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United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. TUDOR RD.
ANCHORAGE, ALASKA 99503

IN REPLY REFER TO:

MBM

MAY 1 4 1990

Memorandum

To: Department of Interior Representative
Exxon Valdez Oil Spill Restoration Planning Work Group

From: Acting Regional Director, Region 7
U.S. Fish and Wildlife Service

Subject: Proposed Oil Spill Restoration Pilot Project

In response to your interest in reviewing pilot projects for restoration planning this year, we are submitting a summary proposal concerning identification of Marbled Murrelet nesting habitat in Prince William Sound. We hope you will favorably consider this project during your review. Please call Paul Gertler (786-3579) or Kathy Kuletz (786-3453) if you have any questions.

Attachment

Restoration Pilot Project 1990 -- Bird Studies

Title: Marbled Murrelet Breeding habitat Identification

JUSTIFICATION

Marbled murrelets are noncolonial seabirds that breed along the west coast from Northern California to Alaska. They are currently being considered for threatened or endangered status along Washington, Oregon and California. An estimated 95% of the total population in U.S. waters occurs in Alaska, with Prince William Sound second only to Southeast Alaska in murrelet abundance (Mendenhall 1988). However, the number of marbled murrelets has been decreasing in the Sound since the early 1970s, with only 40% of the numbers found in 1989 as were present in 1972 (S. Klosiewski, pers comm.). In addition to direct mortality from the 1989 oil spill (Piatt et al. 1989), these birds depend upon the fisheries resource in the Sound which may have been damaged by the oil spill, potentially accelerating the rate of decline.

Preservation of breeding habitat would contribute to support of the population and maintenance of a viable population. In the lower latitudes, the birds are known to nest in trees and have a strong preference for old-growth habitat, i.e., large trees with epiphytes and an open understory (Marshall 1988). However, in Alaska, it is not known whether these birds have the same requirements for nesting habitat, and several ground nests have been found. This study proposes to develop information towards identifying critical terrestrial sites that need protection.

Eventually it may be necessary to identify specific timber stands as marbled murrelet nesting sites. However, given the size and remoteness of the spill area, it would be advantageous to implement pilot studies in the 1990 field season, to test methods and develop the design of a full-scale effort. In Washington, Oregon and California, techniques have been developed to map and identify murrelet nesting habitat (Nelson 1989, Paton et al. 1989). These methods depend on an extensive road system, large numbers of volunteers and minimal logistical complications. Techniques need to be tested in and adapted for remote Alaskan conditions.

During the 1990 field season, Migratory Bird Management, U.S. Fish and Wildlife Service, will have a camp on Naked Island in Prince William Sound for Damage Assessment Bird Study No.2. With support from Restoration funds, Naked Island could provide a base to conduct pilot studies for identifying marbled murrelet nesting habitat. Available field personnel can contribute to the murrelet nesting study, but at least one person should be dedicated full time to the project.

In addition to an existing field camp, Naked Island is advantageous for this pilot study because 1) marbled murrelets are common around the island and are believed to breed there (Kuletz, unpubl. data). 2) The field camp supervisor, Kathy Kuletz, is familiar with the study site and with the murrelet detection technique. 3) Naked Island has a diversity of forest types. 4) Naked Island is small enough, with a sizable murrelet population, that there is a high probability of locating birds and their in-land use patterns. The data set gathered from this pilot study will provide a basis for a full-scale effort in future years.

OBJECTIVES

A. Document the existence of tree nesting in Prince William Sound.

B. Identify characteristics of tree nest habitats in Prince William Sound.

C. Test the efficacy of murrelet detection techniques in typical Prince William Sound habitat.

METHODS

Objective A: Documentation of tree nesting by marbled murrelets

The presence of murrelets inland will be documented using the dawn detection methods described in Nelson (1989) and Paton et al. (1989). Murrelets visit their nests from May through August, with peak activity in July. They can be heard and seen flying inland at dawn, and to a lesser extent, sunset. During the 90 minute activity period a stationary observer will use a tape recorder to record murrelet numbers, flight direction, altitude and behavior. Bird altitude (relative to canopy) and behavior are indications that the observation site is either a nesting grove or a flight corridor to nesting sites further inland. Sites with high murrelet activity will be staked out for an intensive ground search to locate specific trees used by murrelets. This method was used to successfully locate two nests in 1989 (Naslund et al. 1990).

Objective B. Identification of murrelet nesting habitat

Habitat features of Naked Island (distance to ocean and fresh water drainage, slope, aspect, elevation, vegetation layers, tree stand size, tree species and tree size) will be assessed on-site and with aerial photos. The latter are available through the U.S. Forest Service. Presence/absence of murrelet activity will be monitored among habitat types. Such monitoring would provide a base for development of a sampling scheme to examine murrelet habitat selection in a full-scale study.

Objective C. Tests of methodologies

In the course of this study, observers will be able test the efficacy of using the dawn detection techniques in a remote location with a convoluted shoreline. At appropriate sites where birds fly below the canopy, personnel may attempt to mist-net murrelets. This could provide experience and information on capturing murrelets for future radio-tagging efforts.

ESTIMATED BUDGET

Salaries		
	GS-9/3 pay periods (field work, analysis and write-up)	$4200
	GS-5/5 pay periods + overtime	5100
Travel	extra transport arrangements	1000
Contract	aerial photo analysis	2000
Equipment	misc. extra equipment & supplies	1000
Total		$13,300

LITERATURE CITED

Marshall, D.B. 1988. Status of the Marbled Murrelet in North America with special emphasis on populations in Washington, Oregon and California. USFWS Biol. Rep. 88(30).

Mendenhall, V.M. 1988. Distribution, breeding records and conservation problems of the marbled murrelet in Alaska. Unpubl. Rep., USFWS, Anchorage, AK.

Naslund, N.L. 1990. A Proposed Ground Search Technique for Finding Tree Nests of the Marbled Murrelet in Open Canopy Forests. Abst. Pacific Seabird Group Symposium, February, 1990, Victoria, B.C., Canada.

Nelson, K. 1989. Development of Inventory Techniques for Surveying Marbled Murrelets (Brachyramphus marmoratus) in the Central Oregon Coast Range. Oregon Dept. of Fish and Wildlife, Portland, Oregon.

Paton, P.W.C., C.J. Ralph, H.R. Carter, and S.K. Nelson. 1989. The Pacific Seabird Group's 1989 handbook for marbled murrelet surveys at inland sites. Unpubl. Rep., U.S. Agric. For. Serv., Arcata, CA.

Piatt, J.F., C.J. Lensink, W. Butler, M.Kendziorek. 1989. Marine birds killed in the 'Exxon Valdez' oil spill: An interim report. Unpubl. report. U.S.F.W.S. Research Center, Anchorage, AK.

Project Leader -- Kathy Kuletz

Kathy Kuletz received her M.S. from the University of California, Irvine, in 1983. Her thesis, based on research done at Naked Island, was on foraging and reproductive success of Pigeon Guillemots. She is a member of the Pacific Seabird Group. Ms. Kuletz has worked in Alaska since 1976 for the USFWS, Dames & Moore Consulting and LGL Alaska Research. In 1988 she conducted a study on at-sea censusing of murrelets for the AMNWR. In 1989 Ms. Kuletz was P.I. for the Marbled Murrelet damage assessment study (Bird Study Number 6).

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Environmental Research Laboratory
CORVALLIS OR 97333

399-0165
John Armstrong

EPA

FACSIMILE REQUEST AND COVER SHEET

PLEASE PRINT IN BLACK INK ONLY

TO: Brian Ross

OFFICE/PHONE: 868-3424

FAX #: ~~868-2464~~ 7
CONF. #: 868 3083
(Stan Stenmen) 868-3424

REGION/LAB:

FROM: Hal Kibby

PHONE: FTS 420-4625

MAIL CODE:

OFFICE: ERL-Corvallis

DATE: 5/22/90

NUMBER OF PAGES TO INCLUDE THIS COVER SHEET: 14

Please number all pages

INFORMATION FOR SENDING FACSIMILE MESSAGES

EQUIPMENT	FACSIMILE NUMBER	VERIFICATION NUMBER
PANAFAX MV 3000	FTS: 420-4799 Comm: (503) 757-4799	FTS: 420-4600 Comm: (503) 757-4600

1990 FEAS. STUDY
FOCUS —
Draft IAG + SCOPE OF WORK

TRANSMITTED

_____ / _____
(Date) (Time)

CONFIRMED: _____

CERL-24

PAGE ___ OF ___ PAGES

Part II - Approved Budget

EPA IAG Identification Number

22. Budget Categories	Itemization of This Action	Itemization of Total Project Estimated Cost to Date
(a) Personnel	$ 2,000	$
(b) Fringe Benefits		
(c) Travel	1,000	
(d) Equipment		
(e) Supplies	2,000	
(f) Procurement/Assistance	135,000	
(g) Construction		
(h) Other	10,000	
(i) Total Direct Charges	$150,000	$
(j) Indirect Costs: Rate % Base $		
(k) Total (EPA Share %) (Other Agency Share %)	$150,000	$

23. Is equipment authorized to be furnished by EPA or leased, purchased, or rented with EPA funds? (Identify all equipment costing $1,000 or more) [ ] Yes [X] No

24. Are any of these funds being used on extramural agreements? (See Item 22f) $135,000 [X] Yes [ ] No

Type of Extramural Agreement [ ] Grant [ ] Cooperative Agreement [X] Procurement (Includes Small Purchase Order)

Contractor/Recipient Name (if known)	Total Extramural Amount Under This Project	Percent Funded by EPA (if known)
University of Alaska Fairbanks, AK	$≃5,750,000	≃< 3%

Part III - Funding Methods and Billing Instructions

25. [ ] Funds-Out Agreement **(Note: EPA Agency Location Code (ALC) - 68010727)**

[ ] Disbursement Agreement

[ ] Repayment — Request for repayment of actual costs must be itemized on SF 1081 or SF 1080 and submitted to the Financial Management Center, EPA, Cincinnati, OH 45268:

[ ] Monthly [X] Quarterly [ ] Upon Completion of Work

[ ] Advance — Only available for use by Federal agencies on working capital fund or with appropriate justification of need for this type of payment method. Unexpended funds at completion of work will be returned to EPA. Quarterly cost reports will be forwarded to the Financial Management Center, EPA, Cincinnati, OH 45268.

[ ] Allocation Transfer-Out — Used to transfer obligational authority or transfer of function between Federal agencies. Must receive prior approval by the Office of the Comptroller, Budget Division, Budget Formulation and Control Branch, EPA Headquarters. Forward appropriate reports to the Financial Reports and Analysis Branch, Financial Management Division, PM-226F, EPA, Washington, DC 20460.

26. [ ] Funds-In Agreement

[ ] Reimbursement Agreement — [ ] Repayment / [ ] Advance

[ ] Allocation Transfer-In

Other Agency's IAG Identification Number	EPA Program Office Allowance Holder/Responsibility Center Number
Other Agency's Billing Address *(Include Agency Location Code or Station Symbol Number)*	Other Agency's Billing Instructions and Frequency

Part IV - Acceptance Conditions

EFA IAG Identification Number:

27. General Conditions

The other agency covenants and agrees that it will expeditiously initiate and complete the project for which funds have been awarded under this agreement.

28. Special Conditions *(Attach additional sheets if needed)*

U.S. Forest Service will provide barge facilities for field crews at Herring Bay.

Part V - Offer and Acceptance

Note: 1) For Funds-out actions, the agreement/amendment must be signed by the other agency official in duplicate and one original returned to the Grants Administration Division for Headquarters agreements or to the appropriate EPA Regional IAG administration office within 3 calendar weeks after receipt or within any extension of time as may be granted by EPA. The agreement/amendment must be forwarded to the address cited in Item 29 after acceptance signature.

Receipt of a written refusal or failure to return the properly executed document within the prescribed time may result in the withdrawal of the offer by EPA. Any change to the agreement/amendment by the other agency subsequent to the document being signed by the EPA Action Official, which the Action Official determines to materially alter the agreement/amendment, shall void the agreement/amendment.

2) For Funds-in actions, the other agency will initiate the action and forward two original agreements/amendments to the appropriate EPA program office for signature. The agreements/amendments will then be forwarded to the appropriate EPA IAG administration office for acceptance signature on behalf of the EPA. One original copy will be returned to the other agency after acceptance.

EPA IAG Administration Office (for administrative assistance)	EPA Program Office (for technical assistance)
29. Organization/Address Grants Information and Analysis Branch Grants Administration Division (PM-216) Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460	30. Organization/Address Environmental Research Lab-Corvallis, EPA 200 S.W. 35th Street Corvallis, OR 97333 REGION I -

Certification

All signers certify that the statements made on this form and all attachments thereto are true, accurate, and complete. Signers acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

Decision Official on Behalf of the Environmental Protection Agency Program Office

31. Signature	Typed Name and Title	Date
	Norman Jaworski Director, ERL-Narragansett	

Action Official on Behalf of the Environmental Protection Agency

32. Signature	Typed Name and Title	Date
	Thomas L. Hadd, Chief Grants Information & Analysis Branch	

Authorizing Official on Behalf of the Other Agency

33. Signature	Typed Name and Title	Date

FUCUS RESEARCH PLAN

I. INTRODUCTION

The intertidal zones of Prince William Sound support the growth of macrophytes that form the base of an important ecological system. The brown algal macrophyte Fucus is an important primary producer that remains productive for most of the year. This alga is an important food item for several types of marine invertebrates such as snails, limpets, and sea urchins. Equally important, the habitat structure provided by the Fucus beds is critical to successful reproduction of herring. During the spawning season, herring deposit roe on the blades of Fucus , where it remains until hatching. The herring fry find protective cover and planktonic food within the Fucus community.

Oil spilled in the Sound from the Exxon Valdez in March 1989 drifted onto the intertidal zones in many locations. The oil coated the Fucus plants as well as rock surfaces resulting in direct physical and toxicological impacts on the plants. Clean up efforts, used to remove the oil from the intertidal zones in some cases resulted in additional damage to these macrophyte communities. Two of the most damaging clean up procedures to Fucus were the hot water washes and the direct harvesting/removal of heavily oiled Fucus.

Ultimately, the recovery of the ecological systems in the Sound is dependent in part on the re-establishment of the critical primary producers. High valued resources of the system such as the herring fishery are dependent on the primary production and structural habitat of Fucus. This research proposal addresses the natural recovery of Fucus occurring in selected sites in the Sound and explores methods of enhancing restoration of these macrophyte beds.

II. OBJECTIVES

This research proposal has the single objective with three subordinate objectives listed below.

1) To determine the feasibility of re-establishing Fucus in damaged areas of Prince William Sound.

   A) To develop and demonstrate potential large scale embryo seeding techniques to reestablish Fucus.

   B) To demonstrate the efficacy of embryo seeding vs. transplanting of Fucus.

   C) To document the extent and magnitude of recruitment of Fucus in areas subjected to alternative cleaning technologies.

Objective A explores new methods that show promise of being used to restore Fucus in large and inaccessible areas such as those found throughout much of the Sound. Objective B provides a comparison of the new methods to that of existing, more labor-intensive methods of restoration. Documentation of natural recovery (Objective C) is critical to the experimental design since the information obtained in this portion of the research is needed to assess the success of restoration techniques.

III. RATIONALE

Qualitative evidence indicates that Fucus was damaged by both the oil itself and the clean up effort. There may be substantial delay in natural recovery of areas where populations were reduced over large (100 to 1000 meters of shore line) areas because dispersal of embryos is limited (~1 meter in most circumstances Stekoll, Pers. comm.) Drift plants may increase this distance but importance of this mode is unknown.

This is an important perennial plant that is a critical structural component of the intertidal habitat in Prince William Sound and serves as an important spawning habitat for herring. Reestablishment of this macrophyte species will increase the rate of recovery of other associated biotic communities.

The reproductive and life history of the plant is well known. Effective techniques for collection of gametes and production of zygotes and embryos are well established. The specific life cycle of Fucus in Prince William Sound is unknown, but it is expected that plants will be fertile for at least most of the spring and summer.

IV. APPROACH

A. OVERVIEW

The study plan has two parts: 1) Laboratory experiments that develop techniques for obtaining large quantities of embryos suitable for use in reseeding. 2) Field experiments to test the effectiveness of embryo reseeding (relative to reseeding with dispersed receptacles or transplanting adults) in habitats that experienced varying degrees of oiling and cleaning.

Due to potential logistic problems associated with working in remote parts of Alaska, two key biological properties of the species need to be determined. First, techniques for mass release that are appropriate for the use in the field must be investigated. Second, since the embryos must be transported the relationship between "stickiness" and their ability to remain in suspension must be investigated.

It is anticipated that the clean up procedures utilized may affect the success of restoring Fucus habitats. Field tests will

be conducted with various embryo seeding procedures in varying types of oil and clean up disturbance. The embryo dispersal procedures to be tested are:

1) Dispersal of embryos;
2) dispersal of fertile branches;
3) transplant of fertile adults.

All three methods will be tested in each of the "habitats" listed below:

1) Oiled/not cleaned;
2) Bioremediated;
3) Oiled/hot water wash
4) Not oiled/not cleaned (Control)

The experimental design will be to use three replicates of each habitat type and three replicates of each procedure and three replicates of controls to measure natural settlement. In habitat 4 above, artificial clearing of the rocks will occur to eliminate competition from adult plants and create substrate equivalent to the other "habitats".

The endpoints (variables) to be measured will be:

a) height of the plants;
b) number of plants; and
c) percentage cover;

B. LABORATORY RESEARCH

Techniques for obtaining Fucus gardneri embryos are simple and well known (Pollock, 1970), and are routinely used to obtain embryos of Fucus and related genera for laboratory experiments and field outplants (Pollock, 1970; Vadas et al., 1990; Stekoll, pers. com.). However, these techniques must be modified to obtain the large numbers of embryos necessary for reseeding, and to develop handling and dispersal procedures that optimize embryo survival in the field. This laboratory and small scale field portion of the work will be done in Monterey, California where F. gardneri occurs near laboratories with the necessary research facilities.

1. Obtaining large numbers of embryos

Pollock (1970) found that gamete release was stimulated by desiccation, brief (~3 min.) treatment with fresh water, and then immersion in cold sea water. Logistics and availability of fresh water may make this full treatment difficult at remote field sites, so experiment 1 is designed to test the effects of various modifications of these procedures on gamete release from conceptacles.

Fertile receptacles will be collected from the field, equal wet weights placed in plastic mesh containers, and replicates of

three containers treated in one of the following ways:

1. Desiccate for 12 hrs., wash with cold fresh water
2. Desiccate for 12 hrs., wash with cold sea water
3. Desiccate for 12 hrs., no wash
4. No desiccation, now wash

Each container will then be placed in a container of cold sea water and agitated. After 1 hr. the receptacles will be removed, the water plus embryos centrifuged to concentrate but not damage the embryos, and the volume of embryos determined. A subset of embryos from each container will be used to determine a number vs. volume relationship, and for short term (1 week) cultures to determine viability (cell division). Volume and percentage viability will be used in separate ANOVAS to assess which treatment produces the most viable embryos.

2. Optimal Time Between Release and Reseeding

To obtain the best survivorship in the field, embryos should stick to the substrate. However, the "stickiness" of many algal spores and other propagules varies with time (Charters et al.,; Vadas et al., 1990). As embryos need to be kept in suspension for various times prior to dispersal in the field, it is necessary to determine how this will affect stickiness.

Released embryos will be kept in suspension for 1, 2, 4, 6, and 8 hrs., settled on roughened PVC plates and, after 3 hrs., subjected to sea water flows that simulate tidal and small wind surge velocities typical of protected bays (velocities selected in consultation with M. Denny). The difference between the number of embryos attached before and after being subjected to water flow will be used in an ANOVA to assess differences in stickiness.

If stickiness is low in all treatments, addition of natural gums such as algin may be tried.

3. Small Scale Field Testing

Based on the results of B.1. and B.2. above, and before going to the field an optimal release/suspension system will be chosen and used to "seed" triplicate 20 X 20 cm plots near the laboratory and prior to going to Prince William Sound. Triplicate unseeded plots will be used as controls. Three methods of dispersal will be used:

1. Brushing on embryo suspension
2. Pouring on embryo suspension
3. Spraying on embryo suspension (gravity feed)

(An equal number of embryos will be applied with each method by maintaining constant embryo densities in suspension and applying an equal volume of water).

Plots will be searched 2 weeks after embryo seeding to count the number of juvenile Fucus. Observations will be aided by use of 20X magnification hand lenses. Differences in dispersal methods will be determined with ANOVA.

C. FIELD STUDIES

1. Site Selection

Maps prepared by the Damage Assessment Geoprocessing Group of the Exxon Valdez Oil Spill Project will be used to identify potential study sites. The existing classification scheme for classes of oiling will be used. Primary sites will be in or near the Herring Bay area. Potential sites will be examined by direct observation to verify whether the designated classification of oiling are accurate. Only three categories can be verified:

"No oiling" --verified by direct observations, that confirm no oil residue and no record from last summer of oiling.

"Oiling/no clean up treatment" --verified by direct observations of oil residues and records from Alaska DNR and Exxon.

"Oiling/clean-up" --verified by direct observation of either oil residues and documented clean up activity or remnants of damaged plants such as holdfasts and stipes. Further verification will be done to show that both Alaska DNR records and Exxon records concur in the treatment. Two types of treatment will be studied, hot water wash and bioremediation.

Because of the transient features of the oil contamination observed during the past year, no effort will be made to corroborate designations of degrees of oiling [namely heavy, moderate, or light].

Final selection of sites will be based on the following criteria:

1) Verification of the category of oiling to the extent possible as described above;
2) Qualitative representativeness of the site judged by generalized features of exposure to wave action, substrate, and evidence of current or prior presence of Fucus.
3) Accessibility.

Photographic records will made of each potential site. This will serve as additional documentation of the site characteristics in support of narrative descriptions. Polaroid positive/negative film will be used in order to verify that the intended documentation has been captured on film. Site identification code numbers [see later section]. date of photo, name of field crew

chief, and other brief identifying information will be printed using waterproof ink, on the back of the positive print. The positive print and the negative will be stored in separate, water-proof bags.

2. Sample Plot Siting/Selection

For each site selected, the elevational extent and linear extent [length parallel to the waterline] of the Fucus zone will be measured with a meter tape to a precision of one meter. The boundaries of the Fucus beds will be identified based on the distribution of the plants. Qualitative, professional judgement will be used to define the extent of the Fucus, but in general the upper and lower boundaries are identified by a drop in plant density to zero plants per square meter over a distance of one meter; linear boundaries extending parallel to the beach are defined by changes in substrate [eg. rock to cobble] and a decline in plant density to zero plants per square meter for a distance of several meters. A 48 m transect will be located through the mid-elevational level of the Fucus beds parallel to the water line. The transect will be positioned randomly within the linear extent of the Fucus bed.

For those sites that do not have Fucus currently established, the expected zone will be estimated from comparisons of sites that have Fucus. Precise tidal flux will not be known for each site, however, approximate high and low tide measurements and relative position of the Fucus beds will be sufficient to locate sites for this study.

Plots 4 meters x 4 meters will be established along the transects. In the center of these 4x4 meter plots 2 meter by 2 meter study plots will be established. This is done to assure at least a 2 meter separation between treatments. Placement of the treatments along the transect will be done using a table of random numbers.

Once the plots have been established, a photographic record will be made that incorporates two levels of resolution: One coarse resolution shot that shows the 4m x 4m plot; one medium resolution shot that shows the interior 2m x 2m portion of the plot. Photographic documentation will be as described above.

3. Sampling Scheme

Each 2 meter x 2 meter plot will be divided into 16 1/4 meter square quadrats. For all three treatments and controls each of the endpoints described below will be measured in three randomly selected quadrats in each of 3 2 meter x 2 meter plots on each sampling date.

The following endpoints will be determined on each of three sampling dates (see schedule below). Numbers of plants will be determined by counting all Fucus plants within the quadrat. Percent

cover will be determined using the point quadrat technique (Greig-Smith 1983). Height of plants will be determined to the nearest .5 cm on ten randomly selected plants. (1/4 meter square meter quadrats with numbers every cm on two sides will be constructed. For each quadrat 10 pairs of randomly selected numbers will be recorded. The plant closest to the center of these coordinates will be selected for height measurements.)

Schedule:

Site Selection.....	May 29-Jun 8
Develop Culture Techniques.....	May 29-Jun 30
Site Preparation:	Jun 11-Jun 29
Field Sampling and transplant T-1.....	Jul 1-Jul 13
Field Sampling: T-2.....	Aug 15-Aug 22
Field Sampling: T-3.....	Sep 20-Sep 25

V. QUALITY ASSURANCE/QUALITY CONTROL

A. FIELD SAMPLING

1. TRAINING

Field personnel will be trained by the senior scientist. Training plots will be established on location in Herring Bay, Prince William Sound. Methods will be those detailed in Greig-Smith (1983). After instructing all technicians on observational techniques the senior scientist will sample five of the training plots. Each field technician will sample the same five plots. For all endpoints if there is no significant difference between the individual technician and the senior scientist adequate training has been received. If significant differences are noted the senior scientist will evaluate the situation, resolve the probable source of error and repeat the sampling tests.

2. DATA RECORDING

All data will be recorded in dedicated notebooks in ink. Entries will be dated and signed by the individual making the entry. At each visit of either co-PI, they will have the responsibility of reviewing the data entries and initial the notebooks as verification of the materials since the previous date of verification. Any changes, additions or corrections of entries are to be made so as not to obscure the prior entries. Deletions are to be marked will a single line through the entry. All changes are to be initialed.

Field notes and data sheets will be made on waterproof paper with pencil. All such field entries will be transcribed into dedicated notebooks as soon as practical but within three days of returning to the research base station [barge]. Original field notes will be retained as backups to support any audit that might occur.

3. CODE SYSTEM DATA

After sites have been selected, each site will have an unambiguous three letter designation (eg., HRB=Herring Bay, LHB=Lower Herring Bay, etc.). Transects at each site will be identified by a two digit code (eg. 01, 02, etc.). Similarly, two-digit numerical codes will be assigned for each Plot within a transect and each quadrate within a plot. This is illustrated by the following example:

Site	Transect	Plot	Quadrate
HRB	04	01	23

The master list of codes will be recorded in the front of each field notebook, and in the laboratory notebooks on the barge in Prince William Sound.

4. STANDARD OPERATING PROCEDURES

The laboratory techniques for determining the viability of collection and dispersal of embryos have not been developed, consequently there are no existing SOP's. See attached method which will be used as an SOP for the Point Quadrat Method of determining percent cover.

VI. PRODUCTS

1. Report on First Year Results of both Laboratory and Field Restoration Studies on Fucus. Due December 1990.

VII. PERSONNEL

Co-Principle Investigator Mike Stekoll University of Alaska - Juneau

Co-Principle Investigator Mike Foster California State Univ.- Moss Landing

Technician TBD

Technician TBD

VIII. LITERATURE

Charters, A. et.al. 1972 Effects of Water motion on Algal Spore Attachment. Proceedings International Seaweed Symposium. 7:243-247

Greg-Smith, P. 1983. Quantitative Plant Ecology. Third Edition University of California Press, Berkeley. 359 pp.

Kapustka, L. 1989 Ecological Assessment of Hazardous Waste Sites

in Field Guide to Ecological Assessments of Hazardous Waste Sites, Parkhurst, B. et al eds. EPA 89/0000000

Pollock, E. 1970 Fertilization in Fucus. Planta 92:85-99

Scagel, R. et. al. 1989. A Synopsis of the Benthic Marine Algae of British Columbia, Southeast Alaska, Washington and Oregon. Phycological Contribution #3, Dept. of Botany, University of British Columbia, Vanc. 532 p.

Sharman, L. Growth Rate of Fucus distichus along an Environmental Gradient in a Tidewater Glacial Fjord. Marine Science and Limnology, Univ of Alaska, Fairbanks, Alaska, 99775-1080.

Stekoll, M. 1990. Personal Communication

Topinka, J. et.al. 1979 Long Term Oil Contamination of Fucoid Macroalgae following the Amoco Cadiz Oil Spill. Fate and Effects of the Oil Spill. Proceedings of the International Symposium. Centre Oceanlogique de Bretagne, Brest France November 19-22 pp 393-403

Vadas, R. et.al 1990. Recruitment of Ascophyllum nodosum: Wave Action as a Source of Mortality. Marine Ecology Progress Series. 61:263-272.

*** SAMPLE ***

DATE OF SAMPLING: _____ SAMPLING CREW: _____,_____

DATE TRANSCRIBED TO DEDICATED NOTEBOOK:_____

TRANSCRIBED BY_____ TO PAGE _____ IN DEDICATED NOTEBOOK

[SEPARATE DATA SHEET FOR EACH PLOT]

FIELD DATA SHEETS--Fucus RESTORATION STUDY

	SITE #	PLOT #	QUADRATE #	NO. PLANTS	%COVER
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____

HEIGHT

PLANT #	QUADRATE 1 # ____	QUADRATE 2 # ____	QUADRATE 3 # ____
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
6	_____	_____	_____
7	_____	_____	_____
8	_____	_____	_____
9	_____	_____	_____
10	_____	_____	_____

COMMENTS:

14WG
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United States Environmental Protection Agency
Washington, DC 20460

EPA Project Officer's Interagency Agreement Invoice Approval

1/15/91

Instructions

1. Complete and return to the Servicing Finance Office indicated below.
2. Return the original copy; retain the duplicate copy for your files.
3. Send either a completed form or an explanation for disapproval within five calendar days of receipt of invoice to assure responsive payment processing to the other agency. If you cannot approve payment, or if you approve partial payment, return invoice with a memorandum of explanation.
4. Dollar amounts distributed by account number must equal total amount to be paid.

Part 1. Identification

Servicing Finance Office	Agency		
EPA Accounting Operations Office MS213 Cincinnati, OH 45268	Dept of Interior		
	IAG Number DW 14 95 7002 01		
	Invoice Number OPAC # 13303876		
Type of Bill ☐ 1. 1080 ☐ 2. 1081 ☒ 3. OPAC ☐ 4. SIBAC	Date 1/9/91	Invoice Amount 220.88	
	Site *(if necessary)*		

Part 2. Account Charges Instructions

Task	Account Number(s)	Dollar Amount
		.
		.
		.
		.
Total Amount To Be Paid	☐ As Invoiced ☐ Partial Payment	$.

Incomplete or Inaccurate Data on This Form Will Delay Payment of the Invoice

Part 3. Approval for Payment

I have determined that the above-cited IAG has commenced and the payment requested is commensurate with the Agency's level of progress on the IAG:

☐ Goods or services have been delivered in full as requested by the IAG to support this payment.

☐ Sufficient progress has been made by the other agency to support this progress payment as authorized by the IAG.

Payment Document Requires Immediate Action

Certification

I certify that the statements I have made on this form and all attachments thereto are true, accurate, and complete. I acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

Project Officer's Signature	Date
Brian Ross EPA, Alaskan Oper. Office Rm. 537 Federal Bldg. Anchorage, Alaska 99513	Telephone Number

EPA Form 2550-21 (11-88)

14WG
L

United States Environmental Protection Agency
Washington, DC 20460

EPA Project Officer's Interagency Agreement Invoice Approval

1/15/91

Instructions

1. Complete and return to the Servicing Finance Office indicated below.
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3. Send either a completed form or an explanation for disapproval within five calendar days of receipt of invoice to assure responsive payment processing to the other agency. If you cannot approve payment, or if you approve partial payment, return invoice with a memorandum of explanation.
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	IAG Number: DW 14 95 7002 01
	Invoice Number: OPAC # 13303876
Type of Bill: ☐ 1. 1080 ☐ 2. 1081 ☒ 3. OPAC ☐ 4. SIBAC	Date: 1/9/91 — Invoice Amount: 220.88
	Site *(if necessary)*

Part 2. Account Charges I

Task	Account Num
Total Amount To Be Paid	As / Pa

RECEIVED
JAN 23 1991

Incomplete or Inaccurate Data on This Form Wil

Part 3. Approval for Payment

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Project Officer's Signature: Brian Ross EPA, Alaskan Oper. Office Rm. 537 Federal Bldg. Anchorage, Alaska 99513	Date Telephone Number

EPA Form 2550-21 (11-88)

United States Environmental Protection Agency
Washington, DC 20460

EPA Project Officer's Interagency Agreement Invoice Approval

1/15/91

Instructions

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Part 1. Identification

Servicing Finance Office: EPA Accounting Operations Office MS213 Cincinnati, OH 45268	Agency: Dept of Interior
	IAG Number: DW 14 95 7002 01
	Invoice Number: OPAC # 13303876
Type of Bill: ☐ 1. 1080 ☐ 2. 1081 ☒ 3. OPAC ☐ 4. SIBAC	Date: 1/9/91 — Invoice Amount: 220.88
	Site *(if necessary)*

Part 2. Account Charges Instructions

Task	Account Number(s)	Dollar Amount
		.
		.
		.
		.

Total Amount To Be Paid — ☐ As Invoiced ☐ Partial Payment — $.

Incomplete or Inaccurate Data on This Form Will Delay Payment of the Invoice

Part 3. Approval for Payment

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Certification

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Project Officer's Signature: Brian Ross
EPA, Alaskan Oper. Office
Rm. 537 Federal Bldg.
Anchorage, Alaska 99513

Date

Telephone Number

EPA Form 2550-21 (11-88)

BILLS CHARGED TO YOUR ALC: 68-01-0727

2714-6

Billing Agency	Billing ALC	D.O. Symbol	Agency Contact
DEPARTMENT OF THE INTERIOR	14-16-0006	X0133	(FTS) 776-2335

Acctg. Date	Accom. Date	D.O. Symbol	Document Ref. No.	Dollar Amount
01/31/91	01/09/91	X0133	13303857	570.60

8581

jm 1/15/91

Description:
9818312035 BILLING FOR OBLIGATIONS ACCRUED THRU 12-31-90
DW14943502010
AFO EPA404
51410 90-1902-H7 3-7811-0
CONTACT ANNA LOONEY AT FTS 8-776-2339 OR 303-236-2339

Acctg. Date	Accom. Date	D.O. Symbol	Document Ref. No.	Dollar Amount
01/31/91	01/09/91	X0133	13303870	3,750.59

8582

jm 1/15/91

Description:
9818312048 BILLING FOR OBLIGATIONS ACCRUED THRU 12-31-90
DW14931030018
EPA-FWS LIASON
50120 90-1902-66 3-7811-0
CONTACT ANNA LOONEY AT FTS 8-776-2339 OR 303-236-2339

Acctg. Date	Accom. Date	D.O. Symbol	Document Ref. No.	Dollar Amount
01/31/91	01/09/91	X0133	13303876	220.80

8583

jm 1/15/91

Description:
9818312054 BILLING FOR OBLIGATIONS ACCRUED THRU 12-31-90
DW14957002010
DISTRIBUTION&ABUNDANCE OF FORAGE FISH IN RELATION TO MARINE BIRDS&MAMMALS
71480 90-1903-56 3-7811-0 EPA
CONTACT ANNA LOONEY AT FTS 8-776-2339 OR 303-236-2339

MOSS LANDING MARINE LABORATORIES
CALIFORNIA STATE UNIVERSITY FRESNO. HAYWARD. SACRAMENTO. SAN FRANCISCO. SAN JOSE. STANISLAUS

P. O. BOX 450
MOSS LANDING . CA USA
95039-0450
(408) 633-3304

November 10, 1990

Mr. Brian Ross
EPA Restoration Planning Office
Anchorage, AK.

Dear Brian:

Sorry I couldn't make the recent restoration meeting - as the enclosed indicates my budget is tight and I never heard back from you whether or not my expenses could be covered some other way (I assume not).

This letter is to ask if you could send me the most updated version of what I guess are called the ADEC Segment Maps. I think you had one the day we looked at sites early last summer; it breaks the coast into segments showing what SCAT observations and recommendations were, and what was actually done in the segment. We would like the portions of this map for Knight Island (including Herring Bay) as it will help document the treatment of our sampling sites. Also, I ask for an updated version (if available) because our field team heard that various areas were being further cleaned and "bioremediated" this summer, and we are concerned that some of our sites might be treated in some way without our knowing it.

Thanks for you help.

Yours truly,

Michael S. Foster
Professor of Marine Science

RTWG

RESTORATION FEASIBILITY STUDY NUMBER 1

Study Title: Re-establishment of Fucus in Rocky Intertidal Ecosystems

Lead Agency: EPA

Cooperating Agency: USFS

INTRODUCTION

Qualitative evidence indicates that rockweed, the marine alga, Fucus, was damaged by both the spilled oil and the cleanup effort. Fucus is a critical structural component of the intertidal habitat in the oil-spill area, and it serves as an important spawning substrate for herring. Re-establishment of this species will increase the rate of recovery of other associated biotic communities.

There may be a substantial delay in natural recovery of areas where populations were reduced over large areas (100-1000 m of shoreline), because dispersal of seeds is limited (< 1 m in most circumstances). Drift plants may increase this distance, but the importance of this mode is unknown.

The reproductive and life history of Fucus is well known, and techniques for collection of seed are well established. In southern parts of the range plants are fertile year round, so the timing of the application of seeds may be relatively unimportant in the establishment of the plant. The specific life history cycle of the plant in PWS and the GOA is not known. It is expected, however, that the plants will be fertile for at least most of the spring and summer.

Objectives:

A. Document the extent and magnitude of recruitment of Fucus in areas subjected to alternative cleaning technologies.

B. Determine the feasibility of re-establishing Fucus in damaged areas.

C. Develop and demonstrate potential large scale seeding techniques to re-establish Fucus.

D. Demonstrate the efficacy of seeding versus transplanting Fucus.

E. Identify the costs of implementing a full-scale Fucus restoration project.

Relationships with Other Studies:

This study is fundamental to bringing an ecosystem approach to the restoration program. It relates directly to RF 2, re-establishing critical intertidal fauna, and to various NRDA studies, particularly Coastal Habitat Study Number 1.

Methods

The study plan has two parts: (1) laboratory experiments that develop techniques for obtaining large quantities of embryos suitable for use in reseeding, and (2) field experiments to test the effectiveness of embryo reseeding and transplanting in habitats that experienced varying degrees of oiling and cleaning.

Laboratory experiments will be conducted to determine embryo attachment strength over time. Since the seeds must remain in suspension, experiments will also be conducted to assure their viability in culture media for at least two weeks. Although techniques for obtaining Fucus embryos are simple and well known, these techniques will be modified and tested for the production and handling of the large numbers of embryos that would be necessary for a full-scale reseeding project.

Field tests will then be conducted with various "seeding" procedures (e.g., dispersal of embryos, dispersal of embryos, and transplants of fertile adults). All three methods will be tested in one control and one habitat that was disturbed by oil and subsequently cleaned. Dispersal of embryos will then be tested in habitats with different combinations of oil and cleanup techniques (e.g., bioremediated, hot water wash). The experimental design will use three replicates of each habitat type, three replicates of each procedure, and three replicates of controls to measure natural settlement. Variables to be measured include height of Fucus plants, numbers of plants, and percent vegetative cover. Maps prepared by the Damage Assessment Geoprocessing Group will be used to identify potential study sites. In the initial project, primary study sites will be in or near Herring Bay, PWS.

BUDGET: EPA

Salaries	$ 2.0
Travel	11.0
Contractual Services	135.0
Supplies	2.0
Equipment	0.0
TOTAL	150.0

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Environmental Research Laboratory
CORVALLIS OR 97333

EPA

FACSIMILE REQUEST AND COVER SHEET

PLEASE PRINT IN BLACK INK ONLY

TO: Brian Ross

OFFICE/PHONE: 868-3424

FAX #: 868-2464-7
CONF. #: 868 5083
(Stan Stemmer) 868-3424

REGION/LAB:

FROM: Hal Kibby

PHONE: FTS 420-4625

MAIL CODE:

OFFICE: ERL-Corvallis

DATE: 5/22/90

NUMBER OF PAGES TO INCLUDE THIS COVER SHEET: 14

Please number all pages

INFORMATION FOR SENDING FACSIMILE MESSAGES

EQUIPMENT	FACSIMILE NUMBER	VERIFICATION NUMBER
PANAFAX MV 3000	FTS: 420-4799 Comm: (503)757-4799	FTS: 420-4600 Comm: (503)757-4600

TRANSMITTED

_____ / _____
(Date) (Time)

CONFIRMED: _____

CERL-24

PAGE ___ OF ___ PAGES

United States Environmental Protection Agency
Washington, DC 20460

EPA

Interagency Agreement/ Amendment

Part 1 - General Information

1. EPA IAG Identification Number

2. Other Agency IAG ID Number *(if known)*

3. Type of Action
New

4. Funding Location by Region

5. Program Office Abbreviation

6. Name and Address of EPA Organization
ERL-Narragansett
%Environmental Protection Agency
Hatfield Marine Science Center
Marine Science Drive
Newport, OR 97365

7. Name and Address of Other Agency
U.S. Department of Agriculture
U.S. Forest Service
P.O. Box 21628
Juneau, AK 99802-1628

8. Project Title
Restoration of Fucus Communities in Prince William Sound Alaska.

9. EPA Project Officer (Name, Address, Telephone Number)
Gary Chapman
U.S. Environmental Protection Agency
Hatfield Marine Science Center
Newport, OR 97365
(503) 867-4027

10. Other Agency Project Officer (Name, Address, Telephone Number)
Dave Gibbons
P. O. Box 21628
Juneau, AK 99802-1628
FTS 871-7918

11. Project Period
6/1/90 - 5/30/91

12. Budget Period
6/1/90 - 5/30/91

13. Scope of Work (Attach additional sheets, as needed)

See Attachment 1 - This project

This effort will supplement 5.6 milli... Effort on Damage Assessment of Prince William Sound F... Spill. See Attachment 2.

Justification: The objectives of t... , but by using IAG and same study sites, results in significan... ernment, Forest Service is providing barge (heavy accommodati... ort. Further, the IAG assures that data are not duplicative and compat... es.

14. Statutory Authority for Both Transfer of Funds and Project Activities
Economy Act of 1932 as amended (31USC1535)

15. Other Agency Type

Funds	Previous Amount	Amount This Action	Amended Total
16. EPA Amount	0	150,000	150,000
17. EPA In-Kind Amount			
18. Other Agency Amount			
19. Other Agency In-Kind Amount			
20. Total Project Cost			

21. Fiscal Information

Program Element	FY	Appropriation	Doc. Control No.	Account Number	Object Class	Obligation/Deobligation Amt.

Part II - Approved Budget

EPA IAG Identification Number

22. Budget Categories	Itemization of This Action	Itemization of Total Project Estimated Cost to Date
(a) Personnel	$ 2,000	$
(b) Fringe Benefits		
(c) Travel	1,000	
(d) Equipment		
(e) Supplies	2,000	
(f) Procurement/Assistance	135,000	
(g) Construction		
(h) Other	10,000	
(i) Total Direct Charges	$150,000	$
(j) Indirect Costs: Rate % Base $		
(k) Total (EPA Share %) (Other Agency Share %)	$150,000	$

23. Is equipment authorized to be furnished by EPA or leased, purchased, or rented with EPA funds? (Identify all equipment costing $1,000 or more) ☐ Yes ☒ No

24. Are any of these funds being used on extramural agreements? (See Item 22f) $135,000 ☒ Yes ☐ No

Type of Extramural Agreement ☐ Grant ☐ Cooperative Agreement ☒ Procurement (Includes Small Purchase Order)

Contractor/Recipient Name (if known)	Total Extramural Amount Under This Project	Percent Funded by EPA (if known)
University of Alaska Fairbanks, AK	$≈5,750,000	≈ < 3%

Part III - Funding Methods and Billing Instructions

25. ☐ Funds-Out Agreement (Note: EPA Agency Location Code (ALC) - 68010727)

☐ Disbursement Agreement

☐ Repayment — Request for repayment of actual costs must be itemized on SF 1081 or SF 1080 and submitted to the Financial Management Center, EPA, Cincinnati, OH 45268:

☐ Monthly ☒ Quarterly ☐ Upon Completion of Work

☐ Advance — Only available for use by Federal agencies on working capital fund or with appropriate justification of need for this type of payment method. Unexpended funds at completion of work will be returned to EPA. Quarterly cost reports will be forwarded to the Financial Management Center, EPA, Cincinnati, OH 45268.

☐ Allocation Transfer-Out — Used to transfer obligational authority or transfer of function between Federal agencies. Must receive prior approval by the Office of the Comptroller, Budget Division, Budget Formulation and Control Branch, EPA Headquarters. Forward appropriate reports to the Financial Reports and Analysis Branch, Financial Management Division, PM-226F, EPA, Washington, DC 20460.

26. ☐ Funds-In Agreement

☐ Reimbursement Agreement — ☐ Repayment / ☐ Advance

☐ Allocation Transfer-In

Other Agency's IAG Identification Number	EPA Program Office Allowance Holder/Responsibility Center Number
Other Agency's Billing Address *(Include Agency Location Code or Station Symbol Number)*	Other Agency's Billing Instructions and Frequency

Part IV - Acceptance Conditions

EPA IAG Identification Number:

27. General Conditions

The other agency covenants and agrees that it will expeditiously initiate and complete the project for which funds have been awarded under this agreement.

28. Special Conditions *(Attach additional sheets if needed)*

U.S. Forest Service will provide barge facilities for field crews at Herring Bay.

Part V - Offer and Acceptance

Note: 1) For Funds-out actions, the agreement/amendment must be signed by the other agency official in duplicate and one original returned to the Grants Administration Division for Headquarters agreements or to the appropriate EPA Regional IAG administration office within 3 calendar weeks after receipt or within any extension of time as may be granted by EPA. The agreement/amendment must be forwarded to the address cited in Item 29 after acceptance signature.

Receipt of a written refusal or failure to return the properly executed document within the prescribed time may result in the withdrawal of the offer by EPA. Any change to the agreement/amendment by the other agency subsequent to the document being signed by the EPA Action Official, which the Action Official determines to materially alter the agreement/amendment, shall void the agreement/amendment.

2) For Funds-in actions, the other agency will initiate the action and forward two original agreements/amendments to the appropriate EPA program office for signature. The agreements/amendments will then be forwarded to the appropriate EPA IAG administration office for acceptance signature on behalf of the EPA. One original copy will be returned to the other agency after acceptance.

EPA IAG Administration Office (for administrative assistance)	EPA Program Office (for technical assistance)
29. Organization/Address Grants Information and Analysis Branch Grants Administration Division (PM-216) Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460	30. Organization/Address Environmental Research Lab-Corvallis, EPA 200 S.W. 35th Street Corvallis, OR 97333

Certification

All signers certify that the statements made on this form and all attachments thereto are true, accurate, and complete. Signers acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

Decision Official on Behalf of the Environmental Protection Agency Program Office

31. Signature	Typed Name and Title	Date
	Norman Jaworski Director, ERL-Narragansett	

Action Official on Behalf of the Environmental Protection Agency

32. Signature	Typed Name and Title	Date
	Thomas L. Hadd, Chief Grants Information & Analysis Branch	

Authorizing Official on Behalf of the Other Agency

33. Signature	Typed Name and Title	Date

FUCUS RESEARCH PLAN

I. INTRODUCTION

The intertidal zones of Prince William Sound support the growth of macrophytes that form the base of an important ecological system. The brown algal macrophyte Fucus is an important primary producer that remains productive for most of the year. This alga is an important food item for several types of marine invertebrates such as snails, limpets, and sea urchins. Equally important, the habitat structure provided by the Fucus beds is critical to successful reproduction of herring. During the spawning season, herring deposit roe on the blades of Fucus , where it remains until hatching. The herring fry find protective cover and planktonic food within the Fucus community.

Oil spilled in the Sound from the Exxon Valdez in March 1989 drifted onto the intertidal zones in many locations. The oil coated the Fucus plants as well as rock surfaces resulting in direct physical and toxicological impacts on the plants. Clean up efforts, used to remove the oil from the intertidal zones in some cases resulted in additional damage to these macrophyte communities. Two of the most damaging clean up procedures to Fucus were the hot water washes and the direct harvesting/removal of heavily oiled Fucus.

Ultimately, the recovery of the ecological systems in the Sound is dependent in part on the re-establishment of the critical primary producers. High valued resources of the system such as the herring fishery are dependent on the primary production and structural habitat of Fucus. This research proposal addresses the natural recovery of Fucus occurring in selected sites in the Sound and explores methods of enhancing restoration of these macrophyte beds.

II. OBJECTIVES

This research proposal has the single objective with three subordinate objectives listed below.

1) To determine the feasibility of re-establishing Fucus in damaged areas of Prince William Sound.

   A) To develop and demonstrate potential large scale embryo seeding techniques to reestablish Fucus.

   B) To demonstrate the efficacy of embryo seeding vs. transplanting of Fucus.

   C) To document the extent and magnitude of recruitment of Fucus in areas subjected to alternative cleaning technologies.

Objective A explores new methods that show promise of being used to restore Fucus in large and inaccessible areas such as those found throughout much of the Sound. Objective B provides a comparison of the new methods to that of existing, more labor-intensive methods of restoration. Documentation of natural recovery (Objective C) is critical to the experimental design since the information obtained in this portion of the research is needed to assess the success of restoration techniques.

III. RATIONALE

Qualitative evidence indicates that Fucus was damaged by both the oil itself and the clean up effort. There may be substantial delay in natural recovery of areas where populations were reduced over large (100 to 1000 meters of shore line) areas because dispersal of embryos is limited (~1 meter in most circumstances Stekoll, Pers. comm.) Drift plants may increase this distance but importance of this mode is unknown.

This is an important perennial plant that is a critical structural component of the intertidal habitat in Prince William Sound and serves as an important spawning habitat for herring. Reestablishment of this macrophyte species will increase the rate of recovery of other associated biotic communities.

The reproductive and life history of the plant is well known. Effective techniques for collection of gametes and production of zygotes and embryos are well established. The specific life cycle of Fucus in Prince William Sound is unknown, but it is expected that plants will be fertile for at least most of the spring and summer.

IV. APPROACH

A. OVERVIEW

The study plan has two parts: 1) Laboratory experiments that develop techniques for obtaining large quantities of embryos suitable for use in reseeding. 2) Field experiments to test the effectiveness of embryo reseeding (relative to reseeding with dispersed receptacles or transplanting adults) in habitats that experienced varying degrees of oiling and cleaning.

Due to potential logistic problems associated with working in remote parts of Alaska, two key biological properties of the species need to be determined. First, techniques for mass release that are appropriate for the use in the field must be investigated. Second, since the embryos must be transported the relationship between "stickiness" and their ability to remain in suspension must be investigated.

It is anticipated that the clean up procedures utilized may affect the success of restoring Fucus habitats. Field tests will

be conducted with various embryo seeding procedures in varying types of oil and clean up disturbance. The embryo dispersal procedures to be tested are:

1) Dispersal of embryos;
2) dispersal of fertile branches;
3) transplant of fertile adults.

All three methods will be tested in each of the "habitats" listed below:

1) Oiled/not cleaned;
2) Bioremediated;
3) Oiled/hot water wash
4) Not oiled/not cleaned (Control)

The experimental design will be to use three replicates of each habitat type and three replicates of each procedure and three replicates of controls to measure natural settlement. In habitat 4 above, artificial clearing of the rocks will occur to eliminate competition from adult plants and create substrate equivalent to the other "habitats".

The endpoints (variables) to be measured will be:

a) height of the plants;
b) number of plants; and
c) percentage cover;

B. LABORATORY RESEARCH

Techniques for obtaining Fucus gardneri embryos are simple and well known (Pollock, 1970), and are routinely used to obtain embryos of Fucus and related genera for laboratory experiments and field outplants (Pollock, 1970; Vadas et al., 1990; Stekoll, pers. com.). However, these techniques must be modified to obtain the large numbers of embryos necessary for reseeding, and to develop handling and dispersal procedures that optimize embryo survival in the field. This laboratory and small scale field portion of the work will be done in Monterey, California where F. gardneri occurs near laboratories with the necessary research facilities.

1. Obtaining large numbers of embryos

Pollock (1970) found that gamete release was stimulated by desiccation, brief (~3 min.) treatment with fresh water, and then immersion in cold sea water. Logistics and availability of fresh water may make this full treatment difficult at remote field sites, so experiment 1 is designed to test the effects of various modifications of these procedures on gamete release from conceptacles.

Fertile receptacles will be collected from the field, equal wet weights placed in plastic mesh containers, and replicates of

three containers treated in one of the following ways:

1. Desiccate for 12 hrs., wash with cold fresh water
2. Desiccate for 12 hrs., wash with cold sea water
3. Desiccate for 12 hrs., no wash
4. No desiccation, now wash

Each container will then be placed in a container of cold sea water and agitated. After 1 hr. the receptacles will be removed, the water plus embryos centrifuged to concentrate but not damage the embryos, and the volume of embryos determined. A subset of embryos from each container will be used to determine a number vs. volume relationship, and for short term (1 week) cultures to determine viability (cell division). Volume and percentage viability will be used in separate ANOVAS to assess which treatment produces the most viable embryos.

2. Optimal Time Between Release and Reseeding

To obtain the best survivorship in the field, embryos should stick to the substrate. However, the "stickiness" of many algal spores and other propagules varies with time (Charters et al.,; Vadas et al., 1990). As embryos need to be kept in suspension for various times prior to dispersal in the field, it is necessary to determine how this will affect stickiness.

Released embryos will be kept in suspension for 1, 2, 4, 6, and 8 hrs., settled on roughened PVC plates and, after 3 hrs., subjected to sea water flows that simulate tidal and small wind surge velocities typical of protected bays (velocities selected in consultation with M. Denny). The difference between the number of embryos attached before and after being subjected to water flow will be used in an ANOVA to assess differences in stickiness.

If stickiness is low in all treatments, addition of natural gums such as algin may be tried.

3. Small Scale Field Testing

Based on the results of B.1. and B.2. above, and before going to the field an optimal release/suspension system will be chosen and used to "seed" triplicate 20 X 20 cm plots near the laboratory and prior to going to Prince William Sound. Triplicate unseeded plots will be used as controls. Three methods of dispersal will be used:

1. Brushing on embryo suspension
2. Pouring on embryo suspension
3. Spraying on embryo suspension (gravity feed)

(An equal number of embryos will be applied with each method by maintaining constant embryo densities in suspension and applying an equal volume of water).

Plots will be searched 2 weeks after embryo seeding to count the number of juvenile Fucus. Observations will be aided by use of 20X magnification hand lenses. Differences in dispersal methods will be determined with ANOVA.

C. FIELD STUDIES

1. Site Selection

Maps prepared by the Damage Assessment Geoprocessing Group of the Exxon Valdez Oil Spill Project will be used to identify potential study sites. The existing classification scheme for classes of oiling will be used. Primary sites will be in or near the Herring Bay area. Potential sites will be examined by direct observation to verify whether the designated classification of oiling are accurate. Only three categories can be verified:

"No oiling" --verified by direct observations, that confirm no oil residue and no record from last summer of oiling.

"Oiling/no clean up treatment" --verified by direct observations of oil residues and records from Alaska DNR and Exxon.

"Oiling/clean-up" --verified by direct observation of either oil residues and documented clean up activity or remnants of damaged plants such as holdfasts and stipes. Further verification will be done to show that both Alaska DNR records and Exxon records concur in the treatment. Two types of treatment will be studied, hot water wash and bioremediation.

Because of the transient features of the oil contamination observed during the past year, no effort will be made to corroborate designations of degrees of oiling [namely heavy, moderate, or light].

Final selection of sites will be based on the following criteria:

1) Verification of the category of oiling to the extent possible as described above;
2) Qualitative representativeness of the site judged by generalized features of exposure to wave action, substrate, and evidence of current or prior presence of Fucus.
3) Accessibility.

Photographic records will made of each potential site. This will serve as additional documentation of the site characteristics in support of narrative descriptions. Polaroid positive/negative film will be used in order to verify that the intended documentation has been captured on film. Site identification code numbers [see later section]. date of photo, name of field crew

chief, and other brief identifying information will be printed using waterproof ink, on the back of the positive print. The positive print and the negative will be stored in separate, water-proof bags.

2. Sample Plot Siting/Selection

For each site selected, the elevational extent and linear extent [length parallel to the waterline] of the Fucus zone will be measured with a meter tape to a precision of one meter. The boundaries of the Fucus beds will be identified based on the distribution of the plants. Qualitative, professional judgement will be used to define the extent of the Fucus, but in general the upper and lower boundaries are identified by a drop in plant density to zero plants per square meter over a distance of one meter; linear boundaries extending parallel to the beach are defined by changes in substrate [eg. rock to cobble] and a decline in plant density to zero plants per square meter for a distance of several meters. A 48 m transect will be located through the mid-elevational level of the Fucus beds parallel to the water line. The transect will be positioned randomly within the linear extent of the Fucus bed.

For those sites that do not have Fucus currently established, the expected zone will be estimated from comparisons of sites that have Fucus. Precise tidal flux will not be known for each site, however, approximate high and low tide measurements and relative position of the Fucus beds will be sufficient to locate sites for this study.

Plots 4 meters x 4 meters will be established along the transects. In the center of these 4x4 meter plots 2 meter by 2 meter study plots will be established. This is done to assure at least a 2 meter separation between treatments. Placement of the treatments along the transect will be done using a table of random numbers.

Once the plots have been established, a photographic record will be made that incorporates two levels of resolution: One coarse resolution shot that shows the 4m x 4m plot; one medium resolution shot that shows the interior 2m x 2m portion of the plot. Photographic documentation will be as described above.

3. Sampling Scheme

Each 2 meter x 2 meter plot will be divided into 16 1/4 meter square quadrats. For all three treatments and controls each of the endpoints described below will be measured in three randomly selected quadrats in each of 3 2 meter x 2 meter plots on each sampling date.

The following endpoints will be determined on each of three sampling dates (see schedule below). Numbers of plants will be determined by counting all Fucus plants within the quadrat. Percent

cover will be determined using the point quadrat technique (Greig-Smith 1983). Height of plants will be determined to the nearest .5 cm on ten randomly selected plants. (1/4 meter square meter quadrats with numbers every cm on two sides will be constructed. For each quadrat 10 pairs of randomly selected numbers will be recorded. The plant closest to the center of these coordinates will be selected for height measurements.)

Schedule:

Site Selection	May 29-Jun 8
Develop Culture Techniques	May 29-Jun 30
Site Preparation:	Jun 11-Jun 29
Field Sampling and transplant T-1	Jul 1-Jul 13
Field Sampling: T-2	Aug 15-Aug 22
Field Sampling: T-3	Sep 20-Sep 25

V. QUALITY ASSURANCE/QUALITY CONTROL

A. FIELD SAMPLING

1. TRAINING

Field personnel will be trained by the senior scientist. Training plots will be established on location in Herring Bay, Prince William Sound. Methods will be those detailed in Greig-Smith (1983). After instructing all technicians on observational techniques the senior scientist will sample five of the training plots. Each field technician will sample the same five plots. For all endpoints if there is no significant difference between the individual technician and the senior scientist adequate training has been received. If significant differences are noted the senior scientist will evaluate the situation, resolve the probable source of error and repeat the sampling tests.

2. DATA RECORDING

All data will be recorded in dedicated notebooks in ink. Entries will be dated and signed by the individual making the entry. At each visit of either co-PI, they will have the responsibility of reviewing the data entries and initial the notebooks as verification of the materials since the previous date of verification. Any changes, additions or corrections of entries are to be made so as not to obscure the prior entries. Deletions are to be marked will a single line through the entry. All changes are to be initialed.

Field notes and data sheets will be made on waterproof paper with pencil. All such field entries will be transcribed into dedicated notebooks as soon as practical but within three days of returning to the research base station [barge]. Original field notes will be retained as backups to support any audit that might occur.

3. CODE SYSTEM DATA

After sites have been selected, each site will have an unambiguous three letter designation (eg., HRB=Herring Bay, LHB=Lower Herring Bay, etc.). Transects at each site will be identified by a two digit code (eg. 01, 02, etc.). Similarly, two-digit numerical codes will be assigned for each Plot within a transect and each quadrate within a plot. This is illustrated by the following example:

Site	Transect	Plot	Quadrate
HRB	04	01	23

The master list of codes will be recorded in the front of each field notebook, and in the laboratory notebooks on the barge in Prince William Sound.

4. STANDARD OPERATING PROCEDURES

The laboratory techniques for determining the viability of collection and dispersal of embryos have not been developed, consequently there are no existing SOP's. See attached method which will be used as an SOP for the Point Quadrat Method of determining percent cover.

VI. PRODUCTS

1. Report on First Year Results of both Laboratory and Field Restoration Studies on Fucus. Due December 1990.

VII. PERSONNEL

Co-Principle Investigator Mike Stekoll University of Alaska - Juneau

Co-Principle Investigator Mike Foster California State Univ.- Moss Landing

Technician TBD

Technician TBD

VIII. LITERATURE

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Vadas, R. et.al 1990. Recruitment of Ascophyllum nodosum: Wave Action as a Source of Mortality. Marine Ecology Progress Series. 61:263-272.

*** SAMPLE ***

DATE OF SAMPLING: _____ SAMPLING CREW: _____, _____

DATE TRANSCRIBED TO DEDICATED NOTEBOOK:_____

TRANSCRIBED BY_____ TO PAGE _____ IN DEDICATED NOTEBOOK

[SEPARATE DATA SHEET FOR EACH PLOT]

FIELD DATA SHEETS--Fucus RESTORATION STUDY

	SITE #	PLOT #	QUADRATE #	NO. PLANTS	%COVER
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____

HEIGHT

PLANT #	QUADRATE 1 # _____	QUADRATE 2 # _____	QUADRATE 3 # _____
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
6	_____	_____	_____
7	_____	_____	_____
8	_____	_____	_____
9	_____	_____	_____
10	_____	_____	_____

COMMENTS: