publication costs: see DPD for titles and journals		1	1.0
Subcontract to Adv. Visualization Lab: database design and development	22.9	26.6	49.5
Subcontract to Rosenstiel School of Marine and Atmospheric Science: ocean circulation model development	61.2	36.7	97.9
		Contractual Total	$188.0

Commodities Costs:			Proposed
Description	99 Remain	99Close-out	FY 1998
Mass storage media (CD-ROMs, tapes)		1.1	1.1
Bond paper	0.2	0.2	0.4
Toner	0.1	0.1	0.2
Sparc printer drum	0.1		0.1
Dye sublimation papers	0.4	0.4	0.8
Dye sublimation transparency media	0.2	0.2	0.4
Dye sublimation ribbon	0.6	0.6	1.2
Media: display, archive, photographic	0.4	0.4	0.8
Cables, connectors		1.0	0.5
		Commodities Total	$5.5

FY 98

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Server: Memory increase	1	0.7	0.7
Close-out	1	4.2	4.2
Data server: Hard drive mass store increase	2	0.8	1.6
Data server: CD-ROM mass store increase	1	2.0	2.0
Model server: Mass store increase			
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$8.5

Existing Equipment Usage: Description	Number of Units	

FY 98

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

98320-M

Physical Oceanography

Prince William Sound Science Center

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$124.3						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$124.3		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$8.7						
Project Total	$0.0	$133.0		$0.0				
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This Budget includes two major components:
FY 1998 "Remaining": $76.5K -project cost plus $5.4K GA = $81.9K
FY 1999 "Closeout": $47.8K -project cost plus $3.3K GA = $51.1K

Total: $133.0K

1998

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: Prepared: 4/15/97
14Ap 97/wh

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$218.9	$88.5						
Travel	$11.1	$4.6						
Contractual	$41.0	$6.8						
Commodities	$7.5	$3.7						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$278.5	$103.6	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect (20%)	$55.7	$20.7						
Project Total	$334.2	$124.3						
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget is for NOAA CY98: February 1, 1998 – January 31, 1999.
Due to close out the deliverable final report on this project will not be completed until approx. September 30, 1999.
This portion of the project will extend beyond the 12 mo. contract year.

Salary figures include a 3% raise.

FY 98

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTE UNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Personnel Costs:						
Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
S. Vaughan	Physical Oceanographer (PI)	[redacted]	4.5	7.0		31.5
K. Osgood	Physical Oceanographer		4.5	4.9		22.1
S. Gay	Physical Oceanographer		4.5	5.2		23.3
L. Tuttle	Biological Oceanographer		2.5	4.7		11.6
	Subtotal		16.0	21.8	0.0	[illegible]
					Personnel Total	$88.5

Travel Costs:					
Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
CDV-MIA, Circulation Modelling w/ RSMAS (1r/t @ $945., no pd)	945	1	0	0	1.0
SEA PI Mtg. - Anchorage - in FY98 (1r/t @$160, 2 days @ $140)	160	1	2	140	0.4
AGU* Ocean Sciences Mtg. - San Diego - Feb. 9-13 (1r/t @ $600, 5 days @ $140)	600	1	5	140	1.3
EVOS Workshop (10th Anniversary) - Anchorage - March 1999 (3 r/t @ $160, 4 days ea. @ $140)	160	3	4	140	1.1
SEA Workshop - Anchorage - March 1999 (after EVOS) (3 for 2 days ea. @ $140)	0	0	6	140	0.8
*AGU - American Geophysical Union					
				Travel Total	$4.6

FY 98

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Contractual Costs:	Proposed
Description	FY 1998
Phone, fax, copying	1.4
Publication Costs (Titles and Journals are listed in the DPD)	1.0
Mail, freight, shipping	1.3
Network Communications	1.5
Slide processing and poster printing	0.6
Computer and Analytical Software Licensing	1.0
Contractual Total	$6.8

Commodities Costs:	Proposed
Description	FY 1998
Office supplies	1.3
Computer supplies	1.5
Film and camera supplies	0.5
Dye-Sub Paper for GIS Printing	0.4
Commodities Total	$3.7

FY 98

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	

FY 98

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

98320-N

Nekton and Plankton Acoustics

Prince William Sound Science Center

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$160.4						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$160.4		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$11.3						
Project Total	$0.0	$171.7		$0.0				
Full-time Equivalents (FTE)		1.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This Budget includes two major components:
FY 1998 "Remaining": $107.9K -project cost plus $7.6K GA = $115.5K
FY 1999 "Closeout": $52.5K -project cost plus $3.7K GA = $56.2K

Total: $171.7K

1998

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: Prepared: 4/15/97
14Ap 97/wh

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$252.0	$120.9						
Travel	$15.0	$6.0						
Contractual	$6.0	$3.4						
Commodities	$11.0	$3.4						
Equipment	$3.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$287.0	$133.7	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect	$58.0	$26.7						
Project Total	$345.0	$160.4						
Full-time Equivalents (FTE)		1.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget is for NOAA CY98: February 1, 1998 – January 31, 1999.
Due to close out the deliverable final report on this project will not be completed until approx. September 30, 1999.
The close-out of this project will extend beyond a 12 mo. contract year.

Salary figures include a 3% raise.

FY 98

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
G. Thomas	Principal Investigator		1.5	13.6		20.4
J. Kirsch	Electrical Engineer		9.0	6.5		58.5
G. Thomas	Principal Investigator (Close Out)		3.0	14.0		42.0
	Subtotal		13.5	34.1	0.0	
					Personnel Total	$120.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
CDV-ANC (GT,JK) EVOS annual mtg.(PD=4r/t x 4/d incl. trvl.)	224	2	8	170	1.8
CDV-San Diego (GT/JK, acoustics paper, Ocean Sciences Conf.)	550	2	10	126	2.4
Car rental			20	31	0.6
1 RT Cdv-Anc 99SEA Mtg.	165	1	5	170	1.0
Car Rental			5	31	0.2
				Travel Total	$6.0

FY 98

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

February 1, 1998 - January 31, 1999

Contractual Costs:	Proposed
Description	FY 1998
Telephone, mail, facsimile	0.7
film processing and slide & poster preparation	0.6
Copying, printing, publication	0.4
Mail, freight, shipping	0.4
Network communications	1.0
Close out phone, fax, copyiing	0.3
Publication costs	
Mail, freight, shipping	
Network communications	
Contractual Total	$3.4

Commodities Costs:	Proposed
Description	FY 1998
analytical, communications and statistical software (Annual IDL, AVS lisc. and maintenance, communication tools)	2.5
office supplies	0.3
video tapes, disks, film	0.3
Close out office & computer supplies	0.3
Commodities Total	$3.4

FY 98

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTI)UNCIL PROJECT BUDGET

February 1, 1998 - January 31, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	

FY 98

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

APPENDIX I–B

Individual projects being submitted to Alaska Department of Fish and Game

98320-E

Salmon Predation

Alaska Department of Fish and Game

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$334.9	$244.1						
Travel	$3.1	$3.1						
Contractual	$142.1	$20.0						
Commodities	$43.0	$14.9						
Equipment	$47.1	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$570.2	$282.1	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
General Administration	$0.0	$38.0						
Project Total	$570.2	$320.1	$58.9					
Full-time Equivalents (FTE)	4.1	4.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget includes $24.6 K in line 100 and $10.0 K in line 300 for logistical support of SEA herring field sampling.

Line 100 'overtime' is actually 'sea duty'. The 'Months Budgeted' does not include 'sea duty'.

<u>Sea Duty</u>

Juv. Herring Sampling $17.2 K

Juv. Salmon Sampling $16.5 K

FY 98

Project Number: 98320-E

Project Title: Salmon Predation

Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prep 4/15/9

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
M. Willette	Fishery Biologist III	18D	7.0	5.9		41.4
M. Clapsadl	Fishery Biologist II	16A	12.0	4.7		56.4
P. Saddler	Fishery Technician III	11C	11.0	3.5		38.5
M. Powell	Fishery Technician III	11B	3.5	3.5	12.1	24.4
S. Karpovich	Fishery Technician II	9A	4.0	3.2	10.7	23.5
A. Dibaccari	Fishery Technician I	9A	4.0	3.2	10.7	23.5
Vacant	Biometrician I	17A	7.0	5.2		36.4
	Subtotal	[redacted]	48.5	29	34	[redacted]
Those costs associated with program management should be indicated by placement of an *.					Personnel Total	$244.1

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
RT Cordova – Anchorage to attend annual EVOS workshop	200	2	10	95	1.4
RT Cordova – Fairbanks: library research	350	2	10	95	1.7
Those costs associated with program management should be indicated by placement of an *.				Travel Total	$3.1

FY 98

Project Number: 98320-E
Project Title: Salmon Predation
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1996
Vessel charter for juvenile salmon sampling (purse seine, $1000 per day x 20 days)	20.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$20.0

Commodities Costs:	Proposed
Description	FY 1996
Office Supplies (copier paper, toner, computer diskettes, etc.)	0.5
Laboratory Supplies (sample bottles, formaldehyde, weighing scales, etc.)	1.0
Charter vessel fuel for juv. salmon sampling (3000 gals diesel fuel @ $1.0 per gal.)	3.0
Charter vessel fuel for juv. herring sampling (10000 gals diesel fuel @ $1.0 per gal.)	10.0
Software (SAS License)	0.4
Commodities Total	$14.9

FY 98

Project Number: 98320-E
Project Title: Salmon Predation
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1996
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
6m aluminum skiff	2	ADFG
8m figerglass boat	1	ADFG
120 x 17 fm anchovy seine	1	ADFG
Continuously recording light meter	1	ADFG

FY 98

Project Number: 98320-E
Project Title: Salmon Predation
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared: 4/15/97

98320-G

Phytoplankton and Nutrients

University of Alaska Fairbanks

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$99.7						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$99.7		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$7.0						
Project Total	$0.0	$106.7		$58.9				
Full-time Equivalents (FTE)		2.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared: 14 Ap 97 wh
Prepared: 4/15/97

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrients
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$80.9	$67.5						
Travel	$6.2	$5.1						
Contractual	$2.7	$0.9						
Commodities	$7.4	$2.1						
Equipment	$0.0	$4.2	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$97.2	$79.8	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect	$24.3	$19.9						
Project Total	$121.5	$99.7	$55.0					
Full-time Equivalents (FTE)	2.8	2.6						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Comments:

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

Tuition costs are included with graduate student salaries.
Simpson is a resident and Ward's tuition is at the non-resident rate.

FY 98

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrients
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:

Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
C. McRoy	Professor – P.I.		1.0	11.6		11.6
J. Cameron	Technician – Sample Analysis		3.0	5.6		16.7
P. Simpson	Graduate Student – Ph.D.		11.0	1.6		17.6
A. Ward	Graduate Student – M.S.		12.0	1.6		18.7
E. Suring	Undergraduate Student Assistant III		4.5	0.6		2.9
	Subtotal		31.5	21.0	0.0	
					Personnel Total	$67.5

Travel Costs:

Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Fairbanks-Anchorage – Attend EVOS meetings	133	3	16	125	2.4
Fairbanks-San Diego – Attend AGU/ASLO meeting present results	1,200	1	7	100	1.9
Fairbanks-Cordova – Attend SEA meeting	375	1	3	125	0.8
				Travel Total	$5.1

FY 98

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrients
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Communications – Fax and phone tolls directly and solely related to this project	0.3
Printing and Duplicating – directly and solely related to this project	0.6
Contractual Total	$0.9

Commodities Costs:	Proposed
Description	FY 1998
Chemicals for sample analysis	2.1
Commodities Total	$2.1

FY 98

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrie...
Name: University of Alaska Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Digital Image Processing Computer to facilitate sample analysis	1	4,200	4.2
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$4.2

Existing Equipment Usage: Description	Number of Units	

FY 98

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrients
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

98320-H

The Role of Zooplankton

University of Alaska Fairbanks

1998 EXXON VALDEZ TRUSTE UNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$99.2						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$99.2		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$6.9						
Project Total	$0.0	$106.1		$53.5				
Full-time Equivalents (FTE)		1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: Prepared: 4/15/97
14Ap 97/wh

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$90.5	$69.6						
Travel	$5.1	$5.4						
Contractual	$5.2	$2.9						
Commodities	$1.2	$1.5						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$102.0	$79.4	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated
Indirect	$25.5	$19.8	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
Project Total	$127.5	$99.2	$50.0					
Full-time Equivalents (FTE)	2.0	1.0						
			Dollar amounts are shown in thousands of dollars.					
Other Funds								

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.
1 Semester Tuition ($1,455) is included with M. Donovan wages.
Personnel costs for the principal investigator and associated personnel reflect the time required to complete the objectives stated in this proposal. This includes minimal sample processing in the laboratory, continuing data analyses, application of the data for model formulation and validation, report preparation and submission, and manuscript submission and revision. Mr. Donovan has been working on the problem of the feeding ecology of squids in the region and expects to graduate during fall semester, 1998. Completion of his program will bring squid results to the SEA data base.
Travel is requested for one national meeting (American Geophysical Union/American Society of Limnology and Oceanography Joint Ocean Sciences Meeting; February, San Diego) at which the principal investigator will present a synthesis paper on the role of zooplankton in the Prince William Sound ecosystem. As part of his accelerating data application and synthesis duties, the principal investigator expects to collaborate with colleagues at the Prince William Sound Science Center and Alaska Department of Fish and Game, Cordova on at least three occasions. In addition, at least one workshop of the entire program will be called in Anchorage to assist with developing synthesis work. Travel is requested for the annual EVOS workshop as directed in the call for proposals.
A small supply of sample bottles and preservative (formalin) will be required to support the continuing calibration and surveying of zooplankton populations by optical plankton and acoustic techniques. A statistical program being used for data analysis will be upgraded.
No equipment is requested in this proposal.

FY 98

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:

Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
R. Cooney	Professor – P.I.		3.5	11.1		38.7
K. Coyle	Research Associate		2.0	5.7		11.1
C. Stark	Technician		3.0	4.6		13.9
M. Donovan	Graduate Student		4.0	1.5		5.9
	Subtotal		12.5	22.9	0.0	
					Personnel Total	$69.6

Travel Costs:

Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
EVOS Workshop	300	1	7	100	1.0
National Meeting – AGU/ASLO; San Diego, February	900	1	6	100	1.5
Fairbanks to Cordova	400	3	10	70	1.9
SEA Workshop Anchorage	300	1	7	100	1.0
				Travel Total	$5.4

FY 98

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Communications - conference calls for synthesis purposes and other communications with SEA investigators	1.5
SFOS Academic Services - budget preparation and formatting, graphic preparations, internal UAF review of FY99 H-component close out proposal, submission of electronic forms, 35 hours @ $40/hour	1.4
Contractual Total	$2.9

Commodities Costs:	Proposed
Description	FY 1998
Bottles and preservative	1.0
Software upgrade: Statistix, Analytical Software Inc.	0.5
Commodities Total	$1.5

FY 98

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	

Existing Equipment Usage: Description	Number of Units	

FY 98

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

98320-R

Trophodynamic Modelling and Remote Sensing

University of Alaska Fairbanks

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$150.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$150.0		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$10.5						
Project Total	$0.0	$160.5		$59.3				
Full-time Equivalents (FTE)		2.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared: Prepared: 4/15/97
14Ap 97/wh

Project Number: 98320-R
Project Title: Trophodynamic Modeling and Remote Sensing
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$106.0	$81.5						
Travel	$5.1	$12.2						
Contractual	$22.8	$23.0						
Commodities	$2.3	$3.3						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$136.2	$120.0	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect	$34.0	$30.0						
Project Total	$170.2	$150.0	$55.4					
Full-time Equivalents (FTE)	3.6	2.6						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Comments:

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

Graduate Student salaries include $5544 of tuition each.

FY 98

Project Number: 98320-R
Project Title: Trophodynamic Modeling and Remote Sensing
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:

Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
D. Eslinger	Assistant Professor – PI		4.5	7.0		31.4
C. Chu	Programmer Analyst – System Admin		0.8	5.4		4.0
D. Allen	Technician – Buoy/Instrumentation		2.0	4.2		8.5
S. Thornton	Graduate Student		12.0	1.6		19.4
N. Pintchouk	Graduate Student		12.0	1.5		18.2
	Subtotal		31.3	19.7	0.0	
					Personnel Total	$81.5

Travel Costs:

Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Fairbanks-Cordova – Deploy and retrieve buoy	475	2	14	120	2.6
Truck Rental – Equipment movement and sample transport	100		10		1.0
Taxi and Parking Fees					0.1
Fairbanks-Anchorage – SEA synthesis meetings	300	3	15	120	2.7
Car Rental during Meeting	250				0.2
Fairbanks to National Meeting/Present research data before peers	855	3	15	120	4.4
Meeting Registration Fees: San Diego - Ocean Sci.	300	3			0.9
Car Rental during Meeting	300				0.3
				Travel Total	$12.2

FY 98

Project Number: 98320-R
Project Title: Trophodynamic Modeling and Remote Sensing
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Communications – charges for tolls related to SEA 98320-R	1.0
Publishing/Page Charges for 3 papers on project results - Titles and journals are listed in DPD	1.0
Buoy Servicing	1.0
ARGOS Service	3.5
Satellite Charges	3.0
Ship Time Charges	5.0
Terrascan License	4.0
Shipping charges for samples and equipment between Fairbanks and Cordova	3.5
Manuscript Preparation Services	1.0
Contractual Total	$23.0

Commodities Costs:	Proposed
Description	FY 1998
Project Supplies – miscellaneous items necessary to the completion of project 98320-R	0.4
Color Printing Supplies	2.0
DAT Tapes for archiving project data	0.9
Commodities Total	$3.3

FY 98

Project Number: 98320-R
Project Title: Trophodynamic Modeling and Remote Sensing
Name: University of Alaska Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	

FY 98	Project Number: 98320-R Project Title: Trophodynamic Modeling and Remote Sensing Name: University of Alaska Fairbanks	FORM 4B Equipment DETAIL

Prepared: 4/15/97

98320-T

Herring Growth and Habitats

University of Alaska Fairbanks

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$523.7						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$523.7		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$23.0						
Project Total	$0.0	$546.7		$369.5				
Full-time Equivalents (FTE)		9.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared:
14Ap 97/Wh
Prepared: 4/15/97

Project Number: 98320-T
Project Title: Juvenile Herring Distribution and Habitats
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$335.4	$354.4						
Travel	$26.4	$19.1						
Contractual	$314.6	Proposed						
Commodities	$15.0	$0.0						
Equipment	$4.5	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$695.9	$373.5	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect	$174.0	$93.4						
Project Total	$869.9	$523.7	$350.0					
Full-time Equivalents (FTE)		9.6						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Comments:

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

Travel - Funds are requested to include the participation of 4 people from Fairbanks to Anchorage for the annual EVOS meeting. Funds are also requested for the attendance of 4 people to attend the annual Herring Review. The number of people needed to participate at these meetings is necessary to allow proper explanation of each individual's part in the Herring Model. Two research cruises are scheduled for this year and funds are requested for 2 people to go on each cruise, leaving from Fairbanks to Cordova. All of these airfare and per diem charges are based on past expenses incurred by this project for the same activities. Additional trips are planned to Cordova from Fairbanks to facilitate in the analysis and coordination of the hydroacoustics and oceanography data. It is planned that Dr. Stokesbury will go to Cordova 3 times to meet with PWSSC personnel to prepare data and analyze the information that has been collected over the past few years. Additional funds are requested to present papers and/or posters at national meetings. These results will be presented at the annual American Fisheries Society meeting, location unknown at this time.
Tuition - Four semesters of tuition are requested. This includes Fall 98, Spring 99 and Summer 99 for R. Foy. One additional semester is requested for F.J. Muter, a doctoral student working under Dr. Norcross for statistical analysis and consultation.

FY 98

Project Number: 98320-T
Project Title: Juvenile Herring Distribution and Habitats
Name: Un rsity of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
B. Norcross	Associate Professor – P. I.		3.0	7.7		23.2
K. Stokesbury	Research Associate – Co-P. I.		10.0	6.0		60.2
E. Brown	Research Associate – Project Leader		10.0	5.2		52.0
M. Frandsen	Technician – Lab Coordinator		12.0	4.1		49.6
M. Vallarino	Technician – Database		4.0	4.8		19.0
C. Stark	Technician – Zoop/Stomach Analysis		4.0	4.6		18.5
M. McEwen	Technician – Field and Lab		12.0	2.9	5.4	40.2
P. Lovely	Technician – Field Work		12.0	2.9		34.8
F. Muter	Graduate Student – Statistical Analysis		6.0	1.6		9.5
R. Foy	Graduate Student – Habitat Analysis		12.0	1.7		20.6
Vacant	Laborer		6.0	2.4		14.2
Vacant	Student Assistant – Office		12.0	0.5		6.3
Vacant	Student Assistant – Laboratory		12.0	0.5		6.3
	Subtotal		115.0	44.9	5.4	
					Personnel Total	$354.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Fairbanks - Anchorage EVOS Meeting	200	4	16	111	2.6
Fairbanks - Anchorage Herring Review	200	4	16	111	2.6
Fairbanks - Cordova Sampling Trips	300	6	36	111	5.8
Fairbanks - Cordova Data Analysis	300	3	18	111	2.9
Fairbanks - AFS Meeting and Registr -Present project data and results	700	4	20	120	5.2
				Travel Total	$19.1

FY 98

Prepared: 4/15/97

Project Number: 98320-T
Project Title: Juvenile Herring Distribution and Habitats
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs: Description	Proposed FY 1998
Communications charges - phone and fax charges related solely to SEA 98320-T	2.5
Copying and duplication charges related solely to SEA 98320-T	1.0
Page charges for publication of research results	1.0
Reprint charges for published results	1.0
Presentation Preparations - slides, overheads, and posters for EVOS/Herring/AFS meetings	1.5
Shipping supplies, gear and samples to and from Fairbanks, Cordova, and Seward	1.2
Vessel Charter - Seine boat 18 days @ $1350/day	24.3
Photo Analysis	1.0
Statistical Software	1.5
Contractual Total	$35.0

Commodities Costs: Description	Proposed FY 1998
Computer Supplies - diskettes, toner cartridges, etc.	1.5
Office Supplies - paper, miscellaneous office supplies as necessary	1.5
Lab Supplies - vials, gloves, preservatives for stomach content samples, etc.	3.5
Field Supplies - bottles, waterproof paper, baggies, etc.	4.0
Commodities Total	$10.5

FY 98

Project Number: 98320-T
Project Title: Juvenile Herring Distribution and Habitats
Name: University of Alaska Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	

FY 98	Project Number: 98320-T Project Title: Juvenile Herring Distribution and Habitats Name: University of Alaska Fairbanks	FORM 4B Equipment DETAIL

98320-T Supplement

Herring Traditional Ecological Knowledge

University of Alaska Fairbanks

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$70.9						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
				Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Subtotal	$0.0	$70.9						
General Administration		$5.0						
Project Total	$0.0	$75.9		$21.4				
Full-time Equivalents (FTE)		1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared: Prepared: 4/15/97
14Ap 97/wh

Project Number: 98320-T Supplement
Project Title: Documenting Herring and Other Forage Fish Natural History through Traditional Ecological Knowledge
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$19.2	$40.8						
Travel	$8.3	$7.3						
Contractual	$5.5	$7.8						
Commodities	$1.6	$0.8						
Equipment	$3.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$37.6	$56.7	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect	$9.4	$14.2						
Project Total	$47.0	$70.9	$20.0					
Full-time Equivalents (FTE)	0.7	1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Indirect Cost Rate: 25% Total Direct Costs as negotiated with the University of Alaska

Project Total: Per EVOS Trustee Council guidelines, the DPD cover page reflects the total Agency cost of this project. These budget figures pertain only to the portion requested by the University of Alaska Fairbanks.

Personnel: Project Leader: Approx. 1 month for report writing/conference attendance; remainder in the field conducting interviews or in the office planning interviews, processing data, getting data into databases. Virtually all field time is community involvement. Technician time for data entry, processing & mapping. Data entry technician; work under project leader entering interview data. Data retrieval technician; work independently in Juneau to retrieve PWS historic data to electronic form. PI time covered under existing EVOS or UAF projects.

Travel: Anchorage trips - 2 are for EVOS related meetings and one is for a scientific conference (project leader only; PIs have separate funds for these meetings in the 98320T budget). The Valdez, Kodiak and Seward trips are for conducting interviews (project leader only). The Fairbanks trip is for meetings with project staff, mapping, data exchanges (project leader travel). The Juneau trips are to train the data acquisition technician in historic data archival (PI travel). Car rental is needed only in Anchorage, Fairbanks, and Juneau.

Commodity charges should be self explanatory. Phone charges to arrange interviews are significant. Mylar and maps are needed. Copying and reproduction charges relate to interview forms, reports, papers, etc. Database and upgraded software is needed for the computer purchased last fiscal year. The publication charge is based on $50 per page for 25 pages plus reprints.

FY 98

Project Number: 98320-T Supplement
Project Title: Documenting Herring and Other Forage Fish Natural History through Traditional Ecological Knowledge
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:

Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
J. Seitz	Project Leader		6.5	3.6		23.2
Vacant	GIS GMT Technician		1.0	3.4		3.4
Vacant	Data Entry Technician		1.0	2.4		2.4
Vacant	Data Retrieval Technician		3.5	3.4		11.8
	Subtotal		12.0	13	0	
					Personnel Total	$40.8

Travel Costs:

Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Cordova-Anchorage - EVOS and Scientific meetings	200	2	7	125	1.3
Cordova-Valdez - Conduct interviews with people in the community	80	1	7	100	0.8
Cordova-Seward - Conduct interviews with people in the community	350	1	8	100	1.1
Cordova-Fairbanks - Meeting with project staff, mapping, data sharing	380	1	5	100	0.9
Fairbanks-Juneau - Training of data retrieval technician/data retrieval	400	2	6	100	1.4
Cordova-Kodiak - Conduct interviews with people in the community	400	1	10	100	1.4
Car Rental in Anchorage, Juneau, and Fairbanks	25	17			0.4
				Travel Total	$7.3

FY 98

Project Number: 98320-T Supplement
Project Title: Documenting Herring and Other Forage Fish Natural History through Traditional Ecological Knowledge
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Participant costs $20/hr X 40 participants, 6 hours each	4.8
Phone, fax	1.2
Printing and copying	0.8
Publication charges (Local knowledge of herring in Prince William Sound. Arctic Journal)	1.0
Contractual Total	$7.8

Commodities Costs:	Proposed
Description	FY 1998
Mylar, maps	0.3
Software	0.5
Commodities Total	$0.8

FY 98

Project Number: 98320-T Supplement
Project Title: Documenting Herring and Other Forage Fish Natural History through Traditional Ecological Knowledge
Name: University of Alaska Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	
Fax/Printer	1	
Copier	1	
Office Furniture	3	
Work Station - University of Alaska	1	
Work Station Software	1	
Computer purchased in FY97 for Cordova	1	

FY 98

Project Number: 98320-T Supplement
Project Title: Documenting Herring and Other Forage Fish Natural History through Traditional Ecological Knowledge
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

98320-U

Somatic Energetics

University of Alaska Fairbanks

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$98.9						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$98.9		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$6.9						
Project Total	$0.0	$105.8		$52.1				
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared:

Prepared: 4/15/97

14Ap 97/wh

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$106.9	$75.0						
Travel	$5.0	$2.1						
Contractual	$1.6	$1.2						
Commodities	$2.0	$0.8						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$115.5	$79.1	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect	$28.8	$19.8						
Project Total	$144.3	$98.9	$48.7					
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Comments:

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

FY 98

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

ared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
A. Paul	Associate Professor – P. I.		3.4	7.8		26.4
J. McDonald	Technician		12.0	4.1		48.6
	Subtotal		15.4	11.9	0.0	
					Personnel Total	$75.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Seward–Anchorage Round Trip – Attend EVOS and Scientific Meetings	87.0	3	10	187	2.1
				Travel Total	$2.1

FY 98

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Communications	0.4
Copying	0.1
Sample Shipments, Cordova–Seward, 10 x $65/shipment	0.7
Contractual Total	$1.2

Commodities Costs:	Proposed
Description	FY 1998
Calorimeter Supplies	0.2
Label Tape and Markers	0.2
Printer Cartridges	0.1
Sample Bags	0.3
Commodities Total	$0.8

FY 98

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

FY 98

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

98320-Z

SEA Synthesis and Integration

University of Alaska Fairbanks

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$59.8						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$59.8		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$4.2						
Project Total	$0.0	$64.0		$53.5				
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998	Project Number: 98320-Z Project Title: Sound Ecosystem Assessment (SEA): Synthesis and Integration Name: University of Alaska Fairbanks Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: Prepared: 4/15/97
14Ap 97/wh

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel	$22.4	$28.7						
Travel	$17.0	$15.0						
Contractual	$5.9	$4.1						
Commodities	$0.5	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$45.8	$47.8	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect	$11.5	$12.0						
Project Total	$57.3	$59.8	$50.0					
Full-time Equivalents (FTE)	2.0	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

The principal investigator requests 2.6 months of time to coordinate, assemble, write, and submit the single, integrated FY99 DPD for SEA close-out, and the single, integrated FY97 Annual Report. This time will also support the planning of synthesis workshops/meetings and processing requests for meeting and conference calls. The lead scientist, working with the SEA executive committee, is responsible for selecting a meeting site and for setting the meeting/workshop agenda.

Travel is requested to allow each SEA principal investigator to participate in one or more synthesis and integration workshops established at the full program, or sub-model group levels. These meetings could be held in Cordova, Anchorage, or Fairbanks depending on the needs of the whole or partial group.

Support is requested for conference calls (usually several hours in length) and Academic Services Support to assist with the formatting, internal review, and submission (hard and electronic copies) of the FY99 SEA close-out DPD, and the single, integrated FY97 Annual Report. These services are not available to IMS faculty outside the Academic Services Recharge Center. No services, supplies, equipment, salaries or goods used by the Center are included in the University of Alaska Fairbanks Indirect Cost Allocation Pool.
No funds are requested for supplies and equipment

FY 98

Project Number: 98320-Z
Project Title: Sound Ecosystem Assessment (SEA): Synthesis and Integration
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:							
	Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
	R. Cooney	Professor – P. I.		2.6	11.1		28.7
		Subtotal		2.6	11.1	0.0	
						Personnel Total	$28.7

Travel Costs:						
	Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
	Travel expenses and per diem for investigators to attend workshop in Anchorage	500	15	75	100	15.0
					Travel Total	$15.0

FY 98

Project Number: 98320-Z
Project Title: Sound Ecosystem Assessment (SEA): Synthesis and Integration
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Communications – Support of conference calls between project leaders and investigators	2.5
Report formatting and copying; Academic Services; 40 hr @ $40/hr	1.6
Contractual Total	$4.1

Commodities Costs:	Proposed
Description	FY 1998
Commodities Total	$0.0

FY 98

Project Number: 98320-Z
Project Title: Sound Ecosystem Assessment (SEA):
Synthesis and Integration
Name: University of Alaska Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

›ared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	

Existing Equipment Usage: Description	Number of Units	

FY 98

Project Number: 98320-Z
Project Title: Sound Ecosystem Assessment (SEA): Synthesis and Integration
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

APPENDIX II.

Workplans for the FY 98 SEA Model Subgroups

A. Ocean State and Plankton Dynamics

B. Pink Salmon Recruitment Dynamics

C. Pacific Herring Recruitment Dynamics

APPENDIX II–A

Ocean State and Plankton Dynamics*

Ocean State and Plankton Dynamics Model

INTRODUCTION

The SEA Ocean State and Plankton Dynamics Modeling (OP group) group was formed to bring together the various SEA components involved in understanding the physical, chemical and lower trophic-level biological processes, and the interactions among those processes that affect pink salmon and Pacific herring dynamics in Prince William Sound (PWS), Alaska. This group functions in a collaborative way to devise, construct, calibrate and validate numerical models of the physical mixing, advection, and diffusion; nutrient dynamics; and phytoplankton and zooplankton growth, reproduction, and losses. The field components of the group will provide the *in situ* observations needed for the accurate estimation of parameters for the models and for the calibration and validation of the models. This group contains members of the other two modeling groups, and has members representing all trophic levels. The members of this modeling group are: David Eslinger, Chair, Ted Cooney, Tom Kline, Peter McRoy, Chris Mooers, Vince Patrick, Gary Thomas, Shari Vaughan, and Jia Wang.

The OP group is primarily examining the SEA Lake/River hypothesis. Of course, none of the SEA hypotheses are independent, and we will also be addressing the Prey Switching and Herring Overwintering hypotheses, although to a lesser extent. The pink salmon and Pacific herring modeling group will be examining those hypotheses, using information we are producing as part of the OP modeling effort.

Tests of the Lake/River notion relative to interannual differences in zooplankton biomass are probably only really testable using a tuned biophysical model. In FY98 and concluding in FY99, questions of retention and circulation will be explored and answered to the degree needed to achieve the prediction objectives of the combined SEA model. An important function of the group is cross-disciplinary collaboration. For example, late stage *Neocalanus* species observed on the R/V *Alpha Helix* cruise in or near the euphotic zone will provide field data to compare against modeled *Neocalanus* distributions.

GOALS

The SEA Ocean State and Plankton Dynamics modeling group seeks to achieve five goals, which can be broadly stated as:

- To create accurate, three-dimensional, time-varying models of the PWS physical and biological (up through plankton) environment;
- To investigate the role of the physical environment in structuring the lower trophic levels; *and*
- To provide physical and lower trophic level data fields to the salmon and herring modeling groups;

- To maintain and fully exploit the multi-source data sets needed to run the SEA models through the use of the SEA database:
- To foster interdisciplinary collaborative research and integration of SEA results through the use of the SEA intranet, a collection of web-based tools for scientific collaboration.

More specifically, the combined physical oceanography program is aimed at describing and understanding the circulation and mass field of PWS, and supporting the needs of the marine ecosystem and fisheries studies for physical information. Similarly, the phytoplankton and zooplankton field groups and the plankton modeling group are aimed at describing temporal and spatial changes in biomass and species composition and in understanding the physical, chemical and biological mechanisms which produce these changes. We expect to investigate and understand these processes at the spatial and temporal resolution sufficient for understanding pink salmon and Pacific herring dynamics. This will require the creation of models capable of simulating events on diurnal, seasonal, annual, and possibly interannual time scales and over spatial scales from the basin-wide mesoscale down to the near-shore meter or 10 meter scale.

We expect that these models will be developed and implemented separately, but with a large degree of coordination and interaction. Initially, there will be two different three-dimensional models, one of the physical dynamics and one for the plankton dynamics. This is a necessary consequence of the different dynamics of the biological and physical systems. The processes that are important in resolving the first order physical dynamics occur over different spatial and temporal scales than the processes essential to resolving the first order biological dynamics. For example, one of the main physical features to be simulated is the horizontal advective field, especially the degree to which Gulf of Alaska (GOA) waters extend into PWS. Simulation of this feature will require knowledge of the Alaska Coastal Current system, the GOA seasonal circulation patterns, tidal cycles, freshwater inflow, etc. These processes are variable over fairly large horizontal distances, roughly 50 km, and over time scales approximating two weeks. In contrast, one of the major biological events to be simulated is the phytoplankton spring bloom. The occurrence of the bloom is generally dependent on local winds, light, and nutrient conditions, and it is necessary to know these with a vertical resolution of 1–2 m, and at a time scale of 1–2 hours. The larger scale forcing mechanisms needed for the physical model are definitely important to the biological processes, but the primary phytoplankton dynamics occur at much smaller time and space scales. Therefore, we propose to model the physics with a three-dimensional model that can efficiently simulate the flow fields, and to model the biology with a three-dimensional model that can efficiently simulate the phytoplankton and zooplankton dynamics. The results of the physical model will be used as input into the plankton model, therefore the biological model will include **all** appropriate physics, but can proceed at the higher spatial resolution needed to simulate the biological dynamics.

As these models mature, there will be a gradual blending of processes included in both of them. For instance, some of the zooplankton drift/seeding modeling simulations may be done in the physical model, where advective effects are more efficiently modeled at the expense of reduced biological accuracy. These simulations will involve collaborations drawing on the pooled intellectual resources of the OP group to see that simulations do not violate our basic understanding of how the systems are working.

Running all the SEA models and verifying the results requires access to data from the entire SEA project. For convenience, we have formed two sub-groups under the OP modeling group to facilitate this. The first group, chaired by S. Vaughan and R. T. Cooney, will foster database utilization, oversee quality control, and guide additional developments, if needed, to improve the utility of the database. The second group, overseen by V. Patrick, J. Allen, and D. Eslinger; will encourage full exploitation of the intranet collaborative tools, monitor the use of the tools, and recommend additional enhancements to improve their efficiency.

WORK PLAN

The general strategy for achieving our Goals has been and continues to be:

1) to obtain the physical and biological measurements needed to force and verify the model,
2) to implement the models using forcing functions derived from field data,
3) to evaluate the model results,
4) to reassess/revise processes in the model and what field data are needed, and
5) to repeat this sequence until the model simulates the field data with acceptable accuracy.

We have been carrying out the field measurement strategies by a combination of time series measurements at limited, critical locations, and large-scale sound-wide surveys. The time series observations provide information on the phasing of the dynamics; and the surveys provide information on the spatial variability of the sound and the relative location/extent of the "river" versus the "lake".

Specific tasks to be performed are given below, organized under the SEA sub-project which will be performing and/or responsible for them. This is a somewhat artificial breakdown, because many of these tasks will involve participants from several SEA sub-projects. The designations arrayed below are not in anyway exclusive.

Physical field measurements will be made by the Observational Physical Oceanography sub-project (97320-M), Shari Vaughan, principal investigator. The work to be done in FY98 by the physical oceanography group will include:

- Continue data fusion of large scale oceanographic data into the numerical circulation model;
- Continue data analysis to identify physical "river" and "lake" signals and conditions;
- Design a cost-effective monitoring scheme for oceanographic and meteorological variables for these regions and times;
- Prepare collaborative manuscripts.

The physical model development and implementation will be continued by the Modeling and Information Services (SEA DATA) sub-project (97320-J), Vince Patrick, principal investigator. The work to be done in FY97 and FY98 by the physical modeling group will include:

- Continue model refinement, specifically to include:

- throughflow forcing of PWS circulation,
- wind forcing of PWS circulation,
- tidal forcing of PWS circulation,
- freshwater forcing of PWS circulation,
- seasonal wind and thermohaline forcing of PWS circulation,
- annual cycle simulation of PWS circulation,
- interannual simulation of PWS circulation;

- Perform model validation, especially focused on April–May—specifically to include:
  - time series comparisons,
  - synoptic map comparisons,
  - vertical profile comparisons,
  - vertical transect comparisons,
- Provide validated April–May circulation fields for input to ecosystem and fisheries models.

Phytoplankton and nutrient field observations will be made by the Phytoplankton and Nutrient sub-project (97320-G), Peter McRoy, principal investigator. The work to be done in FY98 will include:

- Continue time series measurements at AFK Hatchery of nutrients, phytoplankton species composition and chlorophyll concentration, and dissolved oxygen;

Zooplankton field data and analyzed results needed for the modeling effort will be provided by the Zooplankton sub-project (97320-H), Ted Cooney, principal investigator. The work to be done in FY98 will include:

- Analysis of samples collected by OPC/acoustic projects to provide calibration data from the OPC and high-frequency acoustic surveys;
- Analysis and interpretation of all time-series collections;
- Complete and publish studies of the relationships between physical structure, phytoplankton biomass and macrozooplankton biomass/species composition utilizing the OPC and high-frequency acoustics database from the R/V *Alpha Helix* cruise (in cooperation with SEA-Acoustics/SEA-Physical).

Zooplankton isotopic field data will be continued by the "Confirming Food Web Dependencies with Stable Isotope Tracers" (SEA-FOOD) sub-project (97320-I), Tom Kline, principal investigator. The work to be done in FY98 will include:

- Sampling of terminal feeding stage *Neocalanus* in the GOA and PWS to:
  - confirm the existence of the isotopic gradient each year,
  - compare isotopic signatures with nutrient field data,
  - assess the role of nutrient depletion to isotopic field,
  - compare years, *i.e.*, lake/river assessments,
- Determine characteristic isotopic signatures for GOA and PWS each year to:
  - apply the confirmed isotopic signatures in associated pink and herring isotope studies
  - apply the confirmed isotopic signatures for circulation model validation by

  - sampling diapaused copepods in PWS,
  - assessment of source (GOA vs. PWS) in diapausing copepods.
- Compare the prevalence of lake/river copepods to those found in previous years;
- Compare assessment with model forecasts of copepod seeding;

The plankton model development and implementation will be continued by the Trophodynamic Modelling and Remote Sensing sub-project (97320-R), David Eslinger, principal investigator. The work to be done in FY98 by the plankton modeling group will include:

- Implement full three-dimensional plankton model incorporating physical state variabile fields from output of the physical model;
- Collect and analyze satellite imagery of sea surface temperature and ocean color for comparison with the model results;
- Continue model refinement, specifically to:
  - enhance zooplankton vertical movement dynamics,
  - add herring ichthyoplankton component to examine match/mismatch of herring larval time of first feeding with timing of phytoplankton bloom;
- Design and implement a demonstration nowcast system;
- Perform model validations, specifically to include:
  - time series comparisons at hatchery locations,
  - synoptic spatial comparisons of SST and chlorophyll with satellite data and large-scale survey results,
  - vertical profile comparisons with OPC data,
  - interannual comparisons with phytoplankton and zooplankton time and space data.

MILESTONES

A. Physical Field Program

FY98
- Continue analysis of field data, climatological data sets, seasonal signals and storm data
- Design a cost-effective monitoring scheme for oceanographic and meteorological variables

FY99
- Complete analysis and write final report

B. Physical Modeling Program

FY98
- Iterate with ecosystem and fisheries models focused on April–May
- Continue model validation
- Update annual cycle simulations
- Design future real-time monitoring and nowcast/forecast system
- Participate in "what if?" simulations as part of the SEA synthesis

FY99
- Complete analysis and write final report

C. Phytoplankton Field Program

FY98 • Phytoplankton time series sample analysis and data reduction for model validation
• Test field monitoring program for model input
FY99 • Complete analysis and write final report

D. Zooplankton Analysis and Field Program
FY98 • Zooplankton time series (model validation)
• Zooplankton mapping (OPC/acoustic calibration/validation)
• Test field monitoring program for model input (using OPC/acoustic/nets)
FY99 • Complete analysis and write final report

E. Isotopic Field Program
FY98 • Zooplankton isotopic mapping
• Test field isotopic monitoring program for model input
FY99 • Complete analysis and write final report

F. Plankton Modeling Program
FY98 • Completed phytoplankton/zooplankton/physical model
• Implement nowcast/forecast system
• Integrate plankton model into demonstration model sequence with physical and nekton models
FY99 • Complete analysis and write final report

SUMMARY

Work concluding in FY98 will complete the SEA program as originally described and funded. Nominal funding in FY99 is expected to produce a synthesis describing the influences of bottom-up and top–down forcing on these injured populations. Parts of the completed SEA program are expected to transition forward as new projects. Depending on the continuing modeling needs for management and restoration purposes, a new model-based monitoring program will be proposed for initiation in FY99.

APPENDIX II–B

Pink Salmon Recruitment Dynamics

Pink Salmon Recruitment Model

INTRODUCTION

The pink salmon recruitment model is being developed as a tool to forecast the relative abundance (weak, strong, or average) of wild and enhanced pink salmon, evaluate effects of potential management actions taken to restore pink salmon, and evaluate effects of various enhancement strategies on wild and enhanced salmon production. The pink salmon recruitment model will focus on the early marine period of juvenile salmon from ocean entry to emigration from Prince William Sound (PWS). The model will be composed of three coupled submodels: (1) ocean state model, (2) plankton dynamics model, and (3) nekton model. These models will be developed and coupled during phase II of SEA. The ocean state model will simulate the physical structure and circulation of PWS. The plankton dynamics model will utilize output from the ocean state model to simulate the distribution and abundance of key zooplankton species. The nekton model will utilize output from each of the other submodels to simulate the distribution, feeding, growth, and mortality of several key nekton species that interact with juvenile pink salmon. The nekton model will ultimately estimate losses of wild and enhanced fry along their migratory pathway. Inputs needed to run these models will be obtained from existing agency assessment programs with some directed field measurements. Validation of the submodels will be conducted throughout phase II; however, validation of the entire coupled recruitment model will be initiated in FY99 (phase III). Model estimates of the abundance of wild and enhanced salmon emigrating from PWS will be compared with estimates obtained from a sampling program conducted by ADFG in the southwest passages of the sound.

During phase I, modelling efforts were focused on development of first-order physical and biological models describing predator\prey and energetic processes influencing pink salmon survival. The two components of the SEA nekton (or fish) model have been separately implemented and both have undergone initial simulation and validation studies. In operation, the nekton model describes the simultaneous, instantaneous processes of foraging and dispersion (movement) of interacting fish populations in a format whereby the consequent spatial distribution and overlap of populations can be computed along with the rate of predation of one population upon another. From this, mortality rates and growth rates for each population are computed. The model has two interdependent components. The first is the dispersion model: dispersion depends in part on the rate of foraging, so the foraging model is an essential part of the dispersion model. The second part is the foraging and growth (bioenergetics) component: this second component depends upon the overlap of populations, hence it depends in an essential way upon the dispersion model. The dispersion and the foraging/bioenergetics models have, to date, been implemented using simplifying assumptions regarding the interdependence. For the foraging/bioenergetics model homogeneous spatial distribution is assumed. For the dispersion model gut fullness and satiation are neglected in the foraging model. Of the two components the dispersion model is the more difficult development task because there is significantly more prior work that is applicable for the foraging/bioenergetics model.

Version 4 of the dispersion model was completed and tested during the end of 1995; the dispersion model results presented at the January 1996 EVOS Workshop in Anchorage were the first results from Version 4. (Dispersion model results were also presented at the September 1995 SEA Workshop in Fairbanks, but these were from Version 3) The completion of Version 4 is a major milestone: all of the nekton model development thrusts of 1995 are brought together and are functional in Version 4. These features are :

1. An arbitrary number of interacting fish species can be modelled, with the upper bound dependent solely upon the computational resources available.

2. Version 4 is implemented as a scripting programming language. A scripting language was written whereby the model components can be very rapidly revised and compiled without having to work with the underlying C code. The scripting programming language itself links the C routines from the user scripts. For a wide class of simulations, recompilation is not necessary. A recompilation is required only if the structure of the model is revised; it is not required if only model parameters are changed.

3. Version 4 implements a new algorithm for the solution of the underlying model equations. This new algorithm eliminates numerical constraints that existed in Version 3 regarding how large the directed movement (flight from predators, pursuit of prey, or avoidance of changing physical features) could be relative to randomly directed dispersion (diffusion). The algorithm of Version 4 is near optimal regarding this constraint and the limitations are essentially those of the computing platform.

4. Version 4, like previous versions, is a finite element solution that uses the exponential fitting method. The model therefore has the favorable property of not having overshoots or undershoots extend beyond the containing element. This is not the case with common alternative methods. Consequently, the model does very well with sharp boundaries between populations, even with low resolution grids.

A core set of simulations have been completed using Version 4: pink salmon fry dispersal following net pen releases, pink fry behavior in nearshore areas in response to avoidance of higher velocity currents during flood and ebb tides, and adult pollock movement in response to a combination of fry and macrozooplankton prey.

During the last quarter of 1995 foraging/bioenergetics models were completed and tested for pink salmon fry and adult pollock. Results from simulations with these models coincided well with published experimental data for growth rates and foraging behavior. A key goal for the foraging/bioenergetics model was to provide a realistic link between the widely differing time scales for dispersive behavior and those for somatic growth. The foraging/bioenergetics model connects these two processes by including within the model the intermediate processes of gut filling, evacuation, and foraging and linking these to growth. Moreover, to adequately describe these intermediate processes for the fish species in SEA it was necessary to further develop the foraging/bioenergetics models and include within them the following new features:

1. The ability to simulate night fasting and a short period of very high consumption at dawn that continues until satiation occurs.

2. The simulation of those fish that feed at a low rate to maintain satiation until gut fullness drops below some value or some environmental triggering event occurs.

However, underlying these new features are well known model elements for encounter rate, foraging rates, handling time, and swimming speed.

Field sampling during phase I focused on identification of the principal species preying on pink salmon and the processes affecting rates of predation. Phase I results indicate that predation by pelagic pollock (age 3+) and seabirds may account for only 15–25% of probable losses of juvenile salmon. These results suggest that additional significant losses may be caused by predators coupled with juvenile salmon in nearshore habitats. However, several factors may have resulted in underestimation of juvenile salmon consumption by pelagic pollock. Pollock biomass may have been underestimated due to vessel avoidance, occurrence of pollock in the surface layer (0–5 m) that was not surveyed, and/or occurrence of pollock below 125 m depth that was not surveyed. In addition, pollock food consumption may have been underestimated if the fish are glut feeding in the surface layer then migrating to depth to rest.

It appears that pink salmon recruitment may be determined by the dominance of either of two processes in any single year (Figure 1). Studies of coded-wire tagged juvenile salmon since 1989 indicate that in years when run failures occur there is no relationship between fry growth and fry-to-adult survival (1991, 1992, 1994). However, in years when the adult return is average or above, a relationship exists between fry growth and fry-to-adult survival. The lack of a relationship between growth and survival may indicate that significant mortality occurred before the fry had a chance to grow or predation was not size selective. Predation by pelagic pollock (age 3+) in early May occurs before the fry have had a chance to grow and it is not size selective. However, pelagic pollock do not appear to take significant numbers of juvenile salmon in offshore habitats. If predation by this group has caused run failures observed in recent years, it is likely that age 3+ pollock are coupling with fry in nearshore habitats which may not have been adequately sampled. Recent analyses of data obtained in 1995 indicate that size-selective predation by age 1–2 pollock may be significant in June. In years when predation by this group is dominant, we would expect to see a relationship between growth and survival. In these years, the relationship between fry size (growth) and the timing of the inshore migration of juvenile pollock (age 1–2) and other fish may determine recruitment. Fry growth and inshore juvenile pollock migration appear to be regulated largely by temperature. These results indicate that pink salmon recruitment modelling efforts should focus on (1) determining if predation by age 3+ pollock in nearshore habitats accounts for estimated losses, (2) developing an understanding of the relationship between fry growth and the timing of the inshore migration of age 1–2 pollock, and (3) determining the conditions that lead to the dominance of either process. In addition, we need to determine the proportion of the age 3+ and age 1–2 pollock populations that couple with juvenile salmon. If this can be done, the pink salmon recruitment model can utilize pollock biomass assessments provided by ADFG or NOAA surveys. This would greatly increase the likelihood that the model would be used as a forecasting tool after EVOS funding ends.

An analysis of density-dependent interactions between wild and enhanced salmon is needed to develop rational management plans for the hatchery program in PWS. Alaska has established a legal and financial structure to promote the development of salmon enhancement programs in the state. However, State statutes require that enhancement programs be developed without adversely affecting natural salmon stocks. The presence of large numbers of enhanced salmon may adversely affect wild salmon during the early marine period in several ways. Predation on wild juveniles may be greater if wild and enhanced fish are mixed and predators are attracted to large aggregations of salmon. The impact of this type of interaction may be amplified if predators select wild salmon from the school. Wild and enhanced salmon are often found in mixed schools, and age 1–2 pollock were found to select smaller juvenile salmon in 1995. The presence of large numbers of enhanced salmon may also lead to reduced growth among wild and enhanced fish leading to reduced survival for both groups. An inverse relationship between whole body energy content and fry density at three sites sampled in 1995 suggests that growth may be density-dependent (Paul and Willette 1996). All juvenile pink salmon released from PWS hatcheries will be otolith thermal marked in FY96, providing an essential tool for these investigations. This component of the pink salmon recruitment model will provide a useful tool to improve management of the Sound's wild and enhanced salmon stocks.

OBJECTIVES

The pink salmon recruitment modelling program will focus on the following objectives in phase II.

FY97:

1. Develop a 3-D version of the nekton model.

2. Develop the first version of the coupled the ocean state, zooplankton and nekton models.

3. Evaluate density-dependent interactions among wild and enhanced salmon.

4. Describe the processes affecting the consumption of juvenile salmon by coupled predators in the nearshore zone.

5. Work cooperatively with ADFG to design a sampling program to estimate the relative abundance of wild and enhanced salmon emigrating from PWS.

FY98:

1. Estimate initial conditions for the salmon fry population upon ocean entry.

2. Continue development of a sampling program to estimate the relative abundance of wild and enhanced salmon emigrating from PWS.

FY99 (Phase III):

1. Monitor relative abundance of wild and enhanced salmon emigrating from PWS and evaluate the performance of the pink salmon recruitment model under various environmental conditions (years).

METHODS

FY97:

Objective 1:

The code, algorithms, and graphical user interface for the nekton model is collectively referred to as the ALaska Experimental Windows Interface for Fisheries Ecosystems (ALEWIFE) model. During FY97 the 2-dimensional and 3-dimensional versions (Version 5) of ALEWIFE will be completed. Initial estimates of fry mortality during outmigration will be computed from combined model simulations for a variety of hypothetical scenarios for spatially and temporally varying physical conditions, macrozooplankton distribution, predator distributions and population structures, fry distribution, and outmigration timing and duration. Both Versions 4 and Versions 5 will be used to extend these methods to the cases resulting from the collection of lake/river scenarios from the ocean model applied to the plankton model. These scenarios will be used as forcing that is, the zooplankton abundance and distribution and the fish distribution will not be coupled.

Objective 2:

During the end of FY97 the first version of the coupled ocean/plankton/nekton model for pink salmon fry will be completed. Simulations and tests with this endpoint version of the model will be conducted during FY98.

Objective 3:

Analyses of density-dependent interactions between wild and enhanced salmon will focus on tracking changes in size and water content of somatic tissues of each group in areas of low and high fry abundance over time. The water content of somatic tissues will be used as a proxy for energy content of fry. Data provided by Parker and Vanstone (1966) indicate that water content (% stomachless body weight) is highly correlated with energy content (R^2 = .79). Fry samples (n=100) will be collected with a small-mesh purse seine in mid-May, early June, and mid-June at three sites in areas of high fry abundance (near hatcheries) and three sites in areas of low fry abundance (Port Gravina, Port Fidalgo and Galena Bay). Fry samples utilized for this analysis will be composed of fish obtained from at least three net sets within each site. CTD and zooplankton sampling (20 m vertical tow) will be conducted in association with each fry sample to evaluate environmental conditions at each site. Otolith thermal marks will be used to identify wild- and hatchery-origin fish. Analysis of covariance will be used to test for differences in water content of fry between areas of low and high juvenile salmon abundance and between wild- and hatchery-origin salmon from the same site. Length will be used as a covariate in the analysis.

Size- and condition-dependent predation will be evaluated from analysis of samples of live fry and prey fry collected in FY96. Juvenile salmon previously frozen in seawater will be partially thawed to allow for handling but not loss of fluids. Standard length, wet weight, dry weight, and whole body energy content will be measured for each individual. After freeze drying, bodies will be placed in a convection oven at 60°C until a constant weight is achieved. Individual wet-and dry weight values will be used to calculate moisture content. Dried tissues will be ground in a mill and caloric content will be measured by bomb calorimetry. Fulton's condition factor [CF = g wet wt x 100/(cm standard length)3] will be calculated for each individual. Tests for differences in whole body energy content and size between live fry and prey fry from the same site will be conducted.

Objective 4:
Investigations of predator/prey coupling in the nearshore zone will conducted during three 9-day sampling trips in May and June. Six sites exhibiting a range of fry densities will be sampled in PWS during each trip. Acoustic and net sampling will be conducted every three hours throughout a 12-hour period spanning the night each day. Acoustic surveys will be conducted utilizing side-looking (420 kHz) and downlooking echosounders (70 kHz). Two alongshore transects will be run on each 3 hour cycle to estimate the abundance of predators and juvenile salmon in the nearshore zone. Five acoustic transects will also be run offshore at each site to relate nearshore and offshore predator abundances. Towed underwater video cameras will be used to estimate relative abundance and examine the behavior of predators in nearshore nursery habitats where side-scan acoustics will not be feasible due to reflection from the bottom and sea surface. This technology has been used successfully to estimate fish abundance and size (Irvine et al. 1991, DeMartini and Ellis 1995), identify fish species (DeMartini and Ellis 1995), and evaluate activity and feeding patterns (Collins 1989). Night observations will be made using infrared lighting which cannot be detected by fish and invertebrates (Collins et al. 1991). The diel behavior of pollock will be investigated using sonic tags. Sonic telemetry has been used successfully to investigate the daily activity and movement patterns of juvenile Atlantic cod (Clark and Green 1990). During summer, these fish migrated between a warm surface layer to feed at night and a deep cold layer to rest during the day. It is necessary to determine if pollock exhibit similar daily activity patterns to model their daily food consumption rate and direct sampling. The fish will be captured with jigs, tagged, and held in a net pen for 6 hours to evaluate effects of handling. Thereafter, the fish will be released and tracked continuously using a 8 m vessel. Tags that provide data on the location and depth of the fish will be applied to age 3+ pollock. Smaller sonic tags which do not provide depth information will be applied to age 1–2 pollock. Coupled predators will be sampled using gill nets and jigs to identify acoustic targets and estimate the proportion of the diet comprised of juvenile salmon in the nearshore zone. Both sinking and floating gillnets will be used to obtain a more representative sample of fish in this portion of the nearshore zone. The gear will be checked every 3 hours throughout a 12-hour period spanning night at each site. Water column structure at each study site will be described from CTD casts (0–100 m) taken nearshore and offshore during the first and third sampling period at each site. Seasonal changes in zooplankton biomass and species composition will be described from vertical ring net samples collected twice each week in the passages adjacent to each of the hatcheries operated by the Prince William Sound Aquaculture Corporation.

Objective 5 :
We will work cooperatively with ADFG to design a sampling program to estimate the relative abundance of wild and enhanced salmon emigrating from PWS. Otolith thermal marking will be used to identify wild and enhanced juvenile salmon. Seine sampling will be conducted by the R\V *Montague* during late June and early July. Approximately six hook sets will be made each day in the southwest passages of the sound. A sample (n=100) of juvenile salmon will be collected from each net set if available to obtain a total sample size of 450 on each day. Otolith processing and data analysis will be conducted by the Otolith Mass Marking Project (/320C).

FY98:

Objective 1:
Initial conditions for the fry population upon ocean entry will be estimated using multivariate statistical techniques applied to several historical data sets. The dependent variable in the model will be pre-emergent fry densities (no. m^{-2}) obtained from surveys conducted by ADFG since 1965. Independent variables in the model will be total escapement of the parent generation and precipitation and air temperature during the embryo incubation period. Total escapement will be estimated from aerial survey data with corrections for observer bias, stream life, and escapement in unsurveyed streams. This data is available from NRDA Fish/Shellfish Study #1 conducted by ADFG in 1990 and 1991. Total abundance of pre-emergent fry will be estimated by the product of fry density (no. m^{-2}) and the area of streambed utilized for spawning by the parent generation. The streambed area utilized by spawners will be estimated from the product of total escapement and mean spawner density (McNeil 1967). Multivariate statistical techniques will also be used to estimate fry outmigration timing. Independent variables in the model will be the escapement timing of the parent generation and precipitation and air temperature during the embryo incubation and outmigration periods. Data from Sashin Creek in southeast Alaska (1965–1985) and six streams in PWS (1990–1991) will be used to construct the model.

Objective 2:
The sampling program described under objective 5 above will be continued in FY98.

Phase III:
A sampling program will be implemented in phase III as a monitoring tool to evaluate the performance of the pink salmon recruitment model under various environmental conditions (years). Model estimates of the abundance of wild and enhanced salmon emigrating from PWS will be compared with estimates obtained from the monitoring program each year. The sampling program will estimate the relative abundance of wild and enhanced salmon utilizing recoveries of otolith thermal marked fish from seine sampling in the southwest passages. If the pink salmon recruitment model accurately forecasts abundances of wild and enhanced salmon, the monitoring program will be discontinued.

MILESTONES

FY97:

Model Development:

Couple models for fry and plankton dispersion and growth to reduce dependence upon intensive zooplankton distribution data; evaluation of methods to initialize model with zooplankton overwintering populations.

Complete second generation fry model that incorporates 2 and 3 spatial dimensions.

Publications:

PREY SELECTION AMONG PELAGIC FISH IN A SUBARCTIC ARCHIPELAGO

Content: Data on environmental conditions and diet composition of age 1–2 walleye pollock, age 3+ pollock and herring during the spring bloom period in western Prince William Sound will be analyzed. Processes that may affect prey selection among these fishes will be evaluated with particular emphasis on piscivory.

RELATIONSHIPS BETWEEN DAILY FORAGING TIME OF JUVENILE PINK SALMON IN NEARSHORE NURSERY HABITATS AND PREDATION RISK

Content: Effects of juvenile salmon abundance and prey abundance on the daily foraging time of juvenile pink salmon in nearshore nursery habitats will be evaluated. Relationships between foraging times and predation risk will be evaluated. Zooplankton biomass and species/size composition between nearshore and offshore habitats will be compared. Data from 1995 sampling program.

EFFECTS OF SIZE- AND CONDITION-DEPENDENT PREDATION ON MORTALITY OF WILD AND ENHANCED PINK SALMON

Content: An analysis of the temporal changes in energetic content and size of wild and enhanced juvenile pink salmon and selective predation. Effects of environmental conditions on observed energetic content of fry will be evaluated. Data from 1996 sampling program.

FY98:

Model Development:

Complete assessment of minimum measurements for 1) initializing and updating the model for macrozooplankton advection, growth, and mortality; 2) contribution of primary production to fry feeding and to strength of next generation.

Extend fish models to include coupling between fish populations of salmon, Pacific herring, and pollock along with coupling of each to macrozooplankton.

Publications:

PROCESSES AFFECTING CONSUMPTION OF JUVENILE SALMON BY AGE 3+ POLLOCK IN NEARSHORE HABITATS

Content: An analysis of the processes affecting coupling of age 3+ pollock in nearshore habitats and an assessment of their total juvenile salmon consumption. Data from video monitoring and acoustic sampling in 1997 and extension of results to earlier year's data.

PROCESSES AFFECTING CONSUMPTION OF JUVENILE SALMON BY AGE 1–2 POLLOCK IN NEARSHORE HABITATS

Content: An analysis of the relationships between juvenile salmon growth and the inshore migration of juvenile pollock modulated by temperature. Data from sonic tagging, time-lapse video monitoring, and acoustic sampling in 1997 program.

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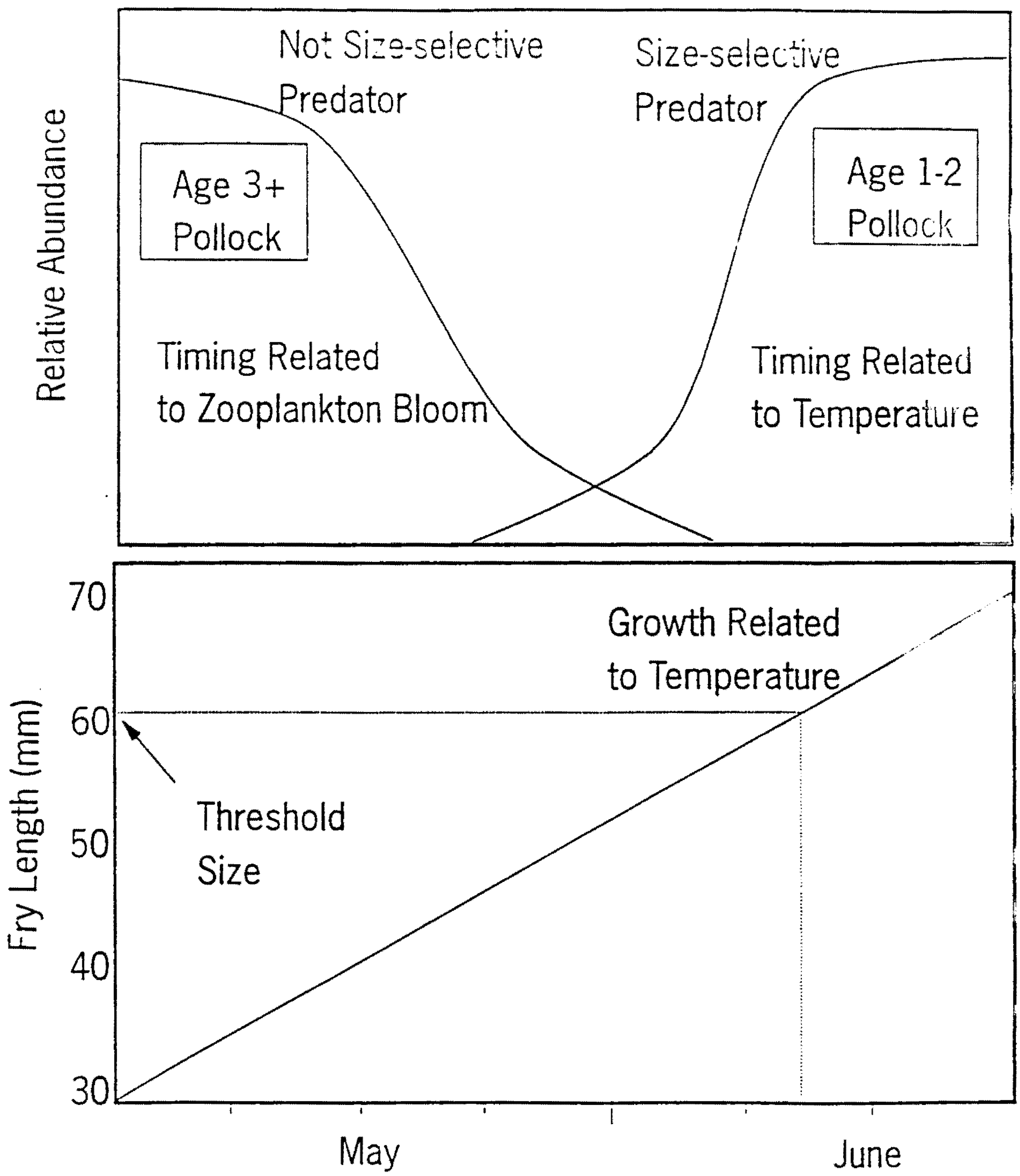

Figure 1. Conceptual model of juvenile pink salmon mortality processes.

APPENDIX II–C

Pacific Herring Recruitment Dynamics

Herring Recruitment Model

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ABSTRACT

The purpose of the Herring Recruitment subgroup of SEA is to create a workable model addressing three objectives (1. Overwintering Survival Model, 2. Summer Habitat Model, 3. Monitoring Strategy), which will result in an understanding of the physical and biological mechanisms affecting the survival of juvenile herring and providing indices of recruitment into the Prince William Sound population. In FY98, the FY96 and FY97 field data will be processed, analyzed and interpreted. Further, a preliminary monitoring strategy will be developed and field tested.

INTRODUCTION

This project examines physical and biological mechanisms influencing the recovery of Pacific herring. Pacific herring is listed as "not recovered" in the "Resources and Services Injured by the Spill" *Exxon Valdez* Oil Spill Restoration Plan.

The Herring Recruitment Model is being developed as the integration of submodels, each of which focuses on a stage in the early life history of Pacific herring (*Clupea pallasi*). We hypothesize that, like other clupeids, year-class strength of Pacific herring in Prince William Sound (PWS) is determined during its early life history. All field, laboratory experiments, and data analysis for all involved components of SEA in FY98 will relate to one or more of the submodels. Two major SEA hypotheses are the focus of these submodels and will be linked within the overall Herring Recruitment Model. The Herring Overwinter Hypothesis states that survival of herring through their first winter is key to survival and ultimate year-class strength of juvenile herring and is dependent upon their condition when they enter winter. We will test this hypothesis by examining distribution and condition of herring in the fall, throughout the winter and again in the spring. We expect to see a change in condition indices and we expect these changes to be related to geographic location and the physical and biological conditions that characterize these locations. A bioenergetic model, combining SEA field and laboratory observations with energetic information from Atlantic herring studies, will be constructed to predict the likelihood of overwinter survival for recruiting herring. In support of the Herring Overwinter Hypothesis we will examine how the Lake/River Hypothesis applies to transport and distribution of herring at the larval stage. We will employ larval drift simulations, using the Circulation and Transport Models for PWS being formulated by Mooers and Wang as part of the Ocean Dynamics Model, to determine the expected drift of larval herring within PWS and how it affects the distribution of summer juvenile nursery areas. We expect to examine various drift patterns in response to simulated "lake" (i.e. retention), "river" (i.e. rapid movement through the sound), and combinations of varying amounts of "lake" and "river" in accordance with the recent evolution of the lake/river hypothesis. The larval drift synthesis is a tool which will link the Summer Habitat Model, which examines location and characteristics of summer nurseries utilized by juvenile herring, with the Overwintering Survival Model. The Summer Habitat Model will determine the survival and growth rates of juvenile herring and the quality of nursery areas by examining changes in herring distribution, density, length, weight, energy (kJg-1), interspecific biological variables (prey abundance, predation) and physical variables (oceanographic conditions, bathymetry). These data will define the initial conditions of herring as they enter the Overwintering Survival Model.

This is a component of the SEA project, Dr. T. Cooney, Lead Scientist. Within SEA, significant coordination exists between projects linking physical and biological data. Multiple authors on proposed publications reflect this integration. In addition, this project coordinates with the APEX and NVP ecosystem projects via field logistics (vessels, equipment and samples), shared data (catch, aerial survey data, and acoustics results), and joint publications. We anticipate that coordination with these groups will increase during FY98 for the purpose of planning the monitoring of key species (i.e. herring) in the ecosystem that directly or indirectly impact oil-spill injured species (fish, birds, mammals) and resources (commercial and subsistence fisheries).

The research completed under this project combined with data from other SEA projects will identify the physical and biological mechanisms determining herring recruitment. This information will enable us to understand the dynamics of the recovery of this species, aid in future fisheries management of the resource, and provide critical information for other "not recovered" species, as herring are a primary forage fish in PWS.

OBJECTIVES

The research objectives of this project are:

1. Develop an Overwinter Survival Model for juvenile herring.

2. Develop a Summer Habitat Model for juvenile herring.

3. Develop a Monitoring Strategy for juvenile herring.

For the Overwinter Survival Model:

Describe overwinter distribution, size, condition, energy needs, and relative abundance of juvenile herring, physical and biological characteristics of herring nursery areas and overwintering bioenergetics.

Tasks:
1. Collect data on the whole body energy content of age-0 and age-1 herring in the late fall and again for those that survive the winter. This information will be collected for the 1995, 1996, and 1997 year classes.

2. Determine changes in bioenergetics over the winter season using time sequence (monthly) sampling of juvenile herring from two or more index sites in 1996–97 and 1997–98.

3. Examine stomach contents of overwintering recruits and make energetic estimates for consumption during the winters of 1996–97 and 1997–98.

4. In the laboratory determine the energy need of fasting herring.

5. Using field and laboratory measurements of overwinter energy needs and literature values for Atlantic herring, develop a model to predict winter survivorship.

6. Describe spring, pre-bloom biological and habitat conditions as an endpoint of the Overwintering Survival Model and beginning of the second year Summer Habitat Model.

For Summer Habitat Model:

Describe summer and fall distribution, size, condition and relative abundance of juvenile herring (biological data), and physical and biological characteristics of herring nursery areas (habitat data) to evaluate quality of summer growth of herring and as initial conditions for the Overwintering Survival Model.

Tasks:
1. Use Circulation and Transport Models (Ocean Dynamics Model) to simulate drift of larval herring and distribution to summer nursery areas.

2. Determine distribution of juvenile herring during the spring, summer and fall using broad scale surveys which include simultaneous overflights, acoustics and net collections.

3. Determine physical (salinity, temperature, depth, currents, light levels, bathymetry) and biological (zooplankton, competitors) parameters which determine "good" vs. "bad" nursery areas measured by condition of herring (length, weight, age, growth rates, stomach contents, energetic condition and stable isotopes).

4. Develop maps of key habitats (nursery areas) for juvenile herring within PWS.

5. Describe the retention characteristics of herring nursery areas using information from the larval drift simulations, physical oceanographic measurements and biological data (spatial distributions, isotopes, growth rates) indicating immigration or emigration.

6. Develop maps of possible retention areas with different historical spawning sites and transport conditions.

For Monitoring Strategy:

Tasks:

1. Identify key index sites and develop monitoring techniques by relating aerial, acoustic and net sampling data during summer surveys to condition of juvenile herring.

METHODS

In order to address the above objectives and tasks, we have formulated our approach into two component models, each of which has several subcomponents. We hypothesize that the Overwinter Survival Model is the most important in determining successful recruitment of juvenile herring. Critical to that model is the feeding, growth and survival of juvenile herring during the summer addressed in the Summer Habitat Model. These models and subcomponents are described in chronological order of herring life history (Figure 1).

The first subcomponent is embryo survival. This component is not a SEA program, but rather projects funded by EVOS outside of SEA. For the starting point of our Summer Habitat Model, we intend to combine the results of 1) the ADF&G spawn deposition survey, 2) the Haldorson, Quinn and Rooper egg loss model which predicts losses due to physical factors and predation, 3) estimates of baseline egg mortality (Brown and Debevec in prep), and 4) estimates of baseline levels of viable hatch (Hose et al. 1996, Kocan et al. 1996). From this we will know the location of spawning of herring, an estimate of the amount of spawn, and the expected percentage of viable larvae produced.

The output of that subcomponent will be input into our larval drift simulation. We will initially examine the direction of transport without incorporating the population size component. We will run the Ocean Circulation and Transport Model with input at the locations of herring spawning and test observed distribution of particles. Distribution predicted by this subcomponent will be verified by the distribution of age-0 herring during the summer. To validate the larval drift simulation we will rely on the literature for transport and retention of larval Atlantic herring (*Clupea harengus*) in the North Atlantic (Graham and Davis 1971, Graham and Townsend 1985, Sinclair and Iles 1985, Sinclair 1988). We will first use 1989 as test case. By inputting location of spawning and physical conditions which we know occurred in 1989, we can test the model against the offshore distribution of larvae observed in May, June and July 1989 (Norcross and

Frandsen 1996) and the nearshore distribution observed in May 1989 (McGurk 1990). We will also use spawning location information from 1995, 1996 and 1997 and relate the distribution of larvae to the distribution of herring observed from the aerial and acoustic surveys. This simulation will be an iterative process.

The output of the larval drift simulation will be validated and used as input for the Summer Habitat Model. From October 1995 to August 1997 acoustic and aerial surveys were conducted and those data will be processed, analyzed, interpreted and combined in 1998 to determine herring nurseries. The broadscale distribution of age-0 herring was evaluated in October 1995, March and July 1996. These surveys covered most of PWS and adjacent waters to Resurrection Bay. Sampling from the air provided approximately weekly estimates of horizontal distribution of herring across the entire sound during the summer.

These broadscale surveys provided preliminary estimates of oceanographic patterns and distribution of herring. Then, in 1997, we focused on the retention of juvenile herring in nursery areas and the biological and physical mechanisms influencing their growth and survival by initiating time-sequence sampling in four bays where age-0 herring were found (Ziakof, Simpson, Whale and Eaglek). Each bay was surveyed three times in a 24 hour period using sidescan sonar. Net collections of herring were coupled with acoustics estimates of horizontal and vertical distribution and abundance and aerial estimates of horizontal distribution. These net collections are used to ground-truth both acoustic and aerial estimates for species size and composition. Subsamples of herring were retained and later evaluated for size, age, stomach contents, condition (energetics and standard fisheries age-weight-length (AWL)), and stable isotopes (trophic analysis). Simultaneous with net collections for fish were vertical plankton to estimate availability of food for planktivorous herring. Oceanographic parameters collected include salinity and temperature at depth (CTD), estimates of current structure (ADCP), light levels and bathymetry at location. The main effort in 1998 will be to process, analyze and interpret these data. Evaluation of these parameters will be used as estimates of the health of the population at each location.

In 1998, multivariate statistics will use biological and physical parameters as independent habitat variables and feeding and condition of herring as dependent variables as a first cut to evaluate the quality of nurseries. From this we will attempt to characterize "good" vs. "bad" nursery habitats. A "good" nursery is defined as one in which herring juveniles are in the best condition as they enter the winter. It will be necessary to determine if herring move among these nursery areas, therefore, we will examine retention within areas based on the 1996 and 1997 spatial distribution data on the large (broadscale) and small (bays) scales. We will examine small scale oceanography (i.e. fronts), and evaluate rates of change of the biological characteristics of herring (i.e. energetics).

Further, in 1998, the field sampling will switch from primarily research to a preliminary monitoring trial. Two surveys, one in October 1997 and the other in March 1998, will be conducted using one vessel supplied with acoustic surveying equipment, a seine for target verification, a plankton net and a CTD for oceanographic measurements. The four bays that were surveyed in 1997 will be surveyed between 1900 and 2400 hours. Herring for AWL, energetics and diet analyses will be collected in each bay. This will provide a critical data set for the Overwintering Model and Summer Habitat Model, plus it will allow us to calibrate this survey technique and estimate its precision as a cost effective monitoring tool.

The Overwintering Survival Model evaluates distribution and condition of age-0 and age-I herring as they enter winter, i.e. October, and as they complete winter, i.e. March. Methods on these cruises are the same as those described for the summer cruises, in the same four bays. The objective of this sampling is to determine change in condition of herring over the course of winter in concert with the hypothesis that herring which enter winter in poor condition due to "bad" nursery habitats will not survive winter, while those from "good" habitats will successfully survive winter. In 1998, the 1996–97 data will be analyzed, an additional October–March sample will be collected, and this model will be linked to the Ocean Dynamics Model to determine the effect of the timing of the phytoplankton bloom on successful herring recruitment.

PUBLICATIONS AND REPORTS

As well as the Annual Report in April 1998 this research will produce numerous primary publications.

Primary publications submitted to journals or in the final stage of preparation:

Mooers, C.N.K. and J. Wang. On the development of a three-dimensional circulation model for Prince William Sound, Alaska. Continental Shelf Research. submitted Dec. 1996.

Paul, A.J., J.M. Paul, and E.D. Brown. Fall and spring somatic energy content for Alaskan Pacific herring (*Clupea pallasi*) relative to age, size and sex. Journal of Experimental Biology and Ecology. submitted.

Paul, A.J., J.M. Paul, and E.D. Brown. Ovarian energy content of Pacific herring from Prince William Sound, Alaska. Alaska Fishery Research Bulletin. submitted.

Kline, T.C., Jr. and A.J. Paul. Isotopic signature and somatic energy content of young of the year Pacific herring at two sites in Prince William Sound Alaska: implications for tropic studies. Canadian Journal of Fisheries and Aquatic Sciences. submitted.

Brown and Norcross. Assessment of forage fish distribution and relative abundance using aerial surveys. Fisheries Research. draft.

Foy and Norcross. Spatial and temporal differences in diet of juvenile herring (*Clupea pallasi*) in Prince William Sound, Alaska. Fisheries Research. draft.

Topics to be covered in future publications:

1. A bioenergetic model for winter energy use by age-0 Pacific herring.

3. Seasonal variation in spatial distribution of juvenile herring in PWS.

4. Winter feeding of age-0 Pacific herring from PWS.

5. Interannual fall and spring abundance of age-0 Pacific herring in PWS.

6. Relative abundance of age-0 Pacific herring and age-0 pollock in PWS.

7. Effects of ocean circulation patterns on distribution and retention of Pacific herring larvae in PWS.

8. Survival of juvenile Pacific herring in relation to spatial and temporal variation in PWS.

9. Growth of juvenile Pacific herring in relation to spatial and temporal variation in PWS

10. Trends in C-13 and C-14 ratios in Pacific herring tissue indicating changes in trophic levels and patterns.

11. Interannual and geographic variations in prey selection of juvenile herring in PWS.

12. Relation of prey selection and stomach fullness of juvenile Pacific herring in PWS to zooplankton production and distribution.

13. Development of a juvenile indexing program for prediction of recruitment and forecasting of Pacific herring populations in Prince William Sound and recommendations for restoration options.

14. Seasonal growth and consumption dynamics of herring in PWS.

15. Spatially-explicit approach for evaluating nursery areas and the spatial distribution of herring.

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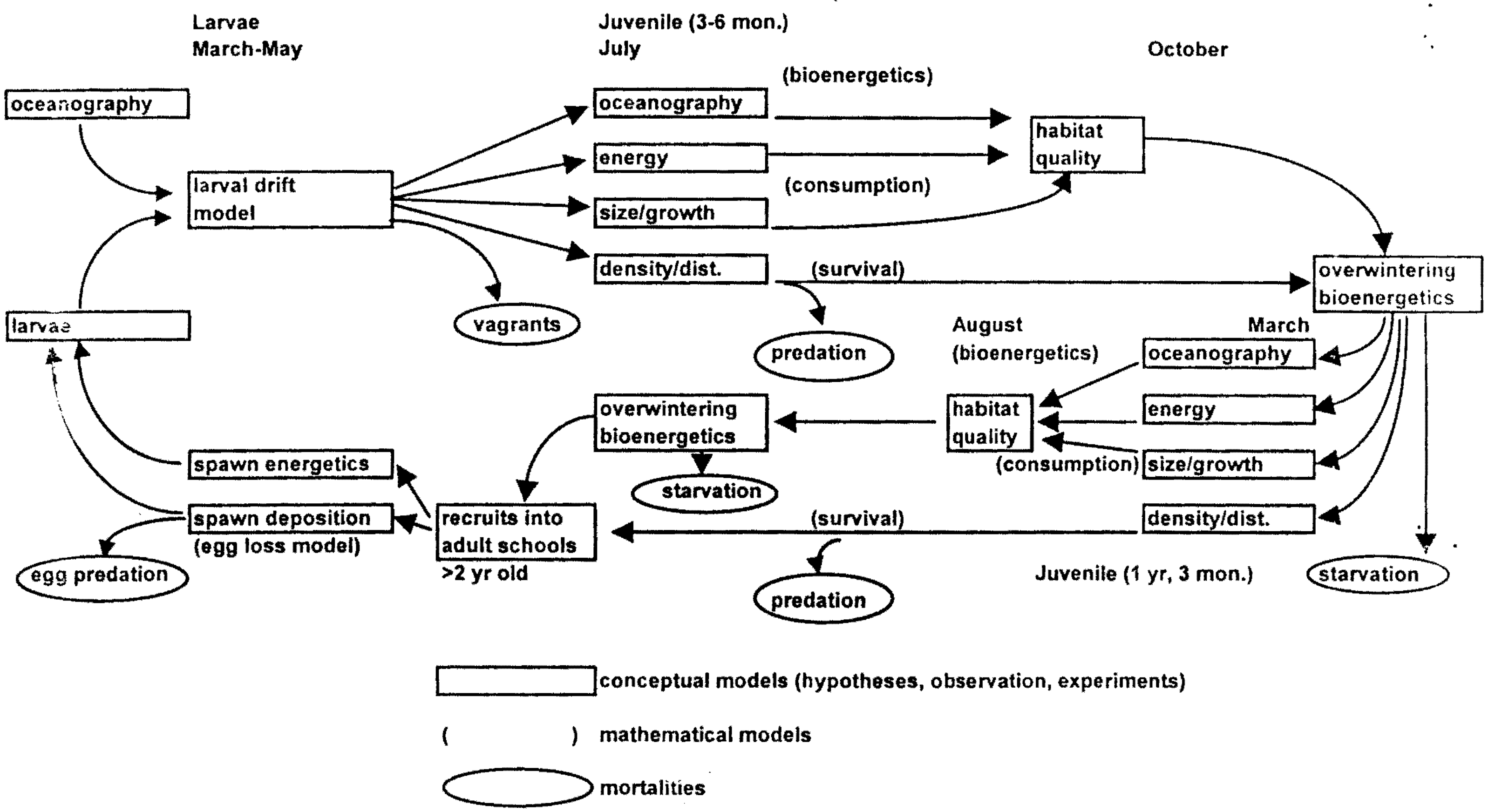

Figure 1. Herring Recruitment Model

DETAILED PROJECT DESCRIPTION: MODELING DIFFERENTIAL *EXXON VALDEZ* OIL SPILL PETROLEUM HYDROCARBON IMPACTS TO ARCHAEOLOGICAL RESOURCES (Submitted under the BAA)

RECEIVED
APR 1 4 1997
EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL

Project Number:	98/new 98323-BAA
Restoration Category:	General Restoration
Proposer:	IMA Consulting, Inc. 3300 University Ave. SE Suite 202 Minneapolis, Minnesota 55414 voice: 612-623-0299; fax: 612-623-0177
Lead Trustee Agency:	unknown
Cooperating Agencies:	unknown
Alaska SeaLife Center:	no
Duration:	1st year, 5-year project
Cost FY 98:	$205,620.00
Cost FY 99:	$44,000.00
Cost FY 00:	$10,000.00
Cost FY 01:	$10,000.00
Cost FY 02:	$10,000.00
Geographic Area:	Federal lands in oil spill area
Injured Resource/Service:	archaeological resources

ABSTRACT

The proposed project seeks to understand the nature of past, current, and future impacts of the *Exxon Valdez* oil spill and subsequent cleanup efforts on known and unknown archaeological resources in the spill area by assessing the potential for differential spill impacts based upon variability within and between locale-specific geomorphic settings. The proposed study integrates archaeology, geomorphology, geographic information systems, and geophysical techniques. The result will be a predictive model of impact severity useful for efficient allocation of resources in ongoing archaeological impact assessment and treatment.

INTRODUCTION

The proposed project seeks to understand the nature of past, current, and future impacts of the *Exxon Valdez* oil spill and subsequent cleanup efforts on known and unknown archaeological resources in the spill area by assessing the potential for differential spill impacts based upon variability within and between locale-specific geomorphic settings. The proposed study integrates archaeology, geomorphology, geographic information systems, geochemistry, and geophysical techniques to derive an empirically-based predictive model of impact severity useful for efficient allocation of human and financial resources for ongoing archaeological impact assessment and treatment efforts. The strengths of the project include the utility of the derived predictive model for developing effective and efficient programs assessing and managing archaeological resources in the oil spill area and the integrated use of field and analytical technologies which are predominantly non-destructive to archaeological resources. The study will prove especially useful in guiding and refining the ongoing research being conducted under Project /007A (Index Site Monitoring) by providing a model indicating which sites and/or geomorphic settings are most in need of monitoring for site-specific recovery progress and for baseline contamination/recovery data.

NEED FOR THE PROJECT

A. Statement of Problem

The proposed project seeks develop a model to ascertain which archaeological sites are most in need of long-term monitoring and data collection by delineating the geomorphological attribute sets contributing to differential petroleum hydrocarbon contamination of the landscape as a result of the *Exxon Valdez* oil spill and subsequent cleanup efforts. Knowledge of the relationships between spill-affected archaeological sites and their associated geomorphological settings will offer lasting benefits to monitoring programs by providing baseline data on differential petroleum hydrocarbon impacts and persistence derived from the location-specific geomorphological processes where sites and hydrocarbons co-occur. Since the Trustee Council will continue to sponsor monitoring programs at a sample of spill-affected sites (index sites), the model development program proposed here will substantially assist in guidance of human and financial resources towards the monitoring goals.

B. Rationale/Link to Restoration

The proposed modeling project is intended as a general restoration project because it is guided towards effective and efficient resources restoration management by refining the knowledge base regarding which archaeological resources may be expected to be in most need of monitoring. This permits allocation of the most human and financial resources where they are most needed. The rationale for the project and its link to restoration are thus straightforward: support and guidance for ongoing restoration management efforts at spill-affected archaeological resources.

C. Location

The field research will be conducted with a sample of 20 known archaeological sites in the spill area. These sites are located in the Prince William Sound, Cook Inlet-Kenai, and Kodiak-Alaska Peninsula spill sectors, and will include 10 sites examined for petroleum hydrocarbon contamination by EVOSADAP (Dekin 1993) because of the existing comparative analytical database supplied by that project. The additional 10 sites will be chosen as representative of variations in geomorphological attributes. Included in these latter 10 sites may be Trustee Council index sites or known sites on newly acquired lands as appropriate.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The proposed project is interested in obtaining the services of one or two Aluutiq natives to assist in fieldwork. The Chugach Native Corporation has for years assisted in sponsoring archaeological field schools, and there are thus numerous individuals who hold sufficient experience to assist in the proposed fieldwork. The most important aspect of native participation in this regard would be the training received in applied use and interpretation of the technologies proposed for the research. The project will discuss the matter with archaeologists Richard Knecht (Cold Bay) and Amy Steffian (Kodiak Museum), who have directed field school efforts there.

PROJECT DESIGN

A. Objectives

The *Exxon Valdez* Oil Spill Archaeological Damage Assessment Project (EVOSADAP) provided considerable data linking the degree of petroleum hydrocarbon contamination (i.e., presence, penetration, and persistence) in archaeological contexts with the effects of hydrostatic pressure and drainage of tidal and upland water sources.

The EVOSADAP research indicated that the least deleterious archaeological impacts of petroleum hydrocarbon contamination are likely to be felt where hydrostatic pressure and upland runoff are of sufficient strength to prohibit hydrocarbons from sinking deeply into subsurface strata and to provide a mechanism to cleanse the archaeological site by draining hydrocarbons into coastal or other adjacent waters (Dekin et al. 1993). It would be expected, then, that the most deleterious effects will occur when hydrostatic pressure and upland runoff are insufficient to the extent that petroleum hydrocarbons penetrate deeply into archaeological strata and remain there. The implication here is that some sites will experience a greater degree of long-term contamination than others by virtue of differential restorative capability.

Links between the degree and persistence of oil and other petroleum hydrocarbon contamination on northern coastlines were recognized prior to the *Exxon Valdez* spill, especially as related to hydrological capabilities engendered by beach morphology and constituent sedimentological components (e.g., Owens et al. 1987). Given the extreme large- and small-scale variability in coastal geomorphology in south Alaska (e.g., Hayes and Michael 1982, 1989), one would expect that the nature of hydrocarbon contamination would be similarly varied at archaeological sites whose settings reflect the local diversity of coastline formation and geomorphic setting.

The proposed research recognizes the potential variability in archaeological contamination and its relationship to geomorphological processes. The objective of the proposed research is to derive an empirical predictive model delineating the relationships between degree and persistence of petroleum hydrocarbons at archaeological sites and the geomorphological attributes extant at site locations. The intent of the model is to provide a means for ongoing archaeological resource monitoring and restoration efforts to be directed primarily to locations where the likelihood of long-term contamination is greatest. With limited resources available to accomplish what appeared to be a problem of infinite extent, such guided research is essential. As Dekin (1993:8) observed, "The blackened rocks on beaches where oil was not removed serve as a reminder that the *Exxon Valdez* spill was but a warning. We are fortunate to have the ability to take steps now to insure that this loss was not in vain and that our stewardship of the past will lead to wiser protection for the future". The proposed project seeks to enhance our stewardship capabilities.

B. Methods

The proposed project will use a variety of appropriate technologies and techniques to gather data which with to derive the model. The sample of archaeological sites chosen for the project is based upon locations of prior data collection (Dekin et al. 1993) and the representation of geomorphological settings present in the spill area.

The proposed project integrates geomorphology, geophysics (ground penetrating radar), geochemistry, archaeology, and Geographic Information Systems (GIS). The data-gathering and interpretive capabilities of these techniques, technologies, and associated technicians will generate the predictive model. The personnel and facilities chosen for the project all have many years experience in their respective fields and have strong backgrounds in interdisciplinary research. All matériel used for the study is held by the respective study institutions.

Geomorphological studies will examine the land- and water-based attributes contributing to landform development (sedimentation, slope, tides, fetch, etc) and the impact of those attributes on differential site restoration capabilities through hydrological cleansing processes. The geomorphological work will be conducted in the field at site locations and non-site areas, will use prior research in the region, and will apply topographic landform analysis to delineate specific attribute combination locations throughout the spill area.

Ground penetrating radar is seen as a key component of the proposed study, as it has the ability to discern areas of petroleum hydrocarbon contamination in shallow and deep contexts (e.g., Daniels et al. 1995; Nash et al. 1997; Fenner and Venal 1992). This will be used to examine the horizontal and vertical extent of contamination at sample sites. This will permit appropriate sampling of contaminated and uncontaminated (control) samples within sites, and will generated baseline data useful for long-term monitoring of shifts in contamination extent.

Geochemical analyses will be performed on recovered soil and artifact samples to determine content and sources of petroleum hydrocarbon at a given site. The source of hydrocarbons is important here, for despite the visible oiling of beaches from *Exxon Valdez* crude, the EVOSADAP study found that kerosene, diesel, white gas, and aviation fuel provided the bulk of hydrocarbon contaminant spectra in archaeological contexts. These contaminant sources are part of the impact of the spill, since they are derived from the boats and aircraft and personnel used in the subsequent cleanup efforts (Dekin et al. 1993). Geochemical studies will also assess the levels of phosphate and calcium, and the impact of hydrocarbons on the visibility of these human-derived markers of past occupation. Samples of soils and cultural material will be extracted in the course of limited archaeological excavations in contaminated and control areas at sites. Geochemical analyses will be conducted by Monteverde Environmental, which conducted similar studies for EVOSADAP. Radiometric samples will also be taken to continue evaluating the effects of hydrocarbons on the ability to accurately assess the dating of cultural events and processes.

Archaeological subsurface research will be conducted in a limited manner through excavation of 0.5 meter excavation units, shovel tests, and soil probes to obtain cultural (artifactual) and soil samples for geochemical study. The archaeological component of the study will be the sole source of invasive (destructive) research at sample sites. Since the project intends to maintain a minimum level of invasiveness, subsurface sampling areas will be chosen according to the results of the ground penetrating radar data rather than using any haphazard or random sampling strategies.

GIS will provide the links between the respective study components by integrating the data from each into a layered, multi-dimensional perspective. The GIS component will generate the model in spatial and (where possible) temporal frameworks delineating the locations throughout the spill area where known (or unknown) archaeological resources were, are, and will continue to likely be most affected by petroleum hydrocarbon contamination, and where resources are likely to be least affected. The project anticipates deliverables generated by GIS to consist of CD and hardcopy images and datasets relating to specific sites visited and the spill area as a whole.

The sample of sites chosen within the spill area will be based upon their ability to accurately represent the range of geomorphological variability. The project anticipates a total of 20 sites for the sample. The sample will include the 10 sites tested by EVOSADAP due to the prior data collection at those locations (Dekin et al. 1993). This will provide a temporal dimension to the study useful for assessing any shifts in contaminant affects to archaeological contexts since the 1991 fieldwork. The additional 10 sites will be chosen based upon their geomorphological characteristics and their concomitant ability to provide data that can be analyzed with an eye towards extrapolation to other spill-affected areas. The project would like to incorporate Trustee Council index sites into this latter sample, if appropriate. The project would also consider incorporation of sites on recently acquired Trustee lands.

The samples taken from within sites will represent the extent of contamination at those sites. As stated above, ground penetrating radar will serve as the primary tool for the sampling strategy. Soils and cultural samples will be taken with a concern for the affects of hydrocarbon contamination across space and through time, and the effects of long-term seepage into site contexts. Samples will derive from cultural (on-site contaminated and, where possible, uncontaminated) and control (off-site and uncontaminated) locations. The procedures for sampling for geochemical and radiometric analyses are outlined in Dekin et al. 1993.

The predictive model linking geomorphological attributes and archaeological context contamination will be assessed through the use of analysis of variance (ANOVA) and correlation matrices. It is recommended that the model and index monitoring program continue to assess the results of the respective projects through FY 2002.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

At this point it is uncertain what if any agency assistance will be required or sought after, with the exception of the coordinating office for Project /007A (Index Site Monitoring).

The project intends specialized analytical services to be contracted to two private firms. Monteverde Environmental (Albuquerque, NM) will conduct the geochemical analysis (petroleum hydrocarbon content and source, phosphate content, calcium content), as they did for the original EVOSADAP project. Radiometric analyses will be contracted to Beta Analytic (Miami, FL), a leading firm in that field. The project also plans to contract for various aspects of field travel and support, primarily in the realm of air or water charter for travel and resupply, and portable watercraft rental.

SCHEDULE

A. Measurable Project Tasks for FY 98

(Not applicable.)

B. Project Milestones and Endpoints

January 15-24	Attend Restoration Workshop
March 1-15	Conduct prior research review
March 15-April 15	Arrange fieldwork logistics
July 1-August 1	Conduct field research; data/sample collection
August 15	Deliver geochemical/radiometric samples to contractors
August 15-September 30	Analyze field/lab data
October 1-December 15	Prepare report of FY 98 findings
December 31	Submit report of FY 98 findings

C. Completion Date

The project schedule is guided towards delivery of the final report on or about December 31 1998, in FY 99. All deliverables will be submitted by April 15 1999.

PUBLICATIONS AND REPORTS

The project considers presenting the results of the model development program in *Science*, *Arctic*, *Arctic and Alpine Research*, *Oil and Gas Journal*, *Photogrammetric Engineering and Remote Sensing*, and *Annals of the American Association of Geographers*, and other appropriate venues.

PROFESSIONAL CONFERENCES

The project is interested in presenting modeling development results at meetings of the Arctic Workshop (INSTAAR), American Association of Geographers, Society for American Archaeology, and other appropriate venues.

NORMAL AGENCY MANAGEMENT

(Not applicable.)

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The proposed project is specifically designed to assist the ongoing Trustee Council Project /007a (Index Site Monitoring) in its efforts. To that end, the project is certainly interested in cooperating with that program in data sharing and in continuing feedback and evaluation regarding links between the results of the proposed project and the findings of Project /007A. Cooperation with the existing program is seen as crucial.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

(Not applicable.)

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Mark S. Cassell (Principal Investigator/Supervisory Archaeologist; MA, Anthropology, 1988, SUNY-Binghamton; PhD program, ABD, Anthropology, SUNY-Binghamton)

Cassell will serve as principal investigator and supervisory archaeologist, and will coordinate all preparatory, field, analytical, and report aspects of the proposed project. He acted as supervisory archaeologist with the initial *Exxon Valdez* Oil Spill Archaeological Damage Assessment Project (EVOSADAP), conducted from 1991-1993 and sponsored by the U.S.D.A.-Forest Service (Dekin et al. 1993). This experience provides him with substantial background and working knowledge regarding the physical and cultural environment and processes in the spill area, the logistic considerations required for fieldwork in the region, and the development and completion of *Exxon Valdez* oil spill-derived research programs. He has directed numerous applied and academic research programs in the Arctic, Midwest, and Northeast, and has considerable experience in working throughout Alaska.

OTHER KEY PERSONNEL

James Jordan (Coastal Geomorphologist/Archaeologist; MS, Quaternary Studies, 1990, University of Alaska-Fairbanks; PhD program, ABD, Geography, University of Wisconsin-Madison)

Jordan will serve in the field as consulting coastal geomorphologist. He worked under Cassell in the field with the initial EVOSADAP. His expertise rests with understanding subarctic coastal processes, and has conducted numerous related field projects along the coastlines of the Gulf of Alaska, Bering Strait, and Bristol Bay.

Jeff Berry (Geographic Information Systems Specialist; BS Anthropology, 1996, Eastern Washington University)

Berry will supervise the GIS-related data gathering, manipulation, and presentation. He has worked with GIS for six years in the Pacific Northwest and the Midwest.

David Maki (Geophysics Specialist; BS 1998, Engineering, University of Minnesota-Minneapolis)

Maki will conduct, analyze, and present the geophysical aspects of the project. His primary field of expertise is interpretation of ground penetrating radar data. He has worked with geophysical techniques for five years in the Midwest, Mexico, and Syria.

Thomas Madigan (Geomorphologist; BS, Geology/Geomorphology, 1995, University of Minnesota-Duluth; MS program, Geomorphology, University of Minnesota-Minneapolis)

Madigan will serve as geomorphologist for the project. His primary expertise lies in terrestrial geomorphology, and thus provides a necessary complement to Jordan. He is well versed in the relationships between geomorphological data and GIS presentation, and has worked in applied and academic realms for seven years.

LITERATURE CITED

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1995 Ground penetrating radar for the detection of liquid contaminants. *Journal of Applied Geophysics* 33:195-207

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Nah., Mike S., Estella Atekwana, and William A. Sauck
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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$139,320.0						
Travel		$34,950.0						
Contractual		$27,500.0						
Commodities		$2,650.0						
Equipment		$1,200.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$205,620.0		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect								
Project Total	$0.0	$205,620.0		$44,000.0	$10,000.0	$10,000.0	$10,000.0	
Full-time Equivalents (FTE)		17.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

- THE IMA CONSULTING INDIRECT RATE IS RECKONED TO APPROXIMATE 66% OF DIRECT PERSONNEL COSTS; INDIRECT COSTS ARE INCLUDED HERE AS PART OF THE PERSONNEL COSTS.

- ALL PROJECT COSTS ARE INTENDED FOR USE FOR THE CONDUCT OF THE PROPOSED PROJECT. REPORT PREPARATION IS SCHEDULED FOR FY 99 (OCTOBER 1-DECEMBER 15 1998) AND THOSE COSTS ($44880) ARE PLACED IN THE ESTIMATED FY 1999 COLUMN; THE FIGURE INCLUDES 5 MONTHS @ $8800/MONTH.

- WHILE RESEARCH JOURNAL PUBLICATION AND CONFERENCE PRESENTATION ARE EXPECTED, NONE WILL TAKE PLACE DURING FY 98 DUE TO TIME CONSTRAINTS, AND NO FUNDS ARE HERE PRESENTED FOR THOSE EXPENSES.

- NO OTHER FUNDS HAVE BEEN REQUESTED OR ARE ANTICIPATED.

- THIS IS NOT A CONTINUING PROJECT.

1998

Prepared: 4/97 of 4

Project Number: 98/NEW 98323-BAA
Project Title: MODELING DIFFERENTIAL *EXXON VALDEZ* OIL SPILL PETROLEUM HYDROCARBON IMPACTS ON ARCHAEOLOGICAL RESOURCES
Name: IMA CONSULTING, INC. (MINNEAPOLIS, MN)

FORM 4A
Non-Trustee
SUMMARY

4/12/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:				Months	Monthly		Proposed
Name		Position Description		Budgeted	Costs	Overtime	FY 1998
CASSELL	M.	PRINCIPAL INVESTIGATOR		4.5	8800.0		39,600.0
BERRY	J.	GIS		3.0	8800.0		26,400.0
MAKI	D.	GEOPHYSICS		2.5	8800.0		22,000.0
MADIGAN	T.	GEOMORPHOLOGIST		2.5	8800.0		22,000.0
JORDAN	J.	COASTAL GEOMORPHOLOGIST		2.5	8800.0		22,000.0
MCCLEETE	L.	ADMIN ASSISTANT		0.3	4400.0		1,320.0
UNKNOWN		ALUUTIQ PERSONNEL		1.0	3000.0		3,000.0
UNKNOWN		ALUUTIQ PERSONNEL		1.0	3000.0		3,000.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		17.3	54400.0	0.0	
						Personnel Total	$139,320.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
AIR: MINNEAPOLIS-ANCHORAGE: RESTORATION WORKSHOP	1000.0	2	8	150.0	3,200.0
AIR: MINNEAPOLIS-ANCH-KODIAK: FIELDWORK	2000.0	5	20	150.0	13,000.0
WATER: KODIAK-1ST SITE (INC. ALL FIELD TIME & PERDIEM)	3000.0	1	150	25.0	6,750.0
AIR: RESUPPLY	3000.0	2			6,000.0
WATER:LARGE WATER CROSSINGS	3000.0	2			6,000.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$34,950.0

1998

Project Number: 98/NEW
Project Title: MODELING DIFFERENTIAL *EXXON VALDEZ* OIL SPILL PETROLEUM HYDROCARBON IMPACTS ON ARCHAEOLOGICAL RESOURCES
Name: IMA CONSULTING, INC (MINNEAPOLIS, MN)

FORM 4B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
PORTABLE WATERCRAFT (ZODIAC) RENTAL FOR FIELDWORK, 3 UNITS	4,500.0
FUEL FOR ZODIACS AND GENERATOR	3,000.0
RADIOMETRIC DATING SERVICES (BETA ANALYTIC)	10,000.0
GEOCHEMICAL ANALYTICAL SERVICES (MONTEVERDE ENVIRONMENTAL)	10,000.0
Contractual Total	**$27,500.0**

Commodities Costs:	Proposed
Description	FY 1998
TENT FOR FIELDWORK (COOK/OFFICE)	400.0
TENT FOR FIELDWORK (RESIDENTIAL)	250.0
TENT FOR FIELDWORK (RESIDENTIAL)	250.0
TENT FOR FIELDWORK (RESIDENTIAL)	250.0
TENT FOR FIELDWORK (RESIDENTIAL)	250.0
TENT FOR FIELDWORK (RESIDENTIAL)	250.0
MISCELLANEOUS SUPPLIES (WATERPROOF PAPER, BAGS, ETC.)	500.0
TOPOGRAPHIC MAPS	500.0
Commodities Total	**$2,650.0**

1998

Prepared: 4/97

Project Number: 98/NEW
Project Title: MODELING DIFFERENTIAL *EXXON VALDEZ* OIL SPILL PETROLEUM HYDROCARBON IMPACTS ON ARCHAEOLOGICAL RESOURCES
Name: IMA CONSULTING, INC. (MINNEAPOLIS, MN)

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
MARINE SINGLE SIDE BAND HAND HELD RADIOS	4	300.0	1,200.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$1,200.0

Existing Equipment Usage: Description		Number of Units	
FIELD:	GROUND PENETRATING RADAR (W/APPURTENANCES)	1	
	LAPTOP COMPUTERS	3	
	GPS HARDWARE	1	
	SOLAR BATTERY RECHARGERS	2	
	PORTABLE GENERATOR	1	
LAB:	SUNSPARC WORKSTATIONS	2	
	COMPUTERS	5	
	PRINTERS/SCANNERS/PLOTTERS	4	
	DIGITIZING TABLETS	2	

1998

Project Number: 98/NEW
Project Title: MODELING DIFFERENTIAL *EXXON VALDEZ* OIL SPILL PETROLEUM HYDROCARBON IMPACTS ON ARCHAEOLOGICAL RESOURCES
Name: IMA CONSULTING, INC. (MINNEAPOLIS, MN)

FORM 4B
Equipment
DETAIL

98324-BAA

Community-Based Harbor Seal Research,
Submitted Under the BAA
Announcement No. 52ABNA700049

RECEIVED
APR 1 4 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project number:	98324-BAA
Restoration category:	Research
Proposer:	Alaska Native Harbor Seal Commission
Lead Trustee Agency:	Alaska Department of Fish and Game
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	Five years
Cost FY 98:	289,100
Cost FY 99:	349,100
Cost FY 00:	349,100
Cost FY 01:	274,100
Cost FY 02:	60,000
Cost FY 03:	0
Geographic Area:	Prince William Sound, Kenai Peninsula, lower Cook Inlet, Kodiak Archipelago, Alaska Peninsula
Injured Resource/Service:	Harbor Seals, Subsistence

ABSTRACT

This project aids restoration of harbor seals and subsistence by developing fundamental data sets needed to (1) evaluate factors affecting the harbor seal decline, (2) document potentially sensitive harbor seal habitats during fall-winter-spring, and (3) document local marine occurrences, such as concentrations of schooling fishes that may be associated with the decline or recovery of harbor seals. This project involves the knowledge and expertise of subsistence users and other community members to: survey seasonal changes in harbor seal distribution during the fall-winter-spring; develop detailed annotated harbor seal distribution maps; and record observations of local marine occurrences and summarize observations in regional newsletters.

INTRODUCTION

The goal of this project is to develop a research program to help the Alaska Native Harbor Seal Commission (ANHSC) contribute to the existing scientific research on harbor seals and aid in the scientific understanding of the winter activities and requirements of harbor seals. A primary focus of the research is to assess factors that affect the recovery of the harbor seal population in the oil spill area. Current research suggests that factors associated with winter survival of harbor seals may be a primary cause of the decline, however, knowledge of the their distribution and activities during the winter is poorly documented. This project proposes to use local and traditional knowledge and winter surveys and observations to develop fundamental data sets needed for the understanding of harbor seal activities during the winter. This project will focus on obtaining information on the distribution and habitat use by harbor seals during the fall-winter-spring by: (1) initiating bi-monthly, vessel-based surveys and monthly aerial surveys of selected areas from October through April, (2) documenting the seasonal distribution of harbor seals in the past and present based on local knowledge, traditional knowledge, and scientific data; (3) and recording local observations of marine occurrences, such as the timing and strength of local fish runs, marine bird and mammal activity, and the relative abundance of local subsistence resources.

This project is closely linked to general restoration project /244, Community-based Harbor Seal Management and Biological Sampling and is the next logical step in the development of collaborative research directed toward the restoration of harbor seals and subsistence. The proposed research was stimulated by needs expressed by scientists and community members at Trustee Council funded workshops conducted by projects (94244, 95244, 96244, and 97244) and a National Marine Fisheries Service workshop held in November 1995 to review population assessment research on harbor seals in Alaska. This project extends community-based research developed through the biosampling program and the Whiskers traditional knowledge database. It also continues to incorporate the knowledge and expertise of community members to expand the body of scientific knowledge. The results of the proposed investigations will be presented to community members and scientists at workshops, organized by project (98244) where the effectiveness of the projects will be reviewed and recommendations for improvements will be made.

NEED FOR THE PROJECT

A. Statement of Problem

Harbor seal populations in Prince William Sound and the northern Gulf of Alaska were in decline before the oil spill for unknown reasons. The spill injured these populations, adding to the decline, and in most regions they are not recovering. Harbor seals are a primary subsistence resource for the Alaska Native communities of the oil spill region. Subsistence harvests of harbor seals also have declined in many communities since the spill because of the seal's reduced population size and the hunters' voluntary efforts to aid recovery by limiting takes.

B. Rationale/Link to Restoration

The recovery objective for harbor seals states that recovery will have occurred when harbor seal population trends are stable or increasing. The recovery objective for subsistence states that recovery will have occurred when injured subsistence resources are healthy and productive and exist at pre-spill levels, and people are confident that the resources are safe to eat. Based on the findings from workshops conducted under project /244, meeting these recovery objectives will be enhanced by involving subsistence hunters in research efforts and developing recommendations for subsistence hunters about how they can help in harbor seal recovery.

Fundamental to understanding the cause of the harbor seal decline, the impact of subsistence takes and any mitigating measures that can be taken to reduce the adverse impacts of takes on harbor seal recovery, is knowledge of the seasonal distribution and activities of harbor seals, especially during the fall, winter, and spring when it is thought that harbor seal numbers are being reduced by natural factors. Scientists have repeatedly stressed a lack of understanding regarding the year-around movements and distribution of harbor seals. This information is needed to: (1) understand important habitats used at different times of the year, (2) document potentially sensitive locations or habitats, and (3) evaluate potential factors adversely affecting the harbor seal populations and contributing to the decline. Winter survey studies of harbor seals are difficult because seals spend most of their time in the water and weather conditions often are poor. For those reasons such studies rarely are funded by management agencies. We believe this project will be successful because of the knowledge, experience, resourcefulness, and proximity of local community members who, year-around, travel extensively throughout Prince William Sound and other coastal regions, and are very familiar with harbor seals and their activities. The continuous involvement of biologists and ADF&G personnel in the project's design, training, execution, and analysis phases will ensure high scientific standards throughout the study.

Subsistence hunters and other community members are intrinsically involved with harbor seals and can provide important information about the winter location and abundance of seals, the condition of seals taken for subsistence purposes, seal activity and behavior, and relevant environmental conditions. Subsistence hunters are knowledgeable about sites used by harbor seals during the winter, methods for approaching seals without frightening them, and are skilled at observing seals and discriminating the size and condition of seals. They are also familiar with many other environmental parameters, including activities and distribution of potential harbor seal prey and winter weather conditions. Their life-long, year-around familiarity with harbor seals and their environment also gives hunters the ability to evaluate their observations in relation to observations made in previous years.

This project is designed to incorporate local and traditional knowledge and community resources and personnel to: (1) over the course of 2-3 years, document seasonal harbor seal distribution in the past and present using a Geographic Information System (GIS) to map known harbor seal haulout sites throughout the spill affected area and store information about harbor seal use of each site; (2) initiate a three-year program to document harbor seal habitat use during the fall, winter, and spring in northern, eastern, and southcentral Prince William Sound. This program will use bi-monthly, vessel-based surveys of three selected routes and will complete monthly aerial surveys of Columbia Bay. If successful in documenting differential habitat use, comparative studies at Kodiak Island and the Kenai Peninsula will be proposed for FY 99 - FY 01. (3) Throughout the entire project, coastal community members will help document local marine occurrences such as the timing, location, and strength of fish runs, the relative abundance of subsistence resources, and unusual occurrences that were observed. We believe these observations will help supplement the investigation of the population decline of harbor seals and other nearshore organisms by providing local information on a year-around basis from people who are familiar with the local environment and have a perspective on how their observations relate to events in the past.

C. Location

The proposed studies will involve sites and communities in Prince William Sound, the Kenai Peninsula and lower Cook Inlet area, the Kodiak Island area, and the south side of the Alaska Peninsula. During the first three years, the fall-winter-spring harbor seal surveys will focus on three survey routes in Prince William Sound: southcentral Prince William Sound, Columbia Bay, and Port Gravina. During FY 99 -FY 01, communities on Kodiak Island and the Kenai Peninsula may become involved in the fall-winter-spring surveys. Personnel, vessels, and supplies will be obtained from communities near the survey routes.

The annotated harbor seal distribution maps will involve hunters and other knowledgeable persons from all coastal communities of the oil spill region. Participating communities include the Prince William Sound communities of Cordova, Chenega Bay, Tatitlek, and Valdez; the Kenai Peninsula and lower Cook Inlet communities of Seward, Homer, Seldovia, Port Graham, and Nanwalek; the Kodiak Island communities of Ouzinkie, Kodiak, Old Harbor, Akhiok, Larsen Bay, Karluk, and Port Lions; and the southern Alaska Peninsula communities of Ivanoff Bay, Perryville, Chignik Lake, Chignik Lagoon, and Chignik Bay. Because of the remoteness of villages on Kodiak Island and the Alaska Peninsula, we plan to establish a focus community in each region based on the community's involvement with harbor seals and interest in the project. For the Kodiak and Alaska Peninsula Regions, efforts will be directed to obtaining information and training personnel at the focus community in FY 98. In subsequent years, an outreach program will be developed to obtain information from the other communities in those regions.

The community observation program will involve communities on the Alaska Peninsula, Kodiak Island, the Kenai Peninsula, and Prince William Sound. A community facilitator (Project /052) or other key community members in each region will be contracted as research assistants to establish the program within their community and oversee a community outreach program. Four additional research assistants will be contracted to aid community outreach within each region. We expect community outreach to expand throughout the lifetime of this project. Community involvement will be a key component to the success of this program.

COMMUNITY INVOLVEMENT

In May 1995, The Alaska Native Harbor Seal Commission (ANHSC) was formed to strengthen and increase the role of Alaska Native resource policy affecting harbor seals and their uses. The goals of the ANHSC include the following: educating and informing the public and scientists on the traditional and contemporary relationship between harbor seals and Alaska Natives, informing scientists about the type and extent of knowledge held by the local people about harbor seals, and involving Alaska Natives directly in the research, regulatory and management processes.

The ANHSC represents harbor seal subsistence communities throughout the oil spill area and can provide effective coordination and implementation of the proposed projects by: (1) contacting local communities about the project and soliciting their involvement, (2) contracting with local community members to collect data and provide locally available resources and equipment, including vessels, and (3) communicating the results of the studies through reports and newsletters identified in this project and through newsletters, workshops, and workshop proceedings identified in Trustee Council project 98244.

Local and traditional knowledge of Alaska Natives of the oil spill area is essential to the success of this project. The ANHSC will itself and in collaboration with its subcontractor A. Hoover-Miller and the ADF&G: (1) contract and train four observers to conduct fall-winter-spring harbor seal surveys; local vessels and crew will be used to conduct the surveys; (2) solicit information from and contract knowledgeable community members to provide data for the annotated harbor seal distribution project; and (3) contract and train eight community research assistants to collect and compile information provided by hunters and local community residents for the marine observation program and to develop outreach programs to obtain similar information from residents of other regional communities.

PROJECT DESIGN:

A. Objectives

1. Document the past and present seasonal distribution of harbor seals using traditional and local knowledge and scientific data.

2. Initiate a fall-winter-spring survey program to investigate seasonal habitat use.

3. Initiate a community observation program to document local marine occurrences.

4. Provide a forum for subsistence hunters to collect and review data.

5. Evaluate the program's effectiveness.

B. METHODS

Objective 1. Document the past and present seasonal distribution of harbor seals using traditional and local knowledge and scientific data.

Information on the location of harbor seal haulouts is available from scientific research programs (including projects /001 and /064) and a variety of reports and surveys (e.g., see Hoover-Miller (1994), Loughlin (1992), Pitcher and Calkins (1979), Pitcher and Vania (1973)), the traditional knowledge program (projects /224, /052, and /214), and from local coastal residents, knowledgeable about particular areas. Data from the scientific surveys primarily focus on the distribution of harbor seals during pupping and molting periods. The location and use of haulouts at other times of the year are poorly documented.

A goal of this project is to develop a geographic information system where haulout sites are mapped and related information about historical and seasonal use by harbor seals is linked through associated databases. The use of a geographic information system will aid integration of local and traditional knowledge with scientific data by using a common interface. These data can then be used for further analysis and may be particularly suitable for near shore ecosystem modeling and ecosystem synthesis.

Extensive information has already been gathered through project /244 that is relevant to this project. We plan to integrate pertinent data and use community-based data collection developed by ADF&G to gather additional information with minimal duplication of effort. W. Simeone, ADF&G Subsistence Resource Specialist, will be involved with data collection and interviewer training. We also plan to consult with H. Huntington and P. Colorado with the Traditional Knowledge program (/052B) to enhance the design and implementation of this project.

Initial data collection is proposed to be accomplished in a variety of ways including interviews by ADF&G personnel, A. Hoover-Miller, and research assistants trained by either ADF&G personnel or A. Hoover-Miller. Interviews will be conducted in conjunction with ANHSC meetings and in local communities. When possible, hunters familiar with particular regions will work in groups to document seal haulouts. During work sessions, hunters will review detailed marine charts and mark the location of specific harbor seal haulout sites. For each site identified, one of two data sheets will be filled out to provide information on the year, date, number of seals observed, whether or not pups or molting seals were present, and miscellaneous comments. A detailed data sheet will be available for particularly familiar sites that includes information about the location and description of the site, the observer's experience with the site, historical use of the site by seals, seasonal use of the site by seals, whether or not the site is used for pupping or molting, and miscellaneous comments. Each form also identifies the observer(s) and date the information was provided.

To help integrate the results of this project with other ecosystem studies, A. Hoover-Miller will enter information from data sheets into a dBASE data base and record the location of associated harbor seal haulouts in a Geographic Information System using ArcCad and ArcView software and a coastline base map compatible with other Trustee Council GIS applications.

Objective 2. Initiate a fall-winter-spring survey program to investigate seasonal habitat use.

The proposed fall-winter-spring surveys are the first of a four-year study to document the fall-winter-spring distribution of harbor seals in areas throughout the oil impacted region. Specific hypotheses we intend to test include: (1) all identified age groups of harbor seals are distributed in equal proportions at different habitats throughout the fall-winter-spring, and (2) all habitats monitored are used equally throughout the fall-winter-spring. Using these hypotheses, we intend to investigate whether certain habitats or regions are more important to specific age groups, especially young of the year, and whether habitat use varies during the year. We also will be looking for changes in visible environmental parameters associated with any observed changes in the distribution, age composition, or activity of harbor seals.

In FY 98, surveys will be conducted in Prince William Sound, from October through April. Preliminary analysis will be completed in March 1998 to determine whether sampling frequency and number of seals observed in different regions and habitats are adequate to test for age-specific regional and habitat differences. Any necessary modifications will be identified and described in the FY 99 restoration proposal and interim report. In addition, if the techniques used are sufficient for regional and habitat comparisons, recommendations will be made for the expansion of the program to comparative areas in the oil spill area. Potential comparative sites include Kodiak Island area, an area where harbor seal populations appear to be recovering and the Kenai Peninsula, an area currently in decline that, geographically, could follow Kodiak Island in recovery.

We believe the surveys in Prince William Sound will be particularly useful as many of the ecosystem studies and harbor seal research programs have focused their efforts there and provide extensive data to aid the interpretation of the results. We also feel this project will provide valuable information to related projects. Project /064 has conducted comprehensive work on harbor seals affected by the oil spill including pupping and molting surveys in the central and eastern PWS, satellite telemetry studies, and food habits studies. Satellite telemetry studies conducted by project /064 documented considerable movements where 41% of 27 seals tagged in PWS between 1981 and spring 1995 traveled to either the Gulf of Alaska or glacial habitats; 27% of 15 seals tagged on Applegate Rocks and Seal Island in central Prince William Sound, visited ice habitats at Columbia Glacier or College Fjord. During the winter and spring of 1995-96, even greater proportions of seals traveled to peripheral areas of PWS and the Gulf of Alaska. Subsistence hunters also have observed increasing numbers of seals in the eastern PWS, which appear to be associated with increasing numbers of herring in the area. Although satellite tagging and lipid analysis studies conducted by project /064 provide information on harbor seal movements and food habits, there are few concurrent observations of the activities of seals and other organisms.

Several factors strongly influenced the selection of survey routes. These factors included the types of habitats used by harbor seals, the likelihood of observing seals during the winter, and the ability to survey the area under limited daylight conditions. Potential survey sights were visited by hunters in February/March 1997. At the March ANHSC meeting, the hunters met with A. Hoover-Miller and discussed which sites had the greatest potential for meeting the project's objectives and how their observations compared with observations in previous years. The selection of survey sites and associated survey protocol resulted from that meeting. The survey routes chosen incorporate a variety of habitats including protected coves, anadromous stream mouths, seasonal pan or glacier ice, and rocky semi-protected shoreline. They were selected on the basis of the comparative information each would provide to contrast, understand and document the fall-winter-spring activity and distribution of seals.

This study involves conducting vessel surveys of three areas in Prince William Sound with contrasting habitats and summer population trends: (1) Central PWS (Applegate Rocks, Channel Island, and Port Chalmers) where seal numbers are declining and there is extensive information on the pupping and molting abundance of seals, information on the movements and diving behavior of satellite tagged seals (project /064), and information on food habits, based on lipid analysis (project /117-BAA), (2) Port Gravina, an area of increasing seal numbers, pupping and molting trend count data, and limited satellite tagging data, and (3) Columbia Bay which has ice and land haulouts, is a destination for seals traveling from the central Prince William Sound, and is being increasingly used by seals during the molting period. These regions encompass important haulout sites and include diverse habitats within and between routes.

Surveys will be conducted two times per month. During each period, the southcentral and Glacier Bay areas will be surveyed twice, in opposite directions, in order to gather data at different tide and time periods. The southcentral survey is expected to take three days to complete, including travel time, and the Glacier Bay survey should be completed in two days; the Gravina Bay site also will be surveyed over a three day period for which selected sites (probably Olsen Bay, Gravina Island, and Gravina Rocks) will be examined twice per survey period. Surveys will document the location, estimated age of the seal (e.g., pup/yearling, juvenile, large adult) if it can be ascertained, the seal's activity, whether the seal is on shore, ice, or in the water, existence and activity of other birds, marine mammals, or fishes in the area. In addition, information on the date, time of day, tide, currents, sea condition, and weather will be collected at specific stations and when it noticeably changes. Sightings of harbor seals will be recorded on field maps and related information recorded on data sheets. Verbal notes may be taken using tape recorders to supplement the data sheet records.

Columbia Bay is a particularly difficult area to survey as many areas are not accessible because of the ice. Vessel surveys will focus on the outer section of the bay and drifting glacial ice. To aid interpretation of the data, aerial surveys of the inaccessible areas will be conducted on a monthly basis and, when time permits, will extend toward Unakwik Bay and College Fjord. An effort will be made to coordinate the aerial and vessel surveys, however, a greater emphasis will be placed on conducting aerial surveys during optimal viewing and haulout conditions.

Observers will be trained by A. Hoover-Miller to conduct surveys using consistent methods from survey to survey that minimizes disturbance to seals. Vessel-based training will occur in October 1997. An effort will be made to standardize survey protocols between routes (e.g., vessel speed, platform height, identification of categorical data such as weather and sea conditions). The assignment of age categories for harbor seals can be very subjective and cannot always be made because of viewing opportunities. Surveys will be conducted using highly experienced observers who have life-long experience observing harbor seals. They have demonstrated skilled abilities in evaluating the age (adult, subadult, or pup) and sex of seals based on morphology and behavior. Nevertheless, each observer may use different cues to assign age/sex classes to seals. Criteria used by each observer to assign age/sex categories to seals will be identified before the first survey and after the completion of surveys the following spring. Although certain categories may be reached by consensus (e.g., large adult male, late-term pregnant female, small 0-1 year-old juveniles) other categories may not be reliably identified by all observers. For FY 98 an emphasis will be placed on standardizing categorical assignments within survey routes (observers). After evaluating the results from FY 98 data, recommendations and training will be conducted to standardize age categories between survey routes (observers) for FY 99 and beyond.

Although continuing surveys throughout the summer would be desirable, we believe, it is important to first statistically evaluate winter surveys, when the likelihood of observing seals is lowest and survey conditions are poorest. A primary purpose of the FY 98 surveys will be to provide information to test the feasibility of using winter surveys to monitor seal distribution and to study habitat use during the winter months. The resulting data is unlikely to be sufficient for monitoring population trends, which is not an objective of this project. Results from FY 98 will be used to estimate sample variances, develop sampling protocol for FY 99, estimate the statistical power of the FY 99 sampling program, and make recommendations for the extension of surveys into the summer and the initiation of surveys on the Kenai Peninsula and Kodiak Island.

Objective 3. Initiate a community observation program to document local marine occurrences.

Occurrences relating to the marine environment (e.g., location and timing of schooling fishes and feeding concentrations of seabirds and marine mammals) often are observed by coastal residents but rarely are recorded. Such observations can provide valuable information on local conditions and annual variations in marine conditions or occurrences, they also provide documentation of unusual occurrences. These observations are important for recording local factors potentially relevant to understanding the cause of the harbor seal population decline and factors that may enhance recovery. Such observations can provide the groundwork for productive scientific investigation.

Information about diverse topics concerning the marine environment is proposed to be gathered by community-based research assistants, trained by either A. Hoover-Miller or W. Simeone, who will explain the objectives of the project to community members and schools, receive information from community members, and ensure relevant critical information (e.g., date, time, and location of the observation, and the observer's name) are included with the observation. The community representative would compile the observations for submission to ANHSC. Regional newsletters from the Alaska Peninsula, Kodiak Island, the Kenai Peninsula, and Prince William Sound will be written and distributed to interested community residents, scientists, and other persons. Depending on the experience of key personnel and the availability of necessary equipment, newsletters and other summaries will either be prepared by the research assistants or submitted to the ANHSC for compilation and publication. Youth Area watch participants (currently limited to Prince William Sound) and youth from local schools will be strongly encouraged to participate in the collection of information and the development of the regional newsletters.

Community representatives also will initiate an outreach program to collect and process similar information from other regional communities. We expect that during FY 98 four additional research assistants will be needed in other communities to aid the development of outreach programs.

Objectives 4 and 5. Provide a forum for subsistence hunters to collect and review data and evaluate the program's effectiveness.

These objectives will be addressed in all phases of the project as subsistence hunters will be active participants in the development and review of all data sets. An initial review of the program's effectiveness will be completed by A. Hoover-Miller prior to April 1998. It will be available to hunters, community members, and interested scientists through the ANHSC and will be used to modify the project's design and execution, if necessary. The review and results of each project objective will be presented at ANHSC meetings and written summaries will be provided to hunters and interested community members and scientists.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Consultation and technical assistance will be provided as in-kind contributions by the Alaska Sea Otter Commission, the Chugach Regional Resources Commission, Rural Alaska Community Action Program, the Indigenous People's Council for Marine Mammals, and the ADF&G, Division of Subsistence. The following contracts are planned:

1. Pacific Rim Research

A. Hoover-Miller at Pacific Rim Research will be contracted by the ANHSC as a biological consultant to develop the year-around distribution of harbor seals based on traditional and local knowledge and fall-winter-spring field surveys.

Proposed Pacific Rim Research Contract: Budget

A. Hoover-Miller, Pacific Rim Research, will be contracted by the ANHSC	
$5,000/mo. for nine months.	$45,000
Overhead (10% contract)	$4,500
Total:	$49,500

2. Fall-winter-spring field surveys.

Four experienced subsistence hunters will be contracted by the ANHSC to conduct bi-monthly vessel-based surveys and monthly aerial surveys from mid-October through early April and record all sightings of harbor seals within specific routes on data maps and data sheets. Twelve surveys vessel-based surveys of each region and seven aerial surveys of Columbia Bay area are expected to be conducted each year.

Proposed Fall-Winter-Spring Survey Contracts: Budgets

Vessels, including crew, will be contracted by the ANHSC:	$76,332
(Vessel costs estimated for an average of 42 ft vessel at a rate of $18/ft/day per survey)	
((42 ft x $18/ft/day x 3 days x 12 surveys x 2 survey routes) plus	
(42 ft x $18/ft/day x 2 days x 12 surveys x 1 survey route) plus one day training)	
Observer @ $150/day will be contracted by the ANHSC	$16,050
(Vessel surveys: 3 persons x 2.67 days per survey period x $150/day x 12 surveys	
Aerial surveys: 1 person x 7 surveys x $150/day plus one day field training for all observers)	
Aircraft will be contracted by the ANHSC	
(7 surveys x 295/hr x 3 hrs)	$6,195
Total:	$98,577

3. Community-based Researchers

Community-based researchers throughout the oil spill region will be contracted by the ANHSC to contribute to the research described in this project. Duties include soliciting and compiling community observations, providing information for annotated harbor seal distribution maps, and submitting information to the ANHSC.

Proposed Community-based Researchers: Budgets

Compensation for time spent compiling and processing village observations and assisting with seasonal distribution maps and fall-winter-spring surveys as needed. Note: it is anticipated that 4 key researchers (one each in Prince William Sound, Kenai Peninsula, Kodiak Island, and the Alaska Peninsula) will spend 5 days per month on the project while an additional 4 community-based researchers will spend 3 days per month compiling and summarizing information from other locations in each region.

4 persons x $120/day x 5 days/mo x 12 mo.	$28,800
4 persons x $120/day x 3 days/mo x 12 mo.	$17,280
Overhead (10% of contract)	$4,608
Total	$50,688

Proposed Annotated Map Development: Budget

Compensation to be paid to contributors for time spent documenting and reviewing annotated harbor seal maps (Note: estimated 750 hours to be contributed @ $15/hr)	$11,250

SCHEDULE

A. Measurable Project Tasks for FY 98

Start-up to October 15:	Contract with Pacific Rim Research, observers, and research assistants. Apply for Marine Mammal Protection Act Section 104 permit for Level B harassment.
October 1997:	Hold village training sessions for fall-winter-spring survey program and community observation program.
October-April 1998	Conduct fall-winter-spring surveys. Collect annotated harbor seal distribution information.
January 1998	Participate in the Trustee Council Restoration Workshop
Prior to May 1998	Participate in 98244 workshop, summarize and evaluate progress to date, make necessary changes to sampling protocol, and provide follow-up training, if needed.
April 1998:	Produce and distribute first community observation newsletters.
September 1998:	Produce and distribute second community observation newsletters. Evaluate first year of program.

B. Project Milestones and Endpoints

1. Conduct workshops in Cordova, Homer, and Kodiak to train hunters and village representatives on providing and recording information for the annotated harbor seal distribution maps and community observation programs: October 1997.
2. Begin fall-winter-spring surveys: October 1997
3. Begin developing geographic information system coverage for annotated harbor seal distribution maps. November 1997.
4. Participate in 98244 workshop, summarize and evaluate progress to date, make necessary changes to sampling protocol, and provide follow-up training, if needed: Prior to May 1998
5. Participate in the Trustee Council Restoration Workshop: January 1998
6. Complete preliminary evaluation of fall-winter-spring surveys: March 1998
7. Produce and distribute first community observation newsletters: April 1998
8. Produce and distribute second community observation newsletters: September 1998
9. Evaluate the program's effectiveness: September 1998
10. Begin fall-winter-spring surveys for FY 99: October 1998
11. Participate in the Trustee Council Restoration Workshop: January 1999
13. First annual report: April 15, 1999.

14. Produce and distribute third community observation newsletters: April 1999
15. Produce and distribute fourth community observation newsletters: September 1999
16. Begin FY 00 fall-winter-spring surveys: October 1999
17. Begin to incorporate scientific data into harbor seal distribution GIS: October 1999
18. Participate in the Trustee Council Restoration Workshop: January 2000
19. Produce and distribute fifth community observation newsletters: April 2000
20. Second annual report: April 15, 2000.
21. Produce and distribute sixth community observation newsletters: September 2000
22. Begin FY 01 fall-winter-spring surveys: October 2000.
23. Participate in the Trustee Council Restoration Workshop: January 2001
24. Produce and distribute seventh community observation newsletters: April 2001
25. Complete and distribute the annotated harbor seal distribution GIS: December 2001
26. Participate in the Trustee Council Restoration Workshop: January 2001
27. Produce and distribute seventh community observation newsletters: April 2001
28. Complete fall-winter-spring surveys: April 2001
29. Third annual report: April 15, 2001
30. Produce and distribute eighth community observation newsletters: September 2001
31. Third annual report: April 15, 2001.
32. Final Report: April 15, 2002.

D. Completion Date

Community-based harbor seal research should continue as long as the Marine Mammal Ecosystem Research package is underway. Presently, fieldwork and data analysis for this study package are proposed through FY 01, with close-out in FY 02. The harbor seal distribution program should be viewed as a developing program to be evaluated for potential expansion to the lower Kenai Peninsula, Kodiak and continued through at least FY 01. At the end of three years a harbor seal distribution GIS coverage should be complete and distributed. Fall-winter-spring surveys and the recording of local observations will be evaluated annually to assess needed modifications.

PUBLICATIONS AND REPORTS

No manuscripts are planned for publication in peer-reviewed journals for FY 98.

Two community observation newsletters each fiscal.
First annual report: April 15, 1999.
Second annual report: April 15, 2000.
Third annual report: April 15, 2001.
Final Report April 15, 2002.

PROFESSIONAL CONFERENCES

Alaska Native Harbor Seal Commission Workshop
Indigenous People's Council for Marine Mammal Meetings
Arctic Science Conference

NORMAL AGENCY MANAGEMENT

Not Applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will supplement and use data about the population status, distribution, and degree of recovery of harbor seals collected by the Marine Mammal Ecosystem study package, including restoration project numbers 98001 and 98064. It also will draw on the results of research conducted by the Division of Subsistence under a contract with the National Marine Fisheries Service to monitor subsistence harvests and project 98244 the Community-based Harbor Seal Management and Biological Sampling. The project will provide information to researchers working on harbor seal restoration projects and aid their access to local and traditional knowledge of Alaska Native hunters. In addition this project will rely greatly on the participation of community members and will coordinate activities with the Community Involvement project (98052) and the Youth Area Watch (98210).

This project also will support other restoration projects proposed for FY 98 such as the Condition and Health of Harbor Seals (98001), Monitoring of Harbor Seals in Prince William Sound (98064), Isotope Ratio Studies of Marine Mammals (98170), the Community Involvement and Traditional Knowledge Project (98052), and the Sound Ecosystem Assessment (98320), and would provide valuable harbor seal seasonal distribution information for Ecosystem Synthesis.

PROPOSED PRINCIPAL INVESTIGATORS, IF KNOWN

Monica Riedel
Alaska Native Harbor Seal Commission
P.O. Box 2229
Cordova, AK 99574
Phone: (907) 424-5882
FAX: (907) 424-5883

Anne Hoover-Miller
Pacific Rim Research
P.O. Box 2507
Seward, AK 99664

PRINCIPAL INVESTIGATORS

Monica Riedel:

Responsibilities: (will be accomplished with the aid of a currently unnamed assistant)

1. Oversight and management of entire project.
2. Establish contracts and manage funds associated with the project.
3. Contact hunters and community members to encourage and coordinate participation in the project.
4. Coordinate training, data collection, analysis, and reporting with respect to the fall-winter-spring surveys, community observation program, and annotated seasonal distribution maps.
5. Aid in the creation and publication of regional newsletters.
6. Be responsible for the development, storage, and maintenance of data sets originated by the project.
7. Participate in the evaluation of the project and facilitate needed improvements.
8. Write interim and final reports.
9. Present the progress and findings of the project at the EVOS Trustee Council Restoration Meeting and at the Alaska Native Harbor Seal Commission annual meeting.

Qualifications: See attached Resume

Monica Riedel

P.O. Box 2229 ▪ Cordova, AK 99574 ▪ (907) 424-5882

Objective

To be fully involved in tribal and cultural preservation. Main focus of interest is conservation of marine mammals and preservation of traditional and customary use of marine mammals.

Employment

Present: **Executive Director /Chair**. Alaska Native Harbor Seal Commission, P.O. Box 2229, Cordova, Alaska. ph. (907) 424-5882, Fax (907) 424-5883.

Duties: (1) to call and preside at all meetings of the Commission of the Executive Committee; (2) to speak on behalf of the Commission and the Executive Committee; (3) to authorize public statements of Commission position; (4) to sign documents on behalf of the Commission; and (5) to perform other such duties of the office as prescribed by the commission of Executive Committee.

Co-Project Leader. *Exxon Valdez* Trustee Council Restoration Project on Community-based Harbor Seal Management and Biological Sampling.

Duties: facilitating workshops related to the harbor seal population and issues, facilitating training sessions for biological sampling, setting up accounts for shipping samples, hiring/subcontracting hunters for program, creating and distributing newsletters to tribes, financial accounting to funding agencies. Writing proposals and applying for grants.

Owner. Dineega Specialty Furs. P.O. Box 1005. Cordova, Alaska, 99574. Phone (907) 424-3241.

Specializing in Alaska Native Parkas, decorated with traditional beadwork, and in-lay applique. Work involves managing all phases of the business and training employee in measuring, altering patterns, grading fur, creating designs for parka trims, buying fur, leather, tools and other materials. Also teach at various spirit camps and villages.

1989 **Expediter**. City of Cordova.

Duties: Transporting dignitaries to and from airport, taking television crews to interviews, logging and filing daily Coast Guard reports, preparing information for Senators, and other decision makers.

1983-86 **Administrative Assistant** to Harbor master. City of Cordova.

Duties: Billing and posting all department charges and receivables via electronic cash register and maintaining computerized records. Perform all normal reception and clerical duties (correspondence, memos, minutes, etc), maintain radio watch and overseen grid assignments, insure proper registration and moorage of vessels, perform facilities check and security presence.

1979-81 **Cannery Worker**. Chugach Alaska Fisheries, North Pacific Processors, Glacier Packing. Cordova, Alaska.

1977-79 **Real Estate Agent**. Red Carpet Realtors. 7300 Franklin Blvd., Sacramento, California.

Duties: Writing contracts, updating listings by reconnaissance, computer researching, comparison, and other functions related to position. Developed skills in public relations, marketing, referral techniques, and follow-up. Served as council member to Red Carpet Realtors at branch office.

Boards and Committees

Executive Director / Chair: Alaska Native Harbor Seal Commission
Native Village of Eyak Representative: Chugach Regional Resources Commission (5/94-1/97)
Vice-chair: Indigenous Peoples Council for Marine Mammals

Education

- Monroe High School, Fairbanks, Alaska (1970-1974)
- Western Michigan University (July-August 1973):
  Cultural Anthropology, Environmental Observation
- Kenai Peninsula Community College, Kenai, Alaska (Sept.-Dec. 1973)
- Anchorage Community College, Anchorage, Alaska (Jan.-May 1974)
- Alaska Methodist University (July-August 1974)
  Field Study: Archaeology in Kachemak Bay and Homer, Alaska
- University of Alaska Fairbanks, Alaska (Sept.-Dec 1974)
- Anthony Real Estate Schools, Sacramento, California (July-Nov 1977)
- Red Carpet Realtors School, Sacramento, California (April-May 1979)
  Comprehensive sales and financial course.
- Prince William Sound Community College, Cordova, Alaska (1981 on)
  Various courses to supplement continuing education.
- David Green Furs, Anchorage, Alaska (Feb 1987)

Honors and Scholarships

- First place trophy winner for Eskimo Contemporary Parka at 1991 and 1992 World Eskimo Indian Olympics

- Scientific Award from Monroe High 1973 Scientific Scholarship through Explorers Club of America to participate with a group from Western Michigan University for six week Environmental Study of the Aleutian Islands. Studies included: anthropology, biology, botany, glaciology, scuba diving, natural habitat.

- Top salesman award for second quarter from Red Carpet Realtors, Sacramento, California, 1978.

- Certificate from Prince William Sound Community College for participating in the Elder-Hostel Program from 1988 through 1990.

Personal

Eyak and Athabascan Indian of the lower Koyukon dialect. Born in Anchorage, Alaska, July 23, 1956. Raised in a bilingual home in Kaltag, Alaska. Able to relate to own people through our native language and cultural background. Wife and mother of 14 year old daughter and 9 year old son.

Anne Hoover-Miller

Responsibilities:

1. Develop protocols for fall-winter-spring surveys, documentation of harbor seal haulouts, and community observations, develop data forms, and incorporate instructions for their use into training programs.

2. Initiate and conduct training for fall-winter-spring survey observers and community-based researchers.

3. Participate in interviewing hunters when developing annotated harbor seal distribution maps.

4. Receive information from workshops, surveys, and community observations and enter information into databases; the location of haulout sites and related population information will be digitized and integrated in an ArcView based geographic information system.

5. Develop readily understandable reports for distribution to community members that summarize the progress and results of the projects.

6. Participate in ANHSC workshops and provide summaries of the results of the research programs.

7. Evaluate the progress and results of the projects and develop recommendations for improving procedures and protocol.

8. Write a summary of the project for inclusion in the interim and final reports for the Trustee Council.

A. Anne Hoover-Miller

Pacific Rim Research
Anchor Cove, Day Harbor
P.O. Box 2507
Seward, AK 99664

Biologist

Education: 1978: B.A., (Psychobiology and Environmental Studies: Natural History). University of California, Santa Cruz.

1983: M.Sc., (Biology). University of Alaska, Fairbanks.

Experience:

Present CO-OWNER of Pacific Rim Research/Wilderness Images, P.O. Box 2507, Seward, AK 99664 since 1983. Scientific research, desktop publishing and computer consulting. Samples of work include the following:

1991-1994. Contracted with the Marine Mammal Commission to evaluate the possible use of a Geographic Information System for conserving marine mammals in Alaska and conduct a workshop with appropriate state and federal agencies.

1985-1994. Contracted with the U.S. Marine Mammal Commission to develop species accounts with management recommendations for Steller sea lions and harbor seals in Alaska and to revise the harbor seal species account.

1995. Contracted with the U.S. Marine Mammal Commission to review traditional knowledge about harbor seals documented by the Division of Subsistence, and develop recommendations for the ANHSC to collect and manage traditional knowledge information for cultural, scientific, and co-management purposes.

1995- present. Worked with the Alaska Native Harbor Seal Commission by providing scientific consultation pertaining to harbor seals in Alaska.

Present FISHERMAN. Crewed on commercial halibut longline and salmon driftnet vessels F/V *Ouzel* and F/V *Eagle Point* since 1983.

05/89 - 05/90 TECHNICAL SPECIALIST for the National Park Service, Seward, Alaska, regarding the *Exxon Valdez* oil spill. Designed and coordinated biological studies, developed and maintained computer databases, wrote and evaluated reports, and represented the National Park Service in multi-agency meetings and operations.

01/87-06/88 INSTRUCTOR for Prince William Sound Community College, Cordova, AK. Instructed students in use of personal computers and software.

10/84 - 06/85 COMPUTER PROGRAMMER for the Center for Disease Control via the Indian Health Service, 225 Eagle St. Anchorage, AK, 99510. Maintained, modified and designed software, data collection forms, and data bases for laboratory and research personnel.

01/84 - 05/84 INSTRUCTOR for Kenai Peninsula Community College, Seward, AK. Taught Biology of Marine Mammals and Birds of Alaska.

01/84 - 05/84 SUBSTITUTE TEACHER Seward High School, Seward, Alaska, 99664. Taught biology, math, physics, special education, and computer classes.

09/78 - 03/83 RESEARCH ASSISTANT at the Institutes of Marine Science and Arctic Biology, University of Alaska, Fairbanks. Contributed to field and literature research on ecology, behavior, population dynamics, and disturbance of marine mammals and birds in the Gulf of Alaska, Bering and Chukchi seas.

01/80 - 05/80 TEACHING ASSISTANT at the University of Alaska, Fairbanks. Prepared and taught lab and discussion sections for Biology and Man.

05/78 - 08/78 CONSULTANT for EG&G Analytical Services Center, Rockville, Maryland. Surveyed the status and distribution of manatees and sea turtles on Vieques Island, Puerto Rico.

12/75 - 09/78 RESEARCH ASSISTANT for the Division of Life Sciences, University of California, Santa Cruz. Participated in field studies on population ecology and reproductive behavior of elephant seals, Steller sea lions and harbor seals.

Reports and Publications:

Fay, F. H., B. P. Kelly, P. H. Gehnrich, J. L. Sease, and A. A. Hoover. 1984. Modern populations, migrations, demography, trophics, and historical status of the Pacific walrus. Final Report. Research Unit 611. NOAA Outer Continental Shelf Environmental Assessment Program. Anchorage. Alaska. 142 pp.

________, B.P. Kelly, A.A. Hoover, and R.R. Nelson. In prep. The reactions of walruses (*Odobenus rosmarus*) in the Bering and Chukchi seas to disturbance by vessels and aircraft.

Hoover, A. A. 1978. Sexual dimorphism in dentition and molting of northern elephant seal pups. Senior Thesis. University of California, Santa Cruz. 64 pp.

________. 1983. Behavior and ecology of harbor seals (*Phoca vitulina richardsi*) inhabiting glacial ice in Aialik Bay, Alaska. M.Sc. Thesis. University of Alaska, Fairbanks. 133 pp.

________. 1988. Harbor seals (*Phoca vitulina*). *In*: Selected marine mammals of Alaska: species accounts with management recommendations, 1991 update. Jack Lentfer (ed.). Marine Mammal Commission. Washington D.C.

________. 1988. Steller sea lions (*Eumetopias jubatus*). *In*: Selected marine mammals of Alaska: species accounts with management recommendations. Jack Lentfer (ed.). Marine Mammal Commission. Washington D.C.

Hoover-Miller, A.A. 1992. Assessment of the possible use of a cooperative/coordinated geographic information system (GIS) to facilitate access to, and integration and analysis of, data bearing upon the conservation of marine mammals in Alaska. Final report for MMC contract T75136297. NTIS PB93-128429.

________. 1994. Harbor seals (*Phoca vitulina*): Biology and Management in Alaska. Report to the Marine Mammal Commission. Contract Number T75134749. Washington, D.C. 45 pp.

________. 1995. Report of the Workshop on Enhancing Methods for Locating, Accessing, and Integrating Population and Environmental Data Related to Marine Resources in Alaska. April 5-7, 1994, Hotel Captain Cook, Anchorage, Alaska.

________. 1995. Recommendations for an Alaska Native Harbor Seal Commission Traditional Knowledge Program. Report to the Alaska Native Harbor Seal Commission, Cordova, AK. 13pp.

Murphy, E. C. and A. Anne Hoover. 1981 Research study of the reactions of wildlife to boating activity along Kenai Fjords coastline. Final Report for the National Park Service, Anchorage, Alaska. Contract No. CX-9000-8-0151. 125 pp.

________. A.A. Hoover, R.H. Day, K.L. Oakley. 1992. Intracolony variability during periods of poor reproductive performance at a glaucous-winged gull colony. The Condor. 94:598-607.

OTHER KEY PERSONNEL

Name: William Simeone, Ph.D.

Address: Division of Subsistence
Alaska Department of Fish and Game
333 Raspberry Rd
Anchorage, AK 99502

Title: Subsistence Resource Specialist

Responsibilities:

1. Assist in the training of community research assistants.

2. Assist in collection and organization of traditional knowledge associated with the community observation program and the annotated harbor seal maps.

Experience:

Dr. William Simeone is a Subsistence Resource Specialist with the Division of Subsistence of the Alaska Department of Fish and Game. He holds a Ph.D. in anthropology. Dr. Simeone has considerable research experience in the oil spill area communities and in the collection and application of traditional knowledge. He was the project manager for Restoration Project 96214, which produced a video on subsistence hunting of harbor seals entitled "Alutiiq Pride: A Story of Subsistence." He also contributed to the development and implementation of Project /052 (Community Involvement and Traditional Ecological Knowledge) and Project /244 (Community-based Harbor Seal Management and Biological Sampling).

LITERATURE CITED

Hoover-Miller, A. A. 1994. Harbor seals (*Phoca vitulina*): Biology and Management in Alaska. Report to the Marine Mammal Commission. Contract Number T75134749. Washington, D.C. 45 pp.

Loughlin, T. R. 1992. Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) in the Gulf of Alaska and Prince William Sound in 1992. 1992 Annual Report to the MMPA Assessment Program, Office of Protected Resources. Silver Springs. MD. 25pp.

Pitcher, K.W., and D. Calkins. 1979. Biology of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 19:231-310.

Pitcher, K.W., and J. S. Vania. 1973. Distribution and abundance of sea otters, sea lions, and harbor seals in Prince William Sound. A Preliminary Report. Alaska Department of Fish and Game, Anchorage, AK.

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$13.8
Travel		$5.1
Contractual		$270.2
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$289.1
General Administration		$0.0
Project Total	$0.0	$289.1
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$349.1	$349.1	$274.1	$60.0

Dollar amounts are shown in thousands of dollars.

Comments:

The Alaska Native Harbor Seal Commission will be administering the project. General Administrative costs are reflected in Form 4A Indirect Costs.

Project Costs: 7% Report Writing and Workshop Attendance; 93% Community Involvement.

FY 99 data analysis and report writing pertaining to FY 98 data: $30,000

1998

Prepared: 4/9/97

Project Number: 98324-BAA
Project Title: Community-based Harbor Seal Research
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
W. Simeone, ADF&G	Subsistence Resource Specialist		3.0	4.6		13.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.0	4.6	0.0	
					Personnel Total	$13.8

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
W. Simeone - training and working sessions					0.0
Anchorage/Chenega	0.7	1	1	0.1	0.8
Anchorage/Tatitlek	0.7	1	1	0.1	0.8
Anchorage/Valdez	0.2	1	1	0.1	0.3
Anchorage/Cordova	0.4	1	2	0.1	0.6
Anchorage/Kodiak	0.2	1	1	0.1	0.3
Kodiak/Old Harbor	0.1	1	2	0.1	0.3
Anchorage/Homer	0.2	2	2	0.1	0.6
Anchorage/Chignik Bay	0.7	1	2	0.1	0.9
Homer/Seldovia/Nanwalek/Port Graham	0.2	1	3	0.1	0.5
					0.0
					0.0
				Travel Total	$5.1

1998

Prepared: 4/9/97

Project Number:
Project Title: Community-based Harbor Seal Research
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
4A Linkage	270.2
When a non-trustee organization is used, the form 4A is required. Contractual Total	$270.2

Commodities Costs:	Proposed
Description	FY 1998
Commodities Total	$0.0

1998

Prepared: 4/9/97

Project Number:
Project Title: Community-based Harbor Seal Research
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1998

Prepared: 4/9/97

Project Number:
Project Title: Community-based Harbor Seal Research
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$23.4						
Travel		$8.0						
Contractual		$210.1						
Commodities		$9.0						
Equipment		$1.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal				Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$18.2						
Project Total		$270.2		$330.2	$330.2	$255.2	$60.0	
Full-time Equivalents (FTE)		0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Indirect = General Administrative Costs as computed by Form 3A.

Project Costs = 7% report writing and workshop attendance, 93% community involvement

1998

Prepared: 4/9/97

Project Number:
Project Title: Community-based Harbor Seal Research
Name: Alaska Native Harbor Seal Commission

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
Name	Position Description					
Monica Riedel	Principal Investigator		3.0	4.0		12.0
Un-named	Assistant		6.0	1.9		11.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal					
					Personnel Total	$23.4

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Description					
A. Hoover-Miller, M. Riedel, or Trainees					0.0
Survey Observer Training, Maps, Observation Program					0.0
Anchorage-Cordova	0.4	2	5	0.1	1.3
Cordova -Valdez	0.1	2	5	0.1	0.7
Fairbanks-Valdez	0.5	1	2	0.1	0.7
Tatitlek-Cordova	0.3	2	5	0.1	1.1
Training - Maps, Observation Program					0.0
Anchorage - Kodiak/Old Harbor	0.3	1	3	0.1	0.6
Anchorage - Homer/Seldovia/Nanwalek/Port Graham	0.3	1	3	0.1	0.6
San Francisco - Anchorage	0.7	3	9	0.1	3.0
					0.0
					0.0
				Travel Total	$8.0

1998

Prepared: 4/9/97

Project Number:
Project Title: Community-based Harbor Seal Research
Name: Alaska Native Harbor Seal Commission

FORM 4B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
A. Hoover-Miller, Pacific Rim Research	49.5
Charter Vessels	76.3
Charter Aircraft	6.2
Observers (4)	16.1
Research Assistants (8)	50.7
Annotated Map Developers	11.3
Contractual Total	$210.1

Commodities Costs:	Proposed
Description	FY 1998
Fuel for surveys	8.0
Field Supplies (Charts, Data Sheets, Write-In-Rain Books, Cassettes)	1.0
Commodities Total	$9.0

1998

Prepared: 4/9/97

Project Number:
Project Title: Community-based Harbor Seal Research
Name: Alaska Native Harbor Seal Commission

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
35 mm Nikon Camera with 70-210 mm zoom lens	1	1.1	1.1
Cassette Recorders	4	0.1	0.4
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	New Equipment Total		$1.5

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1998

Prepared: 4/9/97

Project Number:
Project Title: Community-based Harbor Seal Research
Name: Alaska Native Harbor Seal Commission

FORM 4B
Equipment
DETAIL

98325-BAA

Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the *Exxon Valdez* Oil Spill: Preparation of Manuscripts for Publication - Submitted Under BAA

Project Number:	~~None~~ 98325-BAA
Restoration Category:	Research
Proposer:	Coastal Resources Associates, Inc.
Lead Trustee Agency:	NOAA (Submitted Under BAA)
Cooperating Agencies:	ADF&G
Alaska SeaLife Center:	No
Duration:	1st year, 3-yr project
Cost FY 98:	$104,096
Cost FY 99:	$92,000
Cost FY 00:	$800
Cost FY 01:	None
Cost FY 02:	None
Geographic Area:	No Field Work Proposed, Past Work in Prince William Sound, Kenai/Cook Inlet, and Kodiak/Alaska Peninsula
Injured Resource/Service:	Intertidal Communities

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

This project will prepare manuscripts for publication in scientific journals based on previous Trustee funded evaluations of injury to, and restoration of, coastal habitats (intertidal and subtidal communities).

INTRODUCTION

The *Exxon Valdez* Oil Spill Trustee Council (hereafter referred to as the EVOS Trustees) has funded a number of projects that examined the injury to, and recovery of intertidal and nearshore subtidal systems. These include Coastal Habitat Study 1A: Comprehensive Assessment of Coastal Habitat; Restoration Project 94086: Herring Bay experimental monitoring studies; and several projects dealing with nearshore subtidal communities (Air/Water Project ST2A, and Restoration Projects 93047 and 95106). The final reports for these projects have been submitted to the Trustees (Highsmith et al. 1994, 1995; Jewett et al. 1995; and Jewett and Dean 1996) and several aspects of this work have either been published or are submitted for publication in the peer reviewed scientific literature (see Literature Cited). However, there are still several important scientific aspects of this work that have not been published. This proposal seeks funding to prepare those manuscripts.

NEED FOR THE PROJECT

A. Statement of Problem

Publication of past Trustee sponsored studies of coastal habitats is important because these studies serve as a critical foundation for future injury assessment and restoration efforts. These studies are the most thorough and comprehensive investigations of a major oil spill that have been conducted to date, and should serve as cornerstone for future oil spill studies. Some of the Trustee sponsored work has recently been criticized (e.g. Paine et al. 1996) and a timely publication of coastal habitat studies is needed in order to correct some current misconceptions.

B. Rationale/Link to Restoration

The lessons learned from studies of coastal habitats following the *Exxon Valdez* oil spill, both about the ecology of the nearshore environment and about the process of assessing impacts from a major oil spill, are valuable ones that need to be applied to future restoration efforts.

C. Location

There are no field studies to be conducted. Past studies, on which publications will be based, were conducted in Prince William Sound, Kenai/Cook Inlet, and Kodiak/Alaska Peninsula.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The projects are based on data gathered throughout the damage assessment and restoration phases of the Exxon Valdez Oil Spill studies funded by the Trustees. Past work has been presented at various public meetings sponsored by the council. It is anticipated that manuscripts produced will be the basis of future presentations at Trustee sponsored restoration workshops.

One of the manuscripts that is to be produced as part of this project, "Comparison of Study Designs for Assessment of Shoreline Impacts of the *Exxon Valdez* Oil Spill" will critique study designs utilized by the Trustee sponsored work, studies sponsored by NOAA, and studies by Exxon. An obvious shortcoming of all of these works is the failure to address subsistence issues, and the failure to utilize traditional ecological knowledge in the study design. A discussion of how these shortcomings might be addressed in future studies will be developed in consultation with the Oil Spill Restoration Office, and will be included as part of the manuscript.

PROJECT DESIGN

A. Objectives

The objective of the proposed study is to produce a minimum of ten manuscripts for publication in the peer reviewed scientific literature. Six will be prepared and submitted in FY98. Of these, two are in preparation, and funding for these is being requested for page charges only. A proposal for the additional manuscripts listed will follow in April 1998, for funding in FY99.

B. Methods

The manuscripts will be prepared by a team of scientists who have been directly involved in the coastal habitat studies funded by the Trustees. The work will be coordinated by Coastal Resources Associates, Inc. (CRA), and they will be responsible for the financial and scientific management of the project. Dr. Thomas Dean, President of CRA will serve as project leader. Key individuals in the coastal habitat injury assessment program will serve as lead authors of manuscripts to be prepared. These will include Drs. Ray Highsmith and Mike Stekoll of the University of Alaska, and Dr. Lyman McDonald of West. Dr. Dean will also serve as a lead author, and will be assisted by Dr. Larry Deysher of CRA who has had extensive involvement in the CHIA program.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This proposal is being submitted under BAA by Coastal Resources Associates, Inc. However, it is anticipated that a portion of the funding will be directed to the University of Alaska, with contract administration for that portion of the contract conducted by Alaska Department of Fish and Game.

SCHEDULE

A. Measurable Project Tasks for FY 98 (October 1, 1997 - September 30, 1998)

A total of six manuscripts will be prepared for publication during FY98. A description of these is given under "Publications and Reports" below.

B. Project Milestones and Endpoints

All manuscripts slated for preparation in FY98 will be in draft form and available for internal review by January 31, 1998. At that time, a progress report will be submitted to the Trustees that includes the draft manuscripts. All manuscripts will be submitted by April 15, 1998. A request for funding of four additional manuscripts will be prepared at that time. The schedule for publication will depend on the length of the review period, and on the extent of revisions (if any) required. It is anticipated that all manuscripts will be ready for final acceptance by August 1998.

C. Completion Date

It is anticipated that all ten manuscripts proposed will be submitted and accepted by September 1999. Some carry over of funds may be required to cover page charges incurred in FY00.

PUBLICATIONS AND REPORTS

It is anticipated that a minimum of ten manuscripts will be produced. Six of these are slated for submission in FY98, including two that are in preparation. (Funding is being requested only for page charges for the two manuscripts in preparation). A listing of anticipated authors, titles, journals selected for submission, and a brief description of the content of each manuscript follows.

Manuscripts to be prepared in FY 1998

1. Comparison of Study Designs for Assessment of Shoreline Impacts of the *Exxon Valdez* Oil Spill

Proposed Authors: Lyman L. McDonald, Wallace P. Erickson, M. Dale Strickland, and Charles Peterson. (Order to be determined by relative contribution and amount written.)

Possible Journals: Marine Pollution Bulletin or Oecologica

This manuscript will contrast the design of the Coastal Habitat Injury Assessment (Highsmith et al. 1996, Jewett et al. 1995, McDonald et al. 1995, Stekoll et al 1996) to study designs used in assessment of shoreline impacts of the spill by Exxon supported scientists (Page et al. 1995) and NOAA scientists (Mearns 1996, Houghton et al. 1996). The objectives of these studies will be contrasted and the designs will be evaluated in terms of how well project objectives were met, the relative ability of each design to quantify impacts of the Exxon spill, and the relative strengths and weaknesses of each design. The role of the following will be assessed in each of the studies:

1) random selection of study sites,
2) subjectively selected study sites,
3) interspersion of study sites,
4) definition and selection of reference sites,
5) levels of statistical inference,
6) power to detect important ecological effects (and specifically trade offs one must make with respect to power and ability to make broader statistical inferences),
6) the role of experiments (as contrasted to surveys) in injury assessment,
7) statistical analyses, and
8) definitions for recovery.

2. *Fucus* and the *Exxon Valdez* Oil Spill: Injury and Recovery

Proposed Authors: Michael S. Stekoll, Lawrence E. Deysher, and Mandy R. Lindeberg.

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

Analysis of injury to *Fucus* will be presented for all areas (Prince William Sound, Kenai/Lower Cook Inlet, and Kodiak/Alaskan Peninsula) and habitats (Sheltered Rocky, Exposed Rocky, Coarse Textured, and Estuarine) for the period 1991-1994. The focus will be on *Fucus gardneri* populations (abundance, biomass. reproductive state, injury to plants, extent of fouling, percent cover), and will contrast the patterns observed at the three areas representing different levels of oiling and cleanup, and different physical regimes. The discussion will draw on previously published studies of experimental evaluations on the recovery and recolonization of *Fucus* in Herring Bay (Stekoll and Deysher 1996, Van Tamlen and Stekoll 1995, 1996; and Van Tamlen et al. 1997) to help explain differences in patterns observed in different areas and habitats.

3. Injury to, and Recovery of Rocky Intertidal Communities in Prince William Sound Following the *Exxon Valdez* Oil Spill

Proposed Authors: Raymond C. Highsmith, Thomas A. Dean, and Susan M. Saupe

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

This manuscript will assess injury to dominant taxa of intertidal plants and animals in Prince William Sound in sheltered rocky, exposed rocky, and coarse textured habitats. The paper will utilize data from a broad geographic examination of injury based on studies carried out throughout the Sound (Coastal Habitat Injury Assessment Studies), and from a longer time series of observations in Herring Bay (Herring Bay Population Dynamics Studies) to evaluate injury and recovery of dominant taxa (*Fucus*, ephemeral algae, barnacles, limpets, mussels and littorines). We will examine how the Herring Bay and CHIA data correlate with one another and attempt to use the Herring Bay data to infer mechanisms of impact and processes of recovery for communities throughout the Sound. For example, the paper will related algal species composition and abundance following the spill and potential relationships to subsequent invertebrate distributions, and vice versa.

4. Factors Limiting Recovery of Limpet Populations following the *Exxon Valdez* Oil Spill

Proposed Authors: Raymond C. Highsmith, Thomas A. Dean, and Anthony J. Hooten. (Order to be determined by relative contribution and amount written.)

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

This paper will focus on limpets. The evidence for injury (based mostly on CHIA data), and recovery (based mostly on the Herring Bay population dynamics data) will be reviewed. The bulk of the paper will examine experimental data from fencing and caging experiments on the effects of oiled substrates as well as other factors (e.g. algal density and limpet density) on the recovery process. A preliminary examination of the data suggest that limpets (especially *T. persona* in the upper intertidal) were severely injured, that most populations perhaps recovered by 1993 or 1994, and that oiled substrates apparently did not inhibit recovery. Experimental data indicate that limpets graze on algae and provide a mechanism that might explain why cover by filamentous algae increased following the spill. Experimental data also suggest some interesting biology regarding density dependence in limpets, and the potential effects of predators on survival of limpets. Population dynamics data indicate that there was a large increase in the abundance of limpets at both oiled and control sites in Herring Bay between 1990 and 1994. We can speculate that this might have been natural temporal variation, or a result of a release from predation pressure throughout Herring Bay because of an oil relate reduction in oystercatchers, harlequin ducks and other potential predators.

5. Effects of the *Exxon Valdez* Oil Spill and Non-Anthropogenic Factors on the Distribution and Abundance of Nearshore Benthic Fishes in Prince William Sound, Alaska.

Proposed Authors: T.A. Dean, L. Haldorson, D. Laur, and S. Jewett. (Order to be determined by relative contribution and amount written.)

Possible Journals: Fisheries Bulletin, Environmental Biology of Fishes

This paper will examine the factors affecting the distribution and abundance of nearshore benthic fishes including a variety of habitat characteristics (vegetation type, slope, substrate type, exposure) as well as oiling of adjacent shorelines. We will examine community response (MDS and PCA analysis) as well as responses of dominant taxa (using non-linear models and/or PCA analysis). A previous publication (Laur and Haldorson 1996) examined only the differences between fish abundance at oiled and control sites, by species and habitat. This manuscript will present a more community based approach, that also examines the influence of factors other than oil on distribution and abundance. Data are from the 1990 subtidal surveys, with a few other data from eelgrass habitat surveys in subsequent years . A draft of this manuscript is in preparation.

6. Impacts of the *Exxon Valdez* Oil Spill on Benthic Communities in Eelgrass Habitats.

Proposed Authors: S.J. Jewett, T.A. Dean, A. Blanchard, and R.O. Smith

Possible Journals: Marine Environmental Research, Marine Ecology Progress Series

Examination of impacts to subtidal benthic infauna and small epifauna based on subtidal studies. This is a manuscript that comes directly from sections of the report of Jewett and Dean (1996) on eelgrass communities that deal with dredge sample data. A draft of this manuscript has been produced.

<u>Manuscripts to be prepared in FY99</u>

7. Algal Community Function Following the *Exxon Valdez* Oil Spill

Proposed Authors: Michael S. Stekoll, Lawrence E. Deysher, and M.R. Lindeberg

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

An examination of community level responses following the EVOS, based on algal data from Coastal Habitat Injury Assessment studies conducted in Prince William Sound, Kenai/Cook Inlet, and Kodiak/Alaskan Peninsula. Community similarity (MDS), diversity, functional group analysis (e.g. leafy blades, filamentous algae), higher order taxa analysis (red vs. green algae), and life history groupings (annuals vs. perennials, widely dispersed vs. not so widely dispersed, etc.) will be presented.

8. Responses of Intertidal Communities to the *Exxon Valdez* Oil Spill: Regional Comparisons of the Extent of Injury.

Proposed Authors: Raymond C. Highsmith, Thomas A. Dean, Michael S. Stekoll, Lawrence E. Deysher and Susan M. Saupe

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

A summary of impacts to both algal and invertebrate communities in Prince William Sound, Kenai/Cook Inlet, and Kodiak/Alaska Peninsula will be presented. The focus will be on the differences in response of dominant taxa in different areas, and potential causes for different responses in the different regions including extent of exposure to oil, cleanup methods, and differences in physical environments. The manuscript will also discuss implications toward impacts of different cleanup methods if appropriate.

9. A Summary of Impacts of the *Exxon Valdez* Oil Spill on Nearshore Subtidal Communities.

Proposed Authors: T.A. Dean and S.J. Jewett

Possible Journals: Ecological Applications, Annual Reviews of Ecology and Systematics

A summary of available information on the injury and recovery of subtidal communities including (but not necessarily limited to) studies of impacts and recovery of subtidal communities (Armstrong et al. 1995; Dean et al. 1996a, 1996b; Jewett and Dean 1997; Jewett et al 1995, 1996; Laur and Haldorson 1996) hydrocarbon data (Bence and Burns 1995; Carlson and Kvenvolden 1996; O'Clair et al., 1996; Page et al. 1995; Short and Babcock 1996; Short et al. 1996a, 1996b; Wolfe et al. 1994); bacteria data (Braddock and Richter 1994; Braddock et al. 1995, 1996); toxicity data (Armstrong et al. 1995; Wolfe et al. 1996), biomarker data in subtidal fishes (Armstrong et al. 1995; Collier et al. 1996). Salmon and Herring data will be not be reviewed. This manuscript is in preparation.

10. A Summary of Impacts of the *Exxon Valdez* Oil Spill on Intertidal Communities.

Proposed Authors: Raymond C. Highsmith, Thomas A. Dean, Michael S. Stekoll, Lawrence E. Deysher

Possible Journals: Ecological Applications, Annual Reviews of Ecology and Systematics

A summary of available information on the injury and recovery of intertidal communities including (but not necessarily limited to) studies of impacts on intertidal algae and invertebrates (De Vogelaere and Foster 1994; Ebert and Lees 1996; Fleeger et al. 1996, Gilfilan et al. 1996a, 1996b; Highsmith et al. 1994, 1995, 1996; Hooten and Highsmith 1996, Houghton et al. 1993, 1994, 1995, 1996a, 1996b; Lees et al. 1996; Mearns et al. 1996, Stekoll et al 1996a, 1996b; Van Tamlen and Stekoll 1994, 1995, 1996: van Tamlen et al 1997; Trowbridge et al. 1996) hydrocarbon data (Bence and Burns 1995; Carlson and Kvenvolden 1996; O'Clair et al., 1996; Page et al. 1995; Short and Babcock 1996; Short et al. 1996a, 1996b; Wolfe et al. 1994); bacteria data (Braddock and Richter 1994; Braddock et al. 1995, 1996); and toxicity data (Armstrong et al. 1995; Wolfe et al. 1996).

PROFESSIONAL CONFERENCES

No funding is being requested for attendance at professional conferences in FY98.

NORMAL AGENCY MANAGEMENT

This project has been developed through collaboration of private sector and University of Alaska scientists. None of the proposers have management responsibility. However, it is anticipated that publications produced will be widely utilized in future management decisions.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The scientists involved in the preparation of manuscripts have worked collaboratively in previous Trustee funded investigations of injury and recovery in coastal habitats. Authors will serve as internal reviewers of each of the manuscripts while these manuscripts are in preparation.

Several of the authors are also participants in other large ecosystem studies funded by the Trustees. Thomas Dean and Stephen Jewett are principal investigators for the Nearshore Invertebrate Predator Project and Lyman McDonald serves as consulting statistician for both the Nearshore Vertebrate Predator and APEX projects. The APEX and especially the Nearshore Vertebrate Predator Project have large components that deal with coastal habitats, and new findings produced by these studies will be considered when preparing manuscripts. It is also anticipated that information presented in the manuscripts, along with the information gained in ongoing research and monitoring efforts, will be integrated and utilized in developing future monitoring plans for coastal habitats.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new project.

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BIOGRAPHICAL SKETCHES FOR PRINCIPAL INVESTIGATORS

Dr. Thomas A. Dean is President of the ecological consulting firm Coastal Resources Associates, Inc. (CRA) in Vista CA. Dr. Dean has over 20 years of experience in the study of nearshore ecosystems, and has authored over 20 publications, including several dealing with impacts of the *Exxon Valdez* oil spill on subtidal populations of plants and animals. He has extensive experience in long-term monitoring studies, and has played a major role in both intertidal and subtidal EVOS investigations since 1989.

Dr. Ray Highsmith is a Professor at the University of Alaska Fairbanks and Director of the West Coast National Undersea Research Center. Dr. Highsmith has been the Coordinator and Principal Investigator for two EVOS projects, the coastal habitat injury assessment (CHIA) study and Herring Bay experimental and monitoring studies. Dr. Highsmith's specialties include ongoing research of recruitment and population biology of intertidal invertebrates.

Dr. Lyman McDonald is President of Western Ecosystem Technologies, Inc. (WEST), an ecological consulting firm in Cheyenne, WY. Dr. McDonald is a former Professor of Statistics at the University of Wyoming, and has over 25 years of experience in statistics and experimental design. He has authored over 40 scientific publications is refereed journals, and has served as the lead statistician on both intertidal and subtidal studies of impacts of the EVOS on coastal habitats.

Dr. Michael Stekoll is a Professor of Biology at the University of Alaska Southeast, and the School of Fisheries and Ocean Sciences at the University of Alaska Fairbanks. He has served as the Principal Investigator for the coastal habitat injury assessment (CHIA) study and Herring Bay experimental and monitoring studies that examined the impacts of the EVOS on intertidal and subtidal algae. His specialties include studies of *Fucus*, *Macrocystis*, and other seaweeds in Alaska.

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Budget for:

Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the *Exxon Valdez* Oil Spill: Preparation of Manuscripts for Publication - Submitted under BAA

The following are budgets for the project. Separate detailed budgets are provided for Coastal Resources, Associates, Inc., University of Alaska, Southeast and University of Alaska, Fairbanks. The CRA budget is submitted under BAA. It is anticipated that University of Alaska will be funded through ADF&G through an existing agreement. CRA will retain management responsibilities for the project. A summary of these budgets is as follows:

Coastal Resources Associates, Inc. (BAA)		$ 63,486.00
University of Alaska, Southeast		$ 17,344.00
University of Alaska, Fairbanks		$ 23,266.00
	Total	$ 104,096.00

BUDGET FOR:

COASTAL RESOURCES ASSOCIATES, INC.

1998 EXXON VALDEZ TRUS' :OUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$17,865						
Travel		$1,160						
Contractual		$26,169						
Commodities		$1,200						
Equipment		$0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$46,394		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$17,092						
Project Total		$63,486		$42,000				
Full-time Equivalents (FTE)		3.00						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: 1. Contractual changes are as follows:

West, Inc.

		Months	Cost/Month		Proposed for FY98
Personnel					
L. McDonald	Lead Author	0.8	$ 7,230		$ 5,784
W. Erickson	Co-Author, Statistical Analysis	0.8	$ 4,049		$ 3,239
D. Strickland	Co-Author	0.25	$ 7,230		$ 1,808
Commodities				Sub-total	$ 10,831
Page charges					$ 400
Indirect Costs					$ 13,539
Project Total					$ 24,769
S. Saupe - Consultant					
Personnel	Co-Author	40	$ 35		$ 1,400

2. CRA, Inc. Indirect Rates calculated as follows: Overhead = 59.5% of salaries and fringe.
General Administrative = 13.35% of total direct costs, excluding contractual.
Fee = 5% of total direct and indirect (excluding contractual).
Contractual markup = 8% of contractual fees.
3. Both CRA, Inc. and West, Inc. rates are based on DCAA audits conducted within the past year.

1998

Prepared:

Project Number: 98325-BAA
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: Coastal Resources Associates, Inc.

FORM 4A
Non-Trustee
SUMMARY

4/14/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs: Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
Dean, Thomas A.	Project Coordinator-Lead Author		1.0	7,261	0.0	7,261
Deysher, Lawrence E.	Co-author		1.0	7,261	0.0	7,261
Jung, Dennis	Graphical/Production Assistant		1.0	3,343	0.0	3,343
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.0	17,865	0.0	
					Personnel Total	$17,865

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
					0.0
1 round trip - San Diego to Anchorage	600	1	4	140	1160
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1,160

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: Coastal Resources Associates, Inc.

FORM 4B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Contractual Costs: Description	Proposed FY 1998
West, Inc.	24,769
S. Saupe - Consultant	1,400
Contractual Total	$26,169

Commodities Costs: Description		Proposed FY 1998
Page Charges	3 journal articles	1,200
Commodities Total		$1,200

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: Coastal Resources Associates, Inc.

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			0.0
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

1998	Project Number: Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA" Name: Coastal Resources Associates, Inc.	FORM 4B Equipment DETAIL

Prepared:

BUDGET FOR:

UNIVERSITY OF ALASKA, FAIRBANKS

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$18,113.0						
Travel		$0.0						
Contractual		$0.0						
Commodities		$500.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$18,613.0		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$4,653.0						
Project Total	$0.0	$23,266.0		$25,000.0				
Full-time Equivalents (FTE)		2.00						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
Highsmith, Ray	Lead Author		1.5	10,291	0.0	15,437
Chu, Chirk	Data Base Manager		0.5	5,352		2,676
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.0	15,643	0.0	
					Personnel Total	$18,113

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
					0.0
None					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
None	
Contractual Total	$0.0

Commodities Costs:		Proposed
Description		FY 1998
Page Charges	Manuscript	500
	Commodities Total	$500

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			0.0
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

1998	Project Number: Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA" Name: University of Alaska, Fairbanks	FORM 4B Equipment DETAIL

Prepared:

BUDGET FOR:

UNIVERSITY OF ALASKA, SOUTHEAST

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$13,055.0						
Travel		$0.0						
Contractual		$0.0						
Commodities		$1,000.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$14,055.0		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$3,289.0						
Project Total	$0.0	$17,344.0		$25,000.0				
Full-time Equivalents (FTE)		1.50						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the *Exxon Valdez* Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Southeast

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:				Months	Monthly		Proposed
	Name	Position Description		Budgeted	Costs	Overtime	FY 1998
	Stekoll, Mike	Lead Author		1.5	8,703	0.0	13,055
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		1.50	8,703	0.0	
						Personnel Total	$13,055

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
						0.0
	None					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.0

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Southeast

FORM 4B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs: Description	Proposed FY 1998
None	
Contractual Total	**$0.0**

Commodities Costs: Description	Proposed FY 1998
Office and computer supplies	500
Page charges - manuscript	500
Commodities Total	**$1,000**

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Southeast

FORM 4B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			0.0
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

1998	Project Number: Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA" Name: University of Alaska, Southeast	FORM 4B Equipment DETAIL

Prepared:

4/14/97

98327

Project Title:	**Pigeon Guillemot Restoration Research at the SeaLife Center**
Project Number:	98327
Restoration Category:	Research (new)
Proposer:	Oregon State University (PI - Daniel D. Roby)
Lead Trustee Agency:	DOI
Alaska SeaLife Center:	Yes
Duration:	1st year, 3-year project
Cost FY 98:	$111,906
Cost FY 99:	To be determined
Geographic Area:	Alaska SeaLife Center, and adjoining areas of Resurrection Bay

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Injured Resource/Service: Pigeon Guillemots, other injured seabird resources

ABSTRACT

This study tests the feasibility of direct restoration techniques for Pigeon Guillemots (e.g., installation of artificial nest sites, use of social attractants, captive propagation and release). While raising young guillemots in captivity it will also be possible to conduct controlled experiments crucial to two other restoration objectives: (1) development of nondestructive biomarkers of petroleum hydrocarbon contamination, and (2) understanding how dietary factors (prey species composition, prey size, lipid content, feeding frequency) constrain growth, development, and condition at fledging in guillemots.

INTRODUCTION

The Pigeon Guillemot (*Cepphus columba*) population in Prince William Sound has failed to recover from declines that occurred both before and after the *Exxon Valdez* Oil Spill (EVOS). Post-spill studies of Pigeon Guillemot reproductive success have identified three primary factors preventing recovery:

1) In Prince William Sound (Naked and Jackpot islands) and Kachemak Bay, predation on eggs and chicks was a major source of nesting failure (Hayes 1996, Prichard 1997).

2) There has been a decline in the proportion of sand lance in the diet at some guillemot colonies in Prince William Sound (e.g., Naked island), and the proportion of high-quality schooling forage fish in the diet seems to be a key factor in guillemot reproduction. The Alaska Predator Ecosystem Experiment (APEX) Project components F (Factors Limiting Pigeon Guillemot Recovery) G (Seabird Energetics), and M (Seabird/Forage Fish Studies in Lower Cook Inlet) are investigating the relationship between a lack of recovery and the availability and quality of forage fish. A decline in availability of high-lipid forage fishes (sand lance, herring, capelin) in the last two decades may be responsible for lower growth rates, fledging weights, post-fledging survival, and adult recruitment rates.

3) The Nearshore Vertebrate Predator (NVP) Project (River Otter and Pigeon Guillemot component) is testing the hypothesis that exposure to residual oil from the spill continues to limit recovery of Pigeon Guillemots. Pigeon Guillemots feed on a diversity of nearshore demersal fishes and some schooling forage fishes, prey that were likely injured by EVOS. The approach of this study is to measure certain biomarkers in blood and compare biomarker levels in nestlings from oiled and nonoiled areas. These blood biomarkers still need to be calibrated to known doses of weathered Prudhoe Bay Crude Oil (PBCO).

The proposed research will be conducted at the SeaLife Center in Seward and will address all three of the above limiting factors. Experimental studies using captive subjects will be integrated with raising Pigeon Guillemot nestlings in captivity in order to establish both captive and free-ranging guillemot breeding colonies at the SeaLife Center. Predator-free nest sites will be built at the SeaLife Center and, in association with the use of decoys and audio playbacks of guillemot calls, will be used to attract and recruit prospecting guillemots to breed. Guillemot populations are frequently nest-site limited (Storer 1952) and Pigeon Guillemots readily breed in anthropogenic structures, such as docks and breakwalls, at many locations throughout the species' range. Like most seabirds, guillemots are philopatric to their natal location, and the cohorts that are raised in captivity at the SeaLife Center and released can be expected to return and attempt to breed at the SeaLife Center. Although guillemots only rarely breed before three years of age, prospecting 2-year-olds that are raised in the first year of this three-year study can be expected to visit the SeaLife Center in the last year of this study. For the first two years of the study, immigration from nearby natural colonies will provide recruits to the colony of free-ranging guillemots that we seek to establish at the SeaLife Center.

Providing artificial nest sites has the potential to restore guillemot populations through enhancing both adult recruitment and breeding productivity. The success in recruiting prospecting adult guillemots to use artificial nest sites and the proportions of captive-reared and immigrant birds that utilize artificial nest sites will allow us to test the feasibility of this direct restoration technique for enhancing recovery of guillemot populations in the EVOS area.

The proposed work is intended to result in the establishment of a breeding colony of free-ranging Pigeon Guillemots at the SeaLife Center. By banding immigrants to the colony and young that are raised and released at the SeaLife Center, we can establish a breeding colony comprised of known-age individuals whose breeding history is known. Accessibility of nest sites can be a major obstacle for studies of factors influencing nesting success and demographics of guillemots, and artificial nests sites can provide investigators with unique opportunities. A dockside Black-legged Kittiwake (*Rissa tridactyla*) colony in Great Britain has been studied for the past 30 years and provided most of what is known about that species in the northeastern Atlantic (i.e., Coulson 1988, Coulson and Thomas 1985). Establishment of a Pigeon Guillemot colony at the SeaLife Center has the potential of providing a similar resource, in addition to being integrated with the Center's public education program.

Besides providing recruits for the breeding colony of free-ranging guillemots to be established at the SeaLife Center, raising chicks in captivity will also provide the opportunity to conduct controlled experiments that are relevant to two major issues in Pigeon Guillemot restoration: (1) the importance of prey type, size, quality, and frequency of delivery on growth rates and condition of fledglings and (2) the utility of biomarkers in blood and excreta as indicators of exposure to oil. Research on these two topics can best be conducted using captive subjects whose environment and diet can be carefully controlled to avoid confounding variables so common in natural populations. In the first year of this study, chicks will be raised on different diet regimes to determine the effects of the proportion of schooling forage fishes (sand lance, capelin, herring) vs. nearshore demersal fishes (gunnels, pricklebacks, sculpins) on growth rates. In the subsequent two years of the study, controlled feeding experiments will be conducted that are designed to reveal the tradeoffs inherent in meal size, meal frequency, and meal quality (energy density) as they influence nestling growth performance. The results from this study will complement continuing studies on the role of diet in productivity of guillemots that are part of the APEX Project.

In the second and third years of the study, some chicks that are raised in captivity will be fed small, sublethal doses of weathered Prudhoe Bay crude oil (PBCO). Subsequent to dosing, samples of blood and excreta will be collected at prescribed intervals for measurement of biomarkers of health status. These results will allow us to define the dose-response relationship between ingested PBCO and each biomarker of exposure. Such results are essential for evaluating the efficacy of particular biomarkers and the utility of these biomarkers for assessing the exposure of free-ranging guillemots to oil.

Of particular value for interpretation of the results of captive feeding trials and crude oil dose-response experiments will be the subsequent release of these subjects and measurements of their return rates in subsequent years. Although it can not be assumed that all young guillemots that are fledged from the SeaLife Center and survive to breeding age will return to the SeaLife Center to breed, the return rates of nestlings raised on various diets, plus return rates of oil-dosed and control nestlings, will provide valuable information on the long term effects on guillemot fitness of prey composition and oil exposure.

NEED FOR THE PROJECT

A. Statement of Problem

In the last two decades the Pigeon Guillemot population in Prince William Sound has declined from 15,000 to 5,000 individuals (Laing and Klosiewski 1993). While this decline apparently began prior to the EVOS, an estimated 10-15% of the population in the spill area died as a direct result of the spill. Post-spill censuses have not detected an increase in numbers, suggesting no appreciable recovery has occurred in the aftermath of the spill. Reasons for the lack of recovery are unclear, but may be related to changes in prey resources, continuing exposure of guillemots or their prey to oil, or nesting failure due to predation.

Predation on Pigeon Guillemot eggs and chicks was apparently minimal before EVOS, but post-spill studies have frequently recorded high levels of predation from river otters and mink (Hayes 1995). High predation rates could be reducing production of local birds, increasing breeding dispersal (lack of fidelity to a previously used nest site or location) of established breeders, and decreasing the immigration of guillemots from other colonies. While Pigeon Guillemots typically have high fidelity to their breeding site, disturbance and lack of breeding success can increase the rate and distance of breeding dispersal. Populations suffering high levels of disturbance, such as persistent nesting failure due to terrestrial predators, will decline due to a lack of production of new recruits, dispersal of breeding birds, and decreased immigration.

Two ongoing EVOS projects have identified potential reasons for a lack of recovery. The APEX Project has identified a major shift in the nearshore ecosystem that has apparently resulted in fewer schooling fish, particularly sand lance (*Ammodytes hexapterus*) fed to chicks (Oakley and Kuletz 1994). Pre-spill studies found sand lance, a nearshore schooling fish with a high lipid content, to be the dominant prey returned to chicks. Post-spill studies have found gadids and nearshore demersal fish to constitute the majority of the diet. The NVP project has attempted to determine if blood biomarkers can be used to monitor level of exposure to oil and if blood from individuals in wild populations currently indicates exposure to oil is occurring. Both of these projects have examined wild populations that are exposed to numerous sources of variability that confound the examination of factors affecting chick growth or blood biomarkers.

This study is relevant to EVOS Restoration Work because it is designed to develop direct restoration techniques for Pigeon Guillemots, a species injured by the spill that is failing to recover. Techniques developed during this research will be relevant to restoration of other alcid species. Also, dose-response experiments with guillemot nestlings fed small, sublethal amounts of weathered Prudhoe Bay crude oil will provide crucial validation and calibration results for interpretation of on-going studies of biomarkers as indicators of crude oil exposure. Experimental studies with captive-reared guillemots will also provide a better understanding of how shifts in the diet of guillemots and other seabirds breeding in EVOS area affects growth, development, fledging condition, and, ultimately, fitness. By monitoring the growth and development of nestlings raised on controlled rations, the relative nutritional quality of various prey can be assessed. Also, fitness tradeoffs between prey size/quality and provisioning rate can be assessed through monitoring of subsequent survival in the wild of captive-reared chicks. Understanding the constraints imposed on guillemots by diet composition, oil exposure, and nest site quality will be crucial for designing management initiatives to enhance productivity in this and other seabird species that are failing to recover from EVOS.

B. Rationale/Link to Restoration

Artificial nest sites have the potential to increase the size of both guillemot breeding colonies and populations. A Black Guillemot colony in arctic Alaska increased from 10 to 225 pairs in 17 years through provision of artificial nest sites (Divoky et al. 1974 and in prep.). In Washington State 27% of the 33 Pigeon Guillemot colonies are in piers or other anthropogenic structures (Speich and Wahl 1989). Establishment of a Pigeon Guillemot colony at the SeaLife Center will demonstrate the utility of direct restoration in assisting the recovery of Pigeon Guillemot populations in the northern Gulf of Alaska. If artificial nest sites are successful in attracting breeding adults and if successful reproduction ensues, artificial nest sites can be used in Prince William Sound to enhance productivity, recruitment, and immigration, all of which will facilitate recovery. Clusters of artificial nest sites similar to those at the SeaLife Center can be installed near natural colonies that suffer from chronically high nest predation rates. Nests could be placed on pilings or "dolphins" constructed specifically for colony development.

Aside from providing a prototype for artificial colonies in other parts of the EVOS area, a breeding colony of free-ranging guillemots at the SeaLife Center will allow investigators to conduct research on Pigeon Guillemots that would not be possible at natural colonies. Loss of eggs or chicks to predation has been a major source of nest failure in post-spill studies of Pigeon Guillemots in Prince William Sound (Hayes 1995). In addition, marked adults and returning young will allow an examination of demographics that has not been possible in Prince William Sound studies. A lack of recovery could be due to demographic parameters (e.g., adult survival, subadult survival, immigration/emigration rates) not evident in studies of nesting success or colony censuses. Guillemot demographics are much more easily studied at a colony of artificial nest sites where the banding of chicks and adult entails far fewer problems than at natural colonies. Should the proposed work result in the deployment and use of artificial nest sites in Prince William Sound, investigators will be able to obtain demographic information for that area that could explain the lack of recovery of local populations.

While the proposed colony of Pigeon Guillemots to be established at the SeaLife Center will have the benefit of captive-reared chicks returning to their natal location and assisting in establishment of the colony, immigration is obviously the source of birds founding new colonies. Immigrants can also be the primary source of recruits to established and expanding colonies (Petersen 1981). Unlike many seabirds, guillemots are semi-colonial and able to breed as single pairs as well as colonially. Prospecting guillemots can be expected to search for nesting opportunities more extensively than more colonial seabirds, which require numbers of conspecifics for successful breeding. Nest sites at the SeaLife Center are likely to attract nonbreeding prospectors from the approximately 100 pairs of Pigeon Guillemots breeding between Aialik Cape and Cape Resurrectiôn (Nishimoto and Rice 1987), as well as more distant colonies. An expanding colony of Black Guillemots in arctic Alaska drew most of its recruits from colonies more than 400 km distant (Divoky, in prep.)

A Pigeon Guillemot colony could also have the potential of attracting other seabird species to nest in the area of the SeaLife Center. Some of these other species may also be recruited by nest site provisioning. A Black Guillemot breeding colony that utilized artificial nest sites in arctic Alaska has also attracted Horned Puffins (*Fratercula corniculata*), some of which used the artificial nest sites by the late 1980's (Divoky 1982 and unpubl.).

The research component of the study will allow evaluation and validation of the use of nondestructive biomarkers (in blood and excreta) to assess the health status of individual guillemots and potential exposure to petroleum hydrocarbons. There is evidence that certain acute phase proteins (i.e., haptoglobin) in blood and porphyrins in excreta and induced by ingestion of sublethal doses of weathered crude oil (Prichard et al., in press). The results of a dose-response experiment with wild guillemot nestlings in their natural nest sites, however, were ambiguous because of variability in baseline values for biomarkers among sites (Prichard 1997). Also, guillemot nestlings were fed small doses (0.05-0.2 ml) of highly weathered PBCO; these doses were not sufficient to cause a significant decline in growth rates of nestlings. Finally, blood samples for measuring biomarker levels were not collected until five days post-dosing, when any induction of an acute phase response may have passed. While the use of blood and fecal biomarkers for monitoring oil exposure and general population health of guillemots is promising, more research under controlled, captive conditions is required to validate the techniques and provide a sound basis for interpretation of results from wild guillemots.

There is a definite need for information on the relationship between diet and reproductive success for Pigeon Guillemots, a seabird species that is failing to recover from EVOS at an acceptable rate (1994 *Exxon Valdez* Oil Spill Restoration Plan). Guillemots are the most neritic members of the marine bird family Alcidae (i.e., murres, puffins, and auks), and like the other members of the family, capture prey during pursuit-dives. Pigeon Guillemots prey on a wide variety of fishes, including schooling forage fish (e.g., sand lance, herring, pollock) and subtidal/nearshore demersal fish (e.g., blennies, sculpins; Drent 1965, Kuletz 1983). There is strong evidence of a major shift in diet composition of guillemot pairs breeding at Naked Island. Sand lance were the predominant prey fed to young in the late 1970's (Kuletz 1983), but currently sand lance is a minor component of the diet (D. L. Hayes, unpubl. data). In contrast, guillemots breeding in Kachemak Bay continue to provision their young predominately with sand lance, and sand lance is particularly prevalent in the diet at sites that support high densities of breeding pairs (Prichard 1997). Also, young of breeding pairs that provision their nestlings with most sand lance have higher growth rates (Prichard 1997). Jackpot Island in southwestern Prince William Sound supports the highest nesting densities of guillemots anywhere in the Sound and growth rates of nestlings are correspondingly high. The high availability of juvenile herring to guillemots nesting at Jackpot Island may be responsible for both the high nesting density and high growth rates. Thus availability of high quality schooling forage fishes (herring, sand lance) may be crucial for maintaining high nesting densities of highly productive guillemots.

C. Location

Pigeon Guillemot nestlings will be raised in captivity at the SeaLife Center in Seward. Guillemot nestlings will be hatched from eggs obtained from source colonies on Kodiak Island or at other appropriate Gulf of Alaska colonies. Most of the captive-reared fledglings will be banded and released at the SeaLife Center to assist in efforts to establish local breeding colonies of free-ranging guillemots at the SeaLife Center. Artificial nest sites will be constructed outside of the SeaLife Center on the Center's grounds and on an adjacent dock and breakwall to enhance the prospects for colony establishment. Colonies in Resurrection Bay that may serve as sources of immigrants or may recruit captive-reared guillemots will be censused and checked for banded adults annually during the three years of the project. The information obtained from this project will benefit Pigeon Guillemot populations in the Gulf of Alaska, especially Prince William Sound. An understanding of the affect of prey type on chick growth will help explain the role of ecosystem shifts in continuing declines of Pigeon Guillemot populations. Assessing the utility of blood biomarkers for detecting and quantifying exposure to crude oil will benefit efforts to monitor the health of Pigeon Guillemot populations throughout the spill zone.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

All research will be conducted at the SeaLife Center, which will allow the community in and around Seward to observe progress in the establishment of a guillemot colony in artificial nest sites. The wild breeding colony outside of the SeaLife Center has the potential for involving science classes from local schools. The location of the colony will allow easy viewing by the public and allow science teachers to use the colony for teaching about seabird breeding biology and restoration. Science classes could conduct observations on the occurrence and activities of prospecting and breeding guillemots. Some of these (timing of arrival in the spring and sightings of color banded adults) could provide important information for the period when the investigators are not in Seward. Local science teachers can receive annual summaries of information about the colony (e.g., timing of clutch initiation, breeding success) that can provide the basis for lessons on regional climate change and annual variability in the marine environment. The Seaquest Program of the Chugach School System would be a logical avenue for presenting this material to students.

PROJECT DESIGN

A. Objectives

This research project has three primary objectives listed below. During the first year of the project (CY 98), the emphasis will be on achieving Objective 1, with pilot studies to address Objectives 2 and 3.

1. Determine the feasibility of using direct techniques for restoration of Pigeon Guillemots, including:

    a) providing artificial nest sites

    b) use of social attraction, such as decoys and playbacks of vocalizations

    c) release of captive-reared young

2. Determine the response of particular guillemot biomarkers of crude oil exposure (acute phase proteins, plasma sodium, fecal porphyrins) to variables of exposure, and the survival of exposed nestlings post-fledging. Exposure variables that will be examined include:

    a) dose of ingested oil

    b) degree of weathering of ingested oil

    c) time since ingestion of dose

    d) frequency of exposure

3. Determine the effect of diet variables on growth performance, development, fledging condition, and post-fledging survival of Pigeon Guillemots, including:

a) relative proportions of schooling forage fishes vs. nearshore demersal fishes

b) lipid content of the diet

c) size of prey items

d) frequency of prey delivery

B. Methods

The proposed work will test the following three basic hypotheses, which relate to each of the three primary objectives listed above:

Hypothesis 1. Artificial nest sites, decoys, and playbacks of vocalizations can be used to establish new Pigeon Guillemot breeding colonies and enhance breeding success over that experienced in natural nest sites.

Hypothesis 2. Biomarkers from the plasma and excreta of Pigeon Guillemots can be used as indicators of exposure to weathered crude oil, and the subsequent survival of young guillemots post-fledging.

Hypothesis 3. Growth performance, fledgling condition, and post-fledging survival of Pigeon Guillemots are sensitive to differences in prey type, prey size, feeding frequency, and lipid content of prey.

Methodology employed during the first year of the study (CY 98) will consist of the following:

Objective 1: Testing Feasibility of Direct Restoration Techniques

a. Installation of Artificial Nest Sites and Use of Social Attraction

Pigeon Guillemot nest sites will be constructed and installed at three locations on and adjacent to the SeaLife Center: (1) under the Institute of Marine Science dock, (2) on top of the remnants of a breakwall in front of the SeaLife Center, and (3) on the seaward wall of the SeaLife Center. Five nest sites and three to five decoys will be placed at each location. Additional nest sites will be provided when the number of breeding birds and prospecting adults exceeds 15 pairs. Design of the artificial nest sites will be based on the sites developed by Divoky for Pigeon Guillemots in Puget Sound, with modifications based on studies of nest site characteristics that are associated with nesting success in Kachemak Bay (Prichard 1997). Sites will have two entrances with a central nesting cavity. Baffles in the entryways to the nest cavity will prevent avian predators from viewing nest contents. Based on the locations of Pigeon Guillemot nest sites associated with docks and piers, it appears that placing the sites beneath an overhang will increase their attractiveness to guillemots prospecting for nest sites. Sites under an overhang apparently have the advantage of decreased avian predation. Sites will be large enough to accommodate monitoring devices (such as a closed circuit camera, platform scale, or activity monitor) that may be used in future research.

Guillemot decoys will be made from waterfowl decoy kits. A tape recorder or CD player with external speakers will be used to play adult Pigeon Guillemot calls from March to late August. Because prospectors may make recruitment decisions based on local breeding productivity (Boulinier et al. 1996), from late June to late August the calls of chicks in nest sites will also be played during the early morning and evening, when colony attendance can be expected to be highest. Similar combinations of decoys and audio playbacks have been used successfully for other seabird species (Kress and Nettleship 1989, Kress 1983).

Guillemots may begin prospecting for nest sites as early as March and nest sites and decoys will be deployed in early March 1998. Personnel from this project will not be present at the SeaLife Center during most of March and April and staff from the SeaLife Center will be asked to make incidental observations of any guillemots associating with the nest sites or decoys during our absence. All of the nest sites and decoy placements will be visible from the SeaLife Center. We will begin systematic observations of the nest sites and decoy sets in early May. Daily observations will be conducted at the times expected to have maximum colony attendance (0200-0900 and 1600-2000 Alaska Daylight Time, high tides). Initially observations will be made every 15 minutes on the number of Pigeon Guillemots visible from the roof of the SeaLife Center and their distance from artificial nest sites. Once guillemots begin associating with decoys and nest sites, we will conduct detailed observations on the behavior of prospecting birds. The location and activities of prospectors will be recorded during 15-minute periods. Behavioral observations will be similar to those conducted by Preston (1968) on Black Guillemot social behavior. In the initial stages of the study, when the sighting of any guillemots associating with the nest sites will be important, we will attempt to use a closed-circuit television camera to monitor activity while project personnel are in the SeaLife Center.

b. Monitoring of Pigeon Guillemot Breeding Biology and Demographics

Should breeding occur in the artificial nest sites in 1998, we will obtain information on the breeding biology of birds using the nest sites. To reduce the chances of nest site abandonment, no adults will be captured during 1998. In later years we will attempt to noose breeding adults for banding. In 1998 the following breeding parameters will be monitored:

- date of clutch initiation
- egg weight and volume
- egg color and pattern
- date of hatching
- weight at hatching
- hatching success
- growth rate (measured every two days)
- fledging weight
- fledging age
- fledging success

The observations on breeding chronology and success can be compared with ongoing field studies of Pigeon Guillemot nesting in Prince William Sound and Kachemak Bay. Additionally the information on egg size and color can be used in future years to assess the potential of using egg characteristics to measure female survival and recruitment.

During the nestling period we will conduct observations on the prey types delivered to chicks. These observations will determine the taxonomic composition of nestling diets at each nest and collectively. These observations will be compared with diet data from Prince William Sound and Kachemak Bay (Hayes 1995, Prichard 1997).

c. Captive-rearing of Chicks

Guillemot eggs will be collected in May, during the laying period or early in incubation. Eggs will be collected from nests on Kodiak Island or other locations in the Gulf of Alaska. Collection will occur as soon as possible after clutch completion. Guillemots frequently relay when a clutch is lost within a few days of clutch completion (Divoky, unpubl.), and taking eggs early in incubation would reduce the impact on productivity of the host colony. Additionally, the sensitivity of embryos to lapses in incubation increases during development, and transporting eggs in the early stages of development should increase hatching success. Eggs will be transported to the SeaLife Center and incubated in Hovabater incubators until hatching. We prefer to collect and transport eggs rather than chicks partly so that all the conditions influencing post-natal growth can be controlled in the lab. In addition, chicks translocated late in the nestling period display philopatry to the location of hatching, instead of fledging (Serventy 1967, Fisher 1971).

The source colonies for eggs have yet to be determined. Olga Bay on Kodiak Island has an estimated population of 100 pairs of Pigeon Guillemots breeding in an abandoned cannery building. We will attempt to obtain 50 eggs in each year of the project and hope to release 40 captive-reared chicks into the wild annually. Assuming a level of philopatry similar to that observed for Black Guillemots (Divoky, in prep.), 35% of fledging chicks should return to the SeaLife Center with each cohort providing >10 potential recruits. If all surviving captive reared guillemots recruit at the natal location, a colony of > 20 pairs should be present by 2004, even if the sites do not attract immigrants before that time.

d. Release of Captive-reared Chicks

Guillemots fledge at night as early as 30 days after hatching, with most fledging after 35 days (Hayes 1995). Fledglings are able to fly at the time of nest departure and are independent of parental care post-fledging. When captive-reared chicks reach 32 days of age, they will be moved in their containers to the roof of the SeaLife Center. The covers will be removed from the buckets after sunset and chicks provided the opportunity to fledge. To insure that no predation by gulls occurs, project personnel will attend the chicks whenever they are on the roof. Fledglings will be taken to the roof nightly until all have fledged. Fledglings will be banded with a stainless steel U.S. Fish and Wildlife band and a unique combination of color polyvinyl chloride bands to allow individual identification at a distance. The latter will be sealed with an adhesive to reduce band loss.

e. Assessment of Size and Productivity of Pigeon Guillemot Colonies in Resurrection Bay

An census of guillemot colonies in Resurrection Bay and adjacent areas will facilitate understanding of the conditions contributing to the establishment of a colony at the SeaLife Center. Immigration constituted the majority of recruits at a colony of Black Guillemots in arctic Alaska that was enhanced using artificial nest sites, and birds fledging from local natural colonies that have yet to breed can be expected to prospect the sites at the SeaLife Center. To assess the size of these potential source populations and their annual productivity we will attempt to census as many local colonies as possible and, when possible, determine breeding productivity. We have not budgeted for transportation to these sites but will attempt to visit them on tour boats, National Park Service vessels, or on foot (Caine's Head). Personnel from the Kenai Fjords National Park have indicated they may provide space on their vessels for this purpose.

If it appears that Pigeon Guillemot nest sites can be accessed at these colonies, we will attempt to band nestlings. Resightings of these guillemots at the SeaLife Center will provide information on dispersal distance for this species. Intercolony visits are common for prebreeding alcids (Harris 1983, Kress and Nettleship 1989), and in 1999 and 2000 we will search these colonies for banded individuals that were raised in captivity at the SeaLife Center.

f. Work with SeaLife Center Personnel on Development of a Population of Guillemots Breeding in Captivity

The staff of the SeaLife Center is developing a captive-breeding population of Pigeon Guillemots and there are several potential areas of cooperation between their work and our proposed activities. If the number of chicks raised to fledging age in 1998 is sufficiently large, a small number could be donated to the Center's captive breeding population. Once the captive population is established it can be a source of eggs or chicks for our proposed research on captive chicks. Chicks raised from eggs produced by the captive population have the potential of being released into the wild and displaying philopatry to the SeaLife Center, thus providing potential recruits to the wild breeding population.

The captive colony also has the potential for providing information on guillemots that will assist with interpretation of the findings of our proposed work and knowledge of guillemots in general. We would work with the SeaLife Center's staff to make them aware of the potential importance of these observations. Many of these observations can be made during normal maintenance of the breeding population. Examples of the types of observations include:

1) Growth rate of chicks post-fledging

Guillemot chicks fledge at approximately 90% of adult weight and wing length. No studies have been conducted on post-fledging growth and no one has examined changes in guillemot weight and wing length from fledging to age of first reproduction.

2) Molt progression from fledgling to breeding.

Guillemots retaining remnants of basic (winter) plumage into the breeding season are assumed to be first-year birds by most authors (Petersen 1981, Asbirk 1979). Sightings of these birds are frequently used to assess the number of first-year birds visiting breeding colonies. However, some first-year birds can have complete alternate (breeding) plumage and second-year birds can also retain basic plumage into the breeding season (Divoky, in prep.). If personnel at the SeaLife Center document the molt progression of all captive guillemots from fledging to attainment of full adult alternate plumage, they can determine the utility of aging guillemots from plumage characteristics.

3) Period of flightlessness during wing molt

All large alcids typically undergo a molt of all flight feathers at the end of the breeding period (Ewins 1988). While seabirds are especially vulnerable to oil pollution during this period (they cannot fly and are more likely to come in contact with a spill), the number of days individuals are flightless is unknown. Such information would be important in assessing the potential impact of a spill in late summer or early fall. Personnel of the SeaLife Center will probably be able to observe the flightless period for several individuals each year and obtain information about the length of the flightless period.

Objective 2. Validation and Calibration of Nondestructive Biomarkers for Monitoring the Health and Exposure to Oil of Guillemots

a. <u>Measurement of Baseline Values for Certain Blood Biomarkers of Petroleum Hydrocarbon Exposure</u>

In the first year of this study (CY 98), research on blood biomarkers will be limited to collecting blood samples from chicks raised in captivity at 20, 25, and 30 days post-hatch and measuring haptoglobin and other acute phase protein levels in plasma samples in order to determine baseline values and variability. Blood samples (ca. 1 cc) will be obtained nondestructively via brachial vein puncture and blood will be centrifuged immediately and plasma frozen for later analysis. Assays for blood biomarkers will be conducted in the laboratory of Dr. Larry Duffy at the University of Alaska Fairbanks. Blood biomarker levels will be compared among the four diet groups (see below) to assess the role of diet in determining biomarker levels in blood.

b. <u>Measurement of Baseline Values for Biomarkers in Excreta</u>

In addition to collection of blood samples, samples of excreta will be collected at 20, 25, and 30 days post-hatch in order to measure fecal porphyrin levels and determine baseline values and variability. As with blood biomarkers, fecal porphyrin levels will be compared among the four diet groups. Measurements of fecal porphyrins in excreta will be conducted in the laboratory of Dr. Larry Duffy at the University of Alaska Fairbanks.

Objective 3. Captive Feeding Trials to Assess the Relationship between Diet and Postnatal Development in Guillemots

a. <u>Comparison of Guillemot Growth Performance on Diets of Nearshore Demersal Fish vs. High-lipid Schooling Forage Fish</u>

In CY 98, guillemot chicks will be raised on one of four diets: (1) 100 g of crescent gunnels per day, (2) 100 g of herring per day, (3) 150 g of crescent gunnels per day, 150 g of herring per day. Both of these prey species are major components of guillemot chick diets at certain sites and the two species are representative of the two primary prey types in guillemot diets: nearshore demersal fishes and schooling forage fishes. These daily rations are designed so as to provide a variety of caloric and biomass consumption rates that are within the normal range experienced by guillemot nestling. The rations are also designed so that isocaloric diets of gunnels and herring (150 g of gunnels and 100 g of herring) can be compared. Each chick will be kept in a separate cage so that food consumption can be monitored individually. The daily rations will be provided in six daily feedings at about 0700, 1000, 1300, 1600, 1900, and 2200 Alaska Daylight Time. Each day at approximately the same time the body mass, wing length, and outer primary length of each chick will be measured until each chick is 35 days post-hatch, when captive-reared chicks are capable of fledging and will be released into the wild. Return rates of subadults in the third year of this study will allow us to assess the role of prefledging nutrition and fledging condition on subsequent post-fledging survival.

CY 1999 and 2000

In 1999 and 2000 all of the direct restoration activities listed above for 1998 will be conducted, with the addition of monitoring the survival and site and mate fidelity of any banded birds breeding in the wild colony the preceding year. Additionally, after 1998 we will attempt to locate birds from the SeaLife Center at regional colonies during our surveys.

Also in 1999 and 2000, we will conduct dose-response experiments with captive-reared guillemot chicks to validate the use of certain biomarkers for assessing the health status and oil exposure of wild guillemot chicks. These experiments will emphasize acute phase proteins, such as haptoglobin and hemaplexin, which are known to be induced in birds in response to disease, trauma, or other stress. A range finding experiment will be conducted to determine the no-effect dose for guillemot chicks consuming weathered PBCO. We will also determine the time course of biomarker response to ingestion of PBCO, including the time post-ingestion when biomarker induction is no longer detectable. Finally, we will investigate the role of weathering in reducing the toxicity of PBCO by comparing results of dose-response experiments using PBCO that has been weathered for different periods. Small sample sizes of dosed and undosed (control) chicks will be sacrificed for measurement of CP-450 levels in liver tissues and to examine nasal gland tissues for hypertrophy.

Captive feeding trials in 1999 and 2000 will continue to investigate the relative quality of various prey types commonly fed to guillemot chicks by their parents. Additional experiments will be designed to explore the tradeoffs for guillemot nestlings of meal size, meal frequency, and meal quality. This will be accomplished by raising guillemot chicks on isocaloric rations (same number of calories ingested per day) of large or high energy density prey fed infrequently vs.

small or low energy density prey fed frequently. The growth rates and fledging condition of chicks raised on these various diets will be compared, and subsequent survival post-fledging will be assessed from return rates of captive-reared adults to the natal site. Small samples of chicks raised on the different diet regimes will be sacrificed to measure body composition using proximate analysis techniques. The results of these captive feeding trials will enable us to interpret guillemot diet data that are collected as part of long-term monitoring activities and assess the availability and quality of forage fishes for breeding guillemots.

Approval of the field protocols for work with live birds described in this DPD will be obtained from the Institutional Animal Care and Use Committee at Oregon State University. Any take of eggs or incidental/unintentional take of nestling or adult guillemots will be covered by relevant Federal and State Scientific Collecting permits. All fledgling, captive-reared guillemots released to the wild will be banded with USFWS stainless steel leg bands and polyvinyl chloride colored leg bands under a Master Station banding permit held by the Oregon Cooperative Wildlife Research Unit.

C. Contracts and Other Agency Assistance

Laboratory analyses of the biochemical composition and energy content of forage fishes fed to captive guillemots and the proximate composition of chick carcasses will be conducted in the laboratory of the PI at Oregon State University.

Maintenance of guillemot breeding stock in captivity during the non-breeding season (September - April) will be accomplished by the staff of the SeaLife Center.

Analyses of biomarkers in blood plasma and fecal samples will be conducted in the lab of Dr. Lawrence K. Duffy at the University of Alaska Fairbanks, where the expertise is available to perform this task.

SCHEDULE

A. Measurable Project Tasks for CY 98 (May 1, 1998 - April 30, 1999)

March 1 - May 15: Install artificial nest sites, decoys, and playback sound equipment at SeaLife Center.

May 15 - August 31: Collect field data on guillemot use of artificial nest sites, raise guillemot nestlings in captivity, conduct captive rearing experiments, and release captive-reared fledglings.

Sept. 1 - Dec. 31:	Enter, analyze, and interpret field data and data collected from captive-reared chicks. Conduct laboratory analyses of plasma samples, diet samples, and chick carcass samples.
January 1 - 14:	Prepare for Annual Restoration Workshop
January 15 - 24:	Attend Annual Restoration Workshop and present FY 98 results to peer reviewers.
Jan. 24 - April 14:	Prepare 1998 annual report of findings.
April 15:	Submit annual report (FY 98 findings) Submit FY 99 DPD to Trustee Council
March 16 - April 30:	Arrange logistics and prepare for FY 99 field season and captive-rearing experiments.

B. Project Milestones and Endpoints

CY 98

May 15, 1998	Installation of artificial nest sites, decoys, and audio equipment at SeaLife Center
August 31, 1998	Completion of first field season, release of first cohort of captive-reared nestlings, collection of baseline blood and fecal biomarker samples, completion of captive-feeding trials comparing nestling growth performance on schooling forage fish vs. nearshore demersal fish.
April 30, 1999:	Completion of first annual report of findings

CY 99

August 31, 1999	Completion of first year of a two-year experimental study of the role of diet on nestling growth performance and dose-response experiments with ingested crude oil

CY 00

August 31, 2000	Completion of field work and Objective 1

CY 01

June 30, 2001:	Completion of M.S. thesis
September 30, 2001	Completion of Objectives 2 and 3 and submission of manuscripts addressing these objectives

C. Completion Date

The anticipated completion of this project will be early in FY 02, at the end of calendar year 2001. This will allow adequate time to complete data analysis, thesis preparation by the Masters student, and manuscript preparation and submission following the last field season in 2000 and completion of laboratory analysis early in 2001.

PUBLICATIONS AND PROJECT REPORTS

The following publications are projected for this research project (this is a rough projection and by no means complete):

An annual report for the first year of this project will be submitted by 15 April 1999. The final report for this project will be submitted 15 December 2001. At least three manuscripts will be generated from this research, and all will be published in the peer-reviewed scientific literature. Each of these three manuscripts will address one of the three major objectives/hypotheses of this study: (1) guillemot colony establishment as a direct restoration technique, (2) biomarkers as a means of assessing exposure of guillemots to crude oil, and (3) diet as a factor in nestling growth and post-fledging survival. A portion of the final report will be excerpted from the thesis of the M.S. student on this project. This student will be strongly encouraged and directly assisted by the PI to submit for publication in the peer-reviewed scientific literature the results from this research.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The research described in this proposal takes advantage of the new research facilities and potential represented by the Alaska SeaLife Center and dove-tails nicely with continuing research as part of the APEX and NVP projects that assesses factors limiting recovery of Pigeon Guillemot populations damaged by EVOS. It is also relevant to efforts toward developing seabird models as upper trophic level sentinels of oil pollution in nearshore ecosystems. The proposed research approach utilizes growth performance, fledgling body condition, and blood and fecal biomarkers to assess the health status of guillemot nestling exposed to oil and raised on different diet rations. These data are essential for developing techniques for long term monitoring of the health and status of guillemot populations in the EVOS area.

Studies of foraging, reproduction, and population recovery following the EVOS are on-going for pigeon guillemots. This proposal complements and enhances other studies on pigeon guillemots, without duplication of effort. The PI on the present proposal has been and will continue to work closely with David Irons and Greg Golet (PIs on APEX Component 98163 F "Factors Affecting Recovery of PWS Pigeon Guillemot Populations"), Dave McGuire (Co-PI on NVP studies of biomarkers of oil exposure in guillemot nestlings), and John Piatt (PI on APEX Components 98163 M "Lower Cook Inlet Forage Fish Studies and 98163 N Black-legged Kittiwake Feeding Experiment") in developing protocols for collecting data.

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The PI has extensive experience with studies of the reproductive biology of high latitude seabirds and the relationship between diet composition and productivity. He is currently the PI of the Seabird Energetics component (Component G) of the APEX Project and Co-PI of the Diet Quality and Chick Growth component (Component N) of the APEX Project. He has been involved in research on the factors constraining recovery of Pigeon Guillemots in the EVOS area for the last three years.

OTHER KEY PERSONNEL

The proposed research will be implemented by the Oregon Cooperative Wildlife Research Unit, closely coordinated with and in cooperation with personnel of the Alaska SeaLife Center in Seward. The PI will receive major assistance in conducting the direct restoration aspects of this research project from George Divoky, Postdoctoral Research Associate, who has over 20 years of research experience with guillemots and has been instrumental in designing techniques for direct restoration of guillemot populations. In addition, the PI will be assisted in experiments with captive-reared chicks by a Masters student to be selected from qualified applicants, and an undergraduate research assistant. Laboratory analyses of the proximate composition of diet samples and chick carcasses will be conducted in the laboratory of the PI at Oregon State University. Assays of plasma and fecal biomarkers will be conducted in the laboratory of Dr. Larry Duffy at the University of Alaska Fairbanks. To the PI's knowledge, the expertise and equipment necessary for the proposed research are not available within the federal and state agencies that comprise the Trustees Council.

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EVOS Trustee Council Budget	Pigeon Guillemot Restoration at the SeaLife Center			
	May 1, 1998 to April 30, 1999		CY 98	
	On-Campus	Subtotals	Off-Campus	Subtotals
SALARY				
Graduate Student Stipend, M.S. (9 mo @ $1,100/mo)	$9,900			
Graduate Student Salary - Field season, 3 mo @ $1,500/month			$4,500	
Research Assistant - Field, 12 wk. @ $1,500/month			$4,500	
Subtotal Salary		$9,900		$9,000
BENEFITS				
Graduate Student, summer hire, 5% OPE, 3 mos.			$225	
Research Assistant, Field, 10.0% OPE, 12 weeks			$450	
Subtotal Benefits		$0		$675
TRAVEL				
Travel to SeaLife Center for research, 5 rt @$700/ea			$3,500	
Transportation in Alaska for field personnel to collect guillemot eggs			$2,000	
Per Diem en route to egg collection sites, 9 days @ $120 ea			$1,080	
Travel to Anchorage for Restoration Workshop, PI meetings - 6 RT- $500/rt	$3,000			
Per Diem in Anchorage- $120/day - 14 days	$1,680			
Subtotal Travel		$4,680		$6,580
SERVICES				
Personal Services Contract to George Divoky			$25,000	
Housing in Seward for 3 (4 mo @ $75/day)			$9,000	
Lab/Office space at SeaLife Center *			TO BE DETERMINED	
Duplication/computer fees	$500			
Lab analyses of blood & excreta samples for biomarkers (L. Duffy, UAF) (acute phase proteins in blood, fecal porphyrins)			$3,500	
Shipping for samples	$500			
Publication - page charges, reports, visual aids	$500			
Vehicle rental from Anchorage airport to Seward			$700	
Maintenance for field equipment			$800	
Telephone services - long distance charges	$1,000			
Subtotal Services		$2,500		$39,000
EQUIPMENT				
Subtotal Equipment		$0		$0
COMMODITIES				
Cages for raising chicks			$500	
Nest boxes/sites			$1,000	
Decoys, playbacks, other social attractants			$1,000	
Egg collecting equipment			$300	
Incubators			$300	
Blood sample collection supplies			$1,000	
Food for personnel at Seward, 3 people, 15 weeks @ $200/week)			$3,000	
Ohaus top-loading balance, battery-powered			$600	
Food for chicks			$1,000	
Bands and banding supplies			$200	
Miscellaneous supplies for captive rearing			$500	
Subtotal Commodities		$0		$9,400
STUDENT ASSISTANCE				
Tuition for M.S. student (3 academic terms, 1998-99)	$6,102	$6,102		
TOTAL DIRECT COSTS	$23,182	$23,182	$64,655	$64,655
Modified Total Direct Costs (less tuition, equipment)	$17,080	$17,080	$64,655	$64,655
INDIRECT COSTS	$7,259	$7,259	$16,810	$16,810
42.5% MTDC (On-Campus Research Rate)				
26% MTDC (Off-Campus Research Rate)				
TOTAL COSTS (direct and indirect)	$30,441	$30,441	$81,465	$81,465
TOTAL COST OF PROJECT (Off-campus and On-campus)	$111,906			

* estimated cost for lab or office space (per John Hendricks) is $870/mo. or $6,090 for use of office space (4 mo) and lab space (3 mo). Trustee Council to negotiate rate and potentially reimburse SeaLife Center directly.

12:05 AM b 4/13/97

98328

Synthesis of the toxicological impacts of the Exxon Valdez oil spill on Pacific herring

Project Number:	98328
Restoration Category:	Synthesis, integration, and publication
Proposer:	Mark G. Carls NOAA/NMFS, Auke Bay Laboratory ABL Program Manager: Dr. Stan Rice NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	National Marine Fisheries Service
Cooperating Agencies:	Alaska Department of Fish and Game University of Alaksa, Fairbanks
Alaska SeaLife Center:	
Duration	First year of a 1.5 year project
Cost, FY98:	$35,200
Cost, FY99:	$68,000
Geographic Area:	Prince William Sound (field work completed)
Injured Resource/Service:	Pacific herring

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

This project would synthesize results of Trustee-sponsored studies related to the toxicological damage to Pacific herring, and compare them to results published by Exxon contractors. State and federal researchers concluded that exposure to oil caused egg mortality, morphological and cytogenetic abnormalities, reduced growth, and immunosuppression in adults, but that the effects on the population level were ~~un~~known. These results would be compared to those reached by Exxon contractors, who concluded that the spill had a minor impact on herring eggs, and that the population biomass was not reduced (Pearson et al. 1996). A monograph for publication would be prepared, and presented at the 10th Anniversary *Exxon Valdez* Oil Spill Symposium.

INTRODUCTION

Since the Exxon Valdez oil spill (EVOS) in Prince William Sound (PWS) in 1989, considerable field and laboratory research was focused on Pacific herring as a species injured by the spill. Research included assessment of injury to herring eggs and larvae (Brown et al. 1996; McGurk and Brown 1996; Norcross et al. 1996; Kocan et al. 1996a; Pearson et al. 1995), including genetic injury (Hose et al. 1996) and histopathological examination (Marty et al. in press), experimental oiling of embryos and or adults in laboratory tests (Kocan et al. 1996a; Thomas et al. in press; Carls et al. in prep.), histopathological examination of adults (Moles et al. 1993) and post-spill assessment of reproductive success (Kocan et al. 1996b; Johnson et al. submitted). Ongoing research includes assessment of viral hemorrhagic septicemia virus (VHSV) and *Icthyophonus hoferi* infections in herring in PWS (Marty et al.), nuclear and mitochondrial DNA studies (Seeb), population abundance (Willette), natal habitat (Brown), spatial distribution, density estimates, and growth (Stokesbury). Other research has focused on larger-scale ecosystem questions related to herring, including physical and biological oceanographic observation (SEA).

Two very different interpretations concerning the extent of injury have emerged from these studies. The conclusions reached by Exxon contractors were that the spill had a minor impact on herring eggs, and that the population biomass was not reduced (Pearson et al. 1996). State and Federal researchers concluded that exposure to oil caused egg mortality, morphological and cytogenetic abnormalities, reduced growth, and immunosuppression in adults (Brown et a. 1996; Carls et al. in prep. Hose et al. 1996; Kocan et al. 1996ab; Marty et al. in press; McGurk and Brown 1996; Norcross et al. 1996; Thomas et al. in press), but that the effects on the population level were unknown (EVOSTC 1996). In part, the controversy involves resolution of the extent spawned areas were oiled: Exxon contractors suggest only 4% of the spawned shoreline length was oiled (Pearson et al. 1996), while others concluded that 40 to 50% of the eggs were exposed to oil (Brown et al. 1996). In this synthesis paper we will attempt to resolve these differences, and integrate all laboratory and field work.

NEED FOR THE PROJECT

A. Statement of Problem

Conflicting interpretations of the extent of injury emerged from Natural Resource Assessment Studies and those by Exxon contractors. Exxon contractors concluded that the spill had a minor impact on herring eggs, and that the population biomass was not reduced (Pearson et al. 1996). State and Federal researchers concluded that exposure to oil caused egg mortality, morphological and cytogenetic abnormalities, reduced growth, and immunosuppression in adults (Brown et a. 1996; Carls et al. in prep. Hose et al. 1996; Kocan et al. 1996ab; Marty et al. in press; McGurk and Brown 1996; Norcross et al. 1996; Thomas et al. in press), but that the effects on the population level were unknown (EVOSTC 1996). However, herring were placed on the injured species list; of particular concern was the population collapse in 1993, viewed as a possible delayed consequence of prior spill damage. The proposed synthesis will review published papers and reports pertainent to Pacific herring and the *Exxon Valdez* oil spill, and will integrate all

Trustee-sponsored laboratory and field work. The synthesis will also discuss Exxon contractor findings, and attempt to resolve differences.

B. Rationale/Link to Restoration

This project relates directly to the Oil Spill Restoration Plan objective to recover healthy and productive Pacific herring populations to pre-spill abundance. The significance and causes of long term damage will be evaluated; restoration and management strategies need this information.

C. Location

Prince William Sound. Field work has already been completed.

COMMUNITY INVOLVEMENT

Because all field work has been completed, opportunity for community involvement is very limited.

PROJECT DESIGN

A. Objectives

1. Synthesize results of all Trustee-sponsored studies relating to long-term toxicological injury to and recovery of Pacific herring. All the major hypotheses from the various studies would be examined in the synthesis manuscript.

2. Evaluate and incorporate into the synthesis all of the relevant Exxon funded results, and attempt to reconcile differences with Trustee-sponsored research where possible.

B. Methods.

To discuss content, develop the synthesis outline and assign writing duties, we propose to convene a workshop in November or December of 1997. For the purpose of reducing cost, this workshop might dovetail with other herring workshops routinely convened by the Exxon Valdez Oil Spill Trustee Council. Research considered in this effort would include NRDA and Restoration research funded by the *Exxon Valdez* Oil Spill Trustee Council, and also research published by *Exxon* contractors. Workshop products would include draft outline(s) for synthesis manuscript(s), a draft DPD for FY99 to complete syntheses, development of an FY99 budget, and draft proposals for the 1999 symposium presentations (1-3?). As there will likely be insufficient time to complete synthesis before the 10th anniversary *Exxon Valdez* oil spill symposium if work begins in FY99, we also propose funding of preliminary writing in FY98.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Principal investigators from several agencies, including Dr. Gary Marty (University of California, Davis), Dr. Jo Ellen Hose (Occidental University), Dr. Richard Kocan (University of Washington), Evelyn Brown and Dr. Kevin Stokesbury (University of Alaska, Fairbanks).

SCHEDULE

A. Measurable Project Tasks for FY98 (October 1, 1997 - September 30, 1998)

We propose to start this project in FY98. If the project is delayed until FY99 there will be insufficient time to produce a product and presentation at the anniversary workshop (March 1999). Some subjects for the review are in hand now, others will be completed in FY98. Egg and larval work relating to genetics and morphology have been completed, but some disease work is continuing in the field (Marty et al., Stokesbury et al., Brown et al.) and laboratory (Kocan et al.).

Nov/Dec 97:	Convene herring synthesis workshop
January 98:	Individual authors begin drafting syntheses or assigned sections
March 98:	DPD for completion of herring syntheses, as drafted by workshop attendees and contributing authors, will be submitted.
September 99:	Each author will have completed 1 month effort on manuscripts
April 99:	Writing and preparation of presentations for the 10th annual symposium will be near completion.
March 99:	Present syntheses at 10th anniversary Exxon Valdez oil spill symposium
April 99:	Submit synthesis manuscript(s) to journal
September 99:	Synthesis paper(s) should be in press.

B. Project Milestones and Endpoints

December 97:	Synthesis outline prepared
	Data from publications and reports tabulated
March 99:	Draft synthesis completed and available for review
	Synthesis topics presented at 10th annual symposium
September 99:	Synthesis in press.

C. Completion Date

This project would be completed in Fiscal Year 1999.

PUBLICATIONS AND REPORTS

This project would produce a publication that would synthesize results of the separate Trustee-sponsored studies on toxicological impacts of the *Exxon Valdez* oil spill on Pacific herring, and compare these results to those published by Exxon contractors. It would begin in FY98, be completed in FY99, and submitted for publication in a peer-reviewed journal in April 1999.

The synthesis would be presented at the 10th Anniversary Symposium in March 1999.

PROFESSIONAL CONFERENCES

The synthesis product could be presented at the 1999 SETAC conference.

NORMAL AGENCY MANAGEMENT

NOAA/NMFS has statutory stewardship for all living marine resources; however, if the oil spill had not occurred NOAA would not be conducting this project. NOAA/NMFS proposes to make a significant contribution (as stated in the proposed budget) to the operation of this project, making it truly cooperative.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be coordinated with other projects conducted by ABL and ADF&G. This project is dependent on the completion of the Trustee projects relevant to toxicological impacts to Pacific herring.

PROPOSED PRINCIPAL INVESTIGATOR, IF KNOWN

Mark Carls is the 'token' principal investigator, and will be responsible for the initial formulative phases of the project. It is possible that a different principal investigator will emerge at the formulative workshop (Nov/Dec 97).

Mark G. Carls
NOAA/NMFS
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Juneau, AK 99801
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email: mark.carls@noaa.gov

GS-12 Fishery Biologist - Mark G. Carls

Received BA (1975) in Biology from Gustavus Adolphus College, St. Peter, MN, and MS (1978) in Biological Oceanography from Dalhousie University, Halifax, Nova Scotia. Mark has been employed at the Auke Bay Fisheries Laboratory since 1979. His principal involvement has been in research of petroleum hydrocarbon toxicology to marine fish and invertebrates, including egg, larval, and adult life stages. Mark has published 17 papers, and has 5 *Exxon Valdez* damage assessment papers in preparation or pending publication. Since 1989, he has been involved as a principal investigator and co-investigator on several studies resulting from the *Exxon Valdez* oil spill involving Pacific herring, pink, and chum salmon.

Cooperating investigators (Co-authors)

Cooperating investigators will include Dr. Gary Marty (University of California, Davis), Dr. Jo Ellen Hose (Occidental University), Dr. Richard Kocan (University of Washington), Evelyn Brown and Dr. Kevin Stokesbury (University of Alaska, Fairbanks).

LITERATURE CITED

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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998	PROPOSED FY 1998 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
				$9,192.5				$26,007.0
Personnel	$0.0	$7,800.0						
Travel	$0.0	$6,824.0						
Contractual	$0.0	$19,000.0						
Commodities	$0.0	$0.5						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$33,624.5		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration	$0.0	$1,575.0						
Project Total	$0.0	$35,199.5		$68,000.0	$0.0	$0.0	$0.0	
Full-time Equivalents (FTE)	0.0	0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0		$0.0	$0.0	$0.0	$0.0	

Comments: This project is designed to develop a herring data integration, synthesis and outreach (publication and presentation) strategy in FY98 (Phase 1) and implement this strategy in FY99 (Phase 2). The budgets may be revised for Phase 2 based on FY98 (Phase 1) activities.

1998

Project Number: 98328
Project Title: Herring Integration, Synthesis, and Outreach
Lead Agency: NOAA

FORM 2A
MULTI-TRUSTEE
AGENCY
SUMMARY

Prepared:

4/14/97

1998 EXXON VALDEZ TRUS. __ COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$7,800.0						
Travel		$6,824.0						
Contractual		$10,000.0						
Commodities		$0.5						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$24,624.5		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$1,382.5						
Project Total	$0.0	$26,007.0		$50,000.0				
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars							
Other Resources								

Comments: This project is designed to develop a herring data integration, synthesis and outreach (publication and presentation) strategy in FY98 (Phase 1) and implement this strategy in FY99 (Phase 2). The budgets may be revised for Phase 2 based on FY98 (Phase 1) activities.

1998

Prepared:

Project Number:
Project Title: Herring Integration, Synthesis, and Outreach
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/14/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
M. Carls	Project Coordinator	GS 12/5	0.8	7000.0		5,600.0
J. Rice	advisor	GS 14	0.2	11000.0		2,200.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	18000.0	0.0	
					Personnel Total	$7,800.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Fairbanks to Anchorage (Brown, Norcross, Stokesbury))	212.0	3	6	225.0	1,986.0
Juneau to Anchorage (Carls, Rice)	444.0	2	4	225.0	1,788.0
Los Angles to Anchorage (Hose)	600.0	1	2	225.0	1,050.0
Seattle to Anchorage (Kocan)	500.0	1	2	225.0	950.0
Sacramento to Anchorage (Marty)	600.0	1	2	225.0	1,050.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6,824.0

1998

Project Number:
Project Title: Herring Integration, Synthesis, and Outreach
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

Prepared:

4/14/97

1998 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
contracts for Hose, Kocan, and Marty for .3 months each @ $10.K/mo.= $3.0K each	9,000.0
slide and poster preparation	1,000.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$10,000.0

Commodities Costs:	Proposed
Description	FY 1998
computer software	0.5
Commodities Total	$0.5

1998

Prepared: 4 of 13

Project Number:
Project Title: Herring Integration, Synthesis, and Outreach
Agency: NOAA

FORM 3B
Contractual &
Commodities
DETAIL

4/14/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
computers	2	NOAA
slide scanner	1	NOAA
camera	1	NOAA
photo output device	1	NOAA

1998

Project Number:
Project Title: Herring Integration, Synthesis, and Outreach
Agency: NOAA

FORM 3B
Equipment
DETAIL

4/14/97

1998 EXXON VALDEZ TRUST OUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$0.0						
Travel		$0.0						
Contractual		$9,000.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$9,000.0		Estimated	Estimated	Estimated	Estimated	
General Administration		$192.5		FY 1999	FY 2000	FY 2001	FY 2002	
Project Total	$0.0	$9,192.5		$18,000.0				
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: This project is designed to develop a herring data integration, synthesis and outreach (publication and presentation) strategy in FY98 (Phase 1) and implement this strategy in FY99 (Phase 2). The budgets may be revised for Phase 2 based on FY98 (Phase 1) activities.

1998

Project Number:
Project Title: Herring Integration, Synthesis, and Outreach
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1998

Project Number:
Project Title: Herring Integration, Synthesis, and Outreach
Agency: ADFG

FORM 3B
Personnel
& Travel
DETAIL

Prepared:

4/11/97

Contractual Costs:	Proposed
Description	FY 1998
contracts for Brown, Norcross, and Stokesbury for .3 months each @ $10.K/mo.= $3.0K each	9,000.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$9,000.0

Commodities Costs:	Proposed
Description	FY 1998
Commodities Total	$0.0

1998

Project Number:
Project Title: Herring Integration, Synthesis, and Outreach
Agency: NOAA

FORM 3B
Contractual &
Commodities
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1998

Project Number:
Project Title: Herring Integration, Synthesis, and Outreach
Agency: NOAA

FORM 3B
Equipment
DETAIL

4/14/97

98329

Synthesis of the Toxicological Impacts on Pink Salmon

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project Number: 98329

Restoration Category: Synthesis, Integration, and Publication

Proposer: Stanley D. Rice
NMFS, Auke Bay Laboratory
ABL Program Manager: Dr. Stan Rice
NOAA Program Manager: Bruce Wright

Lead Trustee Agency: NOAA

Cooperating Agencies: ADFG

Alaska SeaLife Center:

Duration: 1st year, 1.5-year project

Cost FY 98: $25,600

Cost FY 99: $51,800

Geographic Area: Prince William Sound (field work completed)

Injured Resource/Service: Pink salmon

ABSTRACT

This project would synthesize results of all Trustee-sponsored studies related to the toxicological damage to pink salmon. Pink Salmon were injured in 1989, and the injury persisted through 1993. The best evidence of long-term damage to any fish species following an oil spill comes from a suite of Trustee-sponsored projects. Since 1989, seven separate Trustee-sponsored projects by both ADFG and NOAA have individually advanced our understanding of the effects of the *Exxon Valdez* oilspill on pink salmon. These studies examined the past and present potential for oil exposure (Project 194), effects on egg/embryo survival (Project 191A and 191B), juvenile feeding and growth (NRDA Project 4), marine survival and straying of returning adults (Projects 076 and 209), and the possibility that effects are heritable (Project 228). We propose to draw on data from the piecemeal results from these studies to construct synthetic conclusions regarding the injury to and subsequent recovery of pink salmon. Contracted studies by EXXON have differed with the Trustee studies; their results would be compared and evaluated with the Trustee studies. A monograph for publication would be prepared, and would be the basis of a presentation at the 10th Anniversary *Exxon Valdez* Oilspill Symposium.

INTRODUCTION

The *Exxon Valdez* oilspill caused several toxicological effects on pink salmon (*Oncorhynchus gorbuscha*), including increased mortality, reproductive impairment, and possible long-term genetic damage in pink salmon eggs and embryos that incubated in oiled intertidal sections of freshwater streams. Short-term effects were measured in 1989 and 1990, but to the surprise of the scientific community, negative impacts to developing embryos continued through 1993. The value of the pink salmon resource in Prince William Sound stimulated the gathering of the best pre-spill information; the long-term impacts stimulated a suite of field and laboratory studies to document the slow rates of recovery and to investigate mechanisms of the long-term damage. The Trustee Council funded seven separate studies to examine possible consequences to pink salmon populations. These studies by both ADFG and NOAA examined the past and present potential for oil exposure (Project 194), effects on egg/embryo survival (Project 191A and 191B), juvenile feeding and growth (NRDA Project 4), marine survival and straying of returning adults (Projects 076 and 209), and the possibility that effects are heritable (Project 228).

The pink salmon studies are the best evidence of continued long-term damage in any fish species following an oil spill. Long-term damage is a rare event that has not been documented in many species following an oil spill. The Trustee emphasis on this question has stimulated EXXON to fund independent studies of toxicological impacts on pink salmon in Prince William Sound. Some interpretations from these studies have been counter to the Trustee studies on several major issues; collectively, the two groups of studies have been controversial.

This synthesis effort would focus on the issue of long-term damage: is it real, is it significant, what are the mechanisms? Although the individual studies have greatly advanced our understanding of the effects of the *Exxon Valdez* oilspill on pink salmon, each when considered separately presents an incomplete picture of the long-term impacts. Considered together, these studies would provide a complete and comprehensive analysis of the toxicological impacts on pink salmon. Further, contradictory conclusions reached by EXXON contractors and Trustee-sponsored studies need to be reviewed and resolved.

NEED FOR THE PROJECT

A. Statement of Problem

Seven separate Trustee-sponsored studies and several EXXON-contracted studies have examined the toxicological impacts of the *Exxon Valdez* oilspill on pink salmon. When considered separately, the studies present an incomplete and sometimes contradictory analysis of the impacts. When analyzed together, these studies would provide the data necessary to construct a synthetic argument about the toxicological impacts on pink salmon. This project would provide the synthesis needed to link the different pieces from these studies into a comprehensive whole picture of the impacts on and recovery of pink salmon after the *Exxon Valdez* oilspill. At the 1997 Restoration Workshop, keynote speaker Dr. Kai Lee emphasized the need for syntheses such as the proposed project to bring cohesiveness to the Trustee's multi-faceted research program, and he recommended funding one synthesis project each year.

B. Rationale/Link to Restoration

This project relates directly to the Oil Spill Restoration Plan objective to recover healthy and productive pink salmon populations to prespill abundance. The significance and causes of long-term damage would be evaluated: restoration and management strategies need this information.

C. Location

Prince William Sound. Field work has already been completed.

COMMUNITY INVOLVEMENT

As all field work has already been completed, only limited community involvement is envisioned for this project.

PROJECT DESIGN

A. Objectives

1. Synthesize results of all Trustee-sponsored studies relating to long-term toxicological injury to and recovery of pink salmon. All the major hypotheses from the various studies would be proposed and tested as part of a synthetic argument developed for this project.

2. Evaluate and incorporate into the synthesis all of the relevant EXXON funded results, and attempt to reconcile differences where possible.

B. Methods

Data from all Trustee-sponsored studies would be collected and synthesized to test the major hypotheses about the toxicological effects of the oil spill on pink salmon. We would work together with the principal investigators to jointly review results and derive conclusions. Some of the hypotheses that would be considered include

H1: Persistent elevated egg/alevin mortality until 1994 was due to genetic damage incurred during the first incubation period after the oil spill.

H1a: Alternatively, persistent egg/alevin mortality was due to continued oil exposure until 1993.

H2: The mechanism of persistent egg/alevin mortality was reproductive impairment in adults incurred by toxicological effects during incubation.

H2a: Alternatively, the mechanism of elevated egg/alevin mortality was genetic impairment.

H3: Toxicological effects included increased egg/alevin mortality, increased marine mortality, increased straying, and decreased fecundity.

H4: Toxicological effects have disappeared at all life-history stages, and population dynamics have recovered.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Principal investigators (Bue and Seeb) from ADFG would be asked to take part in working meetings to assist in constructing a synthesis from their individual studies. The proposed budget includes funds for 0.5 months of Bue's time in FY98 and 0.5 months of Seeb's time in FY99. No other contracts or agency assistance is required.

SCHEDULE

A. Measurable Project Tasks for FY 98

This project would be started in FY 98. Delaying the start to FY 99 would not allow enough time to provide a product and presentation in FY 99. Some subjects for the review are in hand now; others will be completed in FY 98. Results from the oiled stream sediment project (Project 194) will be evaluated in early FY 98, while the tag reading and data evaluation phases of the straying project (Project 076) will continue into mid FY 98 before the data and interpreted results can feed into this synthesis project.

October-December 1997:	Collate data from final reports from all Trustee-sponsored studies and all appropriate EXXON studies related to toxicological impacts on pink salmon. Meet with principal investigators to evaluate the status of past studies, reports, and manuscripts; review EXXON studies; and formulate an outline and schedule for the monograph.
January-September 1998:	Meet with principal investigators; develop component parts to the synthesis. Focus in last half of FY 98 would be the final reports from the straying project and on the results of the matings of exposed fish.
October- December 1998	Final draft of monograph completed; co-author reviews.
January 1999:	Submit synthesis monograph to journal for publication.
March 1999	Present synthesis at the 10th Anniversary Symposium.

B. Project Milestones and Endpoints

January 1998:	Data from final reports collected and tabulated. Outline of monograph prepared.
December 1998:	Draft monograph synthesis completed and available for review.
January 1999:	Monograph synthesis completed and submitted for publication.
March 1999	Synthesis presented at the 10th Anniversary *Exxon Valdez* Oilspill Symposium.

C. Completion Date

This project would be completed in Fiscal Year 1999 (March 1999).

PUBLICATIONS AND REPORTS

This project would produce a monograph publication that would synthesize results of the separate Trustee-sponsored studies on toxicological impacts on pink salmon. It would be started in FY 98, finished in FY 99, and submitted for publication in a peer-reviewed journal in January 1999.

The synthesis would be presented at the 10th Anniversary Symposium in March 1999.

NORMAL AGENCY MANAGEMENT

NOAA NMFS has statutory stewardship for all living marine resources; however, if the oil spill had not occurred, NOAA would not be conducting this project. NOAA NMFS proposes to make a significant contribution (as stated in the proposed budget) to the operation of this project, making it truly cooperative.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project would be coordinated with other projects conducted by ABL and ADFG. This project depends on the completion of the Trustee projects relevant to toxicological impacts on pink salmon. Several of these will be finished in FY 98 (straying, oiled stream sediments, etc.).

PROPOSED PRINCIPAL INVESTIGATOR

Stanley D. Rice
NOAA NMFS Auke Bay Laboratory
11305 Glacier Hwy
Juneau, AK 99801
Phone: (907) 789-6020; Fax: (907) 789-6094
E-mail: jeep.rice@noaa.gov

Cooperating Investigators (Co-authors)

ABL
Alex Wertheimer
Mike Murphy
Jeff Short
Ron Heintz

ADFG
Jim Seeb
Brian Bue

PRINCIPAL INVESTIGATOR

GM-14 Physiologist - Stanley D. Rice

Dr. Stanley D. Rice received a BA (1966) and MA (1968) in Biology at Chico State University, and Ph.D. (1971) in Comparative Physiology at Kent State University. Employed at the Auke Bay Laboratory since 1971 as a research physiologist and task leader. Dr. Rice has been Habitat Program Manager since 1986. He has researched oil effects since 1971 and has published over 80 papers on the subject, and over 20 papers on other pollution/physiological subjects. Dr. Rice was the lead editor for the *Exxon Valdez* Symposium published in 1997. His studies have ranged from field to lab tests, behavioral to biochemical studies, and salmonids to invertebrates. Dr. Rice has conducted and managed cooperative projects since 1974, including the Auke Bay Laboratory's *Exxon Valdez* damage assessment studies. Activities since the oil spill include management of more than 10 damage assessment projects, more than 25 restoration projects, establishment of chemistry lab and analyses, and establishment of hydrocarbon database management. Dr. Rice has provided reviews and critical input to principal investigators and managers in NOAA and other agencies to support agency decisions, and he has interacted closely with other agencies on logistics coordination, study design review, and data interpretation.

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FFY 1997	Proposed FFY 1998						
Personnel		$19.5						
Travel		$2.2						
Contractual		$0.0						
Commodities		$1.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$22.7	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002		
General Administration		$2.9						
Project Total		$25.6	$51.8	$0.0	$0.0	$0.0		
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$16.6	$26.3					

Comments:

NOAA Contributions:
Stan Rice , Program Manager .5 mo = 4.8K, Mike Murphy .5 mo @ 2.8K, for a total of $7.6K

ADFG Contirbutions:
Brian Bue .5 mo @ 4.5K, Jim Seeb .5 mo. @ 4.5K for total contribution of 9K

1998

Project Number: 98329
Project Title: Synthesis of Toxicological Impacts on Pink Salmon
Agency: National Oceanic & Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTL_ _JUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1998
Stanley D. Rice	Physiologist	14	0.5	9.6		4.8
Michael L. Murphy	Fisheries Research Biologist	12/4	1.0	5.7		5.7
Brian Bue	Fisheries Research Biologist		0.5	9.0		4.5
Jim Seeb	Fisheries Research Biologist		0.5	9.0		4.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.5	33.3	0.0	
					Personnel Total	$19.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1998
Anchorage to Juneau, work meeting with Bue, Seeb	0.4	2	4	0.3	2.0
Car rental for above.					0.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.2

1998

Project Number: 98___
Project Title: Synthesis of Toxicological Impacts on Pink Salmon
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 1998
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 1998
Computer repairs, maintenance, software upgrades	1.0
Commodities Total	$1.0

1998

Project Number: 98___
Project Title: Synthesis of Toxicological Impacts on Pink Salmon
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1998
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1998

Project Number: 98___
Project Title: Synthesis of Toxicological Impacts on Pink Salmon
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Equipment
DETAIL