RPWG
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Versar INC.
ESM Operations

CONFIDENTIAL

13 April 1990

Mr. Brian Ross
Oil Spill Restoration Planning Office
437 E Street, Suite 301
Anchorage, AK 99501

Dear Brian:

Two sets (2 each) of tapes from the first workshop plenary session are enclosed along with a tape log that should aid in locating particular presentations. If you need additional copies let me know.

Our team wanted me to thank you again for making arrangements to get to the "Fly by Night" show; it was a big hit. It's always good to pick up some local color. We managed to get out to Darwin's on Friday for some additional relaxation. Biologists fit in well there.

A copy of our in-house bibliography is also enclosed for your reference. If needed, this can be incorporated into a user-friendly database system that can be set up on your computer to aid the workgroup to keep track of incoming information.

I am looking forward to receiving the damage assessment reports. We have arranged to store them in a secure area to ensure their confidential status.

Versar has developed two possible demonstration project pre-proposals. The first describes the potential use of artificial reefs or substrates and the second involves the potential use of remote sensing for assessing damage and tracking the performance of cleanup and restoration actions. If we can obtain earlier satellite images, this latter project may be useful for assessing the extent of damage; existing field collected data could provide the necessary ground truth information.

Sincerely yours,

Daniel J. Sheehy, Ph.D.
Senior Scientist

ENC.

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EPA RESTORATION PLANNING WORKSHOP
TAPE RECORDING LOG

Tape No. Intro Date 3 April 1990

Session Chair Senner/Ross Tape Side A

Time	Counter Reading	Speaker	Comments (subject area, etc.)
0845	000	S. Senner (already in progress)	Restoration Planning Process
0855	160	Robert Adler	Public Meeting Video
0910	355	B. Ross	Intro to RWG
	405		Draft outline of rept. instruc.
	427		Restro. demo projects
0915	445	Weiner	Fate, Damage Assess. Intro
0920	480	Gene Pavia	Geologic-rocky intertidal
0930	570		Asphalt conditions

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EPA RESTORATION PLANNING WORKSHOP
TAPE RECORDING LOG

Tape No. Damage Assessment 1 Date 3 April 1990

Session Chair Senner/Ross Tape Side B (Side A entitled "Intro")

Time	Counter Reading	Speaker	Comments (subject area, etc.)
0931	000	G. Pavia (cont.)	
	060		Hot spots
	160		Sum-up
0940	185		Questions/answers
	217		Resource assess.-quantifying?
	239	Weiner	
0945	244	Andy Hooten	Biological problems
			Methyl chloride treatment
	295		Algae colonization
	315		Epifaunal
	320		Questions
	334	Weiner	
0953	338	John Lindstrom	Microbiology & Chemical
	408		Questions
	463	B. Ross/Weiner	Continuation of Studies
1005	479	B. Ross	Pre-break sum up
1030	487	S. Senner	Re-convene
	505	Dave Gibbons	Coastal Habitats
1040	570		Effects of Cleaning
	~590		Tape end

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EPA RESTORATION PLANNING WORKSHOP
TAPE RECORDING LOG

Tape No. Damage Assessment 2 Date 3 April 1990

Session Chair Senner/Ross Tape Side A

Time	Counter Reading	Speaker	Comments (subject area, etc.)
1041	000	Dave Gibbons	Coastal Habitat cont.
	85	Roy Nowlin	Air/Water Studies
	98	Doug Wolfe	Benthos & Air/Water
	168	D. Gibbons	
	213	Ray Highsmith	Subtidal
	240	Will Barber	Fish
	268		Questions
	271	S. Senner	
1100	276	Chuck Meacham	Fish
	310		Description of studies
	319		Salmon-spawning
	358		Salmon-eggs/fry
	385		Salmon-juveniles
	407		Dolly Varden/Cutthroat
	418		Herring
	437		Clams
	451		Shrimp
	467		Rockfish
	475		Ground fish
	488		Sockeye
	509		Significance of impacts
	530		Summary
	538		Questions
	570		Quantification of impact
	584		% of area impacted
		S. Senner	
1125	596	Roy Nowlin	Mammals

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EPA RESTORATION PLANNING WORKSHOP
TAPE RECORDING LOG

Tape No. Damage Assessment 2 Date 3 April 1990

Session Chair Senner/Ross Tape Side B

Time	Counter Reading	Speaker	Comments (subject area, etc.)
1125	000	Roy Nowlin (cont.)	Mammals
	25	ADFG	Humpback whales
	53		Killer whales
	85		Cetacean necropsies
	103		Harbor seal
	144		Sea otter
	177		Sea otter rehabilitation
	199		Sea lions
	216		Terr. mammals
			Sitka black-tailed deer
	233		R. otter & mink
	254		Brown bear
	265		Mink reproduction
1145	280		Summary
	288		Questions
	294	S. Senner	
	300	Kent Wohl	Birds-intro of PI's
	340		Beach birds
	370		Colony
	388		Shore birds
	394		Blk oyster catcher
			Petrel
	411		Kittiwakes
	420		Murrelets
	428		Guillemots
1155	440		Eagles
	349		Sea ducks

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EPA RESTORATION PLANNING WORKSHOP
TAPE RECORDING LOG

Tape No. Damage Assessment 2 Date 3 April 1990

Session Chair Senner/Ross Tape Side B

Time	Counter Reading	Speaker	Comments (subject area, etc.)
			Peregrine falcon
	355		Questions
	543	S. Senner	Wrap-up
	553	D. Sheehy	Work Groups
1210	563	End-of-session	

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ENTRY CATEGORIES

A	Journal article	1	B	Book	500
C	Portion of book	600	D	Proceedings	800
E	Technical Report	900			

SUBJECTS

110	Algae	112	Zooplankton
100	Coastal Habitat	200	Fisheries
300	Birds	400	Mammals - Terr. & Mar.
500	Seagrass Restoration	600	Salt Marsh Restoration
700	Rest. Philosophy & Practice	800	Benthic
900	Gen. - Recovery, effects, econ.		

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4/13/90

PILOT PROJECT - 1990 COASTAL HABITATS

Title: Remote Sensing Assessment of
Habitat Damage, Clean-Up, and Restoration

Purpose:

This project will demonstrate the feasibility of using satellite remote sensing data to quantitatively assess the extent of damage to coastal habitats within Prince William Sound and to monitor recovery and the effects of clean-up and/or restoration.

Formal statistical tests of observed spectral differences between undamaged control areas, damaged areas, and areas undergoing clean-up and/or restoration will be applied. If significant differences are established, this will be considered a successful demonstration of the technique for quantitative oil spill damage assessment and clean-up/restoration/recovery management.

Rationale:

Oil damage to coastal habitats containing significant amounts of vegetation (e.g. marshes, intertidal zones, and supertidal areas) should be detectable by high resolution (10-30m) satellite multispectral imagers. The impact of clean-up and restoration efforts, including disturbance of associated near-coastal habitats, should also be evident. It seems possible that the current generation of satellite sensors (Landsat 5, SPOT 1), coupled with recently developed image processing methods, would be able to overcome the problems associated with detecting these impacts.

One advantage of this approach is that it provides the opportunity to do a retrospective analysis using archived pre-spill images. Thus, if a method for extending the information known from field studies about specific target areas to the entire coastline can be

developed, quantitative estimates can be derived for spill damage, clean-up impact, and recovery rates.

Using pre- and post-spill satellite multispectral digital imagery of areas of Prince William Sound and similar unaffected control areas, we will attempt to detect changes in major coastal habitats. Two habitats which preliminary analysis indicates contain vegetation sensitive to oil changes, and which may be subjected to restoration efforts, are intertidal areas which support Fucus communities and coastal marshes. The scale of these areas is important to detection from satellites, with the major problem being narrow widths. The most critical of these areas from the standpoint of ecological recovery, however, are likely to be those which are larger and more detectable. In addition, the entire supertidal zone will contain indicators of the degree of damage and recovery.

The satellite imagery can be used similarly for estimating rates of recovery (using later satellite images) in areas which were cleaned-up, not cleaned-up, or subjected to restoration activities. Field sampling data, collected under other projects, can be used to augment the information in the satellite imagery. This capability would be a valuable tool for managing restoration efforts and monitoring the recovery of the Sound. It could provide the basis for a long term Geographic Information System combining spatial information from satellites and point information from field studies.

Approach:

Successful demonstration of this approach will require dealing with several problems. In order to detect changes between scenes, we will have to have similar tidal stages at the overpass time, and be able to find fixed control points to register the scenes to each other. An adjustment to establish equivalent radiometric characteristics between the scenes will be required. Relatively narrow shoreline areas will have to be clearly designated, possibly requiring merging base data from 10m sensors (SPOT panchromatic) with other, lower resolution multispectral imagery (Landsat

Thematic Mapper). Then the unique spectral characteristics of healthy and damaged habitats will have to be determined. There has been recent progress in all of these areas, as outlined in the specific approach steps below. These steps follow the methodology developed by Hall, et al., 1987 for quantitative detection of ecosystem conditions, and transitions between them, using remote sensing.

- Acquire pre- and post-spill Landsat images of affected and unaffected areas. This task will require preliminary evaluation of clouds and tides to get equivalent conditions. Investigate the availability of SPOT data, particularly near-nadir panchromatic scenes (10 m resolution).

- Register and radiometrically rectify the images using the procedures of Hall, et al., 1990.

- Delineate shorelines and develop spectral indices sensitive to habitats of interest.

- Classify the scenes in the areas (shorelines, marshes) of interest using known sites. Existing field data will be the primary source of information. Some travel may be required for establishing spectral baselines and/or verifying classifications.

- Compare scenes to establish, for each pixel, transitions between undamaged, damaged, and recovered states.

- Compute change statistics. Each distinguishable habitat will be represented by a (hopefully large) number of sample points (pixels) in each category of the following information matrix:

	Before spill	After spill	After intervention
control sites	x	x	x
damaged - no action	x	x	x
damaged - action taken	x	x	x

The null hypotheses will be that there is no difference between the control and damaged sites and that there are no spectral changes due to the spill and clean-up and restoration efforts. Significance tests will indicate whether this technique detects any measurable effects. Previous work indicates that change detection is probable. If so, a temporal sequence of images could be used to estimate the rate of recovery. If significant areas are restored, this approach could also be used for evaluating the performance of restoration compared to natural recovery.

Resources:

	FY90	FY91
Equip & Mat	$ 25 K	$10 K
Travel	5	5
Personnel	25	25
Total	$ 55 K	$ 40 K

References:

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F.G.Hall, D.E.Strebel, S.J.Goetz, K.D.Woods, D.B.Botkin
Proc. IGARSS'87, Ann Arbor, May, 1987

Radiometric Rectification of Multi-Date, Multi-Sensor Satellite Images
F.G.Hall, D.E.Strebel, S.J.Goetz, J.E.Nickeson
to appear in Proc. IGARSS'90, College Park, MD, May, 1990

RESTORATION PLANNING WORKSHOP

INFORMATION NEEDS

Recreation

Public attitude surveys -- what are the values and perceptions?

What is the nature and extent of displacemnet of recreation use resulting from the spill?

Did or will displacemnt of recreation use from PWS affect the quality or quantity of use in other areas in Southcentral Alaska?

Did the spill adversely affect the quality or quantity of wilderness values of PWS for local residents? What about the perception of wilderness for potential visitors to the areas? For actual visitors?

Will the spill result in more recreation use thorugh the spill's "advertising" or name recognition value? Will visitors pay less than they would have had they been visiting an un-oiled PWS? Are we trading high value/low volume tourism for lower value/high volume tourism?

Will the spill attract disaster junkies, as was the case with Three Mile Island or Mount St. Helens?

Will a new tourism industry develop out of people wanting to visit PWS to learn about or study natural or human supported restoration?

What is the effect of the spill on the recreation opportunity spectrum in PWS?

User values

What are the patterns of use?

What are the number of users?

What is the value of recreational opportunity translated into consumer surplus?

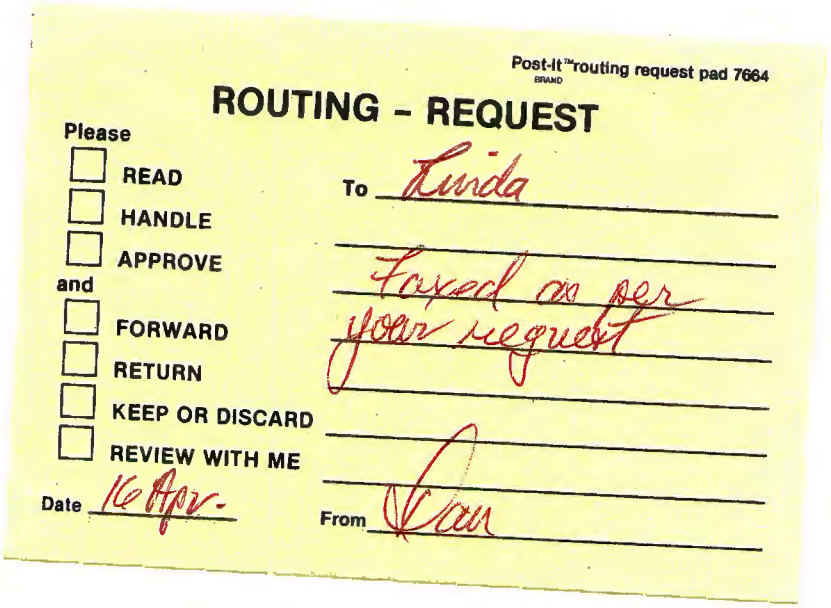
How much worse-off are the PWS-Gulf "users"?

What is the land status/acquistion opportunity with respect to ecological-recreational-cultural responses?

What are the land uses/plans on public lands?

Assess public-use facilites and identify other recreational sites in relation to spill damage by integrating (possibly by mapping exercise):

Spill damage
Resource values
Land status/willingness
Agency priorities



Birds

What are the breeding habitat requirements for the marbled murrelet in the PWS area? Do they nest in trees as in lower latitudes? If so, do they require old-growth forest habitat or can they utilize second growth timber?

What is the status of the sea duck population, especially the harlequin duck? What are breeding habitat requirements? What are the winter distribution and site fidelity attributes of the harlequin duck?

What are the harvest levels for sea ducks, particularly the harequin duck?

What is the availability and distribution of forage fish for seabirds in PWS, particularly herring, sandlance, and other non-commercial forage species?

What is the status of the parakeet auklet population on Smith Island (which was heavily oiled by spill)?

What is the magnitude of bird mortality associated with the nearshore gillnet fishery?

What are the annual food habits and requirements of the bald eagle?

What are the overwintering requirements and immigration patterns of the common murre?

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ADDITIONAL INFORMATION NEEDS
IDENTIFIED BY THE MAMMALS SESSION
RESTORATION PLANNING WORKSHOP
3-5 APRIL 1990

Marine Mammals

Sea Otters

- Population modeling studies to derive an accurate estimate of the proportion of the Prince William Sound sea otter population impacted by the oil spill

Humpback and Killer Whales

- Expansion of individual identification capabilities (fluke and dorsal fin catalogs) to facilitate studies of residency, habitat use, reproductive rates, and stock identity of whales using Prince William Sound and the Gulf of Alaska

- Biopsy sampling studies for stock identification (resident vs transient groups)

- Prey availability surveys

Sea Lions

- Determination of causes of pre-spill population decline and the relative contribution of the spill to the declining trend

- Stock separation and identification

Terrestrial Mammals

Sitka Deer and Bear

- Determination of the frequency and extent of usage of marsh vegetation and beach grasses by deer and bear to assess the value of restoration of those resources

- Assessment of potential delayed effects of oiling on black bears

River otter and Mink

- Determination of: total populations in affected area, habitat use, reproductive potential, and food habits

- Continuation of laboratory study of the effect of oil ingestion on mink reproduction to contribute to an

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estimate of the magnitude of suspected damage to the Prince William Sound population

Exxon Valdez **Oil Spill** CONFIDENTIAL

Damage Assessment Information Needed by the
Coastal Habitats Restoration Work Group

The Coastal Habitat Restoration Work Group was, as were other work groups, frustrated by the general lack of damage assessment information presented at the *Exxon Valdez* Restoration Workshop, April 3-5, 1990. No information was presented concerning the extent and magnitude of oil contamination to the coastline of Prince William Sound. Neither was information available, except in the most general qualitative sense, on the effects of oil contamination to coastal ecological resources.

The Work Group chose to consider damage assessment and restoration alternatives for three major coastal habitats: the supratidal zone, the intertidal zone, and the subtidal zone. Each of these habitats was further divided into low and high energy environments reflecting their exposure to waves, sediment type, and slope.

The Work Group as a whole was of the opinion that it would be valuable to have an overall view of the extent, magnitude, and effects of oil contamination in Prince William Sound. The Work Group also sought to separate the effects of exposure to oil from the effects caused by clean-up efforts. The group thought this was one of the most important points to come from the damage assessment efforts, since such information could be applied to future spills which the group thought were sure to happen.

Although not specifically stated, it was my opinion as rappateur for the Work Group, that the Group wanted made available the following types of information:

- What was the area and proportion of Prince William Sound shoreline made up of sandy beaches, cobble beaches, and rocky shores?
- What proportion of each of these types of shores were impacted by oil from the *Exxon Valdez* and what was the magnitude of oiling?
- What proportion of each of the three habitat types (supratidal, intertidal, and subtidal) was exposed to which clean-up options (no clean-up efforts, hot water rinse, cold water rinse, bioremediation, etc.)?
- What proportion of each of these types of shores was exposed to which clean-up options?
- What were the direct effects of exposure to oil and can these effects be distinguished from the effects caused by the clean-up efforts?

- Was the Prince William Sound shorelines being monitored for long-term effects and if so, were studies being conducted to adequately discern the effects of oil from the effects of clean-up efforts?

In addition to this general type of information, the Coastal Habitat Work Group suggested that the damage assessment should include information concerning the extent, magnitude, and effects of oil on specific communities and populations. For example, questions were raised concerning how much oil reached the sediments within Prince William Sound and what oil concentrations were measured in the sediments. Questions were also raised concerning the communities within those sediments, since benthic communities have been shown in a number of studies to be sensitive to petroleum hydrocarbon inputs. Unfortunately, not only were no data presented, but it was not clear what samples were taken and would be eventually analyzed to address these questions. It was also considered important to know the areal extent and exposure to oil of supratidal marshes. Finally, because of its perceived importance as a population effecting the very structure of intertidal communities in the Sound, information concerning *Fucus* populations was requested. Lacking was information on the areal distribution of *Fucus*, what proportion of the population was exposed to oil and to various clean-up methods, and what effects oil and clean-up efforts had on these communities.

The Habitat Work Group expected and asked for considerable damage assessment information, but received only qualitative descriptions of exposure and effects. Consequently, the Group was not comfortable recommending damage restoration alternatives and none were made.

RESTORATION PLANNING WORKSHOP

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INFORMATION NEEDS FOR FISH/SHELLFISH

It was the consensus of the Fish/Shellfish session members that the damage assessment did not provide adequate information upon which to base firm restoration recommendations. However, it was also recognized that some uncertainty as to the nature and magnitude of damage was likely to exist for some time and that decisions would have to be made under risk.

A range of information needs considered critical to making sound management decisions for exploited resources were identified during the course of the two day session on fish and shellfish. These needs arose from two basic problems: 1) the need for additional damage assessment data either from ongoing but as yet incomplete studies or studies that were cancelled and 2) the requirement for more precise management information due to the uncertainty introduced by the effects of the oil spill. Although some of the continuing studies were not expected to produce results immediately, other studies that were not continued due to their limited relationship to the damage assessment would have, in the session's opinion, provided valuable information for planning restoration.

The following studies identified by the session as important for restoration planning were primarily related to immediate information requirements. These studies were particularly focused on harvested resources for which basic information needed to manage the stocks is currently not available. The session members felt that the uncertainty associated with the spill required more precise information than is currently available and that this information requirement should be a justified expenditure for "restoration" funding.

- Herring scale pattern analysis to identify stocks. This would aid in determining whether there are one or two stocks exploited in Prince William Sound.
- Catalog herring spawning areas.
- Hydroacoustic biomass estimates of resident herring stocks this fall.
- Adult pink salmon tagging near hatcheries to distinguish wild and hatchery stocks.
- Coded wire tags: improve turn around time for management purposes.
- Salmon otolith analysis (hatchery mass marking).
- Tagging rockfish on reefs to provide population estimates.
- Continue groundfish trawling (age and size) and port sampling.
- Catalog and inventory resources in Prince William Sound and lower Cook inlet region.

D.J. Sheehy
Versar, Inc.
13 April 1990

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PILOT PROJECT - 1990 FISH/SHELLFISH

Title: Artificial Reef Evaluation

Purpose:

This project will evaluate the feasibility of providing artificial reef and/or SAV habitat to replace habitat damaged or degraded as a result of the Exxon Valdez oil spill. The proposed pilot project will include the construction and evaluation of an artificial reef placed in Prince William Sound. The specific objective of artificial reef placement is to test the hypothesis that rockfish or other fish and shellfish species will use reefs as shelter and/or feed on the forage base that is 1) concentrated by or attracted to the reef, 2) develops on the reef surface, or 3) uses this fouling community as microhabitat. This demonstration project will determine the effectiveness of this habitat replacement approach for future restoration in Prince William Sound.

Statistical tests will be used to compare the differences in the composition and abundance of fish and shellfish on reef and non-reef control sites. Fouling plates will be used to document the development of a fouling community on the reef and stomach contents analyses will be used to determine the diet of target recreationally or commercially harvested species that utilize the reef. The fish utilization will be documented using diver/ROV observations, time lapse photography, and acoustic surveys.

Rationale:

The Exxon Valdez oil spill has damaged habitat that is critical to some fish or shellfish species or life stages. The nature, extent, and consequence of this damage is currently under investigation. This project will provide information that can be used for restoration if the results of on-going damage assessments indicate significant damage.

The potentially damaged fishery habitat types that are of known importance include rockfish reefs, herring spawning areas, and salmon spawning/nursery areas. Artificial reefs or SAV beds are possible interim restoration measures that may provide additional habitat to replace at least some of the functions of the reef or rocky subtidal habitat lost or damaged as a result of the oil spill. These measures are temporary substitutes that may replace some of the critical habitat functions, such as cover and concealment (reduced predation), forage, or ovideposition substrate that have been lost damaged or degraded.

Rocky reef areas exposed to oil from the Exxon Valdez spill were used by rockfish as well as other demersal fish and shellfish. Rockfish used these areas for cover and concealment, as well as forage. The shallow reef habitat and surrounding benthic areas that provide forage base have been exposed to oil and may be adversely affected for some unknown period of time. Dead rockfish recovered after the Exxon Valdez spill were diagnosed as killed by spilled oil. Preliminary damage assessment results demonstrated the presence of hydrocarbons in the bile of rockfish several weeks after the spill indicating the possible presence of hydrocarbons in the food chain.

The rationale for the use of artificial reefs is based on the premise that the addition of alternate habitat or the provision of alternate forage outside the spill area may aid in maintaining local fish and shellfish stocks until natural recovery or other restoration measures result in the return of the habitat to its pre-spill condition. The maintenance of seed stock within close proximity to currently contaminated areas may aid in the recruitment of fish back to that area as conditions improve.

Background:

Artificial reefs have been traditionally used to enhance commercial or recreational fisheries for both fish and shellfish. Although there has been a continuing debate as to whether reefs attract or increase the production of fish/shellfish, research has clearly demonstrated that for selected species that are dependent on reef habitat for cover/concealment (e.g. American lobster; Homarus americanus) or feed directly on the encrusting community (e.g. tautog; Tautoga onitus) artificial reefs can increase local carrying capacities. In fact, well designed artificial reefs function in a manner identical to natural reefs. The primary difference between natural and artificial reefs in temperate waters is not function, but the manner by which the materials were originally placed.

Recent studies (Sheehy and Vik, 1988, 1989) have suggested that prefabricated designed reefs may be useful tools for mitigating the adverse effects resulting from the loss or damage of coastal habitat. Prefabricated structures (Sheehy, 1983) designed specifically to function in providing shelter or concentrating food can provide substitute habitat for a variety of species that may have been impacted by or displaced as a result of the Exxon Valdez oil spill. These would include demersal rockfish and nearshore forage species dependent on SAV for shelter or spawning habitat. It has been demonstrated that SAV beds afford not only protection from predators but also provide a rich foraging habitat (Rozas and Odum, 1988). Artificial reefs or SAV structures that replicate the physical form or characteristics of natural reef or SAV provide many of the same functions as this natural habitat.

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Approach:

One approach to replacing contaminated reef habitat or providing additional habitat outside of areas that have been impacted by oil contamination is the construction of artificial reefs or SAV beds. This pilot project will deploy two or more artificial reef or SAV modules in order to operationally test and evaluate this technology in Prince William Sound. Performance evaluations of these structures will determine whether or not these units are utilized by rockfish or other species. Artificial reef or SAV modules could be placed either on impacted substrate or in areas that have not been exposed, but are devoid of natural habitat structure. The reef performance evaluation will document occupancy and utilization of the reef by fish and shellfish, examine the development of the fouling community on the reef, examine stomach content of target species, and collect tissue samples for hydrocarbon analysis.

The project is composed of the following specific tasks:

- Coordination with State resource agencies to determine potential test and control sites, schedule, and local participation. Prepare and submit permit applications.

- Conduct pre-placement site surveys to characterize substrate and fauna. Confirm oceanographic conditions for stability analyses.

- Based on site conditions, configure a selected artificial reef/SAV module design to meet site stability conditions and target species requirements. This study will consider only existing, proven and tested prefabricated reef/artificial sea grass technology; no product development is contemplated at this time.

- Specify module design or configuration and order components and construction materials.

- Build reef/SAV units using local labor, if available. Place reef/SAV modules at permitted sites. Conduct initial post-placement inspection.

- Conduct post-placement surveys. Video, acoustic, angling, and diver transect fish surveys are anticipated, depending on site depth and conditions. Fouling plates and other monitoring equipment (settling tubes, azoic sediment trays, etc.) deployed with the reef unit would be sampled seasonally. Stomach content and tissue samples from collected fish would be retained for future analysis.

The results of the proposed study will determine whether or not rockfish and/or other species occupy and utilize artificial reefs or SAV beds. The null hypothesis to be tested will be that there is no difference in species composition and abundance between the artificial reef and non-reef control sites. Earlier

work strongly suggests that a significant difference between test and non-reef control sites will be detected. This information will also be useful to compare with the rates of natural recovery on existing oil impacted reefs. If results indicate this method is effective, information needed to scale and determine the cost of future artificial reef/SAV application will be available.

Resources:

	FY90	FY91
Equipment and Materials	$ 70 K	$ 15 K
Travel	15 K	15 K
Personnel	50 K	30 K
Subcontract	35 K	
Total	$170 K	$ 60 K

References:

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The Use of Designed and Prefabricated Artificial Reefs in the United States

DANIEL J. SHEEHY

ABSTRACT—Designed and prefabricated artificial reefs have been used with great success to promote fisheries development in Japan and Taiwan, and have been tested on several occasions in the United States. Although efforts in the early 1960's to test Japanese-style reefs in California, New York, and Florida met with problems due to lack of experience with that type of reef, those units which were properly placed proved effective in attracting fish. Pumice concrete shelters designed for lobsters were tested in Rhode Island in the 1970's and were shown to increase significantly the abundance of resident lobsters in areas previously devoid of shelter. The Japanese have recently developed a new generation of large-scale, advanced-technology artificial reefs. To introduce this technology in the United States, Japanese FRP (fiberglass reinforced plastic) reefs have been installed off Florida as part of a demonstration/research project funded by the National Marine Fisheries Service. Their cost-effectiveness will be evaluated by comparing them with concrete culvert reefs.

Introduction

Artificial reefs have been used to promote fisheries development in both Japan and the United States for at least 200 years. Taiwan and Australia have more recently begun to construct reefs. Although artificial reefs have been built in other countries, the major reef development activities have occurred in these four countries. Japan has a large, well-funded national artificial reef development program. Taiwan had a nationally funded reef research program for several years; reef construction by regional and private groups is now in progress. Neither the United States nor Australia have national reef programs.

Rocks and logs, or scrap materials such as ships, tires, and construction rubble, were used in most of the early U.S. reef-building efforts. Solid waste disposal has been a secondary motive in many American projects, particularly those using tires.

Many of these projects using available or scrap materials proved to be very effective. In Japan and Taiwan, such reefs were used extensively to improve commercial fisheries and aquaculture. In the United States and Australia they are still used to promote recreational fisheries.

However, research conducted in Japan and Taiwan has shown that even though scrap materials and rock can function effectively as artificial reefs when properly handled and sited, appropriate sites for the deployment of these materials are limited. Furthermore, the shapes, size, and long-term physical stability and biological productivity afforded by such materials are less than ideal. Transportation and handling costs, which constitute the major expenditures in the construction of this type of reef, have increased significantly in recent years and the long-term cost effectiveness of such projects has been reduced.

As a result of this situation and an increasing amount of information on optimum design criteria, prefabricated artificial reef units began to be developed in Japan during the early 1950's. Most of this first generation of designed reefs were made from reinforced concrete and were either cubes (Fig. 1) or rectangular boxes with sides of about 1-2 m, hollow interiors, and "windows" on each side, or cylinders of similar dimensions and properties. The larger cubes and boxes, which generally had bigger "windows" and more open space, were often piled in two or three layers to create high profile reefs, while the cylinders and the smaller, less open cubes and boxes were generally not placed in layers. These concrete units proved to be quite effective. In 1954, designed concrete units were designated as the only type of component to be used in government-subsidized regional reef construction projects.

In both Japan and Taiwan, coordinated programs to improve coastal fisheries production have recently been undertaken in response to declines in fisheries production due to the 200-mile extended jurisdiction statutes, increases in fuel prices, and the deleterious effects of coastal development and pollution. Large-scale designed units prefabricated from a number of materials have been used to expand the artificial reef programs in both countries.

The new generation of artificial reef units developed in Japan is manufactured in a wide variety of shapes, sizes, and materials. An assortment of new midwater and floating fish attractors has also been developed and introduced. These new units can be used in a wide range of site conditions not suitable for earlier designs. Many are quite large and are deployed as single units to build very large-scale fish banks. Results of preliminary studies have indicated that in some cases these new units are more

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cost-effective over the long term than the earlier scrap material or designed units.

Although most artificial reefs in the United States are still built from scrap materials, the availability of some of these (such as liberty ships) has decreased and the cost of transporting, handling, and preparing others has increased in recent years. "White goods" (appliances) and car bodies are no longer considered suitable for reefs because of their high preparation costs and short life expectancy in the water. Both the cost-effectiveness and long-term stability of tire reefs have come into question. Hanni and Mathews (1977) indicated that it is cheaper in Pinellas County, Fla., to dispose of tires in a landfill than to dispose of them at sea by using them for reefs. Problems with tire reefs breaking apart and ending up on tourist beaches or in fishermen's nets have caused several states (i.e., Florida and California) to no longer support the use of tires as an artificial reef material.

Because of the current interest in the United States in installing artificial reefs and the decreasing availability and cost-effectiveness of scrap materials for construction, it is useful to review the past and potential role of designed, prefabricated reefs in American coastal waters.

Figure 1.—Japanese concrete cube reef units (sides = 2 m) being built in Chiba Prefecture, Japan.

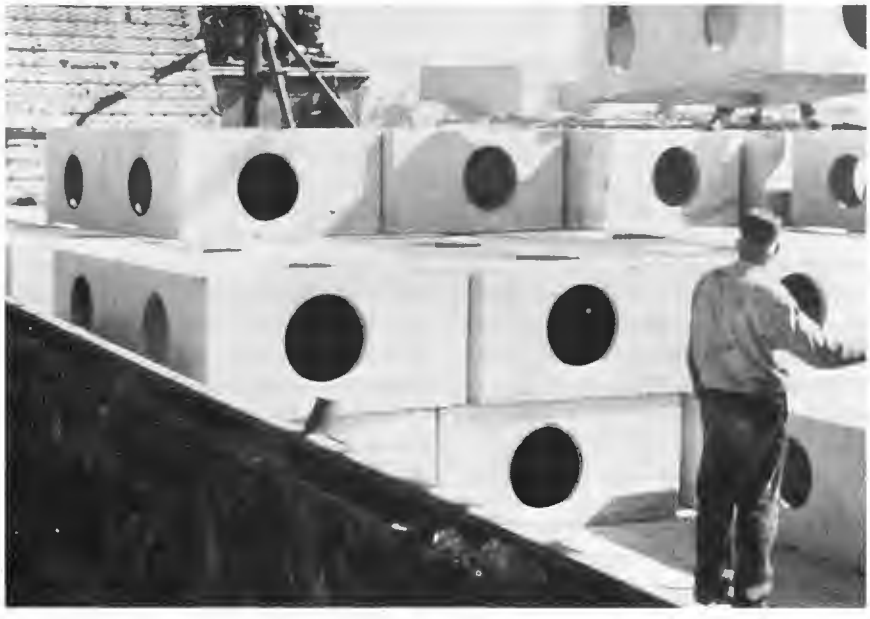

Figure 2.—Japanese-style concrete blocks used in California in the early 1960's. (Photo courtesy of the California Department of Fish and Game.)

Japanese-Style Concrete Reefs

Based on the development of the first reefs designed in Japan during the early 1950's, several states began testing similar structures during the early 1960's. This effort began in California and included Florida and New York. These studies are of interest since the results suggested some of the problems as well as the potential advantages of using such structures.

Early preliminary work by the California Department of Fish and Game (Carlisle et al., 1964) demonstrated that artificial reefs could add productive habitat for recreational fishing.

Further studies, initiated in 1960, compared four types of reef materials in order to determine which would be most suitable for future construction projects in California. Three reefs were built in about 18 m of water on sandy barren ocean bottoms off Malibu, Santa Monica, and Hermosa Beach. Each reef consisted of four subunits composed of the materials under consideration: Streetcars (1/subunit), automobile bodies (14/subunit), designed concrete block shelters(44/subunit) (Fig. 2), and quarry rock (about 333 tons/subunit).

Figure 3.—Concrete units adapted from Japanese-style units prior to placement off Long Island, N.Y., during 1964-65. (Photo courtesy of the New York State Department of Environmental Conservation.)

Each subunit had a volume of approximately 409 m^3.

Extensive observations for several years demonstrated that although differences in effectiveness occurred among the three reef sites, the relative effectiveness of each of the four subunits was consistent. The designed concrete blocks proved to be the most effective subunit material for concentrating and attracting fish. This was followed, in order of declining effectiveness, by quarry rock, car bodies, and streetcars. Further observations indicated that the car bodies and streetcars deteriorated within 3-4 years and became almost completely ineffective. At the time of this study (1963), however, quarry rock was considerably less expensive than the concrete units and was determined to be the most cost-effective material for reef construction in California (Duffy, 1974).

During the late 1960's and early 1970's, a number of tire reefs were constructed in California (Dewees and Gotshall, 1974; Duffy, 1974). Although tires proved to be more durable than car bodies or streetcars and cheaper than quarry rock, problems with binding, puncturing, ballasting, and siting led to eventual dispersal of the reefs and caused tires to be banned as reef-building materials in California (Carlisle[1]).

Pinellas County and the City of Clearwater, Fla., which pioneered the development of artificial reefs in the eastern Gulf of Mexico, built and placed in 1965, 200 Japanese-style concrete "pill box" reef units like those which had been used in California. Each box measured 8 × 4 × 3 feet high and had 18-inch diameter holes in the sides and top. The City of Clearwater placed 75 units in groups of 3-6 on a 2,600 × 500-yard reef site. The remaining 125 units were placed by the county off Indian Rocks Beach.

Due to lack of experience with this type of reef component, inadequate planning, and insufficient control during placement, many of the units ended up scattered over an area believed to cover a half-mile of bottom. Only about 20 of the units remained in the intended area. The rest were so scattered that they cannot be located by fishermen and thus are effectively lost.

A number of concrete units of a design adapted from the Japanese-style units used in California and Florida were placed off southern Long Island, N.Y., during 1964-65. A local contractor used a modified septic tank mold to fabricate the units (Fig. 3).

While available information on this project is incomplete, several problems are known to have made it a failure. The design modifications resulted in apparently extensive damage to the units during handling and placement on the barge used to tow them to the deployment site. Because of further problems resulting from poor weather and lack of proper planning, the location of the placement area was not recorded. The units remain unlocated and unevaluated.

As this brief review indicates, the major problems encountered in attempts to use Japanese-style concrete units in the United States arose from improper design, handling, siting, and placement. (It should be noted, however, that similar problems due to similar causes were not unknown in Japan when designed concrete units were first put into use.) Except in California, where considerable experience in building large-scale reefs had been developed, some or all of the units were lost due to improper placement. Attempts in New York to adapt existing septic tank molds for fabrication of the reef units resulted in structural degradation and losses during handling even prior to actual placement.

In California, where the units were placed relatively properly, they proved to be the most effective form of reef unit; they were 18 percent more effective than quarry rock. Despite the placement problems in Florida, the 20 units which were not lost have been observed by divers for more than 17 years and continue to provide very effective habitat for grouper, sheepshead, and a variety of other species. A recent dive on this reef in December 1981 indicated that these units are completely intact, stable, and very productive (Fig. 4).

Although 20 years ago the California Department of Fish and Game suggested that, at least for the term of their study, quarry rock was more cost-effective than the otherwise more effective concrete units, cost differences may not be such a

[1]Carlisle, J. G. 1980. California Department of Fish and Game, Long Beach. Pers. commun.

significant factor today, especially over a long-term period. This is particularly true in light of the recent advances in reef design, siting, and placement techniques which have been made in Japan and confirmed in Taiwan.

In 1963 the cost of 1,000 tons of quarry rock delivered in place in Santa Monica Bay cost $6,000 ($6/ton). A similar volume of concrete units cost $11,000 at that time. A recent project in California which involved the placement of eight rock-pile reefs off San Onofre cost about $250,000 (10,000 tons at $25/ton), more than four times the 1963 cost. Although the new Japanese-designed reefs may still be somewhat more expensive per unit volume than rock, they may also be more effective on a long-term basis. Furthermore, volumetric comparisons may not be valid for measuring effectiveness.

Figure 4.—Japanese-style "pill box" reef placed off Clearwater, Fla., in 1965 and photographed in 1981.

Lobster Reefs

Designed artificial shelters have also been used to promote or expand fishing areas for commercially important invertebrates and seaweeds. Although most of this work has been done in east Asia, several studies have been conducted in the United States with the northern lobster, *Homarus americanus.*

A number of researchers (Briggs and Zawacki, 1974; Scarratt, 1973; Stewart, 1970) have suggested that in some areas shelter is a limiting factor in the distribution and abundance of nearshore lobsters. The addition of shelter in areas previously devoid of cover or substrate suitable for burrowing has been shown to increase the abundance of resident lobsters. Observations have also indicated that extensive growth of encrusting organisms on artificial substrates serves as a source of food for the lobsters (Sheehy, 1976; Alfiere, 1975; Weiss, 1970).

Several types of designed artificial shelters for lobsters were fabricated from pumice concrete as part of a series of studies begun in Rhode Island during 1971. Preliminary studies with a single chamber unit (Fig. 5A) were conducted at several shallow sites off Point Judith, R.I., to determine if the carrying capacity for lobster in sand bottom areas could be increased.

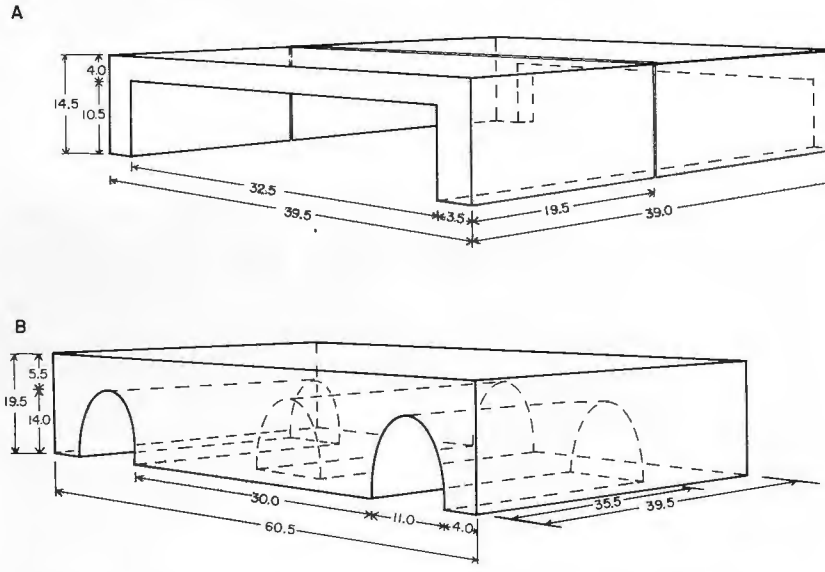

Figure 5.—Artificial shelters fabricated from pumice concrete in Rhode Island: A = single-chamber (2-piece) unit and B = triple-chamber unit.

Results indicated that the addition of lobster shelters significantly increased resident lobster populations (Fig. 6). Observed lobster abundances were equal to or greater than those observed on good natural grounds. In addition, results indicated that shelter spacing had a significant effect on occupancy by lobsters

Figure 6.—Lobster occupying two-piece single-chamber shelter. Extensive mussel growth on the shelter surface.

Figure 7.—Juvenile lobsters and crabs, *Cancer borealus,* found in triple-chamber unit being examined by diver.

and that shelter orientation, with respect to predominant wave and current directions, affected the stability of the shelters on the bottom. Interactions between lobster size and shelter spacing intervals were also suggested (Sheehy, 1976).

Two-piece shelters used in the initial study proved to be unstable during severe wave conditions and current velocities. Shelter loss was due both to subsidence resulting from scour and to overturning and separation of sections by wave action. Shelter orientation had some influence on the rate of loss; however, the design was considered unsuitable for all but experimental purposes (Sheehy, 1976).

A second pilot study which compared single- and triple-chamber shelter units affording approximately the same available shelter volume (Fig. 5B) demonstrated that triple-chamber units had greater overall use and supported larger populations due to the compartmentalization. During this study, all benthic life stages of the lobster were observed on and within the reefs. Significant seasonal variations in both lobster and other populations (Fig. 7) occupying the reefs were also observed (Sheehy, 1976).

Although triple-chamber shelters were more stable due to increased weight and bottom surface area, they proved more difficult for divers to handle and space. Both laboratory and field studies were conducted by Jones (1974) to develop a more stable design and a basic computer simulation program to evaluate these units under various combinations of substrate and oceanographic conditions. This information, as well as fabrication costs and logistic considerations, was used to design a new and smaller single-chamber unit (Fig. 8, 9) to conduct larger scale controlled tests at six sites in Rhode Island.

Each of these six reefs (Fig. 10) was monitored bimonthly by divers for a year. The three most stable reefs were monitored for a second year as part of a tagging program. During each survey, divers carefully monitored the position, size, sex, molt condition, and claw number and size of each lobster (Fig. 11). Multidimensional contingency table analysis was used to examine the interaction of variables in the lobster abun-

dance and distribution within the reef (Sheehy, 1977).

Results from this study confirmed and expanded on the prior studies by again demonstrating that the addition of artificial shelters in areas devoid of natural shelter or substrate suitable for burrowing can significantly increase the abundance of lobsters. However, the results also confirmed earlier statements by Scarratt (1973) and others that suitable sites for lobster reefs are limited. A careful examination of all relevant site factors, particularly maximum wave and current conditions, substrate, and available food resources, should be made prior to future construction.

Unit artificial shelters may offer a viable alternative to the use of natural rock or scrap material in the construction of large-scale reefs for lobsters. Although such designed shelters can be used to create new habitat for lobster, a careful analysis of all cost factors should be made before commercial scale reefs are constructed. If some of the legal restraints to "extensive aquaculture" are removed, additional uses for such reefs may soon develop.

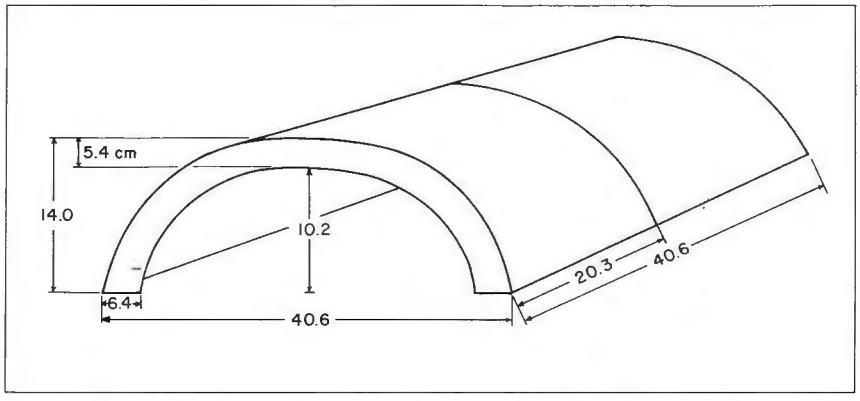

Figure 8.—Smaller single-chamber unit fabricated from pumice concrete (dimensions in centimeters).

Figure 9.—A lobster occupies a smaller single-chamber unit with extensive macroalgae growth on shelter surface.

Japanese Fiberglass Reinforced Plastic (FRP) Reefs in Florida

The new artificial reef technology developed in Japan and Taiwan has been described (Sheehy, 1979, 1981; Chang[2]). These large-scale structures represent a new generation of artificial reefs which are designed, prefabricated, and installed to promote commercial fisheries, to rehabilitate areas adversely impacted by human activities such as pollution and coastal development, and to serve as part of extensive aquacultural projects (Sheehy and Vik, 1981). They are the result of considerable research and development. To receive approval for use in projects funded by the Japanese government, reefs must meet certain standards for strength and stability and must be judged to have a minimum useful life span (without structural degradation) of 30 years when properly built, handled, and sited.

Aquabio, Inc.[3], a marine research and development group, has recently initiated a project to introduce this new Japanese technology in the United States and

[2]Chang, K.-H. 1981. Taiwan's artificial reef research program. Presented at the Mid-Atlantic Artificial Reef Conference, Atlantic City, N.J. Institute of Zoology, Academia Sinica, Taipei, Taiwan.

[3]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

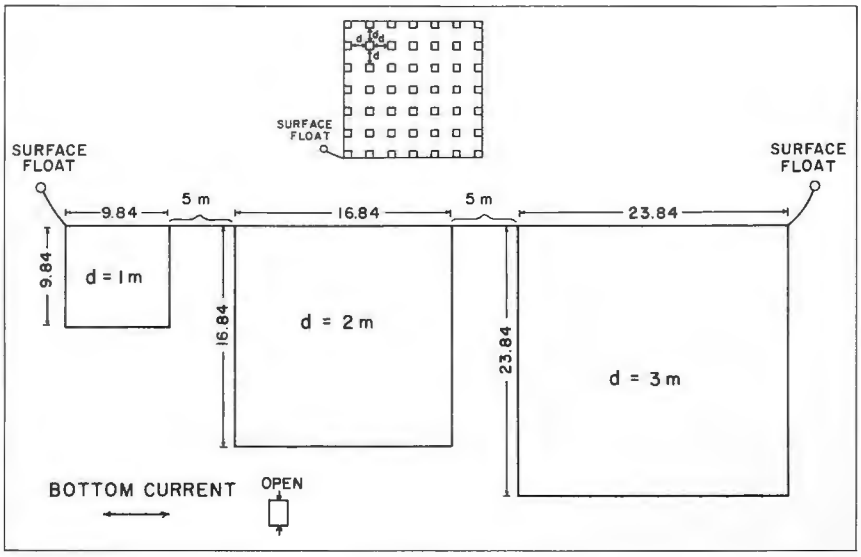

Figure 10.—Placement configuration of individual reefs (spacing intervals in meters). Inset: Expanded view of an individual matrix; "d" is the intershelter distance.

determine which aspects have the most potential for application in American fisheries development. An important part of this project, funded principally by the National Marine Fisheries Service (NMFS), involves a demonstration and evaluation of Japanese artificial reefs in U.S. coastal waters.

To determine which types of reefs have the most potential for immediate use in the United States and would therefore be most appropriate for the demonstration, the stability, strength, life expectancy, and biological effectiveness of a number of manufactured reef units commercially available in Japan were evaluated. Design flexibility and costs associated with construction, transportation, and placement were also considered.

FRP units, manufactured by Asahi Chemical Industry Co., Ltd., were selected as most suitable for small-scale testing and evaluation off the Florida coast. The reef components were readily shipable from Japan, capable of being assembled with relatively unskilled labor and minimal equipment, and could be placed without the use of large cranes and barges. In addition, these units could be built in a variety of configurations, and this could be designed for fish, shellfish, and macroalgae.

Reef components and materials manufactured in Japan were sent by container ship to the United States, erected, and placed off Panama City and Jacksonville,

Figure 11.—Diver examining egg-bearing female lobster while monitoring reef.

Fla., during August and September 1981. Reef components, essential materials, and engineering services were donated by Asahi. The reef units were built and placed by students, graduates, and staff from the Panama City and Jacksonville Marine Institutes with technical supervision by Asahi and Aquabio. Some financial and administrative support to assist with construction of the Japanese units and a concrete culvert reef placed at each site for comparative purposes were provided by the Florida Department of Natural Resources. Assistance with selection of specific sites was provided by the Jacksonville Offshore Sport Fishing Club and the Marine Institutes.

As previously noted, many of the problems encountered in the earlier use of Japanese-style reefs in the United States were due to improper design, siting, handling, and placement. To gain the full benefits of using Japanese reefs in this demonstration project, Aquabio made every effort to ensure that the units were built exactly according to the manufacturer's directions, were handled properly to avoid damage, and were placed correctly and accurately on predesignated, carefully selected sites. This conservative approach, along with the diligent work of the Marine Institute students, graduates, and staff, resulted in the proper placement of undamaged units at the specified permitted sites.

Jacksonville and Panama City were chosen as sites for this project for a variety of oceanographic and logistic reasons, as well as criteria recommended by the manufacturer. Both represent fairly typical substrate types and water depths for reef construction along both coasts of Florida. Jacksonville is relatively typical of areas along the southeast Atlantic coast in terms of slope and bottom type. Panama City, while not really typical of the entire Gulf area, is representative of the northwest coast of Florida and is an area which has potential need for further reef development. Panama City also provides relatively reliable visibility for detailed underwater observations. A maximum depth limit of 80 feet was set in order to provide sufficient no-decompression bottom time for divers to conduct surveys and recover sample plates and instruments.

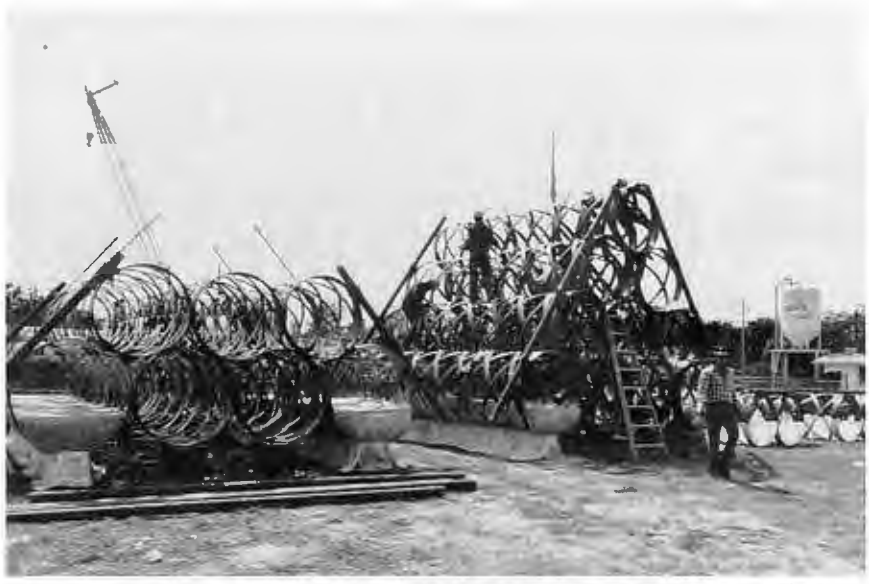

Figure 12.—Three types of FRP units built in Jacksonville, Fla. Concrete ballast has been placed in lower cylinders of largest unit.

Sites were also screened to ensure long-term reef stability. Prior to selection, available oceanographic data and estimates of significant and maximum wave heights and periods and maximum current velocities were collected along with substrate data. Using stability calculation equations developed in Japan, the stability of various reef unit configurations was evaluated. Since these units have been extensively tested in Japan under a variety of conditions, field data confirming these calculations was available.

Both Jacksonville and Panama City have had artificial reef programs for some time and a number of other reefs of different types are available for comparative purposes. The Jacksonville Offshore Sport Fishing Club has built reefs off Jacksonville for over 20 years and has collected considerable information on species caught in the reefs and their seasonal variation. Likewise, the Panama City Marine Institute has built a variety of reefs off Panama City; recent field studies on these reefs conducted by researchers from Texas A&M University will provide useful comparative information.

The specific sites selected in both areas had flat, coarse sand bottoms devoid of any natural relief. Preplacement surveys conducted at each site indicated a relatively low abundance of fish. Adjacent areas with similar bottom characteristics were selected as control sites for future surveys.

The reef components and materials arrived through the port of Savannah, Ga., and were trucked to staging areas in Panama City and Jacksonville. The principal components were cylinders 5 m long and between 1.0 and 1.2 m in diameter fabricated from strips of FRP (Fig. 12). The slight variations in the diameters of the cylinders permitted the components to be nested during shipping to reduce space requirements. Additional structural components, such as guard bars and anchor piles, were made from heavy-wall FRP pipe sections.

Although the FRP reefs are not difficult to build, proper supervision and quality control are essential in all aspects of the building and placement. The erection process took about 2½ days at each site, with several slight delays due to material variations, equipment adjustments, and rain. The work crew consisted of five students or graduates and two supervisors.

Figure 13.—The 10- and 7-cylinder units during construction in Jacksonville, Fla.

Figure 14.—Workers fiberglassing all connecting points.

After being unpacked, the units were sized, placed in position on stands, and fastened together with heavy wire (Fig. 13). FRP guard bars, designed to add structural support and reduce damage from towed fishing gear, and steel lifting eyes used for hoisting the units into the water were also wired into place. All connections were then fiberglassed with impregnated twisted roving wound on a hand machine designed for this purpose (Fig. 14).

Fabric bags used for casting the concrete ballast were also temporarily attached with steel wire to the appropriate number of bottom cylinders. The number to be ballasted and the amount of ballast per cylinder are adjusted to site-specific oceanographic conditions. Anchor piles, used to prevent the reef unit from slipping on the sea bottom, were placed through the fabric bags; specially fabricated reinforcing rod frames and connecting rods and pieces were then placed in the ballast cylinders. Quick setting, early-strength concrete was poured, smoothed, and permitted to harden.

Airbags designed to fit into the lower cylinders were inserted. The reusable airbags permit these units to be floated and towed to the placement site, thus eliminating the need for a barge or floating crane required by all other large-scale Japanese reef units. Nylon covers, FRP sheeting, and linoleum were placed around the airbags to reduce abrasion by the concrete and FRP strips. The bags were then inflated, inspected for leaks, and secured in place (Fig. 15).

Tow bridles and lines were attached to both units and a crane equipped with a special spreader bar was used to pick up the units and place them into the water. The units were temporarily secured at dockside while lines were rearranged and the tow line was secured to the tow vessel. A vessel of about 5 tons is generally sufficient to tow the units in tandem; however, a small tug was used in Panama City and a large charter boat was used in Jacksonville for safety and to carry additional observers.

The units were towed (Fig. 16) to the permitted site where temporary buoys had been placed earlier. On site, the two units were detached and maneuvered into position by a small outboard vessel. The stern of each unit was anchored and the unit was oriented by the outboard. The airbags were vented, causing the reefs to sink (Fig. 17). Dive teams recovered the lines and inspected the

units. The airbags and nylon liners were recovered by the tow vessel.

No damage from impact on the bottom or other causes was observed at either site. Units rested on the bottom and were supported by the anchor piles, with about 5-12 cm between the bottom of the cylinders and the seabed.

A 10-cylinder unit and a smaller unit (9-cylinder unit in Panama City and a 7-cylinder unit in Jacksonville) were placed at each site. This variation was planned as part of a long-term stability test to determine if theoretical calculations concerning stability in "worst case" conditions such as a hurricane were correct.

As part of the project, Aquabio is currently conducting a 1-year research program at both sites funded by an NMFS grant. This program includes surveys of benthic, encrusting, and fish populations, as well as primary productivity and oceanographic studies. The research effort will evaluate the Japanese FRP reefs, the concrete culvert reefs of approximately equal volume constructed at each site, and control areas in terms of fish abundance and distribution, and benthic and encrusting community development (Fig. 18). At the end of the monitoring period, a cost-effectiveness comparison between the FRP and the culvert reefs will be made.

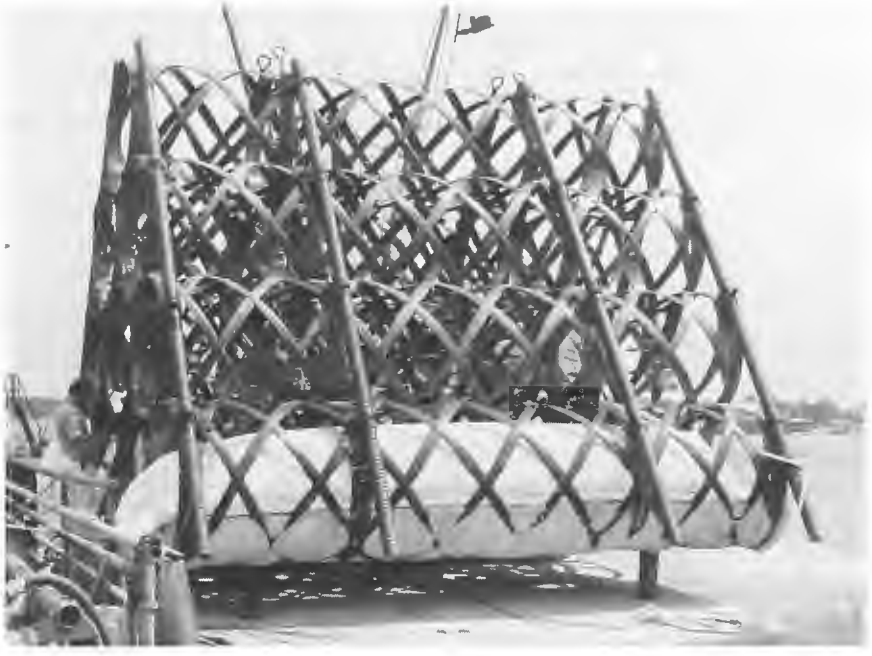

Figure 15.—Reef unit on dock. Airbags are being checked and inflated. The unit is standing on anchor piles.

Figure 16.—Reef units being towed to site off Jacksonville, Fla.

Potential Uses for Designed Reefs in the United States

Designed and prefabricated reefs offer a means of improving and managing coastal marine areas. The design flexibility permits the construction of stable, durable units which can be directed at specific species or even life stages. This flexibility and relative permanence make such reefs particularly suited for enhancing heavily used recreational fishing areas, increasing the production of commercial fisheries, serving as part of compensation/mitigation projects, and developing extensive aquaculture programs.

Although construction of artificial reefs to promote recreational fishing has a long history in the United States (Stone, 1972), very few reefs have been used extensively for commercial fishing, with the exception of those used by charter boat fisherman. It is possible, however, that commercial use may become more common in the future. Many U.S. commercial fisheries could benefit from the application of advanced artificial reef technology. Japan, the premier fishing

Figure 17.—Reef unit being sunk on site off Jacksonville, Fla.

Figure 18.—FRP reef off Panama City, Fla., photographed during the November survey.

nation, has relied on designed units for almost 30 years.

The use of reefs as a means of compensation or mitigation for various coastal development projects has been common in Japan for some time but is relatively recent in the United States. The potential of this application has been shown by recent efforts in California described by Grove (1982). Other coastal and estuarine areas subjected to some form of environmental or fishery loss may find that artificial reefs can contribute to comprehensive mitigation or compensation programs or plans. Many such projects are in high energy coastal or restricted estuarine environments where dredging, filling for land reclamation, power plant effluents, and other disturbances can have significant impacts. It is important that stable, aesthetically acceptable, effective, and relatively permanent structures be used in such compensation or mitigation projects since they should last as long as the impact for which they are compensating or mitigating. Many of these areas are subject to heavy recreational fishing; since suitable available space is limited to multiple uses and physical or biological restraints, it is essential that the most effective type of unit be used.

Artificial reefs have been used quite successfully to improve coastal aquaculture in both Japan and Taiwan. This use has been particularly effective with some of the mobile invertebrates and macroalgae species. Designed reefs are also used as nursery and spawning areas for fish. Some of these reefs are used to augment natural nursery areas or in conjunction with stocking programs. The only real marine culture reefs which have been used commercially in the United States are oyster reefs; however, there is significant potential for a variety of both marine and anadromous fish as well as invertebrates such as the abalone and lobster (*Homarus*), and macroalgae such as *Macrocystis.*

Although there are differences between east Asian and North American fisheries, the advances resulting from the extensive research and development in Japan and Taiwan can be modified for application in the United States. The design and site selection criteria developed for prefabricated units can also be applied to scrap material reefs to help improve their effectiveness and stability. This criteria could be especially valuable to the continued use of tires, concrete rubble, ships, and the expanded use of surplus oil and gas production rigs (Sheehy, 1982).

As the Japanese have demonstrated, the habitat improvement techniques

made possible by designed and fabricated artificial reefs have enormous potential for expanding coastal resources and rehabilitating areas adversely impacted by human activities. The possible applications of this advanced reef technology in the United States should continue to be investigated.

Acknowledgments

The demonstration of Japanese FRP reef technology in Florida was the result of a cooperative effort between the National Marine Fisheries Service, Asahi Chemical Industries Co., Ltd., and Aquabio, Inc., with additional support provided by the Florida Department of Natural Resources, the Associated Marine Institutes, Inc., and the Jacksonville Offshore Sport Fishing Club. I wish to thank all the people from these groups who helped with the project, and give particular acknowledgment to Richard B. Stone of NMFS; S. Inaba, Y. Sakata, and K. Kikusawa of Asahi Chemical Industries; Lonnie Ryder of the Florida Department of Natural Resources; and Tony Traviesa, Fred Kremer, and O. B. Stander of the Associated Marine Institutes. Special thanks are also due to the students, graduates, and staff at the Panama City and Jacksonville Marine Institutes who were involved with construction and placement of the reefs, and to the members of the Jacksonville Offshore Sport Fishing Club who provided assistance throughout all stages of the project. Photographs, unless otherwise credited, were made by the author.

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RECENT ADVANCES IN ARTIFICIAL REEF TECHNOLOGY

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Summary

Prefabricated designed artificial reef units which can be used to build effective, relatively permanent reefs at a wide variety of sites have been developed recently in Japan and other East Asian countries, where they are used to enhance fisheries resources, promote extensive aquaculture, and aid in rehabilitating areas impacted by coastal development, pollution, and overfishing. Because the design flexibility of these units expands the purposes for which artificial reefs can be used and extends the range of sites available for such activities, this technology has been introduced in the United States to address the limitations inherent in traditional American approaches to reef construction and siting.

Artificial Reefs in the United States

Rock and Scrap Material Reefs

Artificial reefs have been used to enhance fisheries in the United States for over 130 years.[1] Most of these reefs have been constructed from scrap materials or rock, and their principal application has been to improve recreational fishing opportunities. Solid waste disposal has frequently been a secondary or even a primary objective. Currently, most American reef construction activities are undertaken by state, county, and municipal groups and local recreational fishing organizations. Funding is generally modest and irregular, and these efforts are often dependent on volunteer labor and donated or salvaged materials.

Due to these factors, artificial reef technology has developed rather sporadically and the resulting reefs have often reflected design and/or siting compromises due to the limitations of the construction materials and the costs involved in properly preparing, handling, and transporting them. There has been a general lack of defined criteria for the selection of materials, sites, preparation of materials, handling, and transport methods. Post-placement evaluations have usually been quite limited, when conducted at all. In addition, scrap material reefs are often limited in terms of effectiveness, site suitability, and permanence, and problems related to stability have developed at a number of sites; the costs associated with the handling, preparation, and transport of scrap materials for reef construction have brought into question the economic benefits of disposing of these materials at sea. In order to make more effective and efficient use of coastal zone areas, improvements in almost all aspects of artificial reef technology and applications have been needed.

Since 1978, Aquabio has conducted artificial reef projects for federal, state, municipal, and private industry groups to expand the effectiveness of reef technology and its applications. These projects have emphasized comprehensive approaches to the development of siting plans, the implementation of advanced reef design and materials technology, extensive post-placement research and evaluation, and assessment of new or non-traditional applications in the U.S. This paper will briefly summarize the approach, research, and results of some of this work, and will suggest potential applications for artificial reef technology to enhance the effective use of marine resources.

Problems Impeding Reef Development

To identify the most immediate problems impeding artificial reef development and effectiveness in the United States, Aquabio assessed the state-of-the-art of American reef construction and use by reviewing available data files and interviewing fisheries administrators, artificial reef program coordinators, local fishermen, and other researchers. In addition, research dives were conducted to evaluate the results of past reef construction. Although these dives were concentrated along the Southeast Atlantic and Gulf of Mexico coasts, they extended as far west as Hawaii.

After analyzing and assessing the results of these investigations, three major problem areas (in addition to funding restraints and buoy maintenance) common to most reef projects in the U.S. were identified: loss or movement of reef materials, limited design and siting flexibility, and transportation limitations. These problems either had been responsible for past reef failures or were inhibiting future reef effectiveness or expansion. Although interrelated, they will be considered separately for the purpose of this discussion.

Loss or Movement of Reef Materials. Direct reef material loss has occurred due either to deterioration, as in the case of metal or wooden items, or to subsidence. Movement of reef materials has generally been the result of wave and current action, or of interaction with heavy commercial fishing gear.

Although loss or movement has been more common with low density items, such as tires, it has also occurred with heavy concrete culvert and large steel ships. In some cases, this has resulted in the defacement of public beaches, damage to commercial fishing gear, reduction in trawling areas, adverse impacts on natural "live bottom" areas, rapid loss of recreational fishing opportunities, and consequential curtailment of future reef construction efforts. In particular, the construction of tire reefs is now prohibited or strongly discouraged by several states.

Limited Design and Siting Flexibility. Limitations in reef design and siting have basically been due to the dependence on scrap or waste items such as old tires, culvert, and ships, and the cost of properly preparing and placing these items. All of these materials have been used in some instances to build effective and successful reefs; however, appropriate sites are limited due to the properties of the materials and oceanographic conditions. On the Gulf of Mexico and Southeast Atlantic coasts, the gradual slope of the shelf precludes nearshore siting of low density or high profile materials. Therefore, many reefs must be located at considerable distances from shore, thus reducing the number of recreational fishermen who can safely use them. On the Pacific coast and in Hawaii, siting advantages related to the availability of deeper water closer to shore are partially offset by the higher and longer period waves which influence the bottom at greater depths. The placement of larger items on slope areas is also limited since even large steel ships have moved more than a half mile off permit positions in these conditions.

Transportation Limitations. The high cost of transporting available materials to shore-based staging areas and then to offshore reef sites has been a limiting factor for many reef projects. Transportation of materials is generally the most expensive aspect of reef construction; these costs have increased dramatically during the past ten years. Barges equipped with cranes, bulldozers, and other heavy equipment are costly

to lease; alternately, they are expensive to operate and maintain. In many areas, they are not readily available. Obsolete offshore petroleum platforms, which on several recent occasions have been cut off below the bottom, hoisted and moved, and reinstalled as artificial reefs, are especially expensive to transport.

Recent Developments in Reef Technology

New Technology

To identify artificial reef technology and methodologies with the potential to improve American reef siting and construction efforts, Aquabio examined alternate approaches which have been developed and used successfully by other countries with major reef programs, such as Japan, Taiwan, and Australia. These investigations focused in depth on Japan, which has invested substantially in the research, development, testing, and evaluation of designed reef technology and has implemented what is indisputably the most successful and extensive artificial reef program in the world.

Because of a greater dependence on the sea as a source of food, the approach to reef construction is quite different in Japan and other areas of East Asia from that in the U.S. In these areas, artificial reefs are primarily used for enhancing commercial fishing and are usually constructed from prefabricated designed units, which offer a number of advantages over scrap material or rock reefs. The flexibility inherent in a designed structure permits the fabrication of units which are more effective, stable, and permanent. Additionally, designed structures can incorporate features or aspects known to be important to the target species or reef objective, and can be reliably sited on the basis of known stability criteria. In particular, the artificial reef technology developed in Japan has resulted in numerous new designs, improved siting and placement methods, and a broader, more integrated approach to fisheries enhancement and reef management which facilitates the most effective use of available resources.

Artificial Reef Development in Japan

Like American artificial reef programs, early Japanese reef construction efforts utilized natural materials such as rocks and wood as well as scrap items such as tires, cars, and ships. However, the Japanese quickly recognized the limitations of these materials and determined that designed reef units were more cost-effective over the long term. When they first implemented a national artificial reef plan in the early 1950's, the Japanese government decided to encourage the development and application of the best technology by subsidizing only those reef projects using manufactured units, a policy which has been continued to the present time.

The first generation of Japanese designed reef units consisted of relatively small hollow concrete cubes and cylinders cast in one piece with open areas or "windows" in the sides. Most measured about 1-2 meters per side or in diameter. They were dropped or pushed off the side of boats to form piles to attract fish. One variety of these earlier units, known as the "pill box" design, was tested in the U.S. during the early 1960's and proved to be quite effective and permanent when properly sited and placed. In a study conducted in California in 1963 to compare these units with quarry rock, car bodies, and streetcars, the Japanese-style units proved to be the most effective of the materials for concentrating and attracting fish.[2]

Japanese field and laboratory studies conducted during this period indicated the desirability of producing larger, higher-profile units with more open space, which would function to attract midwater fish as well as bottom species. It was also determined that a number of different designs suitable for various oceanographic conditions and types of fish and shellfish would be needed to develop more fully Japan's coastal resources.

The impetus for developing a second generation of designed units incorporating these characteristics came in the early 1970's when the combined impacts of the 1973 oil shortage and the implementation of 200 mile extended jurisdiction statutes by a number of countries severely impacted Japan's distant water fisheries. In addition, the cumulative effects of coastal development, pollution, and overfishing for premium species had reduced coastal fisheries and aquacultural production. To help accomplish the intensive rehabilitation and development of coastal resources necessary for meeting current and future seafood requirements, a nationally coordinated effort to improve artificial reef technology was launched.

The wide variety of prefabricated reef units and other enhancement devices developed as a result of this effort are now used to promote capture fisheries, extensive aquaculture, and habitat rehabilitation throughout the coastal areas of Japan. Although most are fabricated from reinforced or prestressed concrete, some are composed of other materials such as fiberglass-reinforced plastic (FRP). Rather than attempting to copy the complexities and surfaces of natural reefs, which result from geological or biological processes and do not reflect an attempt by nature to optimize habitat for fish or shellfish, the current approach to reef design, fabrication, and siting is to create, in a cost-effective manner, those habitat factors which are important in attracting and retaining desired species or communities. Many of the units are designed for specific site conditions, fishing methods, target species, or life cycle stages. To be eligible for use in government-funded projects, new units must undergo extensive testing and evaluation to demonstrate their effectiveness, stability, non-toxicity, and durability; a minimum useful (without structural degradation) life span of 30 years in salt water is mandatory.

Testing and Evaluation in the United States

Based on Aquabio's investigations of Japanese reef technology, we determined that it offered excellent potential for adaptation and use in American fisheries development. We identified specific aspects which could help design, siting, and placement problems encountered in American reef programs, as well as expand the traditional range and scope of applications for reefs in this country. Transfer of this technology would enable U.S. reef construction efforts to benefit from the results of the considerable investment in research and development already made by the Japanese. To test this approach and evaluate its results, we selected several types of Japanese units for field studies in the U.S.

When screening units during the selection process, we assessed current and future American needs for reef applications and gave particular attention to those with the greatest requirement for prefabricated designed units. Specific criteria for screening the units included: effectiveness for target species, stability, design flexibility, material/site compatability, long term cost-effectiveness, and adaptability for use in current American reef construction efforts.

For initial testing and evaluation, we chose units composed of cylinders fabricated from bands of FRP as being especially suited to American needs, conditions, and applications. These units are extremely flexible in terms of design, size, and configuration, and can be readily adapted to the different oceanographic conditions and target species found in U.S. waters. They are relatively easy to construct and can be placed without the expensive floating cranes and/or barges necessary to install most other types of designed Japanese reefs and American scrap material reefs. In Japan, the basic components are generally

produced at a centralized location and can be readily and economically shipped by any available mode of transport.

Testing began in August 1981 with the construction and placement of these units at three sites (depths 15-25 m) along the Gulf and Atlantic coasts of Florida. The units which we constructed ranged in size from two to ten cylinders, using cylinders approximately 1 m in diameter and 5 m in length. (Figure 1.) Because one purpose of the project was to compare the Japanese prefabricated designed reefs with typical American scrap material reefs, a concrete culvert reef with approximately the same void volume as the designed units was built at each site. A control area with similar characteristics was also identified in the vicinity of each site.

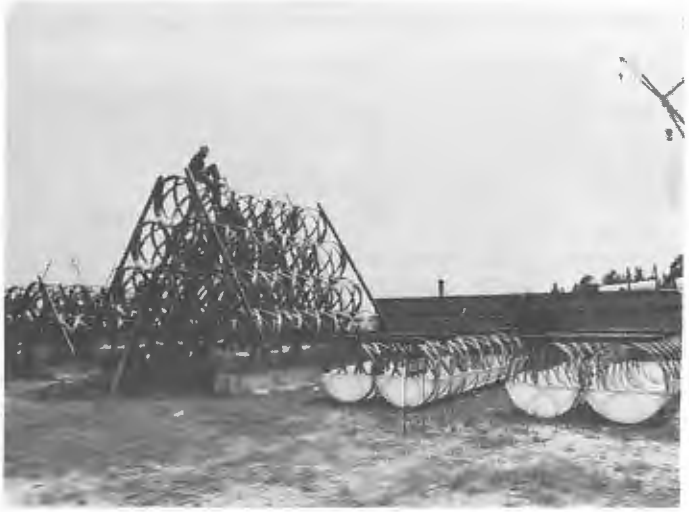

Figure 1. Several Configurations of FRP Units Constructed in Jacksonville, Florida.

All necessary components for the FRP reefs were shipped from Japan and assembled dockside in the vicinity of each site. Although construction of the units was not difficult, it did require careful supervision and quality control. Cylinders, guard bars, and other components were placed in position on stands, temporarily secured, and all connections were then fiberglassed together using special equipment developed for this purpose. Fabric bags attached to appropriate bottom cylinders were used for casting concrete ballast, with the number of cylinders to be ballasted and the amount of ballast per cylinder adjusted according to the unit configuration and site-specific conditions. Anchor piles were placed in the bottom cylinders of some of the units before the concrete was poured to help ensure stability.

Reusuable air bags which permit the units to be floated and towed to the placement site were inserted into the appropriate lower cylinders, inflated, and inspected. Tow lines were secured prior to the units being put into the water. Although a relatively small 5-ton vessel can tow units in tandem to site, larger vessels were used in Florida to accommodate observers. After being towed to the permitted sites (5-20 miles offshore), the reef units were detached, maneuvered into final position, anchored, and oriented. (Figure 2.) The airbags were vented, causing the reefs to sink in place, and lines and airbags were recovered for reuse. Divers immediately inspected the units and reported that no damage had occurred from impact on the bottom or other causes.

Research surveys on the FRP and culvert reefs and control sites have been made very 2-4 months, depending on weather conditions. Diver transect counts, cine transects, gill nets, fish traps, angling, and still and time-lapse photography have been used to assess fish utilization of the reefs. Epibenthic samples from reef substrates and benthic samples from reef and control areas have also been taken during most surveys.

Figure 2. FRP Unit with Airbag Flotation System Maneuvered into Final Position off Panama City, Florida.

Results

Preliminary analysis of the survey data from the first 18 months indicates that the FRP reefs at each site appear to attract and retain a significantly greater total abundance and diversity of fish, and have much richer epibenthic communities than the culvert reefs. Although both types of reefs have been stable, there has been some subsidence of the culvert reefs at two of the sites.

In particular, the FRP reefs have been more effective for larger midwater predators such as the greater amberjack (Seriola dumerili) and king mackerel (Scomberomorus cavalla), and seem to have a greater abundance of the bait fish and juveniles commonly found in the stomach contents of the predator species. Other species, such as the sheepshead (Archosargus probatocephalus) and spadefish (Chaetodipterus faber), which feed directly on the reef epibenthos also appear in greater numbers on the FRP reefs. Typical reef fish such as the black grouper (Mycteroperca bonaci) and red snapper (Lutjanus campechanus) are also more abundant on the FRP reefs, but the degree of this greater abundance varies with the site, season, and distribution of the culvert on the bottom as well as with the fishing pressure, which has been significantly greater on the FRP reefs.

The results of our research to date strongly suggest that these FRP units are very effective and can be used to improve habitat characteristics and fishing opportunities in the U.S. Although prefabricated designed reefs may not be suited for all situations and circumstances, the results of our investigations suggest that they offer significant advantages in many areas and are especially suitable for some of the new applications developing for artificial reefs in the U.S. When long-term benefits and costs are calculated, designed units may be considerably more cost-effective in many cases than scrap material reefs.

Expanded Applications

The design flexibility, effectiveness, stability, and permanence of prefabricated designed units increases the range of potential sites and expands the possible applications for artificial reefs in the United States. Because of the extensive engineering and fisheries research, development, testing, and evaluation already conducted in Japan and other East Asian countries,

American fisheries can readily benefit from this technology.

Prefabricated designed units such as those tested in Florida can be used to extend the range of potential reef sites for recreational fishing in a variety of ways. For example, these units and their improved siting methodologies are particularly suited for near-shore areas with high energy conditions, limited available space, or other special requirements. Since these areas are also subjected to very heavy fishing pressure due to their accessability to a large number of anglers, installation of designed units could be expected to result in a rapid return on investment. Designed units can also be effectively used in conjunction with fishing piers and barges to provide improved opportunities to non-boating anglers.

In addition to their traditional function in the U.S. of improving recreational fishing opportunities, designed units can be used to expand the role of artificial reefs in marine mitigation/compensation, extensive aquaculture, commercial fishing, and fisheries resource management. Because the design flexibility of prefabricated units allows reefs constructed from them to be optimized in terms of siting, configuration, aspect ratio, and overall effectiveness, they are particularly suited for applications such as these which have long-term maximum effectiveness as their objective.

Mitigation/Compensation. Perhaps the most immediate application for designed reef technology in the U.S. will be in efforts to mitigate or compensate for the loss or degradation of aquatic habitat due to coastal development, pollution, land reclamation, dredging, or other activities which adversely affect the aquatic environment. Since these activities often result in a permanent loss or long-term degradation of habitat and frequently occur in areas which are important fishing grounds, nursery or spawning areas, or migratory paths, it is important that the best available technology be used to help compensate or mitigate these activities. The materials used for mitigation/compensation efforts should last as long as the impact for which they are mitigating or compensating. Because designed reefs are generally more effective per unit bottom area, have a greater range of potential sites, and are more permanent than most scrap material reefs, they can be effectively used for this purpose. Ideally, planning for such work should be considered in the initial phases of planning major coastal projects when applicable. The cost of mitigation or compensation may influence the selection of sites or construction methods.

Extensive Aquaculture. Designed reefs and other forms of habitat improvement are often used quite successfully in conjunction with stocking programs in East Asia. Some experimental work in the U.S. has already indicated the possibilities of using this approach with abalone and the northern lobster; this application could be expanded to include a number of fish species. Integration of hatcheries with habitat improvement has proven to be a cost-effective approach for selected species in Japan.

Commercial Fishing. Prefabricated designed reefs and related materials can be a cost-effective means of improving commercial fishing for selected species of fish and shellfish. They can serve to improve catch-per-unit-effort, reduce fuel consumption, and facilitate the use of less energy-intensive fishing methods. In Japan and Taiwan (Republic of China) where artificial reefs are used extensively for commercial fishing, the return on investment (calculated in terms of the value of fish landed) generally occurs in one to five years for a properly sited reef.

Since many commercially-important species in the U.S. spend part of their juvenile or reproductive periods in estuaries, bays, and shallow coastal areas, reefs can also be used to protect, expand, or create new nursery and spawning areas to help ensure continued harvests.

Fisheries and Environmental Resource Management. In addition to directly functional roles, artificial reefs can be used as an effective fisheries or resource management tool. As a management tool, reefs can be used to enhance the environment for desired species, attract fish to more suitable or accessable areas, conserve resources, and help to partition or spread out fishing activities to reduce conflects among competing user groups.

Artificial reefs are certainly not a cure-all for all coastal or environmental problems, and this approach must be carefully integrated with other methods to provide rational resource management. However, designed reefs can be a useful tool with which to provide excellent, reliable, and predictable enhancement, and should be considered in comprehensive coastal planning.

Conclusion

The results of our work with artificial reefs to date strongly suggest that when long-term fisheries or environmental benefits are the primary objective of an artificial reef project, prefabricated designed units should be considered since they can be more effective for desired species, stable, and permanent than typical scrap material reefs. The Japanese FRP units selected for our initial research in Florida have been very successful and are especially suited for American reef construction situations due to their design flexibility and ease of erection and placement. The use of these and other designed structures will permit an expansion of artificial reef applications to include mitigation/compensation, extensive aquaculture, and commercial fishing. Designed units should be given special consideration where available space is limited, special oceanographic or substrate conditions exist, intense fishing pressure is anticipated, and/or the best available technology is required.

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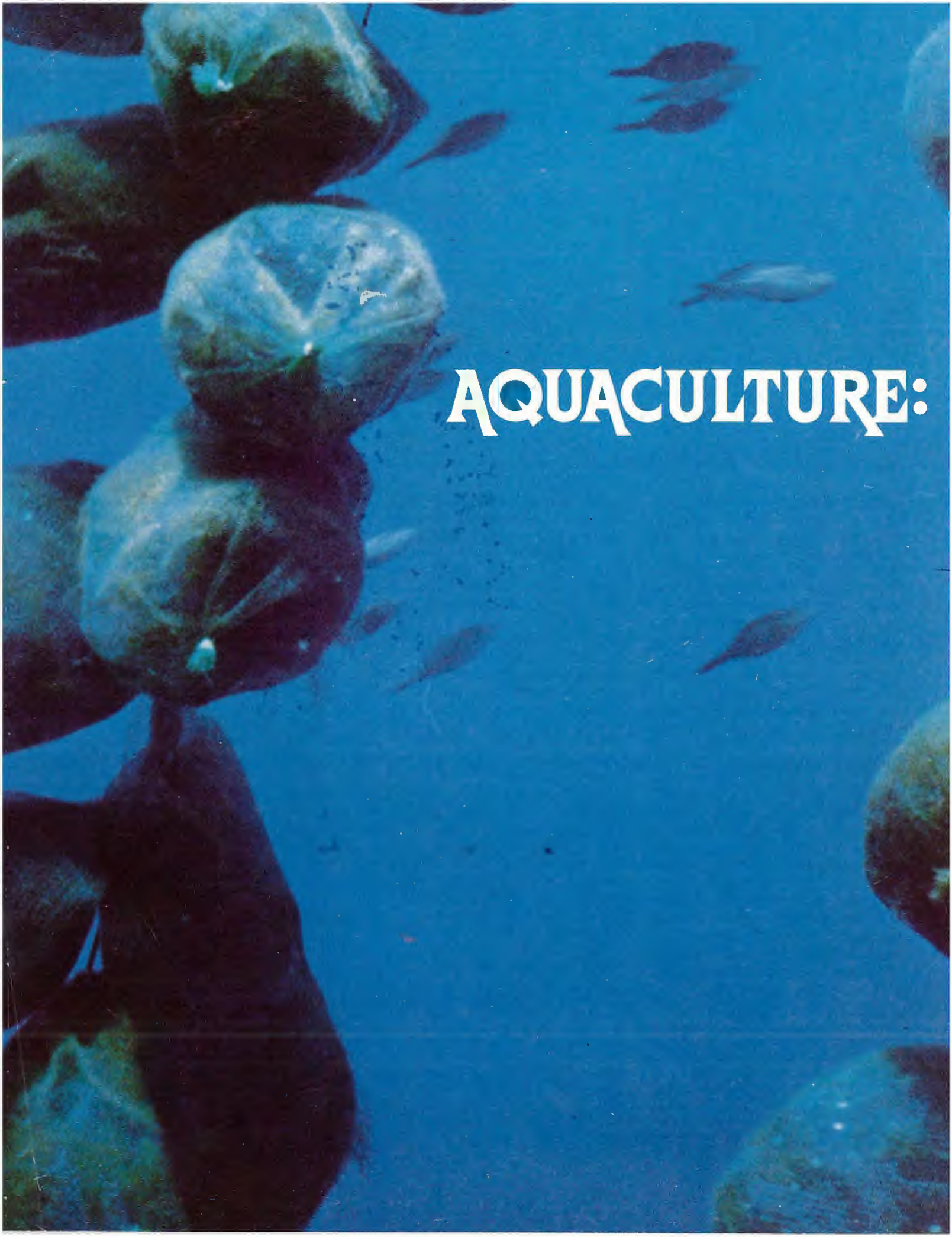

AQUACULTURE:

Developments in East Asia

by Daniel J. Sheehy and Susan F. Vik

Beneath the surface of coastal and inland waters throughout East Asia thrives an increasingly important and rapidly growing industry that contributes significantly to the region's food resources. In some areas, colorful floats mark the mass production of oysters and scallops. In others, abalone are spawned according to precisely calculated timetables. In still other areas, computerized monitoring makes the most efficient use of aquatic resources.

Recent advances in engineering, biology, and management have transformed traditional aquaculture into a complex industry capable of supplying an expanding variety and volume of marine products. At the forefront of aquacultural development in East Asia are Japan, the Republic of Korea, and Taiwan.

Aquaculture has a long history in East Asia. Carp culture is believed to have begun in China more than 3500 years ago and to have become a popular practice by about 1000 B.C. Until recently, however, several major problems inhibited growth: the need to ensure availability of a stable supply of seed organisms, to expand areas suitable for cultivation, to cultivate new species, and to solve disease and nutrition problems.

Although progress toward resolving some of these problems began as early as the 1950s, the rapid technological advances of recent years were stimulated during the early 1970s by two events—the oil crisis and the adoption by many countries of 200-mile extended jurisdiction statutes—which affected the distant-water fisheries of Japan, the Republic of Korea, and Taiwan. Because of their dense populations and relatively limited agricultural land, there countries have traditionally relied upon the sea for a significant portion of their animal protein. The Japanese, for example, obtain more than half their supply of animal protein from the sea and have the highest annual per capita consumption of fish and shellfish in the world—165 pounds per person. Each of these countries developed a large deep-sea fishing fleet to feed its population and provide revenue through export of surplus catch or selected high value species. Rising costs and decreasing availability of distant-water fishing opportunities resulted in an urgent need to increase the productivity of coastal and inshore waters.

Current biological research and engineering developments have begun to solve a number of the problems that formerly inhibited aquaculture. For example, reliable methods of artificially spawning abalone and prawns have been established. The efficiency and effectiveness of collecting scallop spat have also been greatly improved. Continuing biological research has brought additional species from experimental to production stages. Culture techniques for abalone, eels, prawns, mullet, and sea bream have advanced rapidly through applications of this research.

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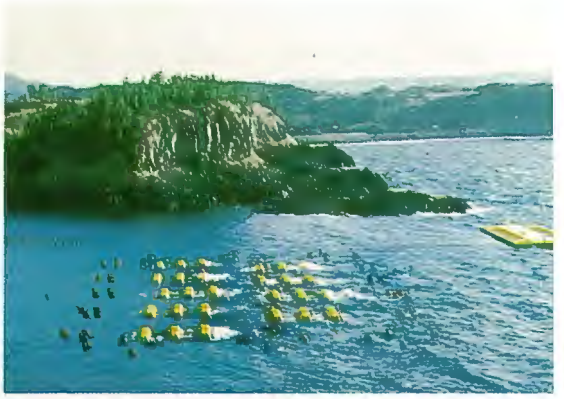
Mesh bags collect scallop spat for culture off Hokkaido, Japan. (Photos courtesy of Aquabio, Inc., unless otherwise noted.)

Large tetrapod breakwater used to create sheltered culture areas.
(Photo courtesy of Nippon Tetrapod Co., Ltd.)



Floating breakwater used to develop a culture area in the outfall of a nuclear power plant in southern Japan.

Engineers have expanded the areas suitable for aquaculture by developing deep water longline culture methods for scallops and oysters and artificial nurseries for abalone and shrimp. Projects to construct breakwaters and improve water exchange through channel modifications have also contributed to making new areas available. Improved pollution control methods have helped to restore areas previously unsuitable for culture.

In addition, improved mass culture methods for efficient food organisms such as chorella and rotifers have helped reduce hatchery costs. Better techniques for monitoring and treating disease have also made such ventures less risky, and insurance coverage is now available for a broader range of projects. Although problem areas still exist, they are yielding to intensive research.

A wide variety of methods is used to culture the principal marine species in Japan, Korea, and Taiwan. Sessile organisms such as bivalve mollusks (oysters, clams, scallops) are cultured on the ocean bottom, on sticks or racks fixed in intertidal areas, or from rafts or longlines anchored in deeper water. The current longline method uses either surface or midwater floats and greatly extends the areas under cultivation by making full use of the water column as well as by opening areas which are either too deep or too exposed for other culture methods. The more mobile species of fish and crustaceans (prawns or shrimp) are cultured in ponds or tanks, floating cages, or pens usually located in embayments or protected areas. Some mobile species such as salmon and abalone, as well as shrimp and other fish, are also stocked in open areas and eventually captured by traditional coastal fishing methods. This technique, known as ocean ranching or extensive culture, is expanding, especially in Japan where an integrated program of stocking, habitat improvement, and close management has led to rapid progress in productivity and cost-effectiveness.

The expanding aquacultural industries in Japan, Taiwan, and Korea are supported by private, university, and government research. Although location and technology transfer have engendered similarities among their aquacultural programs in terms of species cultured and techniques used, there are also differences arising from local customs, marketing channels, and economic conditions. The objective also varies between and within countries; it may be to provide a premium product for the domestic market, an inexpensive staple for domestic consumption, or a product for the foreign market. Objectives are changing as the countries' economies continue to expand, especially in Taiwan and Korea where domestic demand for premium species or sizes is growing and less are being exported to Japan, Hong Kong, or the United States.

Abalone hatchery in Chiba Prefecture. Juvenile abalone are reared to stocking size in outside tanks.

JAPAN

The principal marine species cultivated in Japan for consumption are yellowtail; Kuruma prawn; Japanese oysters; scallops; sea bream; and three algae, Nori, Wakame, and Konbu. A large volume of pearl oysters is also cultured, but they are not used for food.

Earlier aquacultural work in Japan concentrated on the basic reproductive biology of the important species and the development of hatcheries for the mass culture of juveniles. Although this work was generally successful, the cost-effectiveness of the stocking programs came into question because the fate of stocked juveniles was quite variable. Efforts to expand basic ecological knowledge have improved stocking strategies that have increased the return when used in ocean ranching.

The current aquacultural program has developed into an integrated effort that includes intensive pond, cage, pen, raft, and longline culture. In addition, ocean ranching has been expanded to include both stocking and habitat improvement.

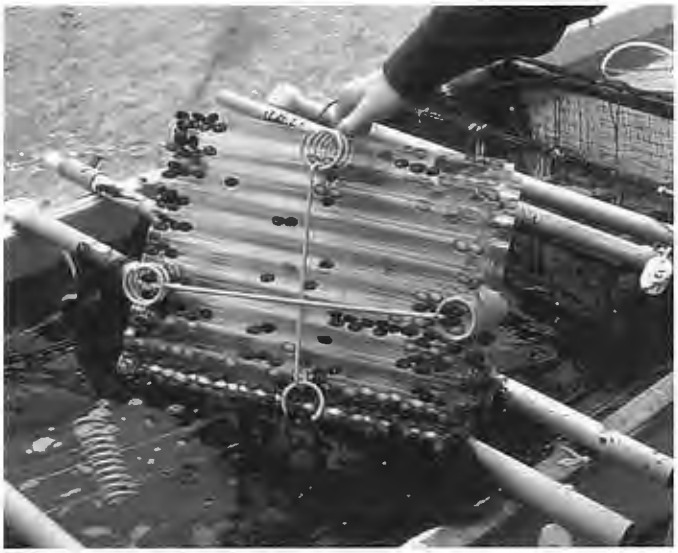
A variety of engineering projects has also contributed to the current efforts to improve the culture grounds. These projects include the development of traditional and floating breakwaters to create protected areas for culture, special tidewater stocking areas for Kuruma prawn, and special nursery grounds for a variety of fish and shellfish. In addition, the carrying capacity of several areas has been increased by the creation or enlargement of channels to improve flow conditions.

ABALONE

Abalone is a high-value species cultivated for domestic consumption in Japan. Great technological progress occurred during the past decade when earlier biological studies on abalone spawning and larval development combined with breakthroughs in controlled methods of artificial spawning to pave the way for the current development of this premium marine resource. Abalone culture is now conducted through a highly integrated, comprehensive program combining hatcheries, stocking, habitat improvement, and resource management.

Artificial spawning techniques were developed after Japanese researchers discovered that water passed through ultraviolet sterilizers served to stimulate preconditioned abalone to spawn. By using this technique, hatcheries can

RIGHT: *Cultured abalone at Mohne Bay, Japan. Abalone feed on diatoms and algae which grow on the plastic plates.*



LEFT: Thermal culture of ayu in Omura, Japan. Warm water is used to increase growth rates and maintain species beyond normal season. Here, water from a conventional power plant is used.

induce mass spawning under artificial conditions. Production volume and scheduling can now be controlled to maximize the capacity of hatchery facilities.

Over 30 abalone hatcheries are currently in operation in Japan, and a number of these produce more than a million 20 to 30-mm. juveniles annually for stocking. To increase production efficiency, several of these hatcheries use thermal effluent water from conventional and nuclear power plants; this use not only produces a greater number of abalone per year but also turns a potential environmental liability into an asset. A hatchery in Hokkaido actually uses geothermal warm water passed through a heat exchanger to increase the growth rate of spawned abalone.

Earlier efforts to stock juvenile abalone were aimed primarily at conserving the resource, which was subject to heavy fishing pressure. Because of the relatively abundant supply of juveniles now available, an extensive ocean ranching program has been put into effect. Juvenile abalone are sold to local fishermen for stocking, generally in areas controlled by a fishermen's cooperative which regulates fishing and access to the ground. Initially, stocking efforts were successful in some places, but it quickly became apparent that the availability of shelter and food limited the carrying capacity of many locations and that even in some natural nursery areas juvenile mortality was increased by wave conditions. A program to improve abalone habitat for both stocked and naturally spawned juveniles as well as adult populations has been undertaken. Today, a wide variety of artificial reefs and other structures specially designed to provide shelter have been installed to promote food growth and stabilize the natural environment. (*See Dr. Sheehy's "Fisheries Development: Japan," in the Winter 1979–1980 issue of* Water Spectrum.)

One of the most ambitious of these habitat improvement projects involves using an integrated resource management approach to convert "marine deserts," barren areas along the coast capable of supporting only sparse communities, into more productive areas. Biologists have identified several factors which cause these marine deserts: colonization by (calcareous) algae, heavy wave action on the rock substrate, and intense grazing pressure by herbivores such as sea urchin. The result of these conditions is a reduction of the standing stock of macroalgae essential for maintaining abundant abalone populations. The Tohoku Regional Lab has initiated a special type of off-the-bottom longline culture of *Laminaria* (Konbu) to re-establish macroalgal populations in areas depleted by sea urchins. This technique protects the parent plants and has led to repopulation of the areas. By carefully managing both the sea urchin and abalone populations through control of fishing activities, biologists converted the marine deserts into productive areas.

A distinctive color variation present on the shells of hatchery-raised abalone but absent on those naturally spawned allows the survival rate of stocked juveniles to be determined with considerable accuracy. It has risen to over 40 percent in some areas. Because

Artificial reef for abalone used to expand habitat and create nursery areas. (Photo courtesy of Asahi Chemical Industry Co., Ltd.)

Dr. O. Sato of Hokkaido University inspects net cages suspended from longlines. (Photo courtesy of Dr. Sato.)

of this high rate of success, the habitat improvement program for abalone has been expanded.

SCALLOPS

Scallop culture has made remarkable progress in Japan since the mid-1960s. The development of new techniques for collecting seed scallops and the implementation of hanging culture methods have been responsible, in part, for almost doubling the world production of scallops. Current Japanese production exceeds 100,000 tons, of which more than half can be attributed to new culture techniques.

Earlier scallop culture efforts were generally limited to collecting and transplanting scallops from one area to another for restoration or development of new beds by means of bottom culture. In several areas off Hokkaido, for example, stocks had declined from overfishing and starfish predation, and new management methods were instituted. An integrated program to remove starfish, stock more than 10 million seedlings, and ensure through monitoring that enough adults remained to sustain the population restored the fishery to a productive level. In bottom culture, however, production is limited by the amount of suitable bottom available.

The use of hanging culture techniques, in which a series of net baskets is suspended well below the water surface, has permitted a rapid expansion in production. The limits to production are spat availability, water conditions, and legal restrictions based upon estimates of local carrying capacity. By taking advantage of the three-dimensional properties of the water column, hanging culture uses available resources efficiently. Engineering research has resulted in stabler, more wave-resistant longlines which serve to expand offshore the areas suitable for culture. When used in deep water, the hanging culture system has few surface floats to interfere with navigation and does not conflict with other water uses.

The general culture technique currently in practice involves the use of small synthetic bags with small sections of fishing net to collect naturally spawned scallop spat as they settle from their planktonic state during the spring. The seed scallops thus collected are reared in these suspended bags to an intermediate size of three to six centimeters, and then either are released at appropriate bottom sites for eventual harvest by trawlers or are hung in cages or on strings where they are grown to market size.

Scallop culture is practiced primarily off Hokkaido and Aomori and along the northeast coast of Iwate. Very dense culture occurs in Mutsu Bay, Aomori, where virtually all of the scallop catch is attributed to hanging or bottom culture. This bay is an ideal natural collecting area for spat and has an estimated water turnover time of 100 days. On occasion, very large concentrations of natural spat can be collected; these are used as seed to support both local and distant culture programs. Seed from a scallop (*Patinopectin yessoenis*) prevalent in Aomori are collected and used in hanging culture projects in areas beyond that scallop's natural range.

Hokkaido fishermen place scallops in culture cages.

Remote environmental data collection buoys monitor the area and provide daily information on temperature, salinity, dissolved oxygen, and current direction and speed. These data are processed through a computer base station and are used to help predict scallop spat collection times as well as to provide early warning of critical conditions that could affect production.

Despite rapid increases in production, the scallop culture industry in Japan has also experienced severe problems from shellfish poisoning, high density culture conditions, and other factors not yet clearly identified. At times, losses in some areas have reached almost 100 percent, and fishermen have suffered accordingly. However, the establishment of density limitations, improved handling and seed selection, and closer inspection of scallops before shipment has helped reduce these problems.

REPUBLIC OF KOREA

Korean aquacultural production has been growing steadily and has risen from about 40,000 metric tons in 1962 to over 350,000 in 1975. The 1975 figure accounts for about 17 percent of Korea's total fisheries production and about 8 percent of its total fisheries exports. Aquacultural production plays an increasingly important role in the economy.

Of Korea's approximately 103,000 hectares of tidal and coastal area suitable for aquaculture, more than 45,000 are currently in use. The main species cultured in Korea are oysters, hard clams (*Meretrix*), cockles and ark shells (*Anadara*), and a variety of edible seaweeds (Laver and Dulse).

The Korean government has made substantial investments to promote aquacultural research, improve management methods, and develop long range plans to ensure continued success and expansion.

Harvesting oysters in Chungmu. Note string of oysters at left.

Hanging oyster culture area in Chungmu, Korea.

OYSTERS

Oysters (*Crassotrea gigas*) have generally been the most important aquacultural product in Korea in terms of volume and value. The major portion of oyster culture activities occurs in the Chungmu area where about 15,000 metric tons are produced annually, principally for export in canned form to the United States and Canada, in dried form to Hong Kong, and live or frozen to Japan. More than 2100 hectares are under cultivation, primarily with longline techniques that provide a yield of over seven metric tons per hectare.

The longline techniques currently in use have been developed from earlier culture methods, including sticks stuck into the bottom to collect spat and wooden frames restricted to use in shallow water. Raft culture methods greatly increased the potential culture area but were limited to use in protected locations. Longline methods, which weather storms better, have permitted further expansion of the grounds.

Although the program in Chungmu is considered quite successful, some significant problems have arisen. Some of the fishermen who now operate longer vessels wash oysters on site before transferring them to processing plants. Pollution has resulted, and the local fisheries research and development agency has stressed the need to wash at the processing plant where settling ponds prevent pollution. It is also believed that the Chungmu area has almost reached its carrying capacity and that current densities may already be too high for optimum growth.

Several natural problems are also associated with high density culture, among them oyster drill disease and red tides. The oyster drill disease can now be controlled by submerging the oysters in 50-degree Celsius water for five minutes. Red tide, occurring mainly during the spring and summer, has been more difficult. Despite good circulation in the Chungmu area, red tide has become a regular problem; in 1973, almost 80 percent of the harvest was lost. Red tide prediction and monitoring are high priority items in the current research program.

To ensure quality products, especially for the expanding export market, oyster sanitation is important. Bacterial levels in the oysters, water, and sediment are monitored at least monthly at more than 32 sampling stations to make sure that conditions are within the range of acceptable sanitation limits.

Small boat pushes a net used to collect milkfish fry off the coast of southern Taiwan.

Milkfish culture pond with a small enclosed area in which fry adjust to conditions before entering main pond.

TAIWAN

Taiwan's involvement with aquaculture dates back to early mainland Chinese work. During the last 20 years, Taiwan had made rapid progress by updating earlier culture methods, adding new species (both endemic and foreign), and applying the results of research to increase production levels.

Aquaculture accounts for about 16 percent of Taiwan's fisheries production. Principal species cultured include milkfish, carp, tilapia, oysters, eels, clams, mullet, and prawns. Taiwan realizes very high yields per acre of harvest from the application of polyculture methods and good management techniques. Recent advances have been made in the production of mullet, freshwater prawns (*Macrobrachium*), and saltwater prawns (*Penaeus*); new developments in open sea culture of abalone are in progress.

MILKFISH

Milkfish has traditionally been Taiwan's top aquacultural product in terms of total weight and is second in value only to eels. Its primary use is as a moderately priced staple for domestic consumption. Although Taiwan has a three month winter period during which milkfish do not grow and it generally has smaller farms than in the Philippines and Indonesia, it has a higher production per hectare, ranging up to 2500–3000 kilograms per year, than the others.

Principally a herbivorous marine species, the milkfish is generally cultured in brackish and freshwater ponds where it feeds on diatoms and algae growing on the pond bottoms. The fishery still depends upon wild fry collected along the coast with hand or small boat nets and then stocked into ponds ranging from one to six hectares in area. Water depth varies according to the size of the fish and ranges from six inches to four feet.

The ponds are carefully managed to ensure optimum conditions. The management process includes annual drying, fertilizing, liming, and treatments to eliminate insect larvae and pest fish. Water flow and salinity are carefully regulated. Stocking levels depend upon the amount of benthic algae which can be supported.

Milkfish culture area in southern Taiwan.

Indoor tanks where larval prawns are reared.

Although milkfish culture continues to be successful in Taiwan and other areas off Southeast Asia, several problems have arisen to slow the growth in production. The main one stems from the dependence upon wild stocks of fry; their availability fluctuates and is at times unpredictable. Research aimed at closing the life cycle of the milkfish is underway at Tung Kang and other labs. Other problems concern the maintenance of appropriate pond salinity and food levels. Stocking densities are reaching the capacity of the ponds, and supplemental feeds may be required to increase stocking levels beyond those currently in use.

PRAWNS

Relatively recent developments in the artificial propagation of marine prawns in Taiwan have led to the very rapid development of the culture industry for these species. While prawns have been cultured for some time, earlier methods depended upon natural stocks of postlarval prawns introduced with pond water influx or collected along the coast in nets and stocked. Artificial propagation of grass prawn (*Penaeus monodon*) spawners was first achieved in 1968. This breakthrough has increased prawn production from 57 tons in 1967 to 3200 tons in 1979.

Over 200 private prawn hatcheries in Taiwan currently produce more than 300 million postlarvae per year. The scheduled availability of seed prawns has served to change the culture practice in most areas from extensive polyculture (with milkfish and crab) to intensive monoculture. The major problem now being researched concerns the cultivation of spawners (the current method uses collected spawners, which have greatly increased in value).

The grass prawn has a number of characteristics which make it particularly suitable for culture. With an average market size of over 100 grams, it is one of the largest penaeids. It is a hardy species, able to tolerate a wide range of water temperatures and salinities. It also grows quickly, feeds on both plant and animal matter, and does not require a sand bottom as does the Kuruma prawn (*Penaeus japonicus*).

Gravid females are brought to the hatchery and spawned. After hatching, the larvae are transferred to indoor tanks and fed a controlled diet, with the exact composition of the feed determined by the larval stage and the available food supplies. In about five days, they molt into the post-larval state and their diet is expanded. At about 20 days after metamorphosis, they are stocked into ponds and are grown to market size, generally around 40 grams. Two or three crops can be raised each year, depending upon location.

Although the current annual yield of 1000–1200 kilograms per hectare is considerably less than that in milkfish or polyculture projects, the high prices commanded by this species make its culture quite profitable. Planning is now under way in Taiwan to begin artificial seeding in coastal waters, as already practiced in Japan, to further increase production.

Prawn culture: earthen ponds with a centralized irrigation system.

Cultured prawns ready for the market.

AQUACULTURE AND THE WORLD FOOD SUPPLY

Aquaculture worldwide currently accounts for over six million metric tons, roughly 10 percent of the annual world fisheries production. Most informed predictions, such as those made by the United Nations Food and Agricultural Organization, estimate that the current production levels could be increased significantly by the end of this century. This would provide developing countries with a relatively inexpensive source of animal protein and income from the export of high value products to developed countries, which could also benefit by expanding their own aquacultural industries.

Heat exchanger used at a geothermal warm water abalone hatchery in Hokkaido, Japan. The warm water increases the growth rate of cultured abalone.

Women divers of Chejudo, Korea. In many areas of Japan and Korea, this is the method of abalone harvest.

The price of seafood products is rising rapidly, and the costs involved with traditional capture fisheries have also gone up as fuel, labor, and equipment costs increased while legal restrictions have limited access to many of the most productive grounds. In addition, current estimates suggest that the supply of fish from conventional sources is limited to about 150 million tons per year, of which about 40 percent is currently being harvested. As more fleets compete for a limited resource, the catch per vessel will decline.

These factors serve to make aquaculture, at least conceptually, a very appealing prospect. The peoples of East Asia have a long tradition in this area, and their well-organized and well-funded national research and development have contributed to the recent progress and have begun to stimulate growth elsewhere. In particular, Southeast Asia has, with the aid of technology transfer support from such agencies as the South East Asian Fisheries Development Center, quickly expanded and developed its own traditional aquacultural techniques.

Technology transfer of these methods could contribute to feeding the world's growing populations. However, introduced technology must be appropriate in terms of cultural, socioeconomic, and environmental conditions in the countries involved. At the present time in East Asia, an unusual mixture of twentieth century technology and traditional practices coexists in some aquacultural industries. Abalone culture in Japan, for example, combines the most modern hatchery practices of rearing abalone with harvesting methods which in many areas are almost the same as those in use for centuries.

The Chinese have an old saying: "If you give people fish, they will have fish for one day; if you teach people to raise fish, they will have food for a lifetime." Although many problem areas still must be resolved, the coordinated biological, engineering, and management efforts currently underway in Japan, Korea, and Taiwan hold promise for the future development of the aquacultural industry around the world. ■

This article is based on research trips to Japan sponsored by the Japan Society for the Promotion of Science, to Taiwan sponsored by the Institute of Zoology at the Academia Sinica, and to Korea assisted by the Fisheries Research and Development Agency. Dr. Sheehy expresses his deep gratitude to Dr. Takashi Ino of Japan, Dr. Kun-Hsuing Chang of Taiwan and Dr. Choong-Kyu Pyen of Korea, whose assistance made this research possible.

RPWG
AA

REVISED 6 April 1990
Draft Outline
EXXON VALDEZ OIL SPILL
RESTORATION PLANNING REPORT

I. Introduction

A. Purpose and goals of the restoration planning effort

B. Definition of restoration for this report (3 basic components)

C. Overview

1. The nature of the preliminary report based upon information available and presented at the restoration workshop.
2. Restoration alternatives that may be implemented at some point in time when damage assessment information becomes available
3. Workshop recommendations for potential 1990 restoration projects.
4. Organization of this report. Restoration alternatives for ecological, cultural, and recreational resources. Candidate 1990 demonstration projects.

II. Overview of Damage Assessment Information

A. Fate of the oil

B. General overview of effects (summary of taped sessions)

C. The need for additional damage asessment information in support of restoration efforts.

III. Development of Restoration Alternatives

A. Ecological Resources

1. Coastal Habitats
   a. State-of-the-art for Northern Latitudes
   b. Restoration alternatives

2. Fish and Shellfish
   a. State-of-the-art for Northern Latitudes
   b. Restoration alternatives

3. Birds
   a. State-of-the-art for Northern Latitudes
   b. Restoration alternatives

4. Mammals
   a. State-of-the art for Northern Latitudes
   b. Restoration alternatives

B. Cultural Resources (based on meeting content)

C. Recreational Resources (based on meeting content)

D. Synthesis of Restoration Options

1. Evaluation of interactions between restoration options proposed by work sessions. (Matrix presentation)
2. Discussion of pros and cons of presented restoration options.

IV. Potential Demonstration Projects (for each resource area)

A. Goal

B. Rationale

C. Approach

D. Preliminary Level of Effort

V. Literature Cited

Appendices

Agendas
List of participants by work session
Information sheets
Relevant literature
List of questions (6) to principal investigators

RPJ
3/30/90 AA

TECHNICAL WORKSHOP (1-A) ON RESTORATION ALTERNATIVES
1-A: ECOLOGICAL RESOURCES

April 3-4, 1990
(If necessary, workshop will continue April 5.)

PURPOSE:

To provide technical input to the decision-making process to enable scientifically valid decisions regarding restoration alternatives.

Following the workshop, information discussed will provide the basis for a written report. Note that outputs and objectives listed below refer only to the workshop itself.

OUTPUTS:

1. List of broad scientific guidelines suggested for use in selecting restoration alternatives.

2. Broadly-inclusive matrix of restoration alternatives that warrant further evaluation.

3. Information needs and/or feasibility studies which will be needed to evaluate candidate restoration alternatives.

OBJECTIVES:

1. Review initial damage assessment results with respect to potential restoration alternatives.

2. Describe the state of the art in restoration technology and the feasibility of applying these technologies to Prince William Sound and the Gulf of Alaska.

3. Develop broad scientific guidelines for evaluating restoration technologies.

4. Develop a broadly-inclusive matrix of restoration alternatives (including restoration, replacement, and acquisition of equivalent resources) that warrant further evaluation.

5. Based on broad scientific guidelines, identify information needs and/or feasibility studies necessary to evaluate candidate restoration alternatives.

3/30/90

PROPOSED DRAFT AGENDA

Tuesday, April 3

8:30 Restoration Planning Process
Expectations of Workshop

9:00 Fate and Status of Oil

9:30 Summary of Natural Resource Damage Assessment Results

12:00 Break for Lunch

1:00 Work Group Assignments —

1:30 Work Groups convene concurrently
(Coastal Habitat, Fish/Shellfish, Mammals, Birds)

Tasks:

Review state of the art in restoration technology and the feasibility of applying these technologies to Prince William Sound and the Gulf of Alaska.

Develop broad scientific guidelines for evaluating restoration alternatives.

Discuss initial damage assessment results with respect to potential restoration alternatives.

5:00 Break for Dinner

7:00 Session chairs meet to review progress and develop overall scientific guidelines which can be applied across all work groups.

3/30/90

Wednesday, April 4

8:00 Plenary Session: Summary of Day 1

8:30 Reconvene Work Groups

Task:

Develop broadly-inclusive matrix of restoration alternatives (including restoration, replacement, and acquisition of equivalent resources) that warrant further evaluation.

12:00 Break for Lunch

1:00 Reconvene Work Groups

Task:

Based on broad scientific guidelines, identify information needs and/or feasibility studies necessary to evaluate candidate restoration alternatives.

4:00 Plenary Session: Summary Reports

5:00 Break for Dinner

7:00 Session chairs meet to discuss work products

Thursday, April 5

8:30 If necessary, key individuals may meet to continue discussion of work products.

TECHNICAL WORKSHOP NO. 1-A 3-4 April 1990 (5th, if necessary)

GROUP (mark one): (A) Fish and Shellfish XX
Coastal Habitats/Air & Water
Mammals
Birds

(B) Cultural
Recreation

DRAFT

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: C. Meacham, ADFG

Group Chairman: B. Ross, USEPA

Principal Investigators: K. Hepler, ADFG
J. Hillsinger, ADFG
S. Sharr, ADFG
A. Wertheimer, NOAA
C. O'Clair, NOAA
H. Feder, UAF/ADFG

Peer Reviewers: P. Mundy, independent

"Outside" Experts: W. Barber, UAF

Agency Representatives:
D. McBride, ADFG
C. Manen, NOAA
G. Chapman, USEPA
?-B. Meehar, USFS
E. Wilson, USFWS

[03-29-90]

TECHNICAL WORKSHOP NO. 1-A 3-4 April 1990

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats/Air & Water XX
Mammals
Birds

(B) Cultural
Recreation

DRAFT

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: D. Gibbons, USFS

Group Chairman: F. Pillifant, ADNR

Principal Investigators: J. Lindstrom, ADEC
D. Wolfe, NOAA
S. Jewett, UAF
R. Highsmith, UAF-?
Schimel, ?
K. Sundberg, ADFG

Peer Reviewers: C. Peterson

"Outside" Experts: H. Sanders, Woods Hole
M. Foster, Moss Landing

Agency Representatives: L. Trasky, ADFG
A. Weiner, ADEC
___?___, ADNR
J. Clark, USEPA
J. Ford, USEP
___?___, USFS
___?___, NPS
R. Slothower, USFWS

[03-29-90]

TECHNICAL WORKSHOP NO. 1-A 3-4 April 1990 (5th, if necessary)

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats/Air & Water
Mammals XX
Birds

(B) Cultural
Recreation

DRAFT

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: R. Nowlin, ADFG

Group Chairman: R. Nowlin, ADFG

Principal Investigators: K. Frost,ADFG
?-W. Testa, UAF/ADFG
T. DeGange, USFWS
D. Burn, USFWS

Peer Reviewers: ?-D. Siniff, Univ. MN

"Outside" Experts: A. Johnson, retired USFWS

Agency Representatives: W. Regelin, ADFG
R. Gould, USFWS
?-J. Sease, NOAA
M. Habler, USEPA
M. Wheeler, ADEC

[03-29-90]

TECHNICAL WORKSHOP NO. 1-A 3-4 April 1990 (5th if necessary)

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats/Air & Water
Mammals
Birds XX

(B) Cultural
Recreation

DRAFT

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: K. Wohl/B. Leedy
USFWS

Group Chairman: S. Senner, ADFG

Principal Investigators: S. Patten, ADFG
L. Denlinger, USFWS
K. Oakley, USFWS
D. Irons, USFWS
K. Kuletz, USFWS
P. Schempf, USFWS (part-time)
D. Nysewander, USFWS "

Peer Reviewers: ?-M. Fry, UC-Davis

"Outside" Experts: N. Snyder, independent (AZ)
P. Mickelson, PWSC (Cordova)

Agency Representatives: T. Rothe or D. Rosenberg, ADFG
P. Gertler, USFWS
J. Parker, USFWS
A. Fairbrother, USEPA

[03-29-90]

TECHNICAL WORKSHOP (1-B) ON RESTORATION ALTERNATIVES
1-B: CULTURAL AND RECREATIONAL RESOURCES

3/30/90

April 5, 1990
(If necessary, workshop will continue April 6.)

PURPOSE:

To provide technical input to the decision-making process to enable scientifically valid decisions regarding restoration alternatives.

This workshop (1-B) closely parallels technical workshop 1-A (Ecological Resources). There are, however, important differences. Since there are almost no results to report from the formal Natural Resources Damage Assessment, information on damages will be largely anecdotal. Further, restoration of recreational resources does not require the same degree of technical considerations as restoration of ecological resources. As a result, primary emphasis here will be on development of a matrix of restoration alternatives and identifying information needed to evaluate those alternatives. Primary participants will be agency personnel with management responsibilities.

Following the workshop, information discussed will provide the basis for a written report. Note that outputs and objectives listed below refer only to the workshop itself.

OUTPUTS:

1. List of broad scientific guidelines suggested for use in selecting restoration alternatives.

2. Broadly-inclusive matrix of restoration alternatives that warrant further evaluation.

3. Information needs and/or feasibility studies which will be needed to evaluate candidate restoration alternatives.

OBJECTIVES:

1. Review initial damage assessment results with respect to potential restoration alternatives.

2. Describe the state of the art in restoration technology and the feasibility of applying these technologies to Prince William Sound and the Gulf of Alaska.

3. Develop broad scientific guidelines for evaluating restoration technologies.

4. Develop a broadly-inclusive matrix of restoration alternatives (including restoration, replacement, and acquisition of equivalent resources) that warrant further evaluation.

5. Based on broad scientific guidelines, identify information needs and/or feasibility studies necessary to evaluate candidate restoration alternatives.

3/30/90

PROPOSED DRAFT AGENDA

Thursday, April 5

8:30 Restoration Planning Process
Expectations of Workshop

9:00 Fate and Status of Oil

9:30 Summary of Site Damages

10:30 Work Group Assignments

11:00 Work Groups convene concurrently
(Cultural, Recreational)

Tasks:

Review state of the art in restoration technology and the feasibility of applying these tecnhologies to Prince William Sound and the western Gulf of Alaska.

Develop broad guidelines for evaluating restoration alternatives

12:00 Break for Lunch

1:00 Work Groups convene concurrently

Tasks:

Develop broadly-inclusive matrix of restoration alternatives (including restoration, replacement, and acquisition of equivalent resources) that warrant further evaluation.

Based on guidelines, identify information needs and/or feasibility studies necessary to evaluate candidate restoration alternatives.

4:00 Plenary Session: Summary Reports

5:00 Session chairs meet to discuss work products

Friday, April 6 (morning only)

8:30 If necessary, key individuals may meet to continue discussion of work products.

TECHNICAL WORKSHOP NO. 1

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats
Mammals
Birds

DRAFT

(B) Cultural XX
Recreation

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: R. Shaw, SHPO
?-Jean Schafe, NPS

[redacted]

Group Chairman: ____?____, DNR

Principal Investigators: none

Peer Reviewers: none

"Outside" Experts: R. Thorn, Univ. MS

Agency Representatives: C. Holmes, ADNR
T. Birkadal, NPS
J. Mattson, USFS
C. Diters, USFWS
J. Fall, ADFG (Subsistence Division)

[03-29-90]

TECHNICAL WORKSHOP NO. 1-B 5 April 1990

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats
Mammals
Birds

(B) Cultural
Recreation XX

DRAFT

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: Ann Castellino (sp.-?), NPS
A. Meiners, ADNR

Group Chairman: G. Ahlstrand or S. Rabinowitz, NPS

Principal Investigators: None

Peer Reviewers: None

"Outside" Experts: T. Gasbarro or A. Jubenville, UAF

Agency Representatives: ?-D. Patterson, FWS
A. Meiners, ADNR
K. Kurtz, USFS
J. Maxwell, ADFG
____?____, ADFG (someone from Sport Fish)

03-29-90 RPW6 AA

TECHNICAL WORKSHOP (1-A) ON RESTORATION ALTERNATIVES
April 3-4, 1990
(If necessary, workshop will continue the morning of April 5.)

PURPOSE:

To provide technical input to the decision-making process to enable scientifically valid decisions regarding restoration alternatives.

OUTPUTS:

1. List of broad scientific guidelines suggested for use in selecting restoration alternatives.

2. Broadly-inclusive matrix of restoration alternatives that warrant further evaluation.

3. Information needs and/or feasibility studies which will be needed to evaluate candidate restoration alternatives.

OBJECTIVES:

1. Review initial damage assessment results with respect to potential restoration alternatives.

2. Describe the state of the art in restoration technology and the feasibility of applying these technologies to Prince William Sound and the Gulf of Alaska.

3. Develop broad scientific guidelines for evaluating restoration technologies.

4. Develop a broadly-inclusive matrix of restoration alternatives (including restoration, replacement, and acquisition of equivalent resources) that warrant further evaluation.

5. Based on broad scientific guidelines, identify information needs and/or candidate feasibility studies necessary to evaluate candidate restoration alternatives.

PROPOSED DRAFT AGENDA

Tuesday, April 3

8:30 Restoration Planning Process
Expectations of Workshop

9:00 Spill Status

9:30 Summary of Natural Resource Damage Assessment Results

12:00 Break for Lunch

1:00 Work Group Assignments

1:30 Work Groups convene concurrently
(Coastal Habitat, Fish/Shellfish, Mammals, Birds)

Tasks:

Review state of the art in restoration technology and the feasibility of applying these technologies to Prince William Sound and the Gulf of Alaska.

Develop broad scientific guidelines for evaluating restoration alternatives.

Begin brainstorming of broadly-inclusive matrix of restoration alternatives (including restoration, replacement, and acquisition of equivalent resources) that warrant further evaluation.

5:00 Break for Dinner

7:00 Session chairs meet to review progress and develop overall scientific guidelines which can be applied across all work groups.

Wednesday, April 4

8:00 Plenary Session: Summary of Day 1 (Session chairs)

8:30 Reconvene Work Groups

Tasks:

Discuss initial damage assessment results with respect to potential restoration activities.

Continue development of broadly-inclusive matrix of restoration alternatives (including restoration, replacement, and acquisition of equivalent resources) that warrant further evaluation.

12:00 Break for Lunch

1:00 Reconvene Work Groups

Task:

Based on broad scientific guidelines, identify information needs and/or feasibility studies necessary to evaluate candidate restoration alternatives.

4:00 Plenary Session: Summary Reports

5:00 Break for dinner

7:00 Session chairs meet to discuss work products

Thursday, April 5

If necessary, continue work group sessions to finalize tasks.

RPWG
AA

Brian

Here is a broad brush of revised outline incorporating the framework suggested Wed. Give me a call with your initial comments. I'll fax to Hal Mon.

Can we get DA references. We can copy + return as needed.

Staying at the Voyager.
277-3501
Rm 306

I'll will probably be here tomorrow unless I can get an earlier flight.

RPWG
AA

RESTORATION PLANNING WORKSHOP
MASTER LIST

Birds

Lynn Denlinger, USFWS
Anne Fairbrother, USEPA
Paul Getler, USFWS
L. Hotchkiss, USFWS
Dave Irons, USFWS
Kathy Kuletz, USFWS
Bob Leedy, USFWS
Pete Mickelson, PWSC
Dave Nysewander, USFWS
Karen Oakley, USFWS
Jill Parker, USFWS
Sam Patten, ADFG
Tom Rothe, ADFG
Dan Rosenberg, ADFG
Phil Schempf, USFWS
Stan Senner, ADFG*
Noel Snyder, AZFG
Foster Stroup, Versar
Kent Wohl, USFWS

Coastal Habitat/Air & Water

Jim Clark, USEPA
Nancy Deshu, NPS
Jessie Ford, USEPA
Mike Foster, Moss Landing
Jeff Frithsen, Versar
Dave Gibbons, USFS*
Ray Highsmith, UAF
Hal Kibby, USEPA
Jon Lindstrom, ADEC
C. Peterson
Frankie Pillifant, ADNR
Howard Sanders, WHOI
Roger Slothower, USFWS
Kim Sundberg, ADFG
Lance Trasky, ADFG
Art Weiner, ADEC
Doug Wolfe, NOAA

Cultural

Ted Birkadal, NPS
Chuck Diters, USFWS
James Fall, ADFG
C. Holmes, ADNR
J. Mattson,
Frankie Pilifant, ADNR*
Robert Shaw, SHPO
Robert Thorne, Univ. MS
Priscilla Wohl, ADNR*
David Yesner, UAA

Fish and Shellfish

Will Barber, UAF
Ross Cavanaugh, NPS
Gary Chapman, USEPA
K. Hepler, ADFG
John Hillsinger, ADFG
Carol Ann Manen, NOAA
Douglas McBride, ADFG
Chuck Meacham, ADFG
B. Meehar, USFS
Charles O'Clair, UAF/ADFG
Brian Ross, USEPA*
Sam Sharr, ADFG
Daniel Sheehy, Versar
Usha Varanasi, NOAA
Alex Wertheimer, NOAA
Everett Robinson-Wilson, USFWS

Mammals

Doug Burn, USFWS
Linda Comerci, USEPA
Tony DeGange, USFWS
Carol DeLisle, Versar
Kathy Frost, ADFG
Rowan Gould, USFWS
Mona Habler, USEPA
Ancel Johnson, USFWS
Roy Nowlin, ADFG*
Wayne Regelin, ADFG
John Sease, NOAA
W. Testa, UAF/ADFG
Mike Wheeler, ADEC

Recreation

Gary Ahlstrand, NPA
Ann Castellino, NPS
Alan Jubenville, UAf
K. Kurtz, USFS
Judi Maxwell, ADFG
Al Meiners, ADNR
Nancy Menning, USEPS
Dave Patterson, FWS
Sandy Rabinowitz, NPS*

General

Sandra Cosentino, ADNR
Priscilla Wohl, ADNR

* Indicates topic chairperson

TPW6
AA

BRIAN - EPA/ORD Scientist at Tech. Wrkshp

[1] Anne Fairbrother — Birds
[2] Gary Chapman — Fish
[3] Mona Haebler — Mammals
[4] Jim Clarke — Habitat
[5] Jesse Ford — Habitat
[6] Hal Kibby

Hal

all panels PI's
↑ Bob Lady

Brian - Paul + (Hal/Dan re: Shanks)
+ Nicoll Re: Hunt, Peterson mandy.

Stan - Bygon

03/22 16:04 #01 7307137

RPWG
AA

EPA

Environmental Research Laboratory
CORVALLIS OR 97333

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(Date) (Time)

CONFIRMED: _____

PAGE ___ OF ___ PAGES

The following are questions that we would like each damage assessment expert to address in their presentations. Understanding the damage is critical to designing restoration approaches.

Damage Assessment Questions -

1. What is the importance of the resource to the ecology and/or human services of Prince William Sound and the Gulf of Alaska?

2. What is the nature, severity and extent of the damage?
   a. What is the pattern of the damage? (The purpose of this question is to determine pattern of damaged resource as this has a major influence on natural recovery)

   b. What is planned for the future? How long will it take to determine additional damage?

3. How was the damage determined? (What studies, approaches etc)

4. What is known about what caused the damage?

5. How long do you think natural recovery will take? What is the basis of your estimate

6. What, if any, Restoration activities do you think should be undertaken to restore the resource? How long will it take to see results?

TPWG
AA

Scoping meetings
- Flier response form
- Public interaction format
- Publicity
- Other Handouts ?
- Work Product ?

Tech'l Workshops 1a+1b
- agenda
- Participants
- Report / Product
- Objectives / Follow-up workshop

RPWG
AA

Draft Agenda
April 3

8:30	Restoration Planning Process	(RPWG member)
	Legal Framework for Restoration What constitutes restoration What are appropriate uses of funds	(RPWG member)
	What does RPWG expect from workshop	(Brian Ross)
9:30	Natural Resource Damages	
	(See questions)	
12:00	Lunch	
1:00	Work Group Assignments	(Dan Sheehy)
1:30	Work Groups Convene: (Coastal Habitat including Benthic, Fish and Shell Fish, Mammals, and Birds)	
	Develop Biological Criteria for ranking restoration alternatives	
5:00	Break for dinner	
7:00	Session chairs meet to review progress and develop criteria to apply across work groups	

April 4

8:00	Summary of Day 1	(Session Chairs)
8:30	Reconvene - Produce outline of restoration alternatives in relation to damage assessment	
12:00	Lunch	
1:00	Plenary Session	(Session Chairs)
	Reports on Alternatives	
2:30	Reconvene Work Groups	
	Flesh out details of Restoration Alternatives For each alternative develop criteria that can be used to judge success. See Report outline -	
5:00	Break	
7:00	Session Chairman meet to discuss days meetings	

April 5 Ecological Resources

8:00 Ecological work groups convene

Develop demonstration projects that are feasible to conduct in summer of 1990.

12:00 Lunch

April 5 -6 Cultural Resources

Restoration Planning work Group to develop agenda

T0# 2802182 03/19 11:21 #01

EPA

Environmental Research Laboratory
CORVALLIS OR 97333

FACSIMILE REQUEST AND COVER SHEET

PLEASE PRINT IN BLACK INK ONLY

TO Brian Ross

OFFICE/PHONE 271-2464

FAX #: 907-271-2467
CONF. #:

REGION/LAB

FROM Hal Kibby

PHONE (503) 757-4625

MAIL CODE

OFFICE ERL-Corv

DATE 3/19/90

NUMBER OF PAGES TO INCLUDE THIS COVER SHEET

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3/19/90 1:00
(Date) (Time)

CONFIRMED: _____

PAGE 1 OF 4 PAGES

TPWG
AA

TECHNICAL WORKSHOP ON RESTORATION ALTERNATIVES
April 3-5, 1990

PURPOSE:

To provide technical input to the decision-making process to enable scientifically valid decisions regarding restoration alternatives.

OUTPUTS:

1. List of broad scientific guidelines suggested for use in selecting restoration alternatives.

2. Broadly-inclusive matrix of restoration alternatives which warrant further evaluation.

3. Probable information needs and/or feasibility studies which will be needed to ~~fully~~ evaluate (initial? candidate?) restoration alternatives (for 1991)

OBJECTIVES:

1. Review initial damage assessment results with respect to potential restoration alternatives.

2. Describe the state of the art in restoration technology and the feasibility of applying these technologies to Prince William Sound and the Gulf of Alaska.

3. Develop broad scientific guidelines for evaluating restoration technologies.

4. Develop a broadly-inclusive matrix of restoration alternatives (including restoration, replacement, and acquisition of equivalent resources) that warrant further evaluation.

5. Identify information needs and/or candidate feasibility studies necessary to fully evaluate (initial? etc.) restoration alternatives (for 1991)

PROPOSED DRAFT AGENDA

Tuesday, April 3

8:30 Restoration Planning Process (RPWG member)

9:00 Legal Framework for Restoration (RPWG member)
- What constitutes restoration
- What are appropriate uses of funds

RPWG expectations of workshop (Brian Ross)

9-9:30 State of the spill

9:30 Natural Resource Damages (PI's)

12:00 Lunch Break

1:00 Work Group Assignments (Dan Sheehy)

1:30 Work Groups convene concurrently
(Coastal Habitat, Fish/Shellfish, Mammals, Birds)

Tasks:

Review state of the art in restoration technology and the feasibility of applying these technologies to Prince William Sound and the Gulf of Alaska.

Develop broad scientific guidelines for evaluating restoration alternatives.

5:00 Break for Dinner

7:00 Session chairs meet to review progress and develop overall scientific guidelines which can be applied across all work groups.

Wednesday, April 4

8:00 Plenary Session: Summary of Day 1 (Session chairs)

8:30 Reconvene Work Groups

Task:

Develop broadly-inclusive matrix of restoration alternatives (including restoration, replacement, and acquisition of equivalent resources) that warrant further evaluation.

~~Wednesday, April 4 (continued)~~

12:00 Lunch

1:00 Reconvene Work Groups

Task:

Identify information needs and/or candidate feasibility studies necessary to fully evaluate restoration alternatives.

4:00 Plenary Session: Progress Reports

5:00 Break for dinner

7:00 Session chairs meet to discuss progress

Thursday, April 5

RPWG
AA

FAX TRANSMITTAL PAGE

Versar INC.
ESM Operations
9200 Rumsey Road
Columbia, MD 21045-1934
(301) 964-9200

Fax Number: (301) 964-5156
Confirmation Number: (301) 964-9200 Ext. 350

To: Brian Ross

Company: EPA Anchorage AK

Fax Telephone #: 907 271-2467

Verification Telephone #: 907-271-2464

From: Dan Sheehy x 364

Date Sent: 21 Mar 94 #1

Account # (For filing purposes only): 31.2 (EPA

Number of Pages 2 Plus Cover Sheet

Notes: Contact Status. Unless advised otherwise we will stop. Need DoJ approved info, EPA Paper. We will send out info (Versar contracts, EPA agreement, Agenda, DoJ info, Admin info) Today via Fed Exp. Versar team will be on-site Monday 2 April to set up + make final arrangements.

MAC 93

Status of Contacts as of 21 March 1990
Restoration Planning Workshop
3-5 April 1990

Attending

Howard Sanders	WHOI	Coastal Habitat
Michael Foster	Moss Landing	Coastal Habitat
Will Barber	U. AK	Fish./Shellf.
Noel Snyder (conflict on 4/5/90)	AZ Fish & Game	Birds
Will Troyer	Ret. Nat'l Park Ser.	Mammals, Terr.
Ancel Johnson	Ret. Fish & Wildlife	Mammals, Terr.
Bob Thorne	U. of Mississippi	Cultural

Not appropriate and not available

Lee Harding	Environment Canada	Coastal Habitat
Recommends:	Tim Parsons U. of British Columbia	Botany
	John Vandermullen Bedford Institute of Oceanography Dept. of Fisheries and Oceans Nova Scotia	
	Carey McCalister Pacific Biological Research Station Dept. of Fisheries and Oceans	Intertidal
	Gary Sergi	oil effects (Baffin I.)
Ernest Seneca	NC State Univ.	Coastal Habitat

Not available

Stan Temple	U. Wisconsin	Birds
Ken Chew	U. Washington	Fish./Shellf.
Recommends:	Ron Thom U. Washington	Benthos/Marsh grasses
John Teal	WHOI	Ecol./Syn.

Dave Duggins	U. Washington	Coastal Habitat
Recommends:	Cathy Ann Miller UC Berkeley School of Fish.	Algal Ecologist
Paul Dayton	Scripps	Ecol./Syn.
Recommends:	Bob Hessler Scripps	Oceanography
	Jim Enwright Scripps	Oceanography
	Joy Zedler	Wetlands
David Norton	N. Slope Borough	Birds

Attempted contact

John Burns	Ret. AK Fish & Game	Mammals, Terr.
David Armstrong	U. Washington	Fish./Shellf.
Dave Klein	U. AK Wildl. Co-op	Mammals, Terr.
John Vandermullen	Bedford Inst. Ocean.	Coastal Hab.
Decklan Troy	LGL Research Assoc.	Birds

RPWG
AA

Oil Spill Restoration Planning Office
437 "E" Street, Suite 301
Anchorage, Alaska 99501

MEMORANDUM 15 MARCH 1990

TO: Restoration Planning Work Group

FR: Stan Senner

RE: Participants in Technical Workshops

Here is a list of confirmed and potential participants for technical workshop 1-A, scheduled for 3-4 April 1990. There are a number of slots to fill or confirm, and it is critical that we do so quickly. Brian Ross will be working on this over the next several days, so please contact him with any names you can supply or confirm. We are also woking on a refined agenda, and that too will be circulated.

Frankie Pillifant is working on an agenda and list of participants for the workshop 1-B, cultural and recreational resources, which is scheduled for 5 April. These will be circulated shortly.

Beyond the participants themselves, a number of details still need resolution. One of them concerns costs for 1-2 outside experts, which are not covered by the contractor retained by EPA. Does any agency volunteer to cover these costs (travel, per diem, and consulting fee)?

As noted above, please direct any feedback to Brian at 271-2464. I will be out of town until the night of 25th.

KPWG
AA

TECHNICAL WORKSHOP NO. 1

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats
Mammals
Birds

(B) Cultural
Recreation

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: Roy Nowlin ✓

Group Chairman: Byron Morris (Stan)

Principal Investigators: Kathy Frost } (Roy)
Killer whale } ask Byron (Stan)
Sea Otter } ask Mike Mitchell, Preston-T
John Farrell (Land Otter) }

Peer Reviewers:

none

"Outside" Experts: (Both)
John Burns = Skeehy (Brian) ✓
Will Troyer = Skeehy (Brian

Agency Representatives:

(Roy) Wayne Regelin, ADF&G

ask Byron (Sta
_____, NMFS (1)
_____ USFWS (1)
~~~~~
✓ ask Rowan (Bri

Total Bodies
~11
~~~~~

Marshall Kendziorek 465-7621 re Bird expert

Erich Gundlach - 265-4541

Pub. AA

TECHNICAL WORKSHOP NO. 1

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats ✓
Mammals
Birds

(B) Cultural
Recreation

Fumes (un-filter?) Amoco Cadiz Works Bigelow, ME. Lab Look for it on database w/ Erich G. 1981 data, 1980 data.

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: Dave Gibbons (Brian) or ask for Fall-Back (Eric Gundlach? or Jacqui) Art Weiner

Group Chairman: (Same) ✓

Principal Investigators:

ADEC Jon Lindstrom Chemist (Ray) X Ray Highsmith
NMFS Jeep Rice (Chuck)
Others? ask Dave

Peer Reviewers:

Bob Spies (ask Dave G) (Brian) AMS, Livermore Ca. (415) 422-1100
Robt Paine - U W Zool. (206) 543-1649
Fed. or Charles Peterson IMS, U.N.C. → (919)-726-6841

"Outside" Experts:

Dave Duggins, Lee Harding > Sheehy (Brian)

Agency Representatives:

Habitat, ADF+G - Lance Trasky (Chuck)
- ADEC (Stan) ask Doug R. or Mike W.
- EPA (Brian)
- NOAA (ask Byron - Stan)
- USFS → ask Dave (Brian)
- DNR → ? (Frankie) → (Stan)
- NPS → ? (Gary) → Brian

RPS
4.4

TECHNICAL WORKSHOP NO. 1

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats
Mammals
Birds

(B) Cultural
Recreation

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: Chuck Meacham

Group Chairman: Brian Rose

Principal Investigators:

Hepler
Hillsberg
Shaw
Wertheimer
O'Clair
Chuck
Byron
FEDER? — me check

Peer Reviewers: (One of)

DOI
Mundy #1
Hillborn #2
(Brian)
Lk Oswego, OR - (503) 235-0667
(H) 697-3474
WW - (206) 543-9026

"Outside" Experts:

Will Barber
Howard Feder
Shelby (Brian)

Agency Representatives:

~~Eggers~~
~~Allen~~
Mac Bride
or Tom Krone
} ADF+G

Usha Varanasi
+ maybe another
} NMFS (Ask Byron) (Stan)

USFS? ask Dave (Brian)?
(~~MMS~~ FWS? ask Rowan (Brian))?

Ross Cavanaugh? (NPS)

EPA — Gary Chapman

TECHNICAL WORKSHOP NO. 1

GROUP (mark one): (A) Fish and Shellfish ✓
Coastal Habitats
Mammals
Birds

(B) Cultural
Recreation

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: Dave Gibbons ✓

Group Chairman: (Frankie (Gomez)) Dave ? Eric Gundlach > ask Dave

Principal Investigators:

(Follow-up → Jon Lightsoms (Reg) Hightower Jewett Schmall Sundberg
Jeep Rice (Chuck)
Other PI's?
Doug Wolfe — NOAA, Washington, DC

Peer Reviewers:

Contract w/ State — Bob Spiers, Rick Rowen
Pete Peters
Charles Peterson

NMFS internal scoping

"Outside" ~~Experts~~:

Duggins out
Harding
Sanders
Foster

Agency Representatives:

Habitat, ADF&G - Lance Trasky (Chuck)

Art Werner, DEC (Stan to call)

Jim Clark, Jessie Ford, EPA

Carol Manen, NOAA (ask Byron)

?, Forest Service (ask Dave)

Harding, _____, Park Service (ask Gary)

Harding Frankie, DNR (ask Frankie)

TECHNICAL WORKSHOP NO. 1

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats
~~Mammals~~
Birds

(B) Cultural
Recreation

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: Roy Nowlin

Group Chairman: ~~Byron Morris~~ Roy Nowlin (Stan)

Ward Testa ?
(R. otter Proj. PI.)
Otters Confirmed.

Principal Investigators: ~~Marilyn Dahlheim~~ NOAA → Killer whale } Stan to ask Byron
Ask Paul → Sea Otter }

Kathy Frost } ADF&G ✓
Wayne Reglund } Roy
~~John Truett~~ } Conflict on 3rd

Peer Reviewers:

Contract w/ state → ~~Don Sennf~~ none
(Jack Lenfer?)

"Outside" Experts:

Anvil Johnson
~~John Burns~~ Will Troyer

Agency Representatives:

(Roy) Wayne Reglein (REGELIN), ADF&G

ask Byron + Rawson, NMFS

[redacted]

ADEC - Mike Wheeler
EPA - Mona Hobler

NOAA? Steve Zimmerman
Chief, Office of Protected Spp.

Σ = ~11 people

TECHNICAL WORKSHOP NO. 1

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats
Mammals
Birds

(B) Cultural
Recreation
(C) Other Participants

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Presentation Results: Bob Leedy (Brian) → Paul Gertler Calling

FWS - Counterpart to Roy + Chuck

Group Chairman: Stan Senner

Principal Investigators:

Sam Patten (Roy) - State

r add est. non birds → Ask Rowan (Brian)

Peer Reviewers: (one of)

#1 Mike ~~Fry~~ HUNT - State DOI

#2 ~~Glenn Ford~~

"Outside" Experts: (Both) ~~One of~~

~~Temple~~ or Snyder Noel → Sheehy (Brian)

~~Norton / Stat~~

Agency Representatives:

Lin Donlinger - Anch
Tony DeGange
Doug Burn

Phil Schempf - Juneau
Lee Hotchkiss - anch. USFWS - Ask Rowan (Brian)
Chris Dipple / Dave Nysewander - Homer

Gertler Doing.

One of { #1 ~~Don Timm~~, ADF+G (Roy)
#2 Tom Rothe, ?

EPA - Anne Fairbrother

Total Bodies: ~ 10

RPWG
AA

Draft Agenda
April 3

8:30	Restoration Planning Process	(RPWG member)
	Legal Framework for Restoration · What constitutes restoration What are appropriate uses of funds	(RPWG member)
	What does RPWG expect from workshop	(Brian Ross)
9:30	Natural Resource Damages	
	(See questions)	
12:00	Lunch	
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1:30	Work Groups Convene: (Coastal Habitat including Benthic, Fish and Shell Fish, Mammals, and Birds)	
	Develop Biological Criteria for ranking restoration alternatives	
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	Reports on Alternatives	
2:30	Reconvene Work Groups	
	Flesh out details of Restoration Alternatives For each alternative develop criteria that can be used to judge success. See Report outline -	
5:00	Break	
7:00	Session Chairman meet to discuss days meetings	

April 5 Ecological Resources

8:00 Ecological work groups convene

Develop demonstration projects that are feasible to conduct in summer of 1990.

12:00 Lunch

April 5 -6 Cultural/Recreational Resources

Restoration Planning work Group to develop agenda

Experts: 1 — Bob Thorne

2 — Kimberly Bowen
Jim Feliciano
Roger Clark

RPWG
AA

Draft Agenda
April 3

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	Flesh out details of Restoration Alternatives See Report outline	
5:00	Break	
7:00	Session Chairman meet to discuss days meetings	

April 5 Ecological Resources

8:00 Ecological work groups convene

Independently applying criteria developed on day 1 rank alternative restoration options

10:00 Plenary Session Discussion of Ranked Options and presentation of work groups rationale:

12:00 Lunch

1:00 Work Groups reconvene

Develop demonstration projects that are feasible to conduct in summer of 1990. (See Outline)

5:00 Adjourn

April 5 Cultural Resources

8:00 Develop Criteria for ranking cultural restoration projects

10:00 Develop Alternative restoration plans

12:00 Lunch

1:00 Rank the various Alternatives
(Prepare report including estimated costs)

5:00 Adjourn

April 6 Cultural and Ecological Resources

8:00 Session Chairs and RPWG meet to discuss results and findings and preliminary planning for second workshop.

10:00 Adjourn

OPTION 1 8:00 Session Chairs – Synthesis
Work Group – Integrate across work groups prepare overall summary

Workshop 11:00 – 1:00 Lunch 1:00 Session chairs meet RPWG – present findings answer questions and help with preliminary planning

TECHNICAL WORKSHOP NO. 1

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats
Mammals
Birds ✓

(B) Cultural
Recreation

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results: Bob Leedy, USFWS

Group Chairman: Stan Senner

Principal Investigators:

Patten (Ray)

_____

_____

Peer Reviewers:

only One { ~~#1 Mike Fryer~~ Roman - Suggests Hunt?
#2 ~~Glenn Ford~~

"Outside" Experts:

#1 Stan Temple (Noel Snyder) #2 ← only one

Dave Norton

Agency Representatives:

_____, USFWS

~~[illegible]~~

only one { #1 Don Timm, ADF&G (Ray)
#2 Tom Rothe, ADF&G

Σ = ~10 people

KPub
AA

NON-AGENCY INDIVIDUALS TO BE CONTACTED FOR TECHNICAL WORKSHOP NO. 1-A 2-5 April 1990

NAME	AFFILIATION	SPECIALTY	SESSION
~~Saul Saila~~	~~Univ. of RI~~	~~fisheries~~	~~Fish and Sheelfish~~
Ken Chew	Univ. Washington	shellfish	Fish and Shellfish
Howard Feder	Univ. Alaska/Fbx.	fisheries	Fish and Shellfish
Will Barber	U. AK/Fairbanks	fisheries	Fish and Shellfish
Ken Wilson or Neuschul	Cal Fish & Game	kelp planting	Coastal Habitat
Ernest Seneca	NC State U.	salt marsh restoration	Coastal Habitat
Howard Sanders	WHOI	benthic ecology	Coastal Habitat
Michael Foster	Moss Landing		Coastal Habitat
David Duggins	Friday Harbor Lab	plant/herbivore interaction	Coastal Habitat
Lee Harding	Environment Canada		Coastal Habitat
Marilyn Dahlberg	Univ. Vancouver		Mammals/Marine
Will Troyer	Retired, National Park Service	Wildlife	Mammals/Terrestrial
Geoff Carrol	North Slope Borough		Mammals/Marine
Craig George	North Slope Borough		Mammal
Dave Klein	Univ. AK-Fairbanks/Coop. Wildlife Res. Unit		~~Birds~~ Terrestrial mammals
B Noel ~~Schneider~~ Snyder	Arizona Fish & Game (805) 649-1164		Birds
A Stan Temple	Univ. Wisconsin		Birds
A David Norton	OCSEAP (former) - now Nw. Slope Borough (907) 852-7337		Birds + Synthesis
Declan Troy	LGL		Birds
John Teal	WHOI	marine ecology	General Ecology
Paul Dayton	SCRIPPS		General Ecology

KPWG
AA

NAME	AFFILIATION	SPECIALTY	EXPERIENCE
David Levigne	Univ. ~~Duluth~~ Guelph	Mammals	artic seals, sea lions, walruses
Ian Sterling	Canadian Wildlife	Mammals	artic marine mammals
Bill Paren	SW Fisheries Center NMFS	Whales	
Steve Kottona	College of the Atlantic	Marine Mammals	Humpback & Grays
Angel Johnson	Retired F&WS	Mammals	sea otters Alaska
Bob Hoffman	Marine Mamal Comm.		Marine Mammals
~~John Fowler~~	~~ph. number -?~~	~~archeology~~	~~Cultural Resources~~
Bob Thorne	Center for archeological reources -?	archeology	restoration
Martin McAlister	ph. number -?	archeology	site preservation vandalism

Recreation -?

John Burns retired ADFG

TR36
AA

Brian Ross has asked that I fax you these questions and proposed agenda for discussion on a conference call that he is setting up with members of the Restoration Planning Work Group. The purpose of the questions is to help structure the damage assessment presentations.

Damage Assessment Questions -
Habitat Loss:

1. What is the role of the habitat to the ecology of Prince William Sound?

2. What is the nature/severity of the damage? (acute toxicity, scouring, etc)

3. What is the ~~extent of the~~ areal extent of damage?

4 What is the spatial and temporal pattern of the damage?

5. What is the areal extent of undamaged resource?

6. How did you determine the damage?
   a. Direct measurement of lost area
   b. Comparison with undamaged area

7. What caused the damage? (Oil toxicity, cleanup or ?)

8. How long do you think natural recovery will take? What is the basis of your estimate.

9. What if any Restoration activities do you think should be undertaken to restore the habitat? *How long do you think this would take?*

10. What is planned for the future? How long will it take to determine additional damage?

Population Loss:

1. What is the ecological and/or economic importance of the population?

2. What is the nature of the damage direct mortality, sublethal chronic effect e.g. lesions etc

3. What percentage of the population was effected?

4 How did you determine the damage?
   a. Body counts
   b. Comparison with undamaged areas (If this method what is natural spatial variability in population?)

5. What caused the damage?

6. Based on previous experience how long do you feel natural recovery will take?

7. What, if any restoration activities do you recommend?

8. What is planned for the future? How long will it take to determine additional damage?

Cultural:
Restoration Planning Work Group to expand questions.

1. What was damaged?

2. How did damage occur?

3. What historical or other records were lost?

4. What restoration options do you recommend?

Other:

1. What was damaged?

2. How did damage occur?

3. What Restoration Options do you reccommend

I0# 7307137 09:81 91/80

TRUE AA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Environmental Research Laboratory
CORVALLIS OR 97333

EPA

FACSIMILE REQUEST AND COVER SHEET

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TO Brian Ross

OFFICE/PHONE 271-2464

FAX #: 907-271-2467
CONF. #:

REGION/LAB

FROM Hal Kibby

PHONE (503) 757-4625

MAIL CODE

OFFICE ERL-Corv

DATE

NUMBER OF PAGES TO INCLUDE THIS COVER SHEET

~~3~~ 5

Please number all pages

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TRANSMITTED

_____ / _____
(Date) (Time)

CONFIRMED: _____

PAGE 1 OF 4 PAGES

DRAFT - Subject to revision by Brian Ross and Restoration Planning Work Group. Final outline to become part of VERSAR scope of work.

Draft Outline of Report

I. Introduction -
   A. Purpose of the Planning effort

   B. Definition of Restoration for this report

   C. Overview:

      1. Linkage between damage assessment and restoration options analysis
      2. Linkage between restoration uncertainty and demonstration projects
      3. Nature of report (working document to be updated as needed when additional information becomes available)

II. Habitats and Resources, Potentially Damaged
   Development of Matrix of Ecosystem Components at Risk.
   A. Review of options for partitioning habitats and resources, focusing on the relationship between target resources (fish/shellfish, birds, mammals, benthic organisms) and habitat zones

   B Overview of Damage Assessment by population and/or habitat

      1. What ~~has been~~ is known about damaged ~~and how was it damaged~~ to date including whether acute or chronic effect.
      2. Importance of the damage relative ~~to Prince William Sound~~ ecological or human services provided.

III. Development of Candidate Restoration Alternatives:

   A. Basic Overview of the State of the Art for Ecological Restoration with special focus on high latitude work.

      1. What has been accomplished
      2. Past performance of restoration activities
      3. Current trends and controversies

   B Prince William Sound/Gulf of Alaska Restoration Alternatives

      1. Preliminary Criteria and attributes for ~~selecting~~ developing candidate restoration alternatives
         a. Relative Importance of criteria ~~for selection~~

      2. Range of Options considered

a. Objective of each
b. Description
   a. What ~~is to~~ could be done
c. Evaluation of the alternative based on the ~~selection~~ DEVELOPMENT criteria (e.g. How fast will this speed natural recovery; What collateral damage can be caused?; Probability of Success)
d. Estimated Cost - $ and Manpower; FOR DEMONSTRATION STUDIES &/OR FULL IMPLEMENTATION
e. ROLE OF MONITORING

3. Synthesis (Discussion of the relative merits of above options and possible combinations of restoration options.)

IV. Demonstration Projects ~~Candidates~~ for 1990. INCL. FUTURE NEEDS BASED ON GAPS IN MATRIX

A. Objective
   1. Statement of purpose + need
   2. Performance evaluation criteria

B. Rationale
   1. What do I need to know?
   2. What is State of Art? (Summarized from Main Report)
   3. What will this specific project tell me?

C. Approach / Study Design
   1. Description of what is to be done
   2. Statistical design of project so that success can be measured.

D Resources Requirements
   1. ~~R&D~~
   2 ~~Federal~~ FTE make generic: EQUIP'T CONTRACT TRAVEL

E. Recommendations for 1990 Demonstration Projects

Draft Agenda
April 3

8:30	Restoration Planning Process	(RPWG member)
	Legal Framework for Restoration What constitutes restoration What are appropriate uses of funds	(RPWG member)
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April 5 Ecological Resources

8:00 Ecological work groups convene

Independently applying criteria developed on day 1 rank alternative restoration options

10:00 Plenary Session Discussion of Ranked Options and presentation of work groups rationale:

12:00 Lunch

1:00 Work Groups reconvene

Develop demonstration projects that are feasible to conduct in summer of 1990. (See Outline)

5:00 Adjourn

April 5 Cultural Resources

8:00 Develop Criteria for ranking cultural restoration projects

10:00 Develop Alternative restoration plans

12:00 Lunch

1:00 Rank the various Alternatives
(Prepare report including estimated costs)

5:00 Adjourn

April 6 Cultural and Ecological Resources

8:00 Session Chairs and RPWG meet to discuss results and findings and preliminary planning for second workshop.

10:00 Adjourn

Alternative:

8:00 Synthesis Work Group (Session Chairs)
(Put together summary Chapter that integrates across the various work groups)

11:00 Working Lunch- Session Chairs meet with RPWG to discuss findings from workshop and assist RPWG with preliminary planning for second workshop.

1:00 Adjourn

From: FRANKIE PILLIFANT, DNR, OSPCO
To: BRIAN ROSS, EPA

RWG
AA

DRAFT DRAFT

QUESTIONS FOR DAMAGE ASSESSMENT PI'S TO PONDER

HABITAT LOSS:

1. DELETE THIS QUESTION OR PLEASE DETAIL FURTHER. ARE WE LOOKING FOR AN ANSWER IN TERMS OF ECOSYSTEMS, FOOD-CHAINS ? ANY QUESTIONS SHOULD REQUIRE THE COMMENTOR TO CONSIDER ALL AFFECTED AREAS NOT JUST PRINCE WILLIAM SOUND.

2. QUESTION SHOULD READ: What is the nature/severity of the HABITAT damage? (define the purpose of acute toxicity, scouring to the question)

3. SHOULD READ: What is the extent of damage?

4. SHOULD READ: What is the ZONE of the damage? (areas of Alaska?)

5. DELETE

9. SHOULD READ: what if any restoration activities do you think should be undertaken to restore the habitat? HOW LONG DO YOU THINK THIS ASSISTED RESTORATION WILL TAKE?

POPULATION LOSS:

2. SHOULD READ: What is the nature of the direct mortality.....

CULTURAL RESOURCES:

1. WHAT IS THE ROLE OF CULTURAL RESOURCES TO THE COMMUNITIES OF ALASKA?

2. WHAT IS THE STATUS OF THE CULTURAL RESOURCES INVENTORY?

3. What was damaged?

4. How did damage occur? SHOULD READ: WHAT WAS THE PATHWAY FOR THE DAMAGE TO OCCUR?

5. WHAT IS THE EXTENT OF DAMAGE? (AREA, ZONES?)

6. HOW HAS DAMAGE BEEN DETERMINED?

7. IS NATURAL RECOVERY POSSIBLE?

8. WHAT HISTORICAL OR OTHER RECORDS WERE LOST? (By Areas or zones?)

9. WHAT IS PLANNED FOR THE FUTURE TO DETERMINE CONTINUING LOSS OR DAMAGE?

10. WHAT RESTORATION OPTIONS DO YOU RECCOMEND?

RECREATION:

1. WHAT IS THE ROLE OF RECREATION TO THE AFFECTED AREAS?

2. WERE RECREATION USE PATTERNS IMPACTED IN THE SPILL AREA? STATEWIDE?

3. HOW WAS LOSS/DAMAGE DETERMINED?

4. WHAT TYPE OF RECREATION USES WERE AFFECTED?

5. WHAT CAN BE DONE TO RESTORE LOST USE?

6. WHAT CAUSED THE DAMAGE? PUBLIC PERCEPTIONS?

7. WHAT IS PLANNED FOR THE FUTURE TO CONTINUE MEASURING LOST USE?

8. WHAT RESTORATION OPTIONS DO YOU RECOMMEND?

OTHER QUESTIONS??????????????????????????

recreation loss:

1. What are the nature and extent of displacement of recreation use resulting from the spill?

2. Did or will displacement of recreation use from the Sound affect the quality or quantity of use in other areas in Southcentral Alaska?

3. Did the spill adversely affect the quality or quantity of wilderness values of the Sound for local residents? What about the perception of wilderness for potential visitors to the areas? For actual visitors? Will future generations of Alaskan's be less impacted because they did not know the Sound before the spill or because most of the obvious signs will be gone?

4. How do recreation and scenic effects of the spill affect different user groups (i.e. cruise ship passengers, ocean kayakers, power or sail boaters, hunters, whale or bird watchers)?

5. Has the long term economic earning potential of the Sound's wilderness image for tourism and recreation related businesses been depreciated?

6. Will the spill result in more recreation use through the spill's "advertising" or name recognition value? Will the visitors pay less than they would have had they been visiting an un-oiled Sound? Are we trading high value/low volume tourism for lower value/high volume tourism?

7. Will the spill attract disaster junkies, as was the case with Three Mile Island or Mount St. Helens?

8. Will a new tourism industry develop out of people wanting to visit the Sound to learn about or study the natural or human supported restoration?

9. What are the different types of impacts to recreational/tourism users?
-changes in wildlife or fish resources
-seeing oil on beaches
-damage to equipment
-damage to perception of wilderness
-wilderness
-smelling oil on warm or sunny days
-seeing or knowing of wildlife kills from the oil
-noise or visual intrusions caused by cleanup, researchers, signs or red X's on cliffs

10) Are the spill's damage to cultural/historic resources, in a recreational/tourism sense, offset or compensated for by the new archaeological and historic information learned from the archaeological efforts associated with the spill response?

11) What is the value of the new biological information generated by the spill response and damage assessment?

12) Will political backlash from the spill result in more conservation or protection of recreational values of the Sound than would have occurred without the spill?

13) Can the wilderness be restored? Can the wilderness be compensated?

14) What is the effect of the spill on the recreation opportunity spectrum in the Sound?

15) Should land managers (Forest Service, State, Native corporations) amend their land use plans to deal with the short and long term changes resulting from the spill?

16) Beyond restoration or instead of restoration, compensation could include:

-purchasing private lands for public recreation use
-developing recreational facilities
-public education efforts to help users avoid oil impact areas
-dedication of unoiled public lands to wilderness or recreation designations
-future spill response to include protection of recreation and wilderness values (including pre-positioning response equipment in these areas)

17) Are there long term costs to public and private land managers resulting from changes in recreation or tourism patterns as a result of the spill?

18) What are the monetary costs to boaters or other recreationists from the physical or chemical effects of oil on their equipment (boat hulls, motors, tent fabric, etc)?

---

prepared for DNR/OSPCO #1
by Al Meiners DNR/Parks
3/21/90
draft

Questions to Guide Work Group Discussions

STATE OF THE ART:

Note: To the extent possible, discussion should focus on high latitude work.

What is the state of the art in restoration technology for this resource (coastal habitat, fish/shellfish, birds, mammals)?

What has been accomplished?

What has been the past performance of restoration activities?

What are the current trends and controversies?

What is the feasibility of applying these technologies to Prince William Sound and the Gulf of Alaska?

BROAD SCIENTIFIC GUIDELINES:

What broad scientific guidelines should decision-makers consider in evaluating restoration alternatives? (For example, probability of success, extent of collateral damage, cost-effectiveness.)

How can these guidelines be best measured or quantified?

INITIAL DAMAGE ASSESSMENT RESULTS:

See questions provided to principal investigators.

MATRIX OF RESTORATION ALTERNATIVES:

What is the full range of options which can be considered?

For each possible restoration alternative, discuss:

- What is the objective?
- What could be done?
- How does the alternative fit the guidelines?
- What is the possible role of monitoring?
- What is the estimated cost to implement the alternative?

Which alternatives can be combined? What are the potential benefits of such combination?

IDENTIFICATION OF INFORMATION NEEDS AND/OR FEASIBILITY STUDIES:

What scientific uncertainties limit full evaluation of restoration alternatives?

What additional information is necessary to reduce those uncertainties?

What feasibility studies or demonstration projects could be conducted to gather necessary information?

As time permits, further clarify possible feasibility studies by answering the following questions for each possible project:

- What would be the objective of the project?
- How would project performance be evaluated?
- What necessary information would the project gather?
- What would be done?
- What statistical design would be used to measure success?
- What resources would be required (equipment and supplies, travel, personnel)?

REVISED (3/22/90) DRAFT OUTLINE
EXXON VALDEZ OIL SPILL
RESTORATION REPORT

I. INTRODUCTION

A. Purpose and goals of the restoration planning effort

B. Definition of restoration for this report

C. Overview

1. Nature of report (working document, to be updated as needed and as additional information becomes available)
2. Linkage between damage assessment and analysis of restoration of alternatives
3. Linkage between restoration uncertainty and recommendations for candidate 1990 demonstration projects

II. HABITATS AND RESOURCES POTENTIALLY DAMAGED

A. Matrix of Potentially Damaged Resources

1. Review of options for relating habitats to resources: an ecosystem approach focusing on relationship between target resources (fish/shellfish, birds, mammals, benthic), coastal habitat zones, and other factors such as specific location and water quality.
2. Develop matrix of resources (with life stages) and habitat areas.

B. Overview of Damage assessment by population and/or habitat

1. What was damaged and how was it damaged?
2. What is the effect of the damage, is it an acute or chronic effect?
3. What is the significance of damage relative to Prince William Sound and/or the Gulf of Alaska?

III. DEVELOPMENT OF CANDIDATE RESTORATION ALTERNATIVES

A. Basic overview of the State-of-the-Art for High Latitude Ecological Restoration

1. What has been attempted?
2. What has been the past performance?
3. What are the current controversies?

B. Prince William Sound/Gulf of Alaska Restoration Alternatives

1. Specific restoration objectives
2. Criteria and measurable attributes for selecting restoration alternatives. For example:
   a. How fast will this speed natural recovery
   b. Probability of success (uncertainty)
   c. What is the probability or consequence of collateral damage?
   d. What is the life cycle cost? (dollars or manpower)
3. Relative importance of criteria/attributes for selection
4. Range of alternatives considered
   a. Objective of each
   b. Description of what is to be done.
5. Evaluating alternatives based on selection criteria and specific measurable attributes
6. Recommended list of candidate restoration alternatives
7. Synthesis (Discussion of the relative merits of above individual restoration alternatives and possible combinations of alternatives)

IV. CANDIDATE DEMONSTRATION PROJECTS (for each project)

A. Purpose

1. Specific objective or hypothesis to be tested.
2. Define performance evaluation criteria

B. Rationale

1. What information is needed?
2. What is the state-of-the-art?
3. What relevant information will this specific project provide.

C. Approach/Study Design

1. Description of what is to be done
2. Experimental design including proposed statistical analysis for performance measurement. (How will success be measured?)

D. Resources Required

1. Equipment and materials
2. Travel
3. Personnel

3/30/90

Principal Investigators:

The following are questions you should take into account as you prepare for the work group discussions at the technical workshop, April 3-4. We are most interested in your thoughts regarding possible restoration activities.

1. What is the importance of the resource to the ecology and/or human services of Prince William Sound and the western Gulf of Alaska?

2. What is the nature, severity, and extent of the damage?

   a. What is the pattern of the damage? (The purpose of this question is to determine how the pattern of damage might influence natural recovery of damaged resources.)

   b. What is planned for the future? How long will it take to determine additional damage?

3. How was the damage determined? (What studies, approaches, etc.)

4. What is known about what caused the damage?

5. How long do you think natural recovery will take? What is the basis of your estimate?

6. What, if any, restoration activities do you think should be undertaken to restore the resource? How long will it take to see results?

RESTORATION PLANNING WORKSHOP
MASTER LIST

Birds

Lynn Denlinger, USFWS
Anne Fairbrother, USEPA
Paul Getler, USFWS
L. Hotchkiss, USFWS
Dave Irons, USFWS
Kathy Kuletz, USFWS
Bob Leedy, USFWS
Pete Mickelson, PWSC
Dave Nysewander, USFWS
Karen Oakley, USFWS
Jill Parker, USFWS
Sam Patten, ADFG
Tom Rothe, ADFG
Dan Rosenberg, ADFG
Phil Schempf, USFWS
Stan Senner, ADFG*
Noel Snyder, AZFG
Foster Stroup, Versar
Kent Wohl, USFWS

Coastal Habitat/Air & Water

Jim Clark, USEPA
Nancy Deshu, NPS
Jessie Ford, USEPA
Mike Foster, Moss Landing
Jeff Frithsen, Versar
Dave Gibbons, USFS*
Ray Highsmith, UAF
Hal Kibby, USEPA
Jon Lindstrom, ADEC
C. Peterson
Frankie Pillifant, ADNR
Howard Sanders, WHOI
Roger Slothower, USFWS
Kim Sundberg, ADFG
Lance Trasky, ADFG
Art Weiner, ADEC
Doug Wolfe, NOAA

Cultural

Ted Birkadal, NPS
Chuck Diters, USFWS
James Fall, ADFG
C. Holmes, ADNR
J. Mattson,
Frankie Pilifant, ADNR*
Robert Shaw, SHPO
Robert Thorne, Univ. MS
Priscilla Wohl, ADNR*
David Yesner, UAA

Fish and Shellfish

Will Barber, UAF
Ross Cavanaugh, NPS
Gary Chapman, USEPA
K. Hepler, ADFG
John Hillsinger, ADFG
Carol Ann Manen, NOAA
Douglas McBride, ADFG
Chuck Meacham, ADFG
B. Meehar, USFS
Charles O'Clair, UAF/ADFG
Brian Ross, USEPA*
Sam Sharr, ADFG
Daniel Sheehy, Versar
Usha Varanasi, NOAA
Alex Wertheimer, NOAA
Everett Robinson-Wilson, USFWS

Mammals

Doug Burn, USFWS
Linda Comerci, USEPA
Tony DeGange, USFWS
Carol DeLisle, Versar
Kathy Frost, ADFG
Rowan Gould, USFWS
Mona Habler, USEPA
Ancel Johnson, USFWS
Roy Nowlin, ADFG*
Wayne Regelin, ADFG
John Sease, NOAA
W. Testa, UAF/ADFG
Mike Wheeler, ADEC
Gareth Pearson, USEPA

Recreation

Gary Ahlstrand, NPA
Ann Castellino, NPS
Alan Jubenville, UAf
K. Kurtz, USFS
Judi Maxwell, ADFG
Al Meiners, ADNR
Nancy Menning, USEPS
Dave Patterson, FWS
Sandy Rabinowitz, NPS*

General

Sandra Cosentino, ADNR
Priscilla Wohl, ADNR

* Indicates topic chairperson

3-22-90

Hal:

You've been around me too long; your phone is always busy! So I'm resorting to this primitive method of communication.

I know I told you that the list of questions for the PIs to address at the workshop was fine with the exception of lack of detail on the non-ecological sessions, and that specific questions would be provided by the Work Group. Well, Park Service and Natural Resources came back yesterday with substantial comments on the rest of the questions as well. (I have to take these comments especially seriously since both a state and a federal agency raised them.) See attached 2 pages from DNR.

After debating the issues back and forth (which got scary, because some of them implied disagreement with or misunderstanding of the very objectives of the Workshop), it was agreed that a shorter list of questions, more generally stated, should be asked. Further, it was felt that more general questions could apply to all sessions without the need to have separate questions for each session. They felt that more detailed questions should arise during the sessions themselves. (They had a problem trying to tailor different questions for different sessions. In addition, it is clear that at least one vocal member is not as interested in pilot projects this summer as we are, and has a different feeling about the inportance of the various objectives for the Workshop.)

We didn't try to agree on specific language; but the desire is for one list of questions that gets at the following issues:

For each species, habitat, or other resource:

1. What is the nature, severity, and extent of the damage? (Your #s 2, 3, 4)

2. How is the damage being determined (what studies, study approaches)? (Your # 6)

3. What is known about what caused the damage? (Your # 7)

4. What is your view about how long natural recovery will take? What is the basis of your estimate? (Your # 8)

5. What if any restoration activities do you think should be undertaken? (Your # 9)

As you see on the attached comments from DNR, there was concern about your question #1. It was agreed that it could stay if it were to be expanded and made clearer. Also missing above is your question #5. Perhaps because they were thinking about cultural resources, the others had trouble understanding the importance. I noted that it would be difficult to prioritize feasibility studies or other restoration options without considering how substantial the effect has been in relation to remaining unaffected resources. In other words, a particular habitat in one area may have been severely damaged, but if that habitat is abundant (not limiting to recovery) in the vicinity, it may be more important to use limited study dollars elsewhere. Anyway, how wuold it be if we leave the direct question out, but make sure (through questioning the speakers if necessary) that it gets addressed under question #1 above?

Enough for now. I've already had 6 phone calls since I talked to you! Call me back with your thoughts ...

Brian

RPWG AA

FAX TRANSMITTAL PAGE

Versar INC.
ESM Operations
9200 Rumsey Road
Columbia, MD 21045-1934
(301) 964-9200

Fax Number: (301) 964-5156
Confirmation Number: (301) 964-9200 Ext. 350

To: Brian Ross

Company: EPA Anchorage

Fax Telephone #: 907 271 2467

Verification Telephone #: 907 271-2464 (AK)

From: Dan Sheely

Date Sent: 16 Mar 90 #1 cc Kirby

Account # (For filing purposes only): EPA 31.2

Number of Pages 5+ Plus Cover Sheet

Notes: Status report as of PM 15th. Coord. info from DOJ (Who will send these forms?) We would like to forward tentative agenda to all participants and guidance on what is planned and expected. I feel that our report is dependent on the framework established. I strongly suggest the workgroup establishment agrees on this now. We can help. but it should include terms (definitions), general criteria for selection, etc.

Status of Contacts as of 15 March 1990
Restoration Planning Workshop
3-5 April 1990

Attending

Howard Sanders	WHOI	Coastal Habitat
Michael Foster	Moss Landing	Coastal Habitat
Howard Feder (conflict on 4/5/90)	U. AK	Fish./Shellf.
Noel Snyder (conflict on 4/5/90)	AZ Fish & Game	Birds
Will Troyer	Ret. Nat'l Park Ser.	Mammals, Terr.
Ancel Johnson	Ret. Fish & Wildlife	Mammals, Terr.

Not appropriate and not available

Lee Harding	Environment Canada	Coastal Habitat
Recommends:	Tim Parsons U. of British Columbia	Botany
	John Vandermullen Bedford Institute of Oceanography Dept. of Fisheries and Oceans Nova Scotia	
	Carey McCalister Pacific Biological Research Station Dept. of Fisheries and Oceans	Intertidal
	Gary Sergi	oil effects (Baffin I.)
Ernest Seneca	NC State Univ.	Coastal Habitat

Not available

Stan Temple	U. Wisconsin	Birds
Ken Chew	U. Washington	Fish./Shellf.
Recommends:	Ron Thom U. Washington	Benthos/Marsh grasses
John Teal	WHOI	Ecol./Syn.

Dave Duggins	U. Washington	Coastal Habitat
Recommends:	Cathy Ann Miller UC Berkeley School of Fish.	Algal Ecologist
Paul Dayton	Scripps	Ecol./Syn.
Recommends:	Bob Hessler Scripps	Oceanography
	Jim Enwright Scripps	Oceanography
	Joy Zedler	Wetlands

Interested, availability unknown on 3/15/90

David Norton	N. Slope Borough	Birds

Attempted contact

John Burns	Ret. AK Fish & Game	Mammals, Terr.
David Armstrong	U. Washington	Fish./Shellf.
Will Barber	U. AK	Fish./Shellf.
Dave Klein	U. AK Wildl. Co-op	Mammals, Terr.
John Vandermullen	Bedford Inst. Ocean.	Coastal Hab.
Decklan Troy	LGL Research Assoc.	Birds

16 April 1990

Regarding Justice Department approval of restoration planning workshop participants:

On the advice of Jim Nicoll, we submitted participants' names and addresses to Peter Flynn in Washington, D.C. He sent us the accompanying non-disclosure statement for distribution to participants. We will contact Mr. Flynn today to determine whether Versar can distribute this directly and under what heading it should appear.

EXPERT WITNESS AGREEMENT

____________________, in consideration of his employment by the U.S. Environmental Protection Agency ("EPA") as an expert consultant ~~and witness~~ in the matter of the Exxon Valdez oil spill, agrees as follows:

1. This contract covers expert consultant ~~and witness~~ services in connection with this matter.

2. All documents or other information provided to me by the United States, State of Alaska or other party in this matter for my review in connection with this matter shall be treated as confidential; I shall not reveal any of this information to any person without prior written approval by the EPA or the U.S. Department of Justice.

3. All documents, information or other work developed by me in connection with this matter ~~is~~ ARE privileged and confidential; I shall not reveal any of this information to any person without prior written approval by the EPA or the Department of Justice.

4. During the pendency of actual or potential litigation relating to this matter, I shall not enter into any agreement with any other person who is a party or potential party to this matter for any purpose, whether or not it relates to pending litigation, without prior written approval by the EPA or the Department of Justice.

5. I have not entered into any contract related to this matter with any person other than the United States.

5. I will deliver to the EPA within 90 days of the expiration of my contract all documents or other data furnished to me by the United States or any other party to this matter in connection with my work on this matter, UNLESS INSTRUCTED OTHERWISE IN WRITING BY EPA OR DOJ.

7. I shall require any person that I hire to assist me in connection with my work on this matter to sign an agreement containing provisions identical to this Agreement.

Dated:

_____

BRIAN -
This should probably go out on Federal letterhead, either DOJ or EPA
Dan.

TRUS 8
AA

MEMORANDUM STATE OF ALASKA

TO: Distribution DATE: March 12, 1990

FROM: Charles P. Meacham
Fishery Program Manager
Oil Spill Impact and Restoration
Anchorage

SUBJECT: First Restoration Meeting--Anchorage

Our first restoration planning meeting is tentatively scheduled for April 3-4, 1990 in Anchorage. To date our fish/shellfish activities have been oriented to damage assessment. CERCLA authorizes funds recovered through public damage claims to be used to restore, replace, or acquire the equivalent of the injured natural resources. Here lies our other responsibility--restoration. If it was the case that the Justice Department and Exxon were going to reach an out-or-court settlement with an assessment of approximately $500,000,000.00, then one has an indication of the dollar resources which may become available, in part for restoration.

The first restoration meeting will include a plenary session for all participants followed by working groups. Each working group is supposed to be restricted to ten participants. Proposed fish/shellfish working group attendance is as follows:

Brian Ross	Restoration Group Chairman
Chuck Meacham	Summary Scientists for NRDA studies
Sam Sharr	PI, Salmon
Alex Wertheimer	PI, NMFS
John Hilsinger	PI, Shellfish
Kelly Hepler	PI, Sport Fish
Phil Mundy	Peer-reviewer
Ken Chew	Non-agency expert
Howard Feder	Non-agency expert
Doug Eggers	Agency Rep, Comm Fish
Doug McBride	Agency Rep, Sport Fish
Brian Allee	Agency Rep, FRED Division
Chuck O'Clair	Agency Rep, NMFS

A tentative agenda is attached for your review. Please confirm your availability to participate in this session in Anchorage. Thank you.

Distribution:
Participants, as proposed
Crawford
Erickson
Senner

DRAFT**DRAFT**DRAFT**DRAFT
(Version 2: March 8, 1990)

Objectives, Agenda, and Products
Technical Workshop on Restoration, No. 1-A
April 3-5, 1990

Objectives

1) Review initial damage assessment results with respect to potential restoration alternatives.

2) Brief the Restoration Planning Work Group (RPWG) and Damage Assessment team about the state of the art in restoration.

3) Develop broadly-inclusive matrix with restoration alternatives that warrant further evaluation (including restoration, replacement, acquisition of equivalent resources, and "no action").

4) Develop criteria for evaluating restoration alternatives, rank alternatives on a preliminary basis, and identify information needs/candidates feasibility studies necessary to fully evaluate restoration alternatives

Agenda

Day 1--08:30 h

Introduction and Overview (1 h) (plenary session)

- Restoration planning process (RPWG member)

- Legal framework for restoration (RPWG member?)
  - what constitutes restoration?
  - what are appropriate uses of restoration funds?

- Responsibilities of/products from the participants (RPWG member)

Natural Resource Damages (2.5 h) (plenary session)

- Fate and current status of the spilled oil

Summary of damage assessment results

Coastal habitat

Fish and shellfish

Mammals, marine and terrestrial

Birds

Lunch (1 h)

Reconvene (10 min) (plenary session) limit to 10 people, all agencies

Working Groups (4 h) (concurrent sessions)
(Four groups: coastal habitat, fish and shellfish, mammals, and birds)

Introduction (group chairman)

State of the art in restoration (outside[1] experts)

Review of damage assessment results and implications for restoration (principal investigators)

Discussion of restoration opportunities (group chairman)

Product: summarize working group discussion from afternoon to serve as starting point for Day 2

Day 2--08:00 h

Summary of progress of working groups (0.5 h) (group chairman) (plenary session)

Working Groups (3.5 h) (concurrent sessions)

Continue discussion of restoration alternatives (group chairman)

Product 1: outline of restoration alternatives in relation to damaged resources (start of matrix)

---

[1]The term "outside" refers to individuals outside of the damage assessment process; not necessarily experts from outside of the State of Alaska (although some may be from out of the state).

Develop criteria (w/weighting) for evaluating restoration alternatives, rank alternatives based on these criteria (preliminary only), and identify information needs/candidate feasibility studies needed for full evaluations of alternatives

Product 2: outline of criteria, ranking, and information needs/candidate feasibility studies

Lunch (1 h)

Summary of working group products[1] (1 h) (plenary session) (group chairman)

Wrap up and discussion of next steps (0.5 h) (RWPG member)

[1]If necessary, the working groups can continue their sessions after lunch.

RPWG
AA

MEMORANDUM STATE OF ALASKA

TO: Distribution

DATE: March 12, 1990

FROM: Charles P. Meacham
Fishery Program Manager
Oil Spill Impact and Restoration
Anchorage

SUBJECT: First Restoration Meeting--Anchorage

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Chuck O'Clair	Agency Rep, NMFS

A tentative agenda is attached for your review. Please confirm your availability to participate in this session in Anchorage. Thank you.

Distribution:
Participants, as proposed
Crawford
Erickson
Senner

DRAFT**DRAFT**DRAFT**DRAFT
(Version 2: March 8, 1990)

Objectives, Agenda, and Products
Technical Workshop on Restoration, No. 1-A
April 3-5, 1990
4

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2) Brief the Restoration Planning Work Group (RPWG) and Damage Assessment team about the state of the art in restoration.

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Develop criteria (w/weighting) for evaluating restoration alternatives, rank alternatives based on these criteria (preliminary only), and identify information needs/candidate feasibility studies needed for full evaluations of alternatives

Product 2: outline of criteria, ranking, and information needs/candidate feasibility studies

Lunch (1 h)

Summary of working group products[1] (1 h) (plenary session) (group chairman)

Wrap up and discussion of next steps (0.5 h) (RWPG member)

[1]If necessary, the working groups can continue their sessions after lunch.

RPWG
AA

437 E Street, Suite 301
Anchorage, Alaska 99501
(907) 271-2461
FAX: (907) 271-2467

Oil Spill Restoration Planning Office

TO: DAN SHEEHY

OFFICE/PHONE: VERSAR - ATN 364

FROM: BRIAN ROSS

DATE: 3-19

NUMBER OF PAGES: 3

MESSAGES: (1) COPY OF WHAT I SENT CONRAD KLEVENO, EPA HQ, RE: LETTERHEAD, FOLLOWS. PLEASE CALL HIM 1ST THING TUES. MORNING @ 245-4070 (HE'S IN FAIRCHILD BLDG, NOT WATERSIDE MALL).

(2) Ecological + Cultural/Recreational workshops will be sequential, so no need for extra recorders. But, need to make sure Bob Thorne's airline ticket, etc., have appropriate dates. Session chairs will meet with you Friday PM, now.

(3) Howard Feder is a P.I. Please substitute Wil Barber for Howard as an outside expert.

RPW
AA

FAX TRANSMITTAL PAGE

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ESM Operations
9200 Rumsey Road
Columbia, MD 21045-1934
(301) 964-9200

Fax Number: (301) 964-5156
Confirmation Number: (301) 964-9200 Ext. 350

To: Hal Kibby & Brian Ross

Company: EPA/ERL

Fax Telephone #: 907 271 2467

Verification Telephone #:

From: Dan Sheehy x 364

Date Sent: 14 March 90 (#2)

Account # (For filing purposes only):

Number of Pages 2 Plus Cover Sheet

Notes: We faxed Jim Nicoll & Peter Flynn (Justice Dept) names of potential attendees.

Status as of today

MAC #3

Status of Contacts as of 14 March 1990
Restoration Planning Workshop
3-5 April 1990

Attending

Howard Sanders	WHOI	Coastal Habitat
Michael Foster	Moss Landing	Coastal Habitat
Howard Feder (conflict on 4/5/90)	U. AK	Fish./Shellf.
Noel Snyder (conflict on 4/5/90)	AZ Fish & Game	Birds
Will Troyer	Ret. Nat'l Park Ser.	Mammals, Terr.

Not appropriate and not available

Lee Harding	Environment Canada	Coastal Habitat
Recommends:	Tim Parsons Botany U. of British Columbia	
	John Vandermullen Bedford Institute of Oceanography Dept. of Fisheries and Oceans Nova Scotia	
	Carey McCalister Intertidal Pacific Biological Research Station Dept. of Fisheries and Oceans	
	Gary Sergi oil effects (Baffin I.)	
Ernest Seneca	NC State Univ.	Coastal Habitat

Not available

Stan Temple	U. Wisconsin	Birds
Ken Chew	U. Washington	Fish./Shellf.
Recommends:	Ron Thom Benthos/Marsh grasses U. Washington	
John Teal	WHOI	Ecol./Syn.

Dave Duggins	U. Washington	Coastal Habitat
Recommends:	Cathy Ann Miller UC Berkeley School of Fish.	Algal Ecologist
Paul Dayton	Scripps	Ecol./Syn.
Recommends:	Bob Hessler Scripps	Oceanography
	Jim Enwright Scripps	Oceanography
	Joy Zedler	Wetlands

Interested, availability unknown on 3/14/90

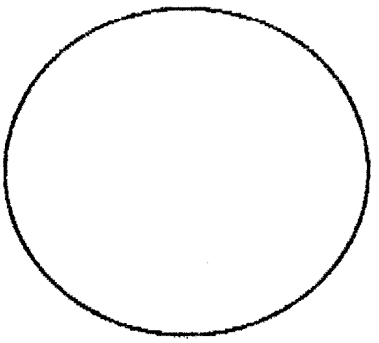
David Norton	N. Slope Borough	Birds
Ancel Johnson	Ret. Fish & Wildl.	Mammals, Terr.

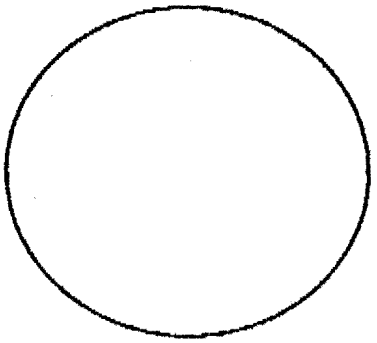
Attempted contact

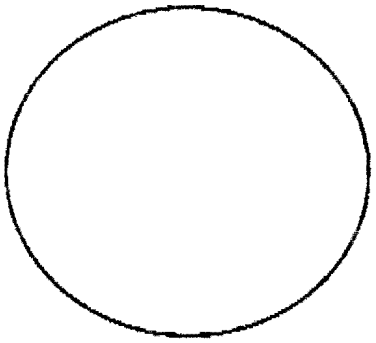
John Burns	Ret. AK Fish & Game	Mammals, Terr.
David Armstrong	U. Washington	Fish./Shellf.
Will Barber	U. AK	Fish./Shellf.
Dave Klein	U. AK Wildl. Co-op	Mammals, Terr.
John Vandermullen	Bedford Inst. Ocean.	Coastal Hab.

RPWG
AA

Preliminary Draft

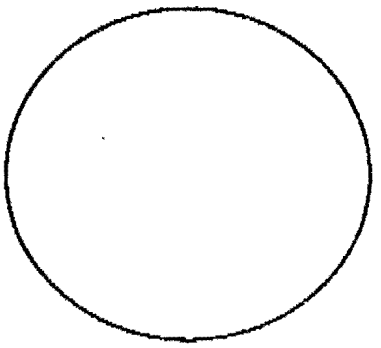


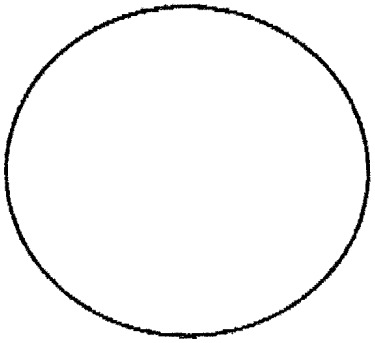


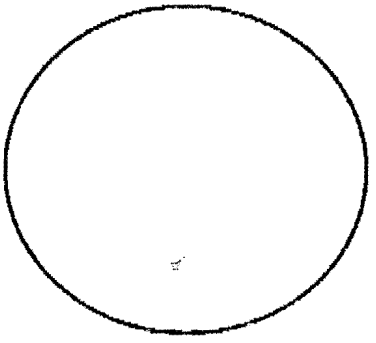


Annotated Bibliography

Prepared for Restoration Planning Work Group
by EPA Office of Research & Development







08/19 10:29 #01 7807187 ID#

EPA

Environmental Research Laboratory
CORVALLIS OR 97333

FACSIMILE REQUEST AND COVER SHEET

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TO Brian Ross

OFFICE/PHONE 271-2464

FAX #: 907-271-2467
CONF. #:

REGION/LAB

FROM Hal Kibby

PHONE (503) 757-4625

MAIL CODE

OFFICE ERL-Corv

DATE

NUMBER OF PAGES TO INCLUDE THIS COVER SHEET
~~7~~ 2

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: _____

PAGE 1 OF ~~7~~ 2 PAGES

TPWG
AA

Brian/Dan

Here are the EPA people that I think are important for us to have at the workshop. (*) indicate people that I feel could do a good job a chairs of individual sessions.

EPA People to invite:

1. Mary Kentula (NSI ERL-Corvallis Onsite Contractor) Wetlands
2. Gary Chapman ERL-Narragansett Fisheries
3. Jim Clarke ERL-Gulf Breeze Algae (*)
4. Mona Haebler ERL-Narragansett Marine Mammals (*)
5. Gareth Pearson EMSL-Las Vegas Monitoring Systems
6. Bill Sanville ERL-Duluth Freshwater Wetlands
7. Anne Fairbrother ERL-Corvallis Birds and Mammals
8. Jessie Ford (NSI) Good at Synthesis (*)

OLD

Damage Assessment Questions -
Habitat Loss:

1. What is the importance of the resource to the ecology of Prince William Sound?

2. What is the nature of the damage? (acute toxicity, scouring, etc)

3. What is the extent of the areal extent of damage?

4 What is the pattern of the damage?

5. What is the areal extent of undamaged resource?

6. How did you determine the damage?
   a. Direct measurement of lost area
   b. Comparison with undamaged area

7. What caused the damage? (Oil toxicity, cleanup or ?)

8. How long do you think natural recovery will take?

9. What if any Restoration activity do you think should be undertaken to restore the resource?

Population Loss:

1. What is the ecological and/or economic importance of the population?

2. What is the nature of the damage direct mortality, sublethal chronic effect ~~e.g.~~ lesions etc

3. What percentage of the population was effected?

4 How did you determine the damage?
   a. Body counts
   b. Comparison with undamaged areas (If this method what is natural spatial variability in population?)

5. What caused the damage?

6. Based on previous experience how long do you feel natural recovery will take?

7. What, if any restoration activity do you recommend?

Cultural:

1. What was damaged?

2. How did damage occur?

3. What historical or other records were lost?

4. What restoration options do you recommend?

RWG
AA

437 E Street, Suite 301
Anchorage, Alaska 99501
(907) 271-2461
FAX: (907) 271-2467

Oil Spill Restoration Planning Office

TO: DAN SHEEHY (OF "ALASKA MEN" MAG.)

OFFICE/PHONE: 964-9200 XTN 364

FROM: BRIAN ROSS

DATE: 3-13

NUMBER OF PAGES: (1)

MESSAGES:

HAL: (1) GO AHEAD + TRY TO GET ANYONE ON THE LIST RECOMMENDED BY LEE HARDING.

(2) I SPOKE TO JIM NICOLL - SAID HE'D GOTTEN MESSAGES FROM YOU BUT HAD MISSED YOU. I TOLD HIM WHY (AGAIN) YOU WERE CALLING - SO TRY AGAIN WED. NOTE: HE'LL BE TRAVELLING TO D.C. ON THURS., + IN D.C. ON FRI. SO TRY HARD TO GET HIM WED. IF YOU MISS HIM, CALL GARY FISHER W/ DOI IN D.C. @ (202) 633-3637.

RPWG
AA

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(301) 964-9200

Fax Number: (301) 964-5156
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To: Brian Ross cc: Hal Kibby

Company: EPA Anchorage

Fax Telephone #: 907 271 2467

Verification Telephone #:

From: Dan Sheehy

Date Sent: 12 March 96

Account # (For filing purposes only):

Number of Pages _____ Plus Cover Sheet

Notes: status contacts

MAC #2

12 March 1990 Status of Contacts
Restoration Planning Workshop
3-5 April 1990

Not appropriate and not available

Lee Harding	Environment Canada	Coastal Habitat
Recommends:	Tim Parsons Botany U. of British Columbia	
	John Vandermullen Bedford Institute of Oceanography Dept. of Fisheries and Oceans Nova Scotia	
	Carey McCalister Intertidal Pacific Biological Research Station Dept. of Fisheries and Oceans	
	Gary Sergi oil effects (Baffin I.)	
Ernest Seneca	NC State Univ.	Coastal Habitat

Interested, availability unknown on 3/12/90

Will Troyer	Ret. Nat'l Park Service	Mammals, Terr.

Attempted contact

Ken Chew	U. Washington School of Fish.	Fish.
Paul Dayton	Scripps	Ecol./Syn.
Howard Feder	U. Alaska	Shellf.
John Burns	Ret. AK Fish & Game	Mammals, Terr.
David Norton	N. Slope Borough	Birds
Noel Synder	AZ Fish & Game	Birds
Howard Sanders	WHOI	Coastal Hab.
Mike Foster	Moss Landing	Coastal Hab.

RPW6
AA

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Confirmation Number: (301) 964-9200 Ext. 350

To: Brian Ross

Company: EPA Anchorage.

Fax Telephone #: 907 271 2467

Verification Telephone #:

From: Dan Sheehy x 364

Date Sent: 9 March 90

Account # (For filing purposes only):

Number of Pages _____ Plus Cover Sheet

Notes: Contacted or left messages for all candidates on first list.

Stan Temple (Bird) Not Available
Dave Duggins (Coastal Hab) Not Available
Proceeding to contact remaining candidates Mon.
Scheduled to meet with Art Buikema on Tuesday.
Need (Number/Address (city) for Lee Harding. Env. Canada, Vancouver (604) 666-2917

MAC #3

RPWG
AA

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To: Brian Ross

Company: EPA Anchorage RPWG

Fax Telephone #: 907 271 2467

Verification Telephone #:

From: Dan Sheehy

Date Sent: 12 Mar 90

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Number of Pages 4 Plus Cover Sheet

Notes: I anticipate the following equipment requirements based on our visit to facilities and meeting organization

5 tape recorders (one backup)
4 overhead projectors
2 Slide projectors

If you feel this is adequate, let me know. I will contact CACI to make local pickup possible.

Add 4 flip-charts

MAC #3

TRW6
AA

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Columbia, MD 21045-1934
(301) 964-9200

Fax Number: (301) 964-5156
Confirmation Number: (301) 964-9200 Ext. 350

To: Brian Ross

Company: EPA Anchorage

Fax Telephone #: 907 271 ~~2464~~ 2467

Verification Telephone #: 907 271 2464

From: Dan Sheehy x364

Date Sent: 9 Mar 90

Account # (For filing purposes only):

Number of Pages _____ Plus Cover Sheet

Notes: Proceeding with contacts. Need further info on Harding (Eng. Canada) Status report to follow this PM.

10# 2812827 15:47 60/80

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Environmental Research Laboratory
CORVALLIS OR 97333

EPA

JPW-AA

FACSIMILE REQUEST AND COVER SHEET

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TO BRIAN ROSS

OFFICE/PHONE 271-2464

FAX #: 907-271-2467
CONF. #:

REGION/LAB

FROM Hal Kibby

PHONE (503) 757-4625

MAIL CODE

OFFICE ERL-Corv

DATE

NUMBER OF PAGES TO INCLUDE THIS COVER SHEET
5

Please number all pages

INFORMATION FOR SENDING FACSIMILE MESSAGES

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TBRIAN

* = Good Group I Know

Hal

TRANSMITTED

/
(Date) (Time)

CONFIRMED: _____

PAGE 1 OF 5 PAGES

Name	Affiliation/ Phone No.	Specialty	Relevant Experience
James Pratt	Penn. State (814) 865-6942	microbial ecology	NETAC bio-remediation conf. participant (Valdez)
Robert Spies	L. Livermore Lab. (415) 422-5792	benthic ecology	oil pollution effects, studied effects of natural pet. seeps in Santa Barbara, consultant for state of AK
Paul Dayton	SCRIPPS (619) 534-6740	general ecology	ecological succession in high lat.
Gordon Chan	College of Marin	intertidal	monitored recovery of rocky intertidal regions of CA coast
Jim Payne ——	SAIC (619) 587-9071	oil weathering processes	
John Scott ——	SAIC (401) 782-3817	toxicology, benthic ecology	
Andy Carey	Oregon State U. (503) 737-2525	benthic ecology	
Scott Overton	Oregon State U. (503) 737-3366	statistical ecology	environmental sampling theory
Thomas Bonickson	Texas A&M	ecological restoration	
William Cross	LGL Ltd. Canada		controlled oil spill studies with dispersants & fertilizers

Jack Gallagher U.N.D. - S. Del Wetlands wetlands restoration

Name	Affiliation/ Phone No.	Specialty	Relevant Experience
Collin Lewis	Fisheries & Oceans Canada (604) 666-7915		
John Rodgers	U. of Mississippi (601) 232-7203	toxicology	remediation
Tom Cade	Peregrine Fund (208) 362-3716		restoration of bald eagle in Rocky Mountains
Ron Tjeerdema	USC, Santa Cruz (408) 624-0946		oil spill response & restoration for state of CA
Kenneth Dickson EPA - SAB	U. of N. Texas (817) 565-2694	environ-mental science	restoration, toxicology
John Farrington	U. of MA, Boston (617) 287-7440	biogeo-chemistry	fate & effects of spilled oil; Argo Merchant, Exxon Valdez spills
Ralph Portier	LUMCOM	microbial ecology	bioremediation
Peter Peterson	U. of N. Carolina (919) 726-6841	benthic ecology	
Jacqueline Michel		marine mammology?	
Charles O'Clair	NMFS, Auke Bay (907) 789-6016	subtidal	distribution of hydrocarbons in subtidal sediments; effect of oil on Dungeness crabs in/out PW Sound
Rita O'Clair	NMFS, Auke Bay (907) 789-6016	intertidal	intertidal ecology in AK
Stanley Rice	NMFS, Auke Bay (907) 789-6020		lab. physiological studies on response to oil pollution

ART Buikema EPA - DC
We Are Working on getting ART.

Restor

Name	Affiliation/ Phone No.	Specialty	Relevant Experience
John Cairns	VPI (703) 231-5538	FW generalist	restoration
Robert Howarth	Cornell (607) 255-3572	general ecology	modeling oil spill effects on fisheries, restoration consultant to state of AK
Robert Huggett	VIMS (804) 642-7236	organic chemistry	behavior of pet. hydrocarbons in sediments
Mike Rugg	CA Fish and Game (707) 944-5523		restoration of San Fransico Bay wetlands, Martinez spill
Robert Paine	U. of Washington (206) 543-1649	marine pop. bio.	peer reviewer Valdez spill
Charles Simenstadt	U. of Washington (206) 543-7185	fisheries	wetlands & estuarine ecology & restoration
Ron Thom	U. of Washington (206) 545-2724		eel grass restoration
David Duggins	Friday Harbor Lab (206) 543-1484		aquatic plant & herbivore interactions in Puget Sound
Michael Foster	Moss Landing Lab (408) 633-3304	intertidal subtidal	Alaskan kelp bed ecology, recovery from Santa Barbara spill, recolonization of rocky shores
Joseph Connell	USC Santa Barbara (805) 968-2764	general ecology	
Ron Atlas*	U. of Louisville (502) 588-5555	microbial ecology	bioremediation in PW Sound

GARY SERGI ENVIRONMENT CANADA High Arctic Oil Spill Recovery BIOS

Other Experts:

1)Lloyd Lowery — Alaska Department of Fish and Game - Fairbanks Outstanding individual, excellent ecologist, good on synthesis of lots of facts. Husband of next person.

2) Kathy Frost — Ecologist that knows Prince William Sound also with Alaska Fish and Game. Wife of above person. (That makes sense doesn't it you know my dumb logic)

*3) Bob Weeden — Wildlife Habitat expert University of Alaska Fairbanks. Recommended to Mona Haebler by Lloyd.

*4) John Oliver — Subtidal ecologist with extensive experience in anartica and in arctic, particularly in Prince William Sound. Currently at Moss Landing.

5) Joanna Berger — Effects of oil on biota other than mammals. Joanna is at Rutgers University Institute of Environmental and Occupational Health Sciences.

? 6) Page Spencer — Page is a restoration specialist with the National Park Service and has excellent knowledge of Prince William Sound before during and after the spill. Reputation has her as an extremely productive person.

Highly recommended maybe Agency Expert!

7) Dave Duggins — University of Washington specialist on Marine invertebrates. Unknown experience in arctic and subarctic areas. Currently at Univ of Washington.

8) Kathy Anne Miller Also at Univ. of Washington marine algae

9) Terry Chapin — Ecologist at University of California formerly working on north slope and formerly with University of Alaska.

10) Dot Helm — Plant ecologist with U of Alaska extension Office in Palmer.

11) Will Troyer — Retired from National Park Service is a wildlife expert, particularly on bears.

12) Cal Lensenik — US Fish and Wildlife Service in Anchorage

13) Dan Rosenburg — Wetlands specialist with Alaska Fish and Game in Anchorage.

Brian - I suspect you know many of these folks better than I, but all come highly recommended by folks I trust. Hal

AA

EXPERT WITNESS AGREEMENT

_____, in consideration of his employment by the U.S. Environmental Protection Agency ("EPA") as an expert consultant ~~and witness~~ in the matter of the Exxon Valdez oil spill, agrees as follows:

1. This contract covers expert consultant ~~and witness~~ services in connection with this matter.

2. All documents or other information provided to me by the United States, State of Alaska or other party in this matter for my review in connection with this matter shall be treated as confidential; I shall not reveal any of this information to any person without prior written approval by the EPA or the U.S. Department of Justice.

3. All documents, information or other work developed by me in connection with this matter ~~is~~ ARE privileged and confidential; I shall not reveal any of this information to any person without prior written approval by the EPA or the Department of Justice.

4. During the pendency of actual or potential litigation relating to this matter, I shall not enter into any agreement with any other person who is a party or potential party to this matter for any purpose, whether or not it relates to pending litigation, without prior written approval by the EPA or the Department of Justice.

5. I have not entered into any contract related to this matter with any person other than the United States.

6. I will deliver to the EPA within 90 days of the expiration of my contract all documents or other data furnished to me by the United States or any other party to this matter in connection with my work on this matter, UNLESS INSTRUCTED OTHERWISE IN WRITING BY EPA OR DOJ.

7. I shall require any person that I hire to assist me in connection with my work on this matter to sign an agreement containing provisions identical to this Agreement.

Dated:

_____

BRIAN -
This should probably go out on Federal letterhead, either DOJ or EPA
Dan.

RPWG
AA

Status of Contacts as of 13 March 1990
Restoration Planning Workshop
3-5 April 1990

Attending

Howard Sanders	WHOI	Coastal Habitat
Michael Foster	Moss Landing	Coastal Habitat
Howard Feder (conflict on 4/5/90)	U. AK	Fish./Shellf.
Noel Snyder (conflict on 4/5/90)	AZ Fish & Game	Birds

Not appropriate and not available

Lee Harding	Environment Canada	Coastal Habitat
Recommends:	Tim Parsons Botany U. of British Columbia	
	John Vandermullen Bedford Institute of Oceanography Dept. of Fisheries and Oceans Nova Scotia	
	Carey McCalister Intertidal Pacific Biological Research Station Dept. of Fisheries and Oceans	
	Gary Sergi oil effects (Baffin I.)	
Ernest Seneca	NC State Univ.	Coastal Habitat

Not available

Stan Temple	U. Wisconsin	Birds
Ken Chew	U. Washington	Fish./Shellf.
Recommends:		
	Ron Thom Benthos/Marsh grasses U. Washington	

Dave Duggins	U. Washington	Coastal Habitat
Recommends:		
	Cathy Ann Miller UC Berkeley School of Fish.	Algal Ecologist
John Teal	WHOI	Ecol./Syn.

Interested, availability unknown on 3/13/90

Will Troyer	Ret. Nat'l Park Service	Mammals, Terr.
David Norton	N. Slope Borough	Birds

Attempted contact

Paul Dayton	Scripps	Ecol./Syn.
John Burns	Ret. AK Fish & Game	Mammals, Terr.
David Armstrong	U. Washington	Fish./Shellf.
Will Barber	U. AK	Fish./Shellf.

TPWG
AA

March 5, 1990

MEMORANDUM

Subject: Non-Agency Contacts for Technical Workshop

Brian Ross

From: Brian D. Ross
EPA, Alaska Operations Office

To: Dan Sheehy
VERSAR

Attached are prioritized lists of "outside experts" that the Restoration Planning Work Group would like you to contact for the workshop to be held April 3-4, 1990 in Anchorage. Highest priority should be given to names on the first list. If an expert from this list is unavailable for any category, contact the person from that category on the second list. If people from the second list are also unavailable, other names from the overall lists already approved by the Restoration Planning Work Group should be contacted (no prioritization has been established for these others). Note that the Work Group has approved your contacting any of the names on the second list you typed (mammals and archeology experts) with the exception of John Fowler. In addition, two names were added to that list: John Burns (marine mammals, first priority list) and Jack Lentfir (also marine mammals, third priority). A few other names may be added by the Work Group, particularly for fisheries and recreational resources. These will be forwarded Tuesday or Wednesday. Phone numbers for some of the blanks appearing below, will be coming Tuesday, as well.

Also attached is the memo I sent to the Work Group members transmitting the two initial lists, for your records.

First Priority

Ken Chew	U. Washington School of Fisheries	Fish/Shellf.
Howard Feder	U. Alaska, Fairbanks	Fish/Shellf.
Dave Duggins	U. Wash., Friday Hbr. Lab	Coastal Hab.
Lee Harding	Environment Canada	Coastal Hab.
Will Troyer	Ret., Nat'l Park Serv.	Mammals, Ter.
John Burns	Ret., Ak Fish & Game	Mammals, Mar.
Stan Temple	U. Wisconsin	Birds
David Norton	N. Slope Borough	Birds
John Teal	Woods Hole Oc. Inst.	Ecology/ Synthesis
Paul Dayton Bill Odum ?	Scripps Inst.	Ecology/ Synthesis
(Bob Thorne	Cent. Archeological Resources	Archeology)
(Martin McAlister	?	Archeology)

Note: Contacts for the Cultural/Recreational workshop to be made only after confirming that funds are available to cover travel & other expenses for this workshop.

Second Priority

Dave Klein	U. Alaska Fairbanks (Wildlf Coop.)	Mammals, Ter.
Noel Snyder	Arizona Fish & Game	Birds
Ancel Johnson	Ret., US Fish & Wildlife Serv.	Sea Otters

All Other Contacts Are Third Priority At This Time.

TPWG
AA

TECHNICAL WORKSHOP NO. 1

GROUP (mark one): (A) Fish and Shellfish
Coastal Habitats
Mammals
Birds

(B) Cultural
Recreation

PARTICIPANTS BY CATEGORY:

Summary Scientist for Damage Assessment Results:

Group Chairman:

Principal Investigators:

Peer Reviewers:

"Outside" Experts:

Agency Representatives:

RPWG
AA

DRAFT**DRAFT**DRAFT**DRAFT
(Version 1: March 1, 1990)

Objectives, Agenda, and Products
Technical Workshop on Restoration, No. 1-A
April 3-5, 1990

Objectives

1) Review initial damage assessment results with respect to potential restoration alternatives

2) Educate members of the Restoration Planning Working Group (RPWG) and Damage Assessment team about the state of the art in restoration technology and opportunities

3) Develop broadly-inclusive matrix with restoration alternatives that warrant further evaluation (including restoration, replacement, and acquisition of equivalent resources)

4) Develop criteria for evaluating restoration alternatives, rank alternatives on a preliminary basis, and identify information needs/candidates feasibility studies necessary to fully evaluate restoration alternatives

Agenda

Day 1--08:30 h

Introduction and Overview (1 h) (plenary session)

Restoration planning process (RPWG member)

Legal framework for restoration (RPWG member?)
what constitutes restoration?
what are appropriate uses of restoration funds?

Responsibilities of/products from the participants (RPWG member)

Natural Resource Damages (2.5 h) (plenary session)

Fate and current status of the spilled oil

Summary of damage assessment results

Coastal habitat

Fish and shellfish

Mammals, marine and terrestrial

Birds

Lunch (1 h)

Reconvene (10 min) (plenary session)

Working Groups (4 h) (concurrent sessions)
(Four groups: coastal habitat, fish and shellfish, mammals, and birds)

Introduction (group chairman)

State of the art in restoration (outside[1] experts)

Review of damage assessment results and implications for restoration (principal investigators)

Discussion of restoration opportunities (group chairman)

Product: summarize working group discussion from afternoon to serve as starting point for Day 2

Day 2--08:00 h

Summary of progress of working groups (0.5 h) (group chairman) (plenary session)

Working Groups (3.5 h) (concurrent sessions)

Continue discussion of restoration alternatives (group chairman)

Product 1: outline of restoration alternatives in relation to damaged resources (start of matrix)

---

[1]The term "outside" refers to individuals outside of the damage assessment process; not necessarily experts from outside of the State of Alaska (although some may be from out of the state).

Develop criteria (w/weighting) for evaluating restoration alternatives, rank alternatives based on these criteria (preliminary only), and identify information needs/candidate feasibility studies needed for full evaluations of alternatives

Product 2: outline of criteria, ranking, and information needs/candidate feasibility studies

Lunch (1 h)

Summary of working group products[2] (1 h) (plenary session) (group chairman)

Wrap up and discussion of next steps (0.5 h) (RWPG member)

[2]If necessary, the working groups can continue their sessions after lunch.

RPWG
AA

U.S. Department of Justice

LAND & NATURAL RESOURCES DIV.
LITIGATION SUPPORT GROUP
601 PENNSYLVANIA AVE.,NW
WASHINGTON, D.C. 20004

Telefax # (202) 724-5854
Confirmation # (202) 272-6210

TO: BRIAN ROSS, EPA ANCHORAGE

FROM: BOB CHABRON, DOJ, WASHINGTON

NUMBER OF PAGES (INCLUDING COVER SHEET): 5

TELEFAX #: (202) [redacted] 724-5854

CONFIRMATION #: (202) 272-6211

DATE/TIME SENT: MARCH 1, 1990 12:35

MESSAGES:

March 1, 1990

Enclosed are some samples and examples of the formal agreements made with our experts.

In the past these agreements have been obtained by Jim Nicoll and Gary Fisher. They have been the ones who have contacted the experts and then passed copies of the agreements on to me. I don't know what verbal understandings may have been made with the experts outside of what appears on these forms.

Bob Charron

U.S. Department of Justice

Expert Witness Agreement

INSTRUCTIONS: Form should be prepared after submission and approval of Form OBD-47, Request and Authorization for Fees and Expenses of Witnesses. Each copy of this form must be signed by the negotiating attorney and the expert witness.
DISTRIBUTION:
ORIGINAL: Hold and submit to Accounting Operations Group, Finance Staff/OC/JMD with the original payment voucher.
COPY NO. 1: To Expert Witness
COPY NO. 2: To Negotiating Attorney
COPY NO. 3: To Special Authorizations Unit, Procurement & Contracts Staff/JMD

Name of Case: Exxon Valdez Oil Spill

Division or Judicial District:

Name and Address of Expert Witness: Dr. Nancy Bockstael
207 Northwood Drive
Silver Spring, MD 20901

Expert's Field: Environmental Economics

Preparation
$ 1,200.00 Rate per day; or
$ 150.00 Rate per hour;
Estimated time: ______ Days; or ______ Hours
$ ______ Incidental expenses. (*Laboratory analysis, charts, etc.*)
Specify ______

Subsistence (*Check one*)
☐ Included in the fees above.
☐ At the rate of $ ______ per day
(*prorated by quarter days for fractional days*)
☒ Actual expenses not exceeding $150.00 per day
(*to be itemized on payment voucher*)
☐ Other (*Specify*)

Court Attendance
$ ______ per day for ______ days; or
$ ______ per hour for ______ hours.

Transportation (*Check appropriate box(es)*)
☒ Common carrier, at less than first-class accommodations
☒ Taxi fares to and from terminals
☐ Privately owned vehicles at ______ cents per mile for travel of 200 miles or less, one way
☐ Privately owned vehicle, not exceeding cost by common carrier at less than first-class rates
☐ Special conditions (*Specify*) ______

Number of round trips anticipated: ______

TERMINATION FOR THE CONVENIENCE OF THE GOVERNMENT

The Contracting Officer, by written notice, may terminate this agreement, in whole or in part, when it is in the best interest of the Government. To the extent that this agreement is for services and is so terminated, the Government shall be liable only for payment in accordance with the payment provisions of this agreement for services rendered prior to the effective date of termination.

Description of Duties (*Explain details of service to be performed and other conditions.*)

To assist in preparation of the United States' natural resource damages claims arising from the Exxon Valdez oil spill including advice regarding the determination of the scope of damage to wildlife and the environment.

Witness is expected to testify at trial.

This contract is subject to the conditions in Attachment A.

(*Continue on reverse*)

Signature (*Government Attorney*)	Date	Signature (*Expert Witness*) I agree to perform the above service and appear as a witness on behalf of the Government.	Date
James L. Nicoll, Jr. Senior Attorney		Nancy E. Bockstael Dr. Nancy Bockstael	5/20/89
Name and Title (*Government Attorney*)		Name and Title (*Expert Witness*)	

ATTACHMENT A

EXPERT WITNESS AGREEMENT

NANCY BOCKSTAEL, in consideration of her employment by the U.S. Department of Justice as an expert consultant and witness in the matter of the Exxon Valdez oil spill, agrees as follows:

1. This contract covers expert consultant and witness services and does not cover studies or investigations done as a principal investigator in connection with damage assessment.

2. All documents or other information provided to me by the United States, State of Alaska or other party in this matter for my review in connection with this matter shall be treated as confidential; I shall not reveal any of this information to any person without prior written approval by the Department of Justice.

3. All documents, information or other work developed by me in connection with this matter is privileged and confidential; I shall not reveal any of this information to any person without prior written approval by the Department of Justice.

4. During the pendency of actual or potential litigation relating to this matter, I shall not enter into any agreement with any other person who is a party or potential party to this matter for any purpose, whether or not it relates to pending litigation, without prior written approval by the Department of Justice.

5. I will deliver to the Department of Justice within 90 days of the expiration of my contract all documents or other data

furnished to me by the United States or any other party to this matter in connection with my work on this matter.

6. I shall require any person that I hire to assist me in connection with my work on this matter to sign an agreement containing provisions identical to this Agreement.

Dated:
5/20/89

Nancy E. Bockstael
NANCY BOCKSTAEL

ATTACHMENT C

Expert Confidentiality Agreement

_____, in consideration of his employment by ********** as an expert consultant and/or witness in the matter of the _____ agrees as follows:

1. This agreement covers expert consultant and/or witness services in connection with this matter and does not cover studies or investigations done as a principal investigator in connection with damage assessment work done in connection with this matter.

2. All documents or other information provided to me by the United States,_____ or other party in this matter for my review in connection with this matter shall be treated as confidential; I shall not reveal any of this information to any person without prior written approval.

3. All documents, information or other work developed by me in connection with this matter is privileged and confidential; I shall not reveal any of this information to any person without written approval.

4. During the pendency of actual or potential litigation relating to this matter, I shall not enter into any agreement with any other person who is a party or potential party to this matter for any purpose, whether or not it relates to pending litigation, without prior written approval.

5. I will turn in to the contractor for return to the Department of Justice within 90 days of the expiration of my contract all documents or other data furnished me by the United States or any other party to this matter in connection with my work on this matter.

6. I shall require any person that I hire to assist me in connection with my work on this matter to sign an agreement containing provisions identical to this Agreement.

Dated:

_____
(Signature)
Typed Name

RPWS
AA

February 21, 1990

To: Hal Kibby
Ecotoxicology, Corvallis ORD

From: Brian Ross
Alaska Operations Office, Anchorage

Re: Scope of Work for Coordination of the
Restoration Planning Technical Workshop

The Restoration Planning Work Group held an all-day (really!) meeting by conference call yesterday (2-21-90). Regarding the proposed Versar scope of work, I have quite a bit to report. First, there was considerable lack of comfort over any appearance that the contractor would "control" the invitees. It took a bit of effort to convince everyone that the contractor is prepared to help the work group. Finally, there was agreement that the contractor should do the following:

1. Prepare the 'state of the science' working paper;
2. provide logistical support during the workshop; and
3. prepare the summary report following the workshop.

In addition, there was agreement that the contractor could propose names of appropriate outside experts for the work group's consideration, providing that the work group clearly has final word over attendees. Upon approval of suggested names (which the work group could give within a day or two), the contractor would contact and otherwise make arrangements for their attendance. The work group members will retain responsibility to contact and make arrangements for agency experts. In other words, the general compromise you and I discussed was ultimately agreed-to!

However, there are other issues. First, the work group insists upon trying to cover the full range of potential restoration approaches (e.g., including replacement, and acquisition of equivalent value resources) to the extent possible at this workshop. To this end, it is proposed that we assume an entire week (5 days) should be devoted to it. For individual topics, experts could come and go without staying the entire time. Other invitees, such as those with particular ecological overview perspectives, would stay longer. Some workshop sessions could run concurrently, for example. I pointed out the need, for

contracting purposes, to be as specific as possible about the support we need; but in truth, no one seems able to address this level of detail right now - they're all swamped by symposium planning. Nevertheless, I did get some guidance: First, the work group wants to shoot for the week of April 2 for this workshop. If this week is absolutely impossible, the week of April 16th is possible (however, the workshop should not start until noon in this case, to avoid asking people to travel on Easter Sunday). The week of the 16th for a fall-back also conflicts with a sea otter conference being held in Anchorage at that time. The week of April 9th was vetoed because of Passover. Would you please get back to me as soon as possible regarding the feasibility of April 2 through 6?

Now for more good news. There is, as you might expect, substantial interest in getting John Cairns involved in the technical workshops somehow. Cairns' first opening of any kind is the week of May 13-19. On the (reasonable) assumption that not everyone else we may wish to hear from will be available in early April, the work group wants to plan a second, follow-up technical workshop for the week of May 14. I did not commit EPA to being able to help with this second workshop. I did note, however, that if we have additional funding squared away by then it may be possible to use the same contractor for support. This would have obvious advantages from the perspectives of continuity, logistics, and report preparation. Also, if we do have additional funding by then, I think it's very appropriate for EPA to stay as closely associated with the technical expert workshops as we can (even more so than other "scoping' activities like the symposium and public meetings).

One good aspect to having another technical workshop later on is that it could possibly take some of the pressure off the first one. In other words, concerns about "diluting" the value we could get from our invited experts (by having a more broadly-focused first workshop) might be less acute. In any event, I recognize that this can significantly complicate the contractor's end of things. I suggest that for some of the "non-scientific" areas to be covered at the overall workshop, the contractor should rely on the agencies to arrange the invitation list, etc., and continue to focus on the aspects more specifically related to direct ecological recovery options. If we do this, and assuming for the time being that we address only the first workshop, might this actually be less work for the contractor in that the agencies would make many of the speaker arrangements themselves? At least, would it give the contractor more time to focus on the "state of the art" paper? (Help me here: I'm looking for something positive in all this!) Then again, it means more to record and summarize.

To summarize, we have agreement to proceed with the three main tasks of the work assignment right away, a proposal to hold the workshop the week of April 2nd, and a desire to start seeing lists of proposed names (including affiliations and areas of expertise - i.e., a quick blurb telling us why we should have these people invited). In addition, we will be planning for a second technical workshop to catch key people we may have missed in April, to help us synthesize what have been proposed by that time, and to help us finalize any proposals for summer, 1990 feasibility studies. To help speed things up for you, I've marked-up the text of the scope of work you sent me yesterday, as well (attached).

Call me when you get a chance to digest all this - I'll be at (907) 271-2464 or -2461. Thanks! (And welcome to the FUN world of restoration!)

(503) 757-4799 20# 7307137 08/20 16:41

BRIAN - PLEASE CALL HMC.

Home Phone (503) 757-0165

Work 8-420-4625

DRAFT SCOPE OF WORK

I. TITLE: Program Coordination for the Restoration Planning Workgroup Technical Workshop on the Development of Restoration and Monitoring Plans for the Valdez Oil Spill.

X = CHANGES ON THIS LINE

II. INTRODUCTION:

The U.S Environmental Protection Agency's (EPA), Corvallis Environmental Research Laboratory is currently supporting studies for the Office of Water and the Restoration Planning Workgroup in their ~~effort to develop a~~ restoration plan ING EFFORTS for natural resources damanaged as a result of the Exxon Valdez Oil spill which occurred during March 1989. This program is a multiagency effort including federal and state agencies. EPA efforts are being coordinated by Office of Environmental Processes and Effects Research (OEPER) and the Office of Water. The EPA program goals are to ~~assess~~ REVIEW the impact of the oil spill on natural resources, INCLUDING ~~document~~ the temporal and spacial extent and magnitude of the damage, to test and evaluate bioremediation technologies, and to participate in the development of restoration plans including development of a monitoring plan to track recovery processes.

The multiagency program to assess damages and evaluate remediation efforts has been underway since March 1989 and the preliminary information on the extent and magnitude of damages and initial recovery processes on which to base a restoration plan is available. OEPER is interested in assisting the Restoration Planning Workgroup in evaluating this information with the goal of ~~deciding what~~ IDENTIFYING types of restoration measures ~~are~~ THAT MAY BE appropriate, and how the performance of any selected measures or the natural restoration process itself should be monitored and assessed. In addition, a public SCOPING meetings ~~to discuss remaining concerns and issues related to~~ RELATING TO RESTORATION FROM the Valdez oil spill will be held IN LATE MARCH ~~on 24 and 25 March 1990~~. AND EARLY APRIL, 1990.

THE RESTORATION PLANNING PROCESS

To aid in ~~accomplishing this goal~~, a multiagency/organization workshop will be held in Anchorage, Alaska during EARLY APRIL, ~~the period 28-30 March 1990~~. The participants WILL INCLUDE scientists from federal agencies, academia, and private activities, WHO PARTICIPANTS will ~~establish a framework to~~ assist EPA and the other agencies involved in ~~developing a~~ restoration plan NING in ~~making decisions concerning~~ IDENTIFYING ~~future requirements~~ NEEDS AND OPPORTUNITIES for restoration and/or monitoring. The agenda for the conference will include confidential presentations on the status and interim results of ongoing natural resource damage assessments, an evaluation of current restoration methods and their past performance, and the ~~preparation~~ IDENTIFICATION of resource-specific ~~recommendations~~ OPTIONS for restoration activities and/or monitoring ~~requirements and~~ methods appropriate for the natural resources adversely affected by the Valdez oil spill. The goal of this work assignment is to provide technical and logistical support for this workshop, contact and arrange for participation of key (6-10) NON-AGENCY scientists, as well as to document the discussions, ~~particularly the~~ concerns, and issues raised at the ~~public meeting to be held on 24 and 25 March~~. WORKSHOP.

EMPHASIS WILL BE PLACED ON

III. SCOPE OF WORK

Versar, Inc. (the Contractor) agrees to provide technical and logistic support for the following tasks.

Versar will assist the Restoration Planning Workgroup and the Office of Water to identify potential technical experts, session leaders, and support requirements. Versar will coordinate efforts to contact outside (NON-AGENCY) experts to determine their availability, interest in participation, and areas of expertise. Versar will prepare an executive summary (i.e., working white paper) that will outline the current state of science for natural resource and habitat restoration ~~methods~~ for oil spills on high latitude ecosystems.

This summary will be a working document which will serve as an introduction to the subject and be suitable for expansion and clarification after the completion of the workshop into a document that can support the final multiagency restoration plan. Versar staff will work with the workshop committee in conducting the workshop and will record the proceedings, serve as rapporteurs, and provide logistic support as required. Versar will be responsible for preparing a summary report documenting the information presented during the workshop as well as a list of restoration AND DISCUSSION and monitoring ~~recommendations~~. OPTIONS DEVELOPED DURING THE WORKSHOP.

IV. REPORTING REQUIREMENTS

DATE? → Versar shall submit a list of potential technical specialists identifying their specialties, and experience to OEPER by 26 February 1990. Versar will submit a draft executive summary by 19 March 1990 outlining the state of science in natural resource restoration methods applicable to oil spill impacts. A draft report summarizing the presentations, discussions, and recommendations resulting from the workshop will be submitted by 30 April 1990. Versar shall keep record of all persons contacted or solicited to participate in the workshop as well as audio and/or video tapes resulting from the workshops. Versar shall notify the task manager by telephone or Telefax of any problems which may impede the progress of the SCHEDULED workshop or deliverables.

STAFFING

Dr. Dan Sheehy will have overall responsibility for this task as project manager for Task No. ___. Dr. Sheehy will provide liaison between the EPA Task Manager and Versar. Dr. Jeff Frithsen will provide technical support to assist in developing recovery monitoring plans. Versar will provide a total of four staff members to provide direct onsite support during the conference. This will include Drs. Sheehy and Frithsen and two additional technical staff.

HAL - IS IT CLEAR ENOUGH THAT VERSAR WILL SUPPORT, RECORD, & REPORT ON WHOLE WORKSHOP, BUT BE RESPONSIBLE FOR WHITE PAPER ON DIRECT RECOVERY ONLY, AND FOR CONTACTING NON-AGENCY EXPERTS ONLY? ALSO, WOULD VERSAR PAY TRAVEL FOR THEM BY THIS CONTRACT?

FAX COVER SHEET

Date: 2-21-90

This FAX is directed to: HAL KIBBY - ECO TOX

Please notify this person that they have been sent a fax.

URGENT? ☒ Yes ☐ No

Department:

Company: EPA - CORVALLIS

Business Phone -4625 FAX Phone: (503) 757-4799

Number of pages (including this cover sheet): 6

Special instructions:

This FAX has been sent by: B. ROSS
Department: A00/A
Company: EPA
Phone: 271-2464

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Kinko's
2210 E. Northern Lights Blvd
Anchorage, Alaska 99508

02/20 16:41 7807187 #02

BRIAN - PLEASE CALL RWG AA

HOME PHONE (503) 757-0165 HAL. WORK 8-470-4625

DRAFT SCOPE OF WORK

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02/20 16:41 7307187 #01

EPA ENVIRONMENTAL RESEARCH LABORATORY
CORVALLIS OR 97333

FACSIMILE REQUEST AND COVER SHEET

PLEASE PRINT IN BLACK INK ONLY

TO: BRIAN ROSS

OFFICE/PHONE: (907) 271-2464

FAX #: (907) 271-2467
CONF. #:

REGION/LAB:

FROM: Hal Kibby

PHONE: FTS-420-~~4612~~ 4625
WORK ~~Home~~ Home (503) 757-0165

MAIL CODE:

OFFICE: ERL - CORVALLIS

DATE: 2/20/90 ~~2/17/90~~ ~~2/15/90~~

NUMBER OF PAGES TO INCLUDE THIS COVER SHEET: ~~3~~ 3

Please number all peges

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 2/20/90 9:35 am
~~2/20/90 3:30~~
(Date) (Time)

CONFIRMED:

Verify contact all non-agency (univ. etc) w/ WB approval of names
RPWB contact all agencies

PAGE 1 OF 2 PAGES

AQ Sci Brooks Poll. abate - list of

Aq. Sci Hab. Creation, Dan Sheehy - (301) 964-9200
etc; 3409 refs
if limit to marine/shoreline ~~1220~~ 1500 if incl streams, etc but not marine

NAS Academy of Sciences

OCTOBER 1989

COMMITTEE ON RESTORATION OF AQUATIC SYSTEMS: SCIENCE, TECHNOLOGY, AND PUBLIC POLICY

NAME	ADDRESS	TELEPHONE
John Cairns, Jr. (Chairman)	Center for Environmental and Hazardous Materials Studies Virginia Polytechnic Institute and State University Blacksburg, Virginia 24061-0415	(703) 231-7075
G. Ronnie Best	Ecologist and Associate Director Center for Wetlands Phelps Laboratory University of Florida Gainesville, Florida 32611	(904) 392-2424 (O) 378-2385 (H)
Patrick L. Brezonik	Water Resources Research Center 860 Bio Sciences Center University of Minnesota Minneapolis, Minnesota 55108	(612) 624-9282
Stephen R. Carpenter	Center for Limnology University of Wisconsin Madison, Wisconsin 53706	BITNET:SRCLAKE@ WISCMACC (608) 262-8690 Sec. phone: (608) 262-2840
G. Dennis Cooke	Department of Biological Sciences Kent State University Kent, Ohio 44242	(216) 672-3613 or 3429
Donald L. Hey	Wetlands Research, Inc. 53 West Jackson Boulevard, Suite 1401 Chicago, Illinois 60604	– (312) 922-0777
Jon A. Kusler	Executive Director Association of State Wetland Managers P.O. Box 2463 Berne, New York 12023	(518) 872-1804
Claire L. Schelske	University of Florida Department of Fisheries and Aquaculture 7922 NW 71st Street Gainesville, Florida 32606	(904) 392-6903
Rebecca R. Sharitz	Savannah River Ecology Laboratory Drawer E Aiken, South Carolina 29802	(803) 725-2752

Clarence M. Skau	University of Nevada-Reno 12295 Brentfield Reno, Nevada 89511	(702) 851-2211
Richard E. Sparks	Illinois Natural History Survey River Research Laboratory of the Forbes Biological Station P.O. Box 599 Havana, Illinois 62644	(309) 543-3950
James T. B. Tripp	Environmental Defense Fund 257 Park Avenue, South New York, New York 10010	(212) 505-2100 ext. 304
Daniel E. Willard	School of Public and Environmental Affairs Indiana University Bloomington, Indiana 47405	(812) 855-9485

CONSULTANT

John J. Berger	Restoring the Earth Home Address: 419 Talbot Avenue Albany, California 94706	(415) 527-7530

NRC STAFF

Sheila D. David	Staff Officer Water Science and Technology Board 2101 Constitution Avenue, NW, HA278 Washington, D.C. 20418	(202) 334-3422

EX OFFICIO

M. Gordon Wolman	Department of Geography and Environmental Engineering 313 Ames Hall The Johns Hopkins University Baltimore, Maryland 21218	(301) 338-7090 or 5533

RPWG
AA

February 8, 1990

Ken -

Here is a draft of a memo I propose to send out next week asking the Laboratory Directors to Help us set up a technical Advisory Panel for Restoration Activities. I intend to discuss it with Brian Ross on Monday before we send it out. Any comments that you have would be most welcome.

Hal

FROM: Gary Chapman and Hal Kibby, Coordinators
ORD Restoration Activities - Prince William Sound

Subject: Technical Advisory Panel for Restoration of Prince William Sound

To: See Below

The purpose of this memo is to ask your assistance in putting together an EPA technical advisory panel for restoration of Prince William Sound. If you have people with expertise in restoration or monitoring of ecological resources we would appreciate your naming one or two people from your laboratory that could serve on this advisory panel. If you have any questions please do not hesitate to contact either one of us. (Gary Chapman ERL-Narragansett 8-503-867-4027 or Hal Kibby ERL -Corvallis FT^S 420 4625)

EPA has been designated by the President to coordinate the planning of restoration activities on behalf of the Federal Government. The Office of Water has been given the lead ~~to develop a Restoration Plan.~~ The Office of Research and Development (ORD) has been asked to assist Region X, the Office of Marine and Estuarine Programs (OMEP) and the Restoration Planning Work Group (RPWG) ~~in the development of~~ Restoration Plans for Prince William Sound. Within ORD the Office of Environmental Processes and Effects Research (OEPER) has been assigned the lead to coordinate our participation.

At present, ORD is ~~expected to contribute~~ conducting undertaking to the following activities:

1) Conduct a comprehensive literature review ~~on~~ restoration of ~~oil~~ damaged ecosystems. The literature search will cover both techniques to restore habitats as well as literature on natural recovery of systems following oil spills.

2) Develop a "State of the Art" ~~document on~~ working document on techniques for restoration of habitats of Prince William Sound.

3) Assist in the planning for a technical workshop on restoration following public meetings in Alaska on March 23 and 24.

lit review + expert workshop

Probably Vernon (working w/ P. Bourhema & Cairns)

ORD will assist RPWG in the writing of the Restoration Plan due in June of 1990.

4) Develop ~~six to eight~~ demonstration projects, applicable to restoration of damaged resources. ~~Possibly one to three~~ of these could be funded and initiated in the Summer of 1990.

5) Assist the Regional Office and RPWG in the development of a long range monitoring plan that documents the recovery of Prince William Sound.

While the short term assignment is not intended as a research planning exercise, we fully expect that during the course of events over the next 4 or 5 months that several research opportunities may arise and provide us with some ideas for an initiative for FY 93

In order to most efficiently provide the necessary technical assistance we have decided to set up a technical advisory council of ORD and other EPA scientists. It is expected that the technical advisory council will participate in biweekly conference calls, review documents and participate in the technical workshop to be held March 26 through 29 in Anchorage.

[Question on Dates]

[Travel paid by individual Labs]

ORD Laboratory Directors
Ken Hood
Mike Slimak
Conrad Kleveno, OMEP
Art Buikema OPP
Brian Ross

RPwb
AA

DRAFT - Subject to revision by Brian Ross and Restoration Planning Work Group. Final outline to become part of VERSAR scope of work.

February 26, 1990

Draft Outline of Report

I. Introduction -

II. Zones (Habitats) [Wetlands, Freshwater, Wildlife (Terrestrial) Intertidal, Subtidal]

A. Major populations and Habitats within Zone
(For each major population and/or habitat type:
1. Discussion of Damage and Extent of undamaged resource
2. Importance of Resource - Within Zone (Habitat)
3. Importance of Resource within Prince William Sound

B. State of Art of Restoration Techniques for the resource

C. Specific Options for Prince William Sound + GULF OF AK
1. Objective
2. Description
a. What is to be done
b. What will be accomplished (How fast will this speed natural recovery
c. What damage can be caused
3. Probability of Success
4. Estimated Cost - $ and Manpower

III. Synthesis Chapter which discusses the relative merits of above options and possible combinations of restoration options.

IV. Appendix - CANDIDATE Demonstration Projects

A. Objective

B. Rationale
1. What do I need to know?
2. What is State of Art? (Summarized from Main Report)
3. What will this specific project tell me?

C. Approach
1. Description of what is to be done
2. Statistical design of project so that success can be measured.

D Resources
1. R&D
2 Federal FTE

U.S. Department of Justice

TRG
AA

LAND & NATURAL RESOURCES DIV.
LITIGATION SUPPORT GROUP
601 PENNSYLVANIA AVE.,NW
WASHINGTON, D.C. 20004

Telefax # (202) 724-5854
Confirmation # (202) 272-6210

TO: BRIAN ROSS, EPA ANCHORAGE

FROM: BOB CHARRON, DOJ, WASHINGTON

NUMBER OF PAGES (INCLUDING COVER SHEET): 5

TELEFAX #: (202) [redacted] 724-5854

CONFIRMATION #: (202) 272-6211

DATE/TIME SENT: MARCH 1, 1990 12:35

MESSAGES:

March 1, 1990

Enclosed are some samples and examples of the formal agreements made with our experts.

In the past these agreements have been obtained by Jim Nicoll and Gary Fisher. They have been the ones who have contacted the experts and then passed copies of the agreements on to me. I don't know what verbal understandings may have been made with the experts outside of what appears on these forms.

Bob Charron

U.S. Department of Justice — **Expert Witness Agreement**

INSTRUCTIONS: Form should be prepared after submission and approval of Form OBD-47, Request and Authorization for Fees and Expenses of Witnesses. Each copy of this form must be signed by the negotiating attorney and the expert witness.
DISTRIBUTION:
ORIGINAL: Hold and submit to Accounting Operations Group, Finance Staff/OC/JMD with the original payment voucher.
COPY NO. 1: To Expert Witness
COPY NO. 2: To Negotiating Attorney
COPY NO. 3: To Special Authorizations Unit, Procurement & Contracts Staff/JMD

Name of Case	Division or Judicial District
Exxon Valdez Oil Spill	
Name and Address of Expert Witness	**Expert's Field**
Dr. Nancy Bockstael 207 Northwood Drive Silver Spring, MD 20901	Environmental Economics

Preparation
$ 1,200.00 Rate per day; or
$ 150.00 Rate per hour;
Estimated time: _____ Days; or _____ Hours
$ _____ Incidental expenses. (*Laboratory analysis, charts, etc.*)
Specify _____

Subsistence (*Check one*)
☐ Included in the fees above.
☐ At the rate of $ _____ per day
(*prorated by quarter days for fractional days*)
☒ Actual expenses not exceeding $150.00 per day
(*to be itemized on payment voucher*)
☐ Other (*Specify*)

Court Attendance
$ _____ per day for _____ days; or
$ _____ per hour for _____ hours.

Transportation (*Check appropriate box(es)*)
☒ Common carrier, at less than first-class accommodations
☒ Taxi fares to and from terminals
☐ Privately owned vehicles at _____ cents per mile for travel of 200 miles or less, one way
☐ Privately owned vehicle, not exceeding cost by common carrier at less than first-class rates
☐ Special conditions (*Specify*) _____

Number of round trips anticipated: _____

TERMINATION FOR THE CONVENIENCE OF THE GOVERNMENT

The Contracting Officer, by written notice, may terminate this agreement, in whole or in part, when it is in the best interest of the Government. To the extent that this agreement is for services and is so terminated, the Government shall be liable only for payment in accordance with the payment provisions of this agreement for services rendered prior to the effective date of termination.

Description of Duties (*Explain details of service to be performed and other conditions.*)

To assist in preparation of the United States' natural resource damages claims arising from the Exxon Valdez oil spill including advice regarding the determination of the scope of damage to wildlife and the environment.

Witness is expected to testify at trial.

This contract is subject to the conditions in Attachment A.

(*Continue on reverse*)

Signature (*Government Attorney*)	Date	Signature (*Expert Witness*) I agree to perform the above service and appear as a witness on behalf of the Government.	Date
James L. Nicoll, Jr. Senior Attorney		Nancy E. Bockstael Dr. Nancy Bockstael	5/20/89
Name and Title (*Government Attorney*)		Name and Title (*Expert Witness*)	

FORM OBD-12
APR. 82

ATTACHMENT A

EXPERT WITNESS AGREEMENT

NANCY BOCKSTAEL, in consideration of her employment by the U.S. Department of Justice as an expert consultant and witness in the matter of the Exxon Valdez oil spill, agrees as follows:

1. This contract covers expert consultant and witness services and does not cover studies or investigations done as a principal investigator in connection with damage assessment.

2. All documents or other information provided to me by the United States, State of Alaska or other party in this matter for my review in connection with this matter shall be treated as confidential; I shall not reveal any of this information to any person without prior written approval by the Department of Justice.

3. All documents, information or other work developed by me in connection with this matter is privileged and confidential; I shall not reveal any of this information to any person without prior written approval by the Department of Justice.

4. During the pendency of actual or potential litigation relating to this matter, I shall not enter into any agreement with any other person who is a party or potential party to this matter for any purpose, whether or not it relates to pending litigation, without prior written approval by the Department of Justice.

5. I will deliver to the Department of Justice within 90 days of the expiration of my contract all documents or other data

furnished to me by the United States or any other party to this matter in connection with my work on this matter.

6. I shall require any person that I hire to assist me in connection with my work on this matter to sign an agreement containing provisions identical to this Agreement.

Dated:
5/20/89

Nancy E. Bockstael
NANCY BOCKSTAEL

ATTACHMENT C

Expert Confidentiality Agreement

_____, in consideration of his employment by ********** as an expert consultant and/or witness in the matter of the _____ agrees as follows:

1. This agreement covers expert consultant and/or witness services in connection with this matter and does not cover studies or investigations done as a principal investigator in connection with damage assessment work done in connection with this matter.

2. All documents or other information provided to me by the United States, _____ or other party in this matter for my review in connection with this matter shall be treated as confidential; I shall not reveal any of this information to any person without prior written approval.

3. All documents, information or other work developed by me in connection with this matter is privileged and confidential; I shall not reveal any of this information to any person without written approval.

4. During the pendency of actual or potential litigation relating to this matter, I shall not enter into any agreement with any other person who is a party or potential party to this matter for any purpose, whether or not it relates to pending litigation, without prior written approval.

5. I will turn in to the contractor for return to the Department of Justice within 90 days of the expiration of my contract all documents or other data furnished me by the United States or any other party to this matter in connection with my work on this matter.

6. I shall require any person that I hire to assist me in connection with my work on this matter to sign an agreement containing provisions identical to this Agreement.

Dated:

_____(Signature)_____
Typed Name

Brian,

Here are phone #'s for potential cultural panel members (names sent yesterday):

Restoration experts		
Dr. Gary Summers, NPS, Hawaii Area Office	(808)	541-2693
Dr. Bob Thorn, University of Mississippi	(601)	232-7129
Dr. Martin McAllister, Consultant	(715)	674-5903
Dr. John Erenhard, NPS, SE Region	(404)	841-2643
Subject matter (archeology) experts		
Dr. David Yesner, UAA, Anchorage	(907)	786-1397
	or	688-0664
Dr. Rick Jordan, UAF, Fairbanks	(907)	474-6751
Mr. Richard Knecht, KANA Corp.	(907)	486-5725
Dr. David Huelsbec, Univ. of Puget Sound	(206)	no # yet

Ted B. emphasized calling McAllister soon if we want him - but he has already agreed to come, right?

I will be out of the office 8-13 March.

RPWG
AA

INJURED RESOURCES[1]
PRINCE WILLIAM SOUND/NORTH GULF OF ALASKA

COASTAL HABITATS
- INTERTIDAL
- SUPRATIDAL
- UPPER SUBTIDAL

WATER RESOURCES AND SEDIMENTS

DEEP BENTHIC INFAUNAL RESOURCES

FISH AND SHELLFISH

- SALMONIDS
  - SPAWNING REARING AREAS
  - EARLY LIFE HISTORY STAGES
  - FISHERIES MANAGEMENT
- HERRING
  - SPAWNING AND REARING AREAS
  - JUVENILE AND ADULT SURVIVAL/GROWTH AND REPRODUCTION
- BIVALVE MOLLUSKS
  - RESOURCES AND HABITATS
- CRABS
  - EXPOSURE DAMAGE
  - HABITAT DAMAGE
  - LARVAL PRODUCTION
- SPOT SHRIMP
  - EGGS AND EARLY LIFE STAGES
- OYSTERS
  - HABITAT DAMAGE
- ROCKFISH
  - DIRECT MORTALITY
  - HABITAT DAMAGE

I Coastal Habs. Water Rex. Benthic — Dave / NOAA

II Fish — F+G

III Shellfish

IV Mar. Mammals > MINOR

V Ter. Mammals

VI Birds

VII Cultural — NPS/BLM

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[1]The categories listed below are right out of the yellow book, the Natural Resources Damage Assessment Plan.

SPORT AND COMMERCIAL FISHERIES

BOTTOM FISH

- EXPOSURE DAMAGE
- HABITAT DAMAGE

LARVAL FISH AND SHELLFISH (VARIOUS SPP.)

- PRODUCTION LOSS
- HABITAT DAMAGE

GROUND FISH

- DECREASE IN ABUNDANCE
- HABITAT DEGRADATION

SCALLOPS

- GROWTH AND SURIVAL

SEA URCHINS

- ABUNDANCE
- ROE QUALITY
- RECRUITMENT
- HABITAT

MARINE MAMMALS

- POPULATION DECLINES
- HABITAT

TERRESTRIAL MAMMALS

- TISSUE CONTAMINATION
- GROWTH AND MORTALITY

BIRDS

- MORTALITY AND POPULATION CHANGES

Key Peer Reviewers

3/6

Pete Peterson

Bob Spies

Don Bosch

Charles Simenstad

~~Don Malins~~

Jackie Michel

Doug Robson (Biometrician)

Phil Mundy (Fish) - Ore?

Ray Hilborn - Wash St.

Mike Fry - Buds - Calif.

These are the best that I can think of Today

Dave

Date: 3/7

Cover Page

To: BRIAN ROSS Fax No.: 271-2467

Unit: _____ Verification No.: _____

WO (DC): _____ WO (Arlington/Rosslyn): _____

From: DAVE GIBBONS Fax No.: 586-7840

Unit: _____ Verification No.: _____

Remarks: _____

Total number of pages (excluding cover): 1

Date Sent: 3/2/90 Time: 11:20