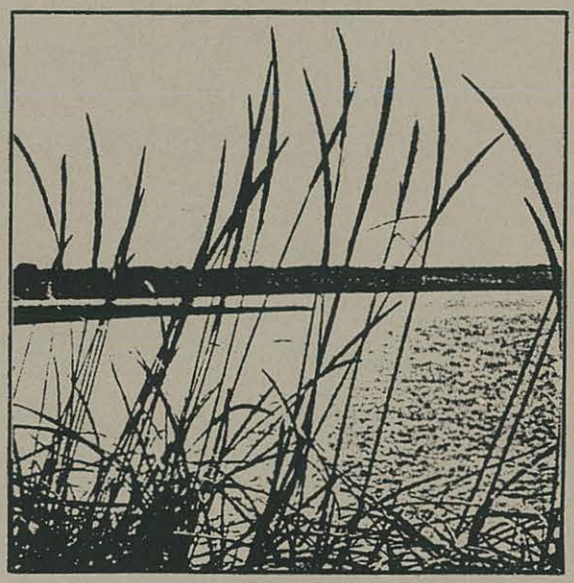
NOAA TECHNICAL MEMORANDUM CS/NOPPO 91-2

THE FEDERAL EFFORT TO EVALUATE COASTAL WETLAND MITIGATION



APPENDIX C: PROGRAM SUMMARIES

April 1991

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Part I: Wetland Restoration and Creation Research Program Summaries

Part II: Wetland Mitigation Project Follow-up Study Summaries

PART I: WETLAND RESTORATION AND CREATION RESEARCH PROGRAM SUMMARIES

John Sutherland

MITIGATION RESEARCH

OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH
OAR

NOAA'S LINK TO THE ACADEMIC COMMUNITY

1. NATIONAL SEA GRANT COLLEGE PROGRAM (NSGCP)
2. COASTAL OCEAN PROGRAM/ESTUARINE HABITAT PROGRAM (COP/EHP)

NATIONAL SEA GRANT COLLEGE PROGRAM (NSGCP)
ANNUAL PROGRAM GUIDANCE FOR FISCAL YEAR 1991

ENVIRONMENTAL STUDIES

HABITAT UTILIZATION AND DYNAMICS

1. PROCESSES CONTROLLING HABITAT VARIABILITY

2. PREDICTING HABITAT ALTERATIONS ASSOCIATED WITH CHANGES IN FACTORS SUCH AS HYDROLOGICAL REGIME, SEDIMENT LOADING, AND ENVIRONMENTAL QUALITY

3. IMPLICATIONS OF HABITAT ALTERATION TO DISTRIBUTION AND ABUNDANCE OF LMR

4. MITIGATION - RESTORING OR CREATING WETLAND AND ESTUARINE HABITATS

COASTAL OCEAN PROGRAM/ESTUARINE HABITAT PROGRAM (COP/EHP)
ANNOUNCEMENT OF AVAILABILITY OF FUNDS - DECEMBER 1989

HABITAT ALTERATION - EFFECT ON FAUNAL UTILIZATION AND PRODUCTION

1. SEAGRASSES - WATER CLARITY AND DISEASE
2. SALT MARSHES - HYDROLOGY

HABITAT ENHANCEMENT, RESTORATION, AND CONSTRUCTION

1. FUNCTIONAL DEVELOPMENT AND EQUIVALENCY
2. ACCELERATING HABITAT RESTORATION
3. BIOTIC MANIPULATION

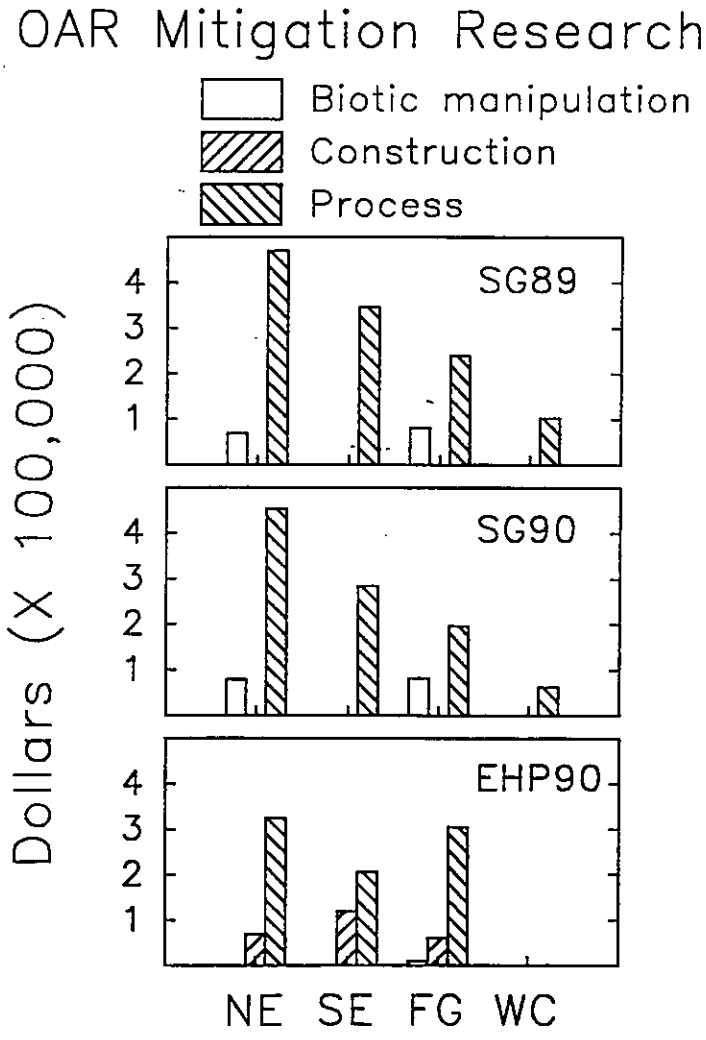
CATEGORIES OF RESEARCH SUPPORTED
NSGCP FY89
NSGCP FY90
EHP FY90

GEOGRAPHIC REGION

1. NE (OF CHESAPEAKE BAY)
2. SE (CHESAPEAKE BAY - FLORIDA)
3. FLORIDA AND GULF
4. WEST COAST

RESEARCH TYPE

1. BIOTIC MANIPULATION
2. HABITAT CONSTRUCTION
3. PROCESS STUDIES
   A. NORMAL FUNCTION
   B. EQUIVALENCY OF CONSTRUCTED VS. NATURAL
   C. STABILITY - RESPONSE TO DISTURBANCES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Biotic manipulation
Construction
Process
Dollars (X 100,000)
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SG90
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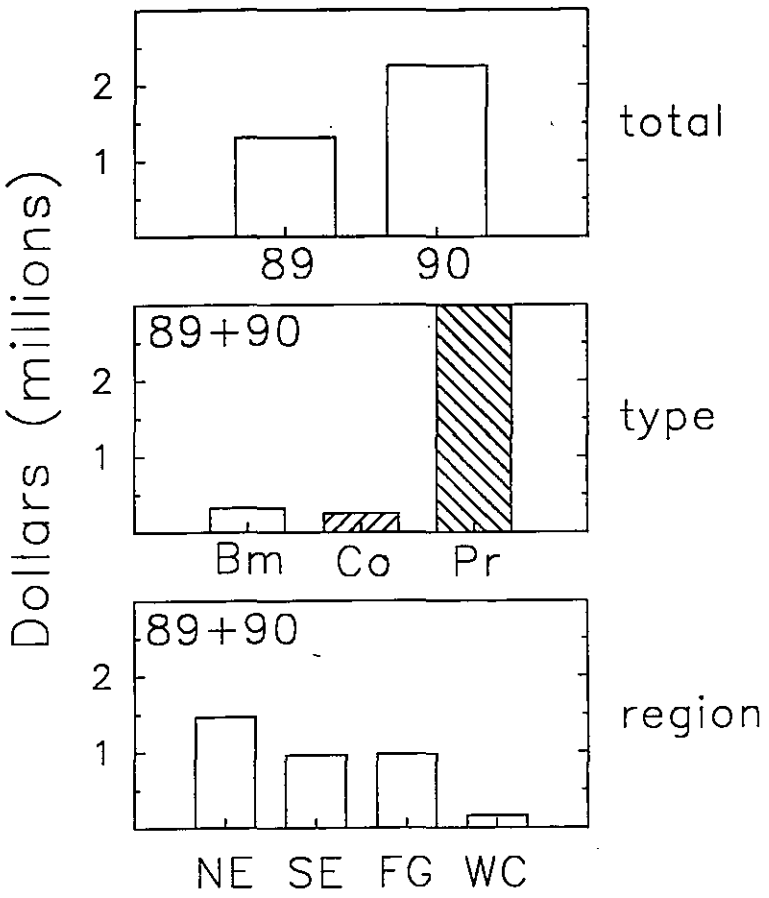
OAR Mitigation Research



NATIONAL SEA GRANT COLLEGE PROGRAM (NSGCP)
NOAA/OAR

Research sponsored by NOAA's NSGCP focuses on basic research leading to the development and use of marine resources. Proposed efforts are subjected to a three-tired review process at the national level (extramural written peer review, on-site review, and review by the NSGCP staff). No proposed project in research education, or advisory fields are considered for funding unless the rational (and programmatic values), methods (project protocol), and a prospective use (user relationships) are considered suitable. Proposed activities must have sufficient intellectual content to make them appropriate university functions.

Research sponsored by the NSGCP is divided into the following areas:

1. **Living Resources**, including fisheries, aquaculture, marine biotechnology, and seafood science and technology.

2. **Nonliving Resources**, including marine geological resources, and coastal and ocean processes.

3. **Technology and Commercial Development**, including ocean engineering, marine transportation, marine economics, and recreation and tourism.

4. **Environmental Studies.**

5. **Human Resources**, including the Sea Grant Advisory/ Extension Service, education and training, communications, marine policy and social sciences, and ocean law and policy.

Mitigation research is sponsored by the Environmental Studies division of the NSGCP. The intent is to sponsor research that extends beyond traditional, descriptive studies of local ecosystems. Instead, investigations must focus on fundamental ecological processes that regulate ecosystem structure, ecosystem production, and ecosystem response to natural and human-induced conditions. The ultimate goal of such research is the development of a detailed, quantitative understanding of ecosystem response that will permit timely and accurate environmental prediction. Five broad topics are identified as focal points for environmental studies: 1) primary production and nutrient dynamics; 2) the coupling of primary and secondary production; 3) habitat dynamics and utilization; 4) toxicants and other materials that pose threats to the well-being of marine organisms and ecosystems; and 5) human health concerns. Mitigation research is included primarily in the topic, "habitat dynamics and utilization."

The NSGCP focus on "habitat dynamics and utilization" recognizes the importance of understanding the processes that shape marine communities over time and space, and with the importance of

specific habitats to the well-being of living marine resources (LMR). Special emphasis is placed on estuarine and wetland habitats because of their proximity to centers of human population, their use by society for multiple, often conflicting purposes, and their roles as spawning grounds and nursery areas for economically valuable species of finfish and shellfish. Tasks of high priority include:

1. Attaining an understanding of the processes that control habitat variability.

2. Developing techniques to predict habitat alterations associated with changes in factors such as hydrological regime, sediment loading, and environmental quality.

3. Quantifying the implications of habitat alteration to the abundance and distribution of valuable living marine resources.

4. Evaluating the success of mitigation efforts in restoring or creating wetland and estuarine habitats.

COASTAL OCEAN PROGRAM/ESTUARINE HABITAT PROGRAM (COP/EHP)
NOAA/COP/EHP

The EHP, initiated in FY90, focuses special attention on wetlands (seagrasses, salt marshes, and mangroves) because of their importance to the production of living marine resources. Federal and state habitat managers need more quantitative information on the functional mechanisms by which wetlands support living marine resources. Managers need to know the location, extent, and rate of loss or modification of existing wetlands. Finally, managers need to know how to restore and/or create these habitats more effectively. Information on which to base management decisions must be easily available in the form of "...accurate maps depicting where wetlands exist, [and]... information banks containing the results of research on the functioning of wetlands, and on restoration and creation efforts (Kean et al. 1988)." Accordingly, the three basic and interrelated objectives of the EHP are:

1. To determine how coastal and estuarine habitats function to support living marine resources. This includes research on factors causing habitat degradation and loss, as well as on methods for habitat restoration.

2. To determine the location and extent of critical habitats and the rate at which these habitats are being changed or lost. This includes satellite, aerial photographic, and surface level surveys to map habitat location and extent, and to determine change through time.

3. To synthesize the new and existing information in the form

of mechanistic models of habitat function, of use to managers in protecting, conserving, and restoring critical habitats.

The Estuarine Habitat Program (EHP) is designed to achieve its objectives through three interrelated avenues of investigation: A) research on estuarine habitat function and restoration; B) a program of habitat mapping and change analysis; and C) a program of synthesis and model building to make this information available to managers.

A. Habitat function and restoration

Research initiated in FY90 and continued in FY91 focuses on three research efforts identified in FY89 workshops which included managers and research scientists:

1. How do stresses impact the viability of seagrass habitats and what are the consequences of loss of seagrass habitat?

2. What are the effects of hydraulic manipulation on salt marsh viability and their functional role in marine ecosystems?

3. How can seagrass and salt marsh habitats be restored to assure they are functionally equivalent to natural habitats and how can the process be accelerated and improved?

B. Habitat mapping and change analysis

The monitoring cycle for change analysis will range from 1 to 5 years depending on region. Areas of most rapid change will be monitored annually while areas of less rapid change will be monitored on a less frequent basis (2-5 years).

The current program has three specific objectives:

1. To demonstrate the feasibility of using satellite imagery and aerial photography to map coastal habitats and to determine habitat change through time.

2. To develop standard, nationally accepted protocols for mapping SAV, emergent coastal wetlands and adjacent uplands. National acceptance of these protocols will allow comparable data to be obtained regardless of which Federal or state agency or university conducts the effort.

3. To perform a literature search and review, and summarize the status of remote sensing of biomass, productivity and functional health of coastal wetland habitats.

C. Synthesis and Model Development

The eventual goal of habitat research is to produce mechanistic models of habitat function. These models will enable managers:

1. To evaluate the functional health of existing wetlands.

2. To estimate the consequences for living marine resources of habitat change, such as measured in the habitat mapping program.

3. To predict the consequences of planned and unplanned environmental modifications, e.g., changes in hydrology brought about by dredging and filling, or decreased water quality brought about by eutrophication.

4. To determine the success of restoration projects, i.e, whether they are functionally equivalent to existing wetlands.

The modeling effort will focus on the way habitats respond to environmental change and the effect of change on their ability to support living marine resources. Models will synthesize past information as well as that produced by the EHP. The modeling approach will be inclusive; functional health will be evaluated by the presence or absence of physical and biological characteristics typical of undisturbed habitats, rather than on the basis of a few commercially important species.

Ultimately, a comprehensive Geographic Information System (GIS) will be developed for each ecologically distinct region of the U.S. combining: 1) the models of habitat function; 2) information derived from the habitat classification and change analysis; and 3) other spatial data (e.g., demographic, land use, pollution, distribution of commercially important species, fisheries yields, and economic activity). Thus, demographic patterns can be linked to wetland stability or loss on an area specific basis. Spatial and temporal patterns of habitat change (loss) can be related to changes in (loss of) fisheries productivity. Economic assessments can be made of alternative management strategies.

LITERATURE CITED

Kean, T.H., C. Campbell, B. Gardner, and W.K. Reilly. 1988. Protecting America's Wetlands: An Action Agenda. The Final Report of the National Wetlands Policy Forum. The Conservation Foundation, Washington, D.C. 69 pp.

Using Science for Decision Making: The Chula Vista Bayfront Local Coastal Program

Eric D. Metz and Joy B. Zedler

Eric D. Metz is Wetland Coordinator for The California Coastal Commission, based in San Francisco. Joy B. Zedler is Professor of Biology, San Diego State University. As manager and scientist, they have participated in some of the most controversial plans and projects for wetlands which have come before the Commission. This case study was part of a paper presented by the authors at the Third Symposium on Coastal Zone and Ocean Management, June 1983, and published in the proceedings of that meeting by the ASCE.

This case study describes how the California Coastal Commission uses scientific information in its wetland regulatory and planning activities. The study illustrates five factors critical to successful planner/scientist interactions:

1. An informed planner is required to translate the technical information for the layman and to evaluate scientific input.
2. Planners should develop a close, routine working relationship with scientists.
3. University scientists must receive some professional benefit from assisting planners.
4. Scientific input is most valuable if solicited and used early in the planning process.
5. Scientists should obtain feedback from agencies to monitor how their advice or involvement is applied or characterized.

The City of Chula Vista Bayfront study involved the preparation of a Local Coastal Program (LCP). LCPs include land use plans and policies, accompanied by local ordinances. After certification by the California Coastal Commission, LCPs are administered by local governments and become the standard of review for development in the coastal zone, subject to limited rights of appeal to the Commission.

The Chula Vista Bayfront LCP was the first plan reviewed for certification by the Commission in which the compatibility of the proposed land uses with wetland and related habitat areas was virtually the only issue. The Commission rejected the City's proposed program primarily on the basis of scientific opinion and evidence documented by the Commission staff. This evidence led to the Commission's findings that:

1. There was a high probability that the plan would have significant adverse impacts on the Sweetwater Marsh section of the bayfront.
2. The adjacent upland areas (e.g., Gunpowder Point) were ecologically related to the marsh (see Figure 1).

The City of Chula Vista sued the Commission over the decision on both procedural and substantive grounds. The Commission won in the Superior Court of the County of San Diego (*City of Chula Vista* v. *Superior Court of the County of San Diego* 4 Civil 26584. Dec. 16, 1981). The City appealed, but the Court of Appeal upheld the decision in favor of the Commission, on the basis that "Opinion evidence of experts in environmental planning or ecological sciences is a permissible basis for decision" (*City of Chula Vista* v. *Superior Court.* 133 Cal. App. 3rd. 472. 1982).

The City's Bayfront Plan proposed residential and industrial uses, visitor-service facilities, public parks and open space, marsh and buffer areas. The most controversial aspect was the plan's designation for the 40-acre Gunpowder Point site. This included a seven-story, 700-unit hotel, conference center, restaurant, and eight-acre park. In addition, the plan proposed that a portion of the tidal mudflats adjacent to the Point be replaced by a public beach.

In their early review of the proposed program, the Commission staff felt that more scientific information was available than was being used in planning for the bayfront development. The staff's experience at a series of technical wetland

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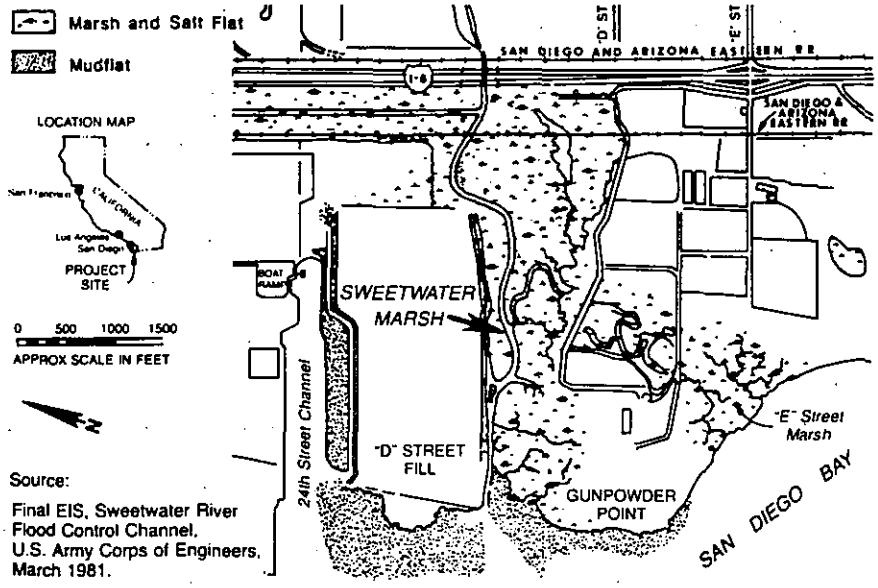
Figure 1. This map of the Chula Vista bayfront shows the location of Sweetwater Marsh and Gunpowder Point, ecologically related areas threatened by development under the City's proposed Local Coastal Program.



workshops which it convened to assist local governments prepare their plans suggested that the city's plan did not assess impacts adequately. Therefore, the staff prepared a questionnaire that was mailed to biologists at universities and state and federal agencies. The individuals familiar with the natural resources and biological functioning of the local wetlands were identified from their participation at the workshops, and their willingness to respond in part depended upon rapport established at that time.

The staff's cover letter solicited expert opinion regarding the impacts of implementing the proposed plan on the Sweetwater Marsh complex (which included both the uplands and the wetlands). One question was:

> *How important is Gunpowder Point as an upland habitat to the wildlife of Sweetwater Marsh, particularly in connection with any rare and endangered species that are known to frequent the area?*

A sample response to this question revealed that:

> *Three key features which make the Point valuable to wildlife are: (1) it is an undeveloped upland on the bayfront; (2) it is interposed between two salt marshes; and (3) it is used by Belding's Savannah sparrows (a state listed endangered species which is marsh dependent) as foraging habitat.*
>
> *The proposed development would eliminate the use of the Point by the sparrow and by migrating waterfowl, herons, hawks, owls and other species and would prevent the enhancement of the site for possible California least tern (a federally listed endangered species which is wetland-related) nesting habitat or resting and nesting habitat for any wildlife . . . (3)*

Due to the length and depth of the responses and the complexity of the issues, the staff prepared a summary of all responses to each question, identifying the author of each opinion. In this way, the Commissioners were able to determine that experts agreed and repeatedly pointed to the same kinds of likely impacts. In addition to written contributions, several of the biologists testified at the Commission's public hearings and were

available to answer Commissioners' questions about their testimony.

Thus, through evidence such as this, the staff built the case that Gunpowder Point was one of several types of habitat areas in the bayfront that were interrelated ecologically. The Commission found that the components of the Sweetwater Marsh complex were functionally related, and consequently evaluated the overall impact of the bayfront development plan on the entire system. The Commission acknowledged the fact that the City attempted to recognize the rarity and value of the habitat areas contained within the complex, but the Commission was compelled to conclude nonetheless that more protection and less intensive development were necessary to bring the plan into conformity with the Coastal Act of 1976.

Another aspect of this case illustrates the point that planners must be able to use and understand scientific data and scientific literature. The City attempted to show that the placement of a road in Sweetwater Marsh would not significantly affect wetland productivity. The evidence offered by the City included a biological study conducted on the effects of road fills in salt marshes in the state of Florida. The staff responded initially that southern California salt marshes function quite differently from those in the eastern United States and therefore this type of comparison may not be valid.

The staff continued by pointing out that, even assuming comparability of the two systems, the parameters investigated in the Florida study, namely vegetational zonation, densities of three species of molluscs, salinity, and elevation,were not applicable to the City's argument. The staff noted that while the Florida study may provide a reasonable indication of the impact of a road on the sampled species of invertebrates, it did not follow that such data could be extrapolated to predict impacts on west coast populations of molluscs, much less other invertebrate populations, and certainly not to predict impacts on avian populations (as asserted by the City). Furthermore, the study did not measure production. Finally, the staff noted that the Florida study contained a qualification that the results would not necessarily hold true for marshes dominated by plant species other than *Juncus* (southern California salt marshes are dominated by *Salicornia*).

As seen by this case study, several of the critical factors for the successful interaction of planners and scientists discussed above were in operation: based upon previous interactions with scientists, the staff was aware that information and expertise existed and knew how to obtain answers to technical questions; the staff was able to discriminate between scientific information and scientific opinion, and in fact deliberately sought opinion due to the paucity of data; and the staff was sufficiently versed in wetland ecology to evaluate biological reports critically and to construct and rebut technical arguments.

If any of these elements had been missing, the Commission may not have chosen to designate Gunpowder Point for special protection, or been able to defend that position once it had been taken. As a result of the extensive scientific testimony in the record, the Court of Appeal found that the " . . . (Commission's administrative) record is replete with substantial evidence of risk to the marsh environment if the proposed development is allowed. *(City of Chula Vista* v. *Superior Court.* 133 Cal. App. 3rd) 472. 1981.

The case of the Chula Vista LCP also illustrates the disadvantages of not involving scientists early. While the City had coordinated with public agency biologists in the development of its plan, the City had not asked the fundamental ecological questions that the Commission asked of the university scientists. Public agencies are limited in their involvement in the planning process by their respective mandates, whereas scientists view biological questions more broadly. Perhaps if the City had organized and convened an advisory committee which included representatives from the scientific community during preparation of its LCP, the resulting plan may have been more compatible with the natural resource values of the Sweetwater Marsh complex.

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MITIGATION AND RESTORATION RESEARCH AT THE NMFS BEAUFORT LABORATORY

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NOAA/NMFS
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Attempts to restore degraded habitats have been occurring for many years, yet their success has been questioned almost from the beginning. Under the Administration's No Net Habitat Loss policy, and as a result of recoveries for restoration of natural resources, restoration, mitigation, and habitat creation will get increasingly greater attention. The scientific data base is extremely limited, but a review of available literature indicates strongly that although many techniques exist to create and restore coastal wetland habitats, the general process of habitat restoration and mitigation has not been successful, particularly through the permit process with which NOAA and other resource agencies interact with the U. S. Army Corps of Engineers (COE). The assumption that man-created habitats function in a manner equivalent to natural habitats is generally unsupported by available literature. In large measure, the problem that exists is one of lack of man-power to evaluate existing mitigation/restoration projects and a consequent lack of enforcement of regulations; an insufficient research and development focus on restoration techniques and assessment of restoration of functional values of habitats; and a general lack of a centralized restoration program in any resource agency.

For many years the NMFS Habitat Conservation Division in the Southeast Region has been concerned with the efficacy of mitigation, creation, and restoration approaches and the functional value of these habitats. In fact, beginning in 1987 the Division began to recommend mitigation on fewer permit requests they received from the COE to comment on. Recognizing this dilemma, the Beaufort Laboratory of NMFS initiated a program of research on mitigation/restoration technologies in 1981. The current program deals primarily with seagrass and salt marsh habitat restoration/creation, but also has been involved in evaluation of use of dredge material to restore oyster reefs. These efforts have received funding from NMFS base funds, the COE, Florida DNR, and NOAA's Coastal Ocean Program.

Much of our restoration technology development efforts at the Laboratory has been related to seagrasses. Beginning in 1981 the

Laboratory and the COE's Coastal Engineering Research Center (while at Fort Belvoir) initiated a cooperative agreement to study the transplanting of seagrasses for stabilization of subtidal dredged material and habitat development. Research under this agreement developed cost-effective transplanting techniques, evaluated erosion control by these plant communities, provided operational cost estimates, and standardized restoration and management protocol for most North American seagrass species.

During the ensuing years, this research effort continued to evaluate methodologies to improve success, but turned its attention to research on the functional value of created seagrass beds. This effort has determined that in created eelgrass (Zostera marina) beds in southern Pamlico Sound, NC, and shoalgrass (Halodule wrightii) beds in Tampa Bay, FL, equivalent numerical abundance of macroepibenthic fauna can be achieved in 3-4 years. Faunal composition, however, does not converge with natural habitats as quickly as does the numerical abundance. After 3.8 years, created seagrass beds have stabilized in terms of plant density, but often have lower faunal similarity to their natural counterparts than do comparisons among natural seagrass beds of different species. Other factors such as sediment bacterial abundance and sediment organic matter and particle size, which describe other aspects of equivalent functioning, indicate that longer time periods may be required for their development.

These findings must be interpreted in terms of whether persistent, equivalent acreage of seagrass can be developed. Failure of many transplants indicate that as a first order effect, our overall ability to predict persistent, equivalent acreage is in the range of 50% success. This is consistent with previous findings of continued net loss of seagrass acreage under the permit process. Because fishery organism recovery is directly linked to acreage, we can assume a net loss of function.

We are continuing our research on developing means to accelerate seagrass plantings growth. Research on fertilizer enhancement indicates that phosphorus addition to Halodule plantings in sediments containing low carbonate can stimulate initial population growth rates three-times over controls. We also are continuing research on the effect of water motion on seagrass bed ecology and restoration. This work, together with our long-term research on water motion effects on seagrass bed ecology and restoration will be used to predict functional differences in seagrass beds when created under different energy regimes. We also will use these data to assist in developing replacement ratios and critical patch size for predicting functional equivalency or dysfunction.

Several projects currently are being conducted by staff of the Laboratory on the value of transplanted salt marshes for fishery species. Two studies have been experimental and we have been involved in the design of the marsh, while a third study has involved evaluation of a marsh created from upland habitat as a mitigation for a condominium-marina complex.

In 1985 NMFS and the COE entered into an agreement to test the feasibility of restoring and creating fishery habitat in the ongoing operation and maintenance of COE water resource projects. In North Carolina we selected three dredge material islands that were eroding and designed an experiment with two major objectives: to evaluate the use of planted salt marsh habitat to reduce erosion and channel refilling and to evaluate the use of these marshes as fishery habitat. Salt marsh was planted as uniform plantings, and as areas with several unplanted sections to allow access of fishery organisms to the interior. Sampling will be completed in September 1991, but preliminary analyses of fish and invertebrate data indicate that increasing the edge or access to the interior of the marsh enhanced the utilization of the marsh relative to the uniformly planted areas. These findings are similar to those observed by Tom Minello of the NMFS Galveston Laboratory with a similar study conducted in Texas.

A second experimental study was initiated in June 1990 and is an Atlantic coast analog to a study being carried out by Joy Zedler and her staff here at San Diego State University. In North Carolina, the project is joint with staff from the University of North Carolina and North Carolina State University. The study is designed to evaluate approaches to accelerating the development of created/restored marshes. Available information indicates that created marshes generally have sediment organic matter and nitrogen contents considerably lower than natural marshes, and it has been hypothesized that these low levels can limit the rate of plant, sediment and infaunal development in the created marsh. The study site was created in June and sampling for microbial parameters, interstitial nutrients, plant growth and nutrient content, and infaunal abundances are currently being carried out. The treatments being evaluated are additions to the sediment of straw, alfalfa, peat and Spartina with and without nitrogen additions.

We also have been evaluating a mitigation site in the Newport River estuary, North Carolina, that was graded down from upland to estuarine elevations and planted with Spartina in 1985. This study has been cooperative with staff and students from North Carolina State University, and we have been evaluating plant growth and abundance, sediment organic matter and particle size, infaunal invertebrates, and mobile fish and invertebrates. Plant density

increased during the first three years, attaining above-ground biomass values similar to adjacent marshes; below-ground biomass is considerably lower than the adjacent marsh. Sediment organic matter and nitrogen contents are low relative to the adjacent marsh and, while numeric abundance of infauna have been similar (after 2 years), the composition of the community has differed greatly from the adjacent marsh. Analyses of the fisheries data indicate that a viable fishery habitat has been created but one that is being utilized by a different complex of organisms that either the adjacent natural marsh or a habitat similar to that which was traded-off for development. The created habitat is dominated by mummichog and blue crabs while the adjacent marsh is dominated by spot, mummichog, and shrimp. The marsh lost to development was utilized by a much more diverse fishery community including several species of commercial and recreational fish.

Two additional projects that the Laboratory has conducted involve use of dredge material to create or restore habitats in the Chesapeake Bay. Under an amendment to the NMFS-COE Memorandum of Agreement of 1985, the COE deposited dredge material at two sites, one at Twitch Cove for the purpose of creating seagrass habitat and one at Slaughter Creek for the purpose of restoring a dead oyster reef. In each case, we have monitored the site annually for three years.

At Twitch Cove dredge material was placed in an area to elevate the bottom and create conditions conducive to the growth of seagrasses. Eelgrass was transplanted in 1987 over a 3-acre site. According to contractor reports there was a 66% survival with an estimated 2 acres of eelgrass habitat after 1 year. We surveyed the site using a systematic approach and obtained a three year annual average for the experimental site of approximately 0.70 acres of seagrass. Thus, survival has been marginal at best. The site selected for this experiment is a high energy area with fairly high turbidity, and it is possible that both conditions resulted in the lack of success. Experimental data are demonstrating that light requirements of seagrasses are much higher than originally thought to be, and it is likely that light is the limiting factor at this sight.

Evaluation of the dredge material disposal site that was capped with oyster cultch at Slaughter Creek in the Chesapeake Bay has been much more encouraging. We have demonstrated that spat settlement, sublegal and legal oyster densities have increased at this experimental site over the three year study period. In fact, there is no statistical difference in data among experimental and natural oyster bar control sites. As a consequence, we have recommended to the COE that rehabilitation or restoration of dead

oyster reefs using dredged material followed by capping with cultch appears to be a viable approach to using dredge material and to habitat restoration. We emphasize, however, that this is restoration and not open water disposal on live bottom for the purpose of creating oyster reef.

It is our strong belief that restoration ecology research must continue to be experimental and address the recovery of functional attributes of habitats. For this to be successful long-term funding and direction must be provided that emphasizes research on the functional values of natural and restored habitats under a variety of environmental and geographic scenarios. Intelligent management that promotes production of natural resources is not possible without fundamental knowledge of how habitats function to provide requisites for growth and survival or how they differ in importance between species under various circumstances. Research approaches must be coupled with augmented management evaluations and management dedication to enforce regulations and compliance of permits as well as restoration procedures used in addressing claims received from Superfund and oil spill litigation.

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RECOMMENDATIONS FOR SEAGRASS MANAGEMENT AND RESTORATION

1) INCREASE PUBLIC AWARENESS OF THE VALUE OF SEAGRASS SYSTEMS

2) CONSERVE EXISTING SEAGRASS RESOURCES

3) INVENTORY SEAGRASS DISTRIBUTION

4) STANDARDIZE SELECTION CRITERIA FOR CHOICE OF RESTORATION SITES:

   a) match area covered by considering growth patterns

   b) emphasize on-site, in-kind restoration

   c) use only definable, anthropogenically impacted sites

   d) prohibit planting among existing patches

   e) prohibit planting onto naturally unvegetated areas

   f) utilize site engineering to enhance conditions

   g) reclaim dredge and fill areas

   h) pre-planting monitoring of environmental factors

5) EMPHASIZE UP-FRONT MITIGATION (under conditions of item 4)

6) REQUIRE APPLICANTS BEAR SITE MONITORING AND PREPARATION COSTS

7) POST-PLANTING MONITORING PROCEEDS FOR 3 YEARS:

   a) survey number of surviving planting units

   b) survey mean area covered and number of shoots per surviving planting unit; compute actual acreage restored versus acreage lost: mean area X no. surviving units

   c) assessment of fishery function

8) PERFORMANCE EVALUATION BASED ON COVERAGE AND POPULATION GROWTH RATES OF PLANTINGS, COMPLIANCE BASED ONLY ON DIRECT COMPARISON OF ACREAGE GAINED VS. ACREAGE LOST

9) REPLACEMENT RATIO OF 2:1 ON AN ACREAGE BASIS

10) DEVISE CENTRAL COMPILATION OF MONITORING RESULTS

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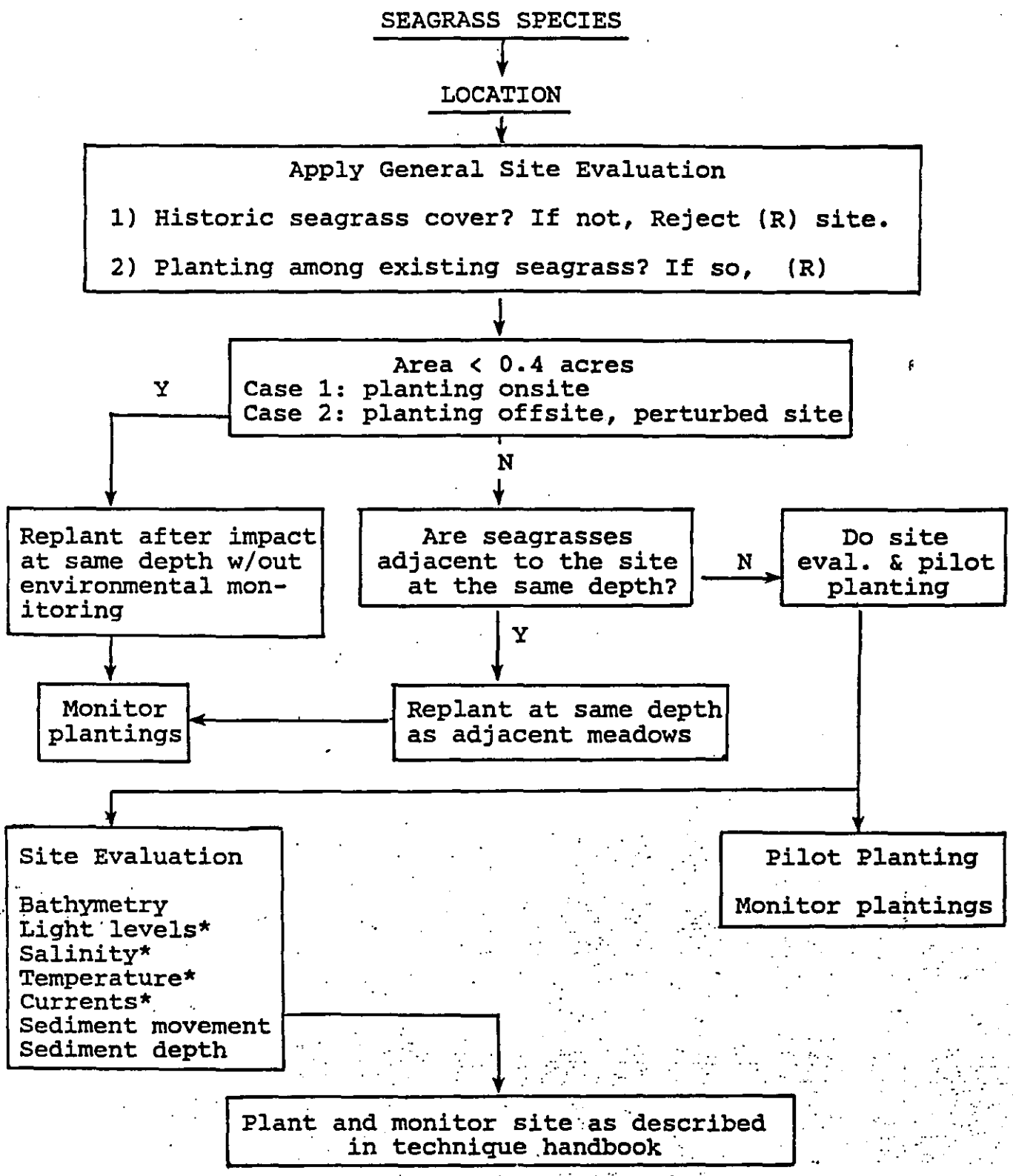

* Requires determination of appropriate time frame for accurate monitoring

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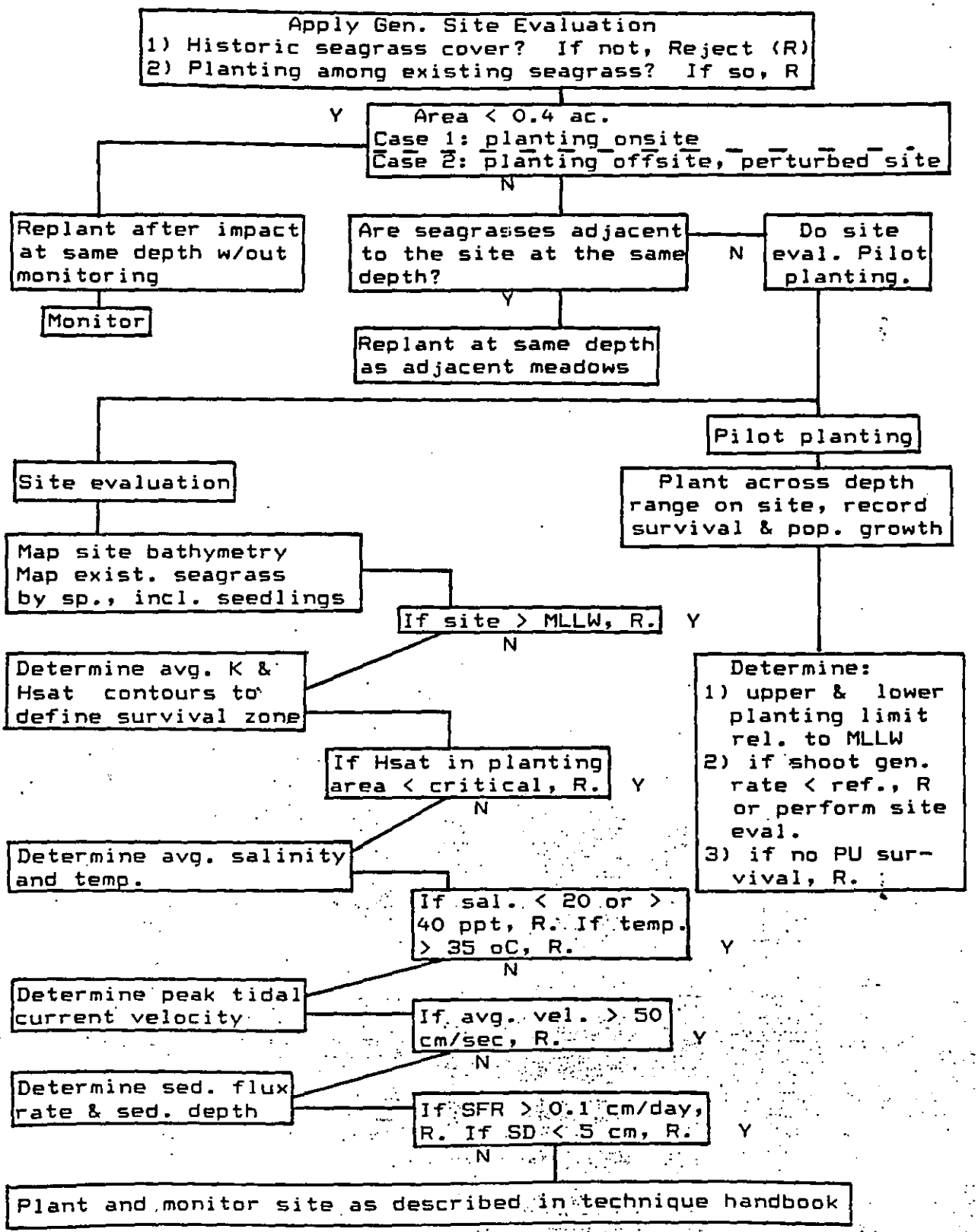
Beaufort, North Carolina 28516 9722

SEAGRASS SPECIES: Halodule wrightii
LOCATION: Southeast U.S., north of Tampa Bay



Creation of Salt Marshes for Fishery Species

Tom Minello
NMFS/SEFC Galveston Laboratory

Research on salt marsh creation must be associated with research on the value and functions of natural marshes. Our ability to create a valuable salt marsh and replace the functions of the marsh for fishery species, depends on the type of functions and how they are provided. Indeed, the evaluation of success in restoration projects depends to some extent on our understanding of the functions being restored. All salt marshes are not the same in the functions they provide, and not all fishery species obtain similar benefits from salt marsh habitats. Successful marsh restoration techniques, therefore, should be expected to vary with the fishery species of interest and the location of the marsh.

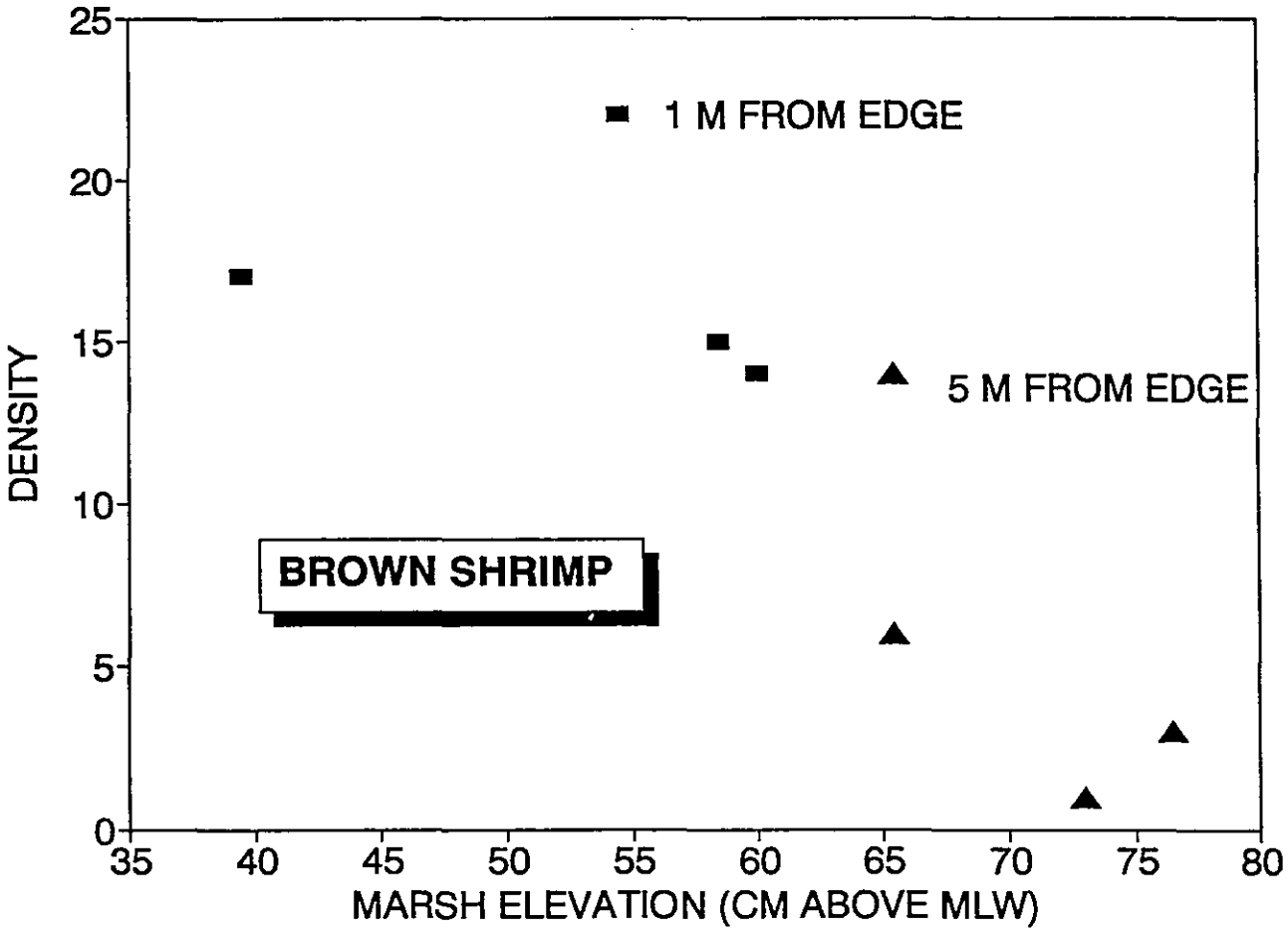
Habitat studies at the Galveston Laboratory have demonstrated that densities of many juvenile fishery species are frequently high in flooded salt marshes of the northern Gulf of Mexico. For brown shrimp and blue crabs, these marshes have been shown to function by providing food for growth and structure for protection from predators. Information on other fishery species is limited, however, and marshes may not provide these functions. Juvenile white shrimp, for example, do not appear to exhibit increased growth in salt marsh habitats, and young Gulf menhaden are seldom found on the marsh surface. More basic research on the functions of natural marshes is needed.

The way a marsh provides a function may also be important. As an example, consider the function of providing food for growth. This transfer of organic matter from salt marshes to fishery species can follow several basic paths: 1) direct export of detritus to estuaries, 2) export of organic matter in the form of small forage species which feed in the marsh, and 3) direct feeding of fishery species on the marsh surface. The relative importance of these pathways probably depends upon the fishery species, the tidal regime, and the physical structure of the marsh (elevation, slope, edge). Restoration of this function will require an understanding of these processes.

In marshes that are directly exploited by fishery species, such as those in the northern Gulf, two of the most important marsh characteristics, influencing marsh value, appear to be elevation of the marsh surface and distance from a low water refuge. In the natural marsh surrounding Hall's Lake of West Galveston Bay, we measured brown shrimp density in relation to elevation and distance from the edge. Densities were negatively correlated with elevation. The distance from the marsh edge, although confounded with elevation, also appeared to be an important marsh characteristic. Experimental manipulation of a transplanted marsh near Hall's Lake has shown that densities of most fishery species, including brown shrimp, increased on the inner marsh surface if access channels were provided. This increase occurred even though marsh elevation was not altered. The channels constructed within the marsh in this project also provided a valuable nonvegetated habitat for many small forage fish. These

data suggest that, in the northern Gulf of Mexico, the most valuable marshes for brown shrimp and other crustacea, are low elevation marshes with a great amount of marsh to water edge.

The ability of transplanted salt marshes to function like natural marshes probably depends upon how well these important marsh characteristics are reproduced. Our Coastal Ocean Program research in Galveston is designed to compare marsh characteristics and productivity among ten transplanted marshes and five natural marshes in the lower Galveston Bay system. The transplanted marshes range from 3 to 15 years in age. Parameters being examined include marsh elevation, edge, slope, fetch, exposure, hydroperiod, and sediment characteristics. The abundance of food organisms including benthic algae, epiphytes, meiofauna, and infauna are also being measured. Marsh value for fishery species is being determined on the basis of macrofauna densities, productivity of infauna, and growth rates of penaeid shrimp.



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CREATION OF SALT MARSHES FOR FISHERY SPECIES

Are marshes valuable for fishery species?

How do marshes function?

What marsh characteristics are important?

Do created marshes function like natural marshes?

What characteristics differ between created and natural marshes?

Can we create better marshes?

MARSH CHARACTERISTICS

Primary

Vegetation Type and Density
● Sediment Organic Content
Sediment Texture
● Elevation
● Distance from Low Water Refuge

Secondary

Food Abundance
(Benthic Algae,
Epiphytes,
Benthic Infauna)

HOW TO DETERMINE IMPORTANT MARSH CHARACTERISTICS

Comparative Utilization Studies in Natural and Created Marshes

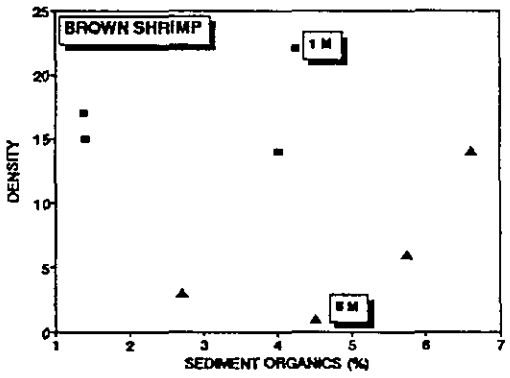
Functional Approach

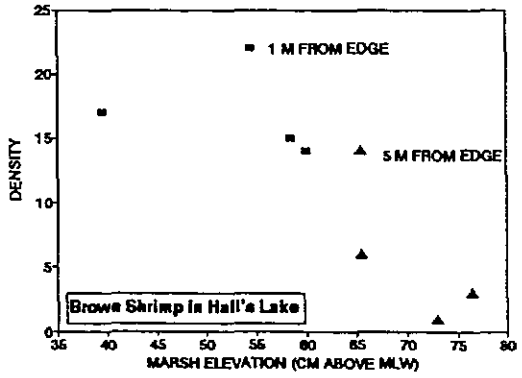
Experimental Manipulation

SEDIMENT ORGANIC CONTENT

1) Detrital Food Web

2) Increases with Marsh Age





A Proposal for the
NOAA Coastal Ocean Program
Estuarine Habitat Research Program

An Ecosystem Comparison of Transplanted and Native Salt Marshes: The Chronological Development of Habitat Value for Fishery Species.

Principal Investigators:

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4700 Avenue U
Galveston, Texas 77550

James W. Webb — Texas A&M University at Galveston
Department of Marine Biology
P.O. Box 1675
Galveston, Texas 77553

MARSH PARAMETERS MEASURED IN COP

Macro-scale Characteristics
(elevation, edge, slope, fetch, exposure)

Hydroperiod

Sediments
(organics, grain size, accumulation rates)

Food Organisms
(benthic algae, epiphytes, meiofauna, infauna)

Benthic Macrofauna and Nekton

Infaunal Productivity

Shrimp Growth

Restored / Created Marshes in Galveston Bay

MARSH	VEG	DREDGE MAT.	AREA (h)	AGE 1990
T1	TRANS	YES	12.6	7
T2	TRANS	NO	0.05	5
T3	TRANS	NO	0.05	6
T4	TRANS	YES	0. 2	3
T5	NRVEG	YES	5.4	7
T6	TRANS	YES	0.05	5
T7	TRANS	YES	0.1	5
T8	NRVEG	YES	0.2	6
T9	TRANS	YES	1.7	13
T10	TRANS	NO	0.2	15

Forested Wetlands of the Gulf of Mexico Coastal Zone: Status, Mitigation Efforts, and Research Needs

James Allen
U.S. Fish and Wildlife Service
National Wetlands Research Center

Forested wetlands are amongst the most important habitats in the Gulf of Mexico coastal zone. The term forested wetlands includes such diverse habitat types as pine-dominated flatwoods, bottomland hardwoods, deep cypress-tupelo swamps, and mangroves, all of which are found in considerable quantity within the coastal zone. Although all types are important, this paper primarily covers bottomland hardwood and cypress-tupelo wetlands, with an emphasis on Louisiana.

Status:

According to one estimate, there are roughly 7,390 square miles of forested wetlands within the Gulf of Mexico Estuarine Drainage Area (EDA). Forested wetlands account for 48% of the total wetland acreage and 9% of the total land within the EDA. Together, Florida and Louisiana account for 97% of the total area of forested wetlands in the EDA, with approximately 3,621 and 3,571 square miles, respectively (NOAA 1987).

I have been unable to locate any estimates of loss of forested wetlands for the coastal zone as a whole. Soon, however, it should be possible to compile such estimates by using NWI data that is going into a new status and trends report being prepared for submission to Congress.

Even without good trends data, it is readily apparent that a large proportion of the existing forested wetland area is seriously threatened by processes ranging from highway and urban development to natural subsidence. Furthermore, if even the more moderate predictions for global climate change-induced sea level rise come true, then a much larger proportion of the forested wetland area will be threatened over the next century.

The threat of future losses seems most severe in Louisiana. Thousands of acres of so-called "ghost forests" can be seen in some of the coastal parishes; these are primarily cypress-tupelo forests that have been killed by salt water intrusion. Ghost forests are found mostly along the larger navigation canals (e.g., Houma Navigation Canal and Mississippi River Gulf Outlet) and in the Lake Ponchartrain basin. In areas protected from salt water intrusion, the main threat is natural subsidence, which in most cases is compounded by reduced rates of sedimentation and/or increased flooding caused by levees and channelization projects. The threats to Louisiana's forested wetlands are truly on a grand scale. The forested wetlands of entire watersheds, such as the Lake Verret basin (which contains approximately 115,000 acres of

forested wetlands), may be converted largely to open water over the next 50 - 100 years (Conner and Brody 1989).

Mitigation Efforts:

I have divided the ongoing forested wetland mitigation projects into three broad categories: small scale projects; agricultural field reforestation; and large scale hydrologic modifications.

Small scale projects are generally under 20 acres in size, and are usually much less. These include such activities as tree planting on spoil banks and mitigation for small highway or building construction projects. Based on discussions with personnel from Fish and Wildlife Service field offices in the Florida Panhandle, Alabama, and Louisiana, it appears that there are perhaps 100 to 150 of these projects in existence. There are probably many more projects along the lower Florida Gulf coast, where much work has been done with mangrove restoration. The total acreage of projects along the northern Gulf coast probably does not exceed 2,000 acres. Unfortunately, there is very little documentation available, even on whether or not the projects were actually implemented.

The best evaluation of small scale projects I could find is in a report by Kinler (1988), on the establishment of bottomland hardwood tree species on oil and gas exploration canal spoil banks in southern Louisiana. He found that, of 25 sites planted over two seasons, at least 7 (and probably 9) had no surviving seedlings whatsoever. The seedlings on these 9 sites had no protection, and were apparently lost to nutria. Seedlings on the other 16 sites were protected either with wire enclosures (14 sites) or the chemical repellent RO-PEL (2 sites). A sample of 6 of the sites planted using wire exclosures found an overall seedling survival of 57%. One of the sites planted using RO-PEL was visited and no surviving seedlings were found, although the contractor reported 90% survival for the second site. The bottom line of this study appears to be that spoil bank reforestation can work, but much greater attention needs to be given to site preparation, species selection, seedling protection, and post-planting weed control than typically has been given in the past.

The above conclusion probably also holds true for most other types of small scale projects. In brief summaries of 5 forested wetland mitigation projects in Alabama, problems reported included: filling or dredging sites to improper elevations (making the sites too wet or dry for the species that were to be planted); depredation of seedlings by beaver; and domination of the planting sites by undesirable vegetation. None of these problems is insurmountable given proper planning, implementation and follow-up.

Agricultural field reforestation may be the category of mitigation that has been used the least along the Gulf of Mexico coast in the past, but it is being carried out on a large scale further inland. The Louisiana Department of Wildlife and Fisheries, for example, has established over 3500 acres of bottomland hardwoods on old fields within its wildlife management areas. The U.S. Fish and Wildlife Service, several state wildlife and forestry agencies, and hundreds of private landowners have also become involved in this type of reforestation/mitigation. Most of this type of reforestation is generally not being done as mitigation for specific development projects, but this year nearly 600 acres of old fields on a coastal wildlife management area in Louisiana will be reforested as off-site mitigation for various projects in the region. The National Wetlands Research Center has produced several publications on agricultural field reforestation (see Attachment 1).

Several large scale hydrologic modifications that will mitigate for losses of forested wetlands have been proposed or are being implemented in Louisiana. These are part of an overall state program to reduce the loss of coastal wetlands (Wetland Conservation and Restoration Task Force 1990). One example is the Falgout Canal project (see Attachment 2) which may allow for the natural regeneration of a large area of salt-killed cypress-tupelo swamp. The project is designed to allow for fresh water to flow in from the north, but will exclude salt water from entering through the Falgout and Houma Navigation Canals. Some on-the-ground monitoring of these projects is planned, but for the most part monitoring will rely on aerial photography.

Research Needs:

Excellent discussions of research needs can be found in Kusler and Kentula (1990), particularly in the chapter on forested wetlands by Clewell and Lee, the executive summary, and the overview of Part One. The suggestions below, then, are in addition to those, and really refer more to the larger scale of restoration particularly relevant to Louisiana.

Better Data on Extent of Losses and Future Threats:

- o Determine forested wetland loss rates in coastal zone
- o Determine area of "ghost forests"
- o Identify threatened areas
  - based on subsidence and salinity trends
  - based on global climate change scenarios
- o Develop improved techniques for identifying sublethal stress
  - for individual trees
  - for whole forests (i.e., through remote sensing)

Planting and Seeding Technologies:

- o Develop cost-effective means of protection from nutria
- o Develop seedling planters for mucky soils
- o Test direct seeding in coastal environments
- o Determine when natural regeneration can be used effectively

Restoration of Hydrology:

- o Identify areas where hydrologic restoration/enhancement is feasible
- o Monitor diversion projects and other large hydrologic modifications
- o Take advantage of existing projects (case studies)

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ATTACHMENT 1

Publications on Forested Wetland Restoration
Available from the National Wetlands Research Center

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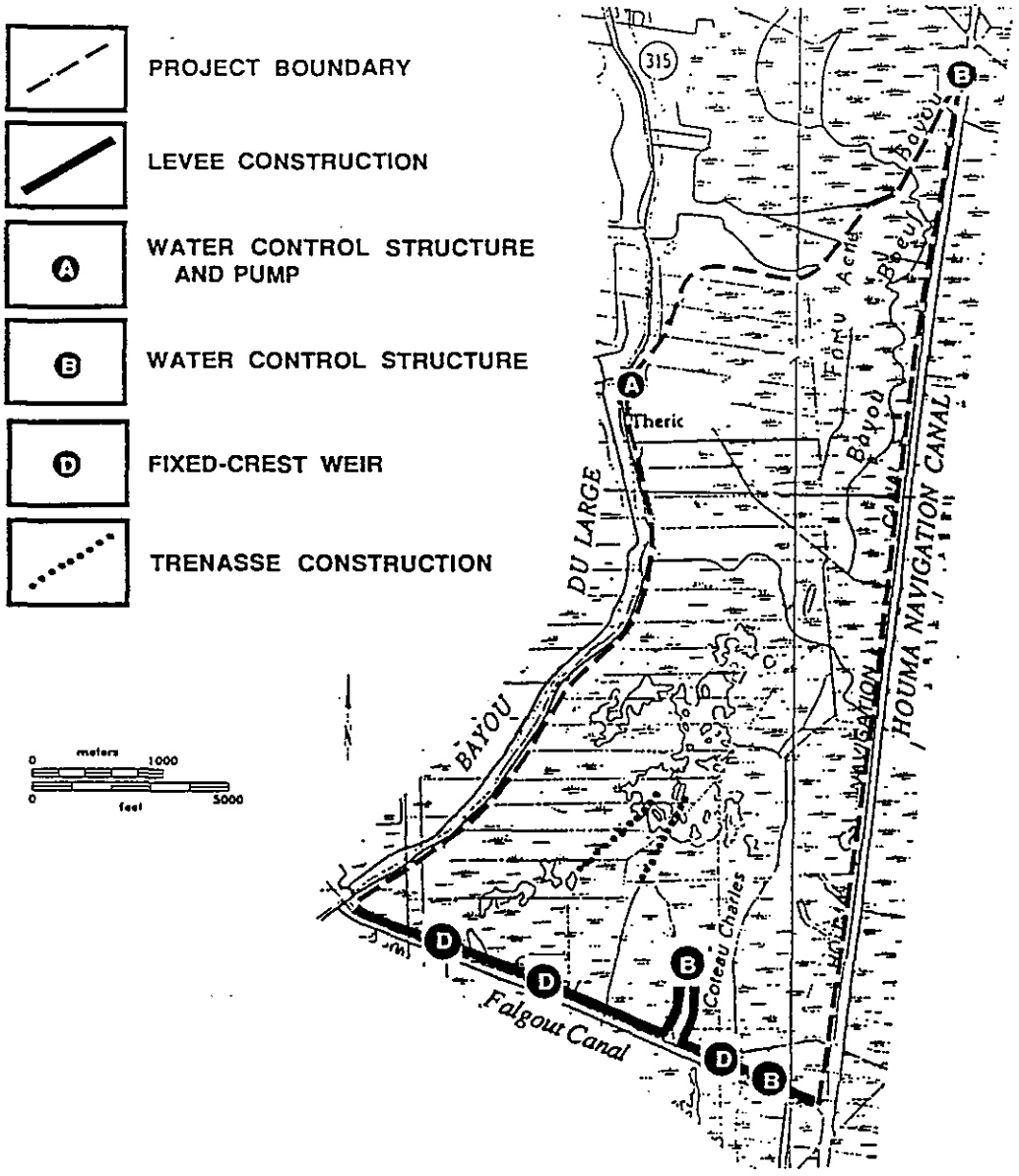
Allen, J.A. and H. Beierman. 1989. Fertilization has mixed effect on planted Nuttall oak seedlings. U.S. Fish and Wildlife Service Research Information Bulletin No. 89-115, December. 2pp.

Allen, J.A. and H.E. Kennedy, Jr. 1989. Bottomland hardwood reforestation in the Lower Mississippi Valley. U.S. Fish and Wildlife Service and U.S. Forest Service. Slidell, LA. 28 pp.

U.S. Fish and Wildlife Service. 1989. Guidelines for modifying the John Deere 7100 Max-Emerge planter to plant acorns. (This mimeographed document was prepared as a handout for farmers and others interested in reforestation by direct seeding). 7 pp.

Haynes, R.J., J.A. Allen, and E.C. Pendleton. 1988. Reestablishment of bottomland hardwood forests on disturbed sites: An annotated bibliography. U.S. Fish and Wildlife Service Biological Report 88(42). 104 pp.



TE-2. FALGOUT CANAL WETLAND

Hydrologic Basin: Terrebonne
Parish: Terrebonne
Acreage Benefitted: 4,000

Purpose and Need: This area experiences a significant loss of wetlands and an increase in salinities. The primary objectives of this project are to improve freshwater retention and restore vegetation by moderating water flux and tidal energy in the deteriorating wetland community.

Project Description: Greater utilization of freshwater will restore a more favorable hydrological regime. The use of levees and control structures will allow reduction of the rate of saltwater intrusion and the associated wetland loss.

TE-2. FALGOUT CANAL WETLAND

Location and Size

The Falgout Canal wetland consists of 4,000 ac of marshland south of Houma. The area extends northward from the Falgout Canal between the west bank of the Houma Navigation Canal and the eastern natural levee ridge of Bayou du Large (Figure TE-0).

Objectives

The primary objective is to curtail marsh loss. Currently, intermediate and brackish marsh comprise most of the Falgout Canal wetland. The area continues to experience a significant loss of wetlands. In 1978, most of the area consisted of fresh marsh and cypress swamp. Since then, salinities have increased, cypress has died, fresh marsh has become intermediate, and intermediate marsh has become open water or brackish marsh. A second objective is to limit the area that is hydrologically connected to the Houma Navigation Canal, thereby lessening saltwater intrusion and rapid loss of freshwater. The loss of wetlands diminishes freshwater retention within the area and increases water exchange between the project area and surrounding water bodies. Both cause further increases in the rate of erosion.

Project Features

Proposed project features are shown in Figure TE-2. The project provides for structural control over water exchange with surrounding water bodies, including the Houma navigation Canal and Bayou du Large. Water management is achieved through maintenance of the existing spoil bank along the Houma Navigation Channel, construction of a levee along the Falgout Canal, and the installation of water-control structures for the removal of water along the southern boundary and for the introduction of water, from the Houma Navigation Canal and Bayou du Large during low salinity conditions. The project establishes increased retention of freshwater derived from local runoff, control of saltwater inflow from the Gulf, and control of water levels. In this manner, the project is expected to prolong the existence of the remaining wetlands, enhance existing wetlands, and restore wetlands through revegetation.

Status and Schedule

All required Federal and state permits for implementation of the proposed project features have been obtained by Terrebonne Parish. Currently, the spoil banks along the Houma Navigation Canal and the mineral access canal on the south side have been implemented.

Project Elements	90/91	91/92	92/93
Wetland protection and enhancement	PFD/CI	OMR	OMR

ARCTIC ALASKA WETLANDS: HABITAT FUNCTIONAL VALUES AND MITIGATION

summary of presentation to

Habitat Loss and Modification Working Group
Workshop on Federal Efforts to Evaluate Coastal Wetland Mitigation
San Diego State University
San Diego, California 92182
January 1991

sponsored by

National Ocean Pollution Policy Board
National Oceanic and Atmospheric Administration
Office of the Chief Scientist
Washington, D.C. 20230

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ALASKA WETLANDS: HABITAT FUNCTIONAL VALUES AND MITIGATION

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In Alaska, North Slope oilfields contain the majority of the state's wetlands that are currently affected by development. Most of the oil development (exclusive of the Trans-Alaska Pipeline System and offshore development) has been, and probably will continue to be, on the nearly flat Arctic Coastal Plain. A majority of the Coastal Plain landscape is covered with water or waterlogged, at least periodically during the ice-free season, and most has been designated as wetlands. This paper addresses oilfield development in these coastal plain wetlands, the impacts on fish and wildlife of the major habitat changes, the current mitigation practices and plans, and the recommended directions for mitigation policy and research. Recommendations are based on the functional values of wetland habitats in supporting fish and wildlife populations.

Oilfield development in arctic Alaska commenced with the discovery of the Prudhoe Bay Oilfield in 1968. Studies of the impacts of oil development on the region's biota began within the next few years, and the total magnitude of such studies has increased more or less annually since then. Currently, three large oilfields--Prudhoe Bay, Kuparuk, and Endicott--contribute the majority of disturbance to the region's wetlands.

Initially, the major impacts to wetland habitats arose from small gravel drilling pads, roads constructed of surface soil and peat, and vehicle travel on tundra. But within a few years after development commenced, oil companies began using gravel fill for all facilities placement and vehicular travel, and most habitat alterations in the past 20 years have been caused by gravel mining and placement and associated activities.

The extent of habitat change is different for the different kinds of activities. Gravel mines (pits) occupy very small acreages. Production facilities, well-drilling pads, and roads require gravel fill two to five feet thick; this fill and the water impounded in drainages blocked by the fill

constitute the major acreages of drastically altered habitat. Gravel fill covers at most 2 to 3 percent of the surface areas of existing oil fields; impounded water covers additional acreages of the same order of magnitude. Additional but generally smaller total acreages are affected by dust from vehicular traffic, vehicle tracks and peat roads in areas without gravel fill, elevated pipelines, and ice roads used during winter.

Responses of fish and wildlife populations to these habitat changes vary among species and types of activity. Gravel pits destroy habitat for nearly all terrestrial species. Addition of gravel fill destroys nesting habitat for most birds, but for others provides better nesting and feeding habitat than existed previously; birds are attracted more to gravel fill when it is partly recolonized by vegetation. Impoundments upslope of fill appear to function similarly in many respects to natural ponds as waterbird feeding and nesting habitat. Water bodies and terrestrial sites that are in dust shadows of well-traveled roads attract more birds in early summer than other areas because snow melts there first. Currently-used gravel roads discourage many birds from nesting within 50 to 100 m, but gravel fill no longer used may enhance the immediately adjacent tundra as habitat for some birds. Surface subsidence, or thermokarst, resulting from tundra surface disturbance, impounding of water, or near proximity of gravel fill, typically enhances primary productivity and sometimes creates new water bodies; herbivorous or pond-feeding species such as caribou and waterfowl may thereby benefit. Aboveground pipelines that are not elevated at least four feet above ground level may hinder caribou access to habitat. Abandoned peat roads appear to have enhanced the original habitat's value for nesting and feeding by most birds.

Mitigation has been instituted in some cases but is in planning or research stages in others. Mitigation that has been used to offset some of the adverse changes includes flooding of abandoned gravel pits so they can be used as fish habitat, selectively placing gravel fill in sites that are considered relatively "poor" habitat for birds, reducing the acreage of fill needed (by spatially crowding activities), and using culverts to minimize the sizes of impoundments. Mitigation options that are largely in the planning or research stages include experimenting with various ways of revegetating abandoned gravel fill, placing new developments atop old disturbances, removing fill after it has been abandoned, and draining impoundments. Innovative research for mitigation is sometimes discouraged by regulations that restrict habitat alteration; for example, testing the utility of artificial islands to benefit nesting waterfowl would be hindered by the necessity for obtaining a "fill" permit to create

islands. Returning habitats to their original condition is frustrated by thermokarst and the slowness of plant community development.

Existing research, on both the impacts of development and the efficacy of mitigation practices, has disclosed some interesting patterns in the functional values of wetland habitats. Fish and wildlife populations seem generally more sensitive to changes in the physical structure of the habitat (e.g., micro-relief, presence and characteristics of water bodies, presence of islands in ponds and lakes, stature and percent cover of the vegetation, presence and characteristics of man-made facilities) than to qualitative changes in foodchains or the vegetative composition of habitats. Introduction of small-scale structural anomalies (e.g., peat roads, gravel pads, water-filled pits, pipelines, and other structures) frequently enhances locally the fish or wildlife species richness and abundance. For many of the species present, the original habitat condition seems often not to be the best possible. Changes introduced by either development or mitigation actions seem invariably to adversely affect some species but to benefit others. Changes that are aesthetically displeasing do not necessarily cause decreases in habitat value, and in fact usually improve the habitat for some species.

Recommendations for how to proceed with mitigation and mitigation research and planning are several. First, establish fish and wildlife species priorities and management goals prior to further effort, for any mitigative action may adversely affect some species as it benefits others. Focus research on functional links between the habitat and the species of greatest concern, i.e., clarify which characteristics of the habitat control its value for the species. Do not assume a priori that the "pristine" condition of the habitat is necessarily the best possible condition for fish and wildlife populations. Always distinguish between human aesthetic values and wildlife habitat values when planning mitigation, for the two are often at odds. Investigate ways to circumvent those regulatory prescriptions and policies that currently hinder the development of efficient and effective mitigation. Above all, as new research findings surface, use the information to adjust priorities for further research and to modify existing mitigation practices when appropriate.

A STUDY OF MARSH MANAGEMENT PRACTICE IN COASTAL LOUISIANA

Donald R. Cahoon

and

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INTRODUCTION

The purpose of this two-year study was to determine the suitability of marsh management practices for mitigating wetland loss in the varied habitats of coastal Louisiana. The report summarizes the essential aspects of marsh management in Louisiana - the administrative framework within which it occurs, public interest goals, engineering and construction techniques, an annotated literature review, environmental conditions within which it occurs, historical and field monitoring, and ecological consequences. This presentation summary reviews the history of marsh management in Louisiana and the findings of the monitoring program.

HISTORY OF MARSH (WATER-LEVEL) MANAGEMENT IN LOUISIANA

Weirs

Water-level management (excluding drainage for agriculture) in the marshes of Louisiana apparently began in the early 1940s with the construction of weirs (low dams) in access ditches used for hunting and trapping (O'Neill 1949). Weirs allowed the marsh to flood during high tides but prevented the ditches from completely draining the marsh at ebb tide. Thus weirs prevented vegetative changes associated with excessive drainage. The use of weirs increased during the 1940s and 1950s; the peak of construction activity occurred from 1955 to 1965 (Nyman 1989), mostly in intermediate and brackish marshes. By 1967, approximately 100,000 hectares (ha) of coastal marsh were being managed by weirs (Herke 1968). Weirs were used extensively to counteract changes in water levels

and flows and water salinity caused by an ever-growing network of canals. The purpose of the weirs was to reduce salinity, stabilize water levels, minimize turbidity, and restrict the rate of tidal exchange (Perry and Joanen 1986). Weirs are effective at stabilizing water levels but they affect salinity and turbidity only slightly, if at all (Chabreck and Hoffpauir 1962; Turner et al. 1989). However, production of aquatic vegetation suitable for waterfowl food is often enhanced by weirs (Chabreck 1968).

Marsh Impoundments

"A marsh is considered impounded when completely surrounded by elevated land, including levees and natural ridges, that restricts water movement between the marsh and adjacent drainage systems" (Chabreck 1988:82). Water is added or removed from the impounded marsh via water-control structures (e.g., weirs, culverts, pumps) located in drainage channels. Marsh impoundments were first constructed in Louisiana on Rockefeller Refuge in the 1950's.

Marsh impoundments are closed systems that provide a mechanism for controlling water depth and salinity (Chabreck et al. 1989). They are most commonly used to manage marshes to improve wildlife habitat (Chabreck 1988; Chabreck et al. 1989). Because wildlife, especially waterfowl, depend on specific plant species for food and shelter, marsh management should maintain water levels and salinity within the ranges that are best for target wetland plant species. In the face of saltwater intrusion, this means maintaining existing fresh, intermediate, and brackish marsh zones and/or creating lower-salinity vegetation zones by converting one marsh type to another (e.g., changing brackish marsh to intermediate marsh).

Mitigating Wetland Loss

Wetlands are open systems with direct connections from marsh zone to marsh zone, marsh to estuary, river to marsh and estuary, uplands to marsh and estuary, and marsh and estuary to the Gulf, as well as intercontinental links via migratory waterfowl (Gosselink 1984). These open connections between upland, coast, and ocean are the reason wetlands are among the most productive ecosystems in the world (Odum 1971). The extensive network of canals and their associated spoil banks in coastal Louisiana has increased the direct hydrologic links and rate of water exchange between interior marshes and the estuary (i.e., bays and the Gulf of Mexico), different marsh types (e.g., saline and fresh marshes), and hydrologic basins and sub-basins. These artificial linkages may contribute to imbalances between fresh and salt water, increased tidal amplitude, altered sediment distribution patterns, altered water levels in the marsh, and changes in the normal duration of flooding (see Turner and Cahoon 1987 for a review). Such hydrologic and sedimentologic alterations in the rapidly subsiding environment of coastal Louisiana contribute, at least in part, to wetland loss.

Structural marsh management is being employed to mitigate wetland loss associated with these hydrologic alterations because it creates a closed system -- one in which hydrologic exchanges are severely reduced or periodically eliminated. Controversy has developed over the use of this management technique because of concern that necessary hydrologic connections are being severed and

open systems are being replaced by closed ones in increasingly larger portions of the coast. On the other hand, landowners want to combat saltwater intrusion and stop ecologic and economic deterioration by restoring more natural hydrologic conditions on their pieces of the altered open system. This controversy is fueled by limited documentation of and a lack of long-term databases on the effectiveness of structural management (Wicker 1983).

Structural marsh management and particularly marsh impoundments have been proposed to mitigate the impacts of saltwater intrusion and increased tidal amplitude. Because weirs and levees reduce the rate of water exchange between marshes and waterways, it is thought that structural management may retard saltwater intrusion, decrease the physical or erosive impact of amplified tides, and restore more natural hydrologic conditions to marsh altered by canals. Therefore, the closed systems being used to manage wildlife habitat are also intended to mitigate the loss of wetlands. Profit gained from the harvest of wildlife resources provides an added incentive to landowners to employ this type of management because they must bear the costs.

Critics of this approach caution that because weirs and levees reduce water exchange, they may restrict sediment distribution and accumulation, increase plant stress due to waterlogging of the soil, and decrease the overall primary productivity of the marsh. If so, vertical accretion in the marsh will be reduced; in the rapidly subsiding environs of coastal Louisiana this may damage the health of the managed marshes and the marshes influenced by levees and lead to increased wetland loss.

This controversy will only be resolved when the influence of structural management on water salinity, water levels and flows, plant growth and species composition, nutrient cycling, soil development, and sediment distribution and accumulation within a managed marsh and marshes within the surrounding basin has been determined. This study is the first comprehensive analysis of the effects of structural marsh management as it is employed in coastal Louisiana.

RESULTS OF MONITORING PROGRAM

Our monitoring program was conducted in three phases: (1) an analysis of landowner monitoring efforts; (2) an evaluation of habitat change in managed areas; and (3) field studies of two manipulated impoundments.

Analysis of Landowner Monitoring Programs

Methods

The objectives of this analysis were to determine: (1) the intensity and quality of monitoring by permittees; (2) the suitability of the data base for evaluating the effectiveness of structural management; and, (3) the effectiveness of structural marsh management in achieving stated objectives. We determined the extent of monitoring by reviewing the permit files of the Louisiana Department of Natural Resources and noting monitoring data submitted by the permittees. The quality of data was determined from the variables measured and the techniques and experimental design used in data collection. We assessed the suitability of the data base for evaluating the effectiveness of structural management by comparing the types and quality of data to the management goals. Management effectiveness

was determined by synthesizing all available data.

Results

The monitoring data base on file at the Department of Natural Resources is small in relation to the number of implemented managed areas (9 plans out of approximately 20 fully and 30 partially implemented plans). The intensity of the monitoring programs varies greatly. Some efforts are dedicated to creating long-term data bases; other monitoring efforts have ceased.

The quality of the monitoring programs varies greatly. The monitoring programs focused on measuring plant species composition, water parameters (e.g. level and salinity), and habitat change. However, these variables were rarely measured in a nearby unmanaged marsh for comparison. Also, only one of the monitoring programs provided data on plant growth and no programs provided data on abiotic factors that may affect plant growth, such as water and matter flux, nutrient cycling, sediment distribution and accretion, soil conditions, subsidence, and evapotranspiration.

The ability of the monitoring programs to evaluate the effectiveness of management is limited by the variation in monitoring intensity and quality.

Habitat Change Analysis

Methods

The objective of this analysis was to measure habitat change in managed and unmanaged marshes in different environmental settings. Sixteen managed sites with an associated unmanaged reference area were selected in both the delta and chenier plains in as many different marsh types as possible. These sixteen sites most likely represent a majority of the fully implemented management plans permitted since 1980. Habitat change was determined by comparing aerial photographic images from 1955/56, 1978, 1981/82/83, 1985, and 1988. Variables analyzed included marsh-to-water ratios, change in marsh type, change in marsh area, and change in habitat diversity.

Results

Marsh management is not consistently effective at increasing marsh acreage, reversing salinity influence on habitat composition, or improving marsh-to-water ratios. When analyzed over the entire interval of management, some managed areas became fresher, or had improved marsh-to-water ratios compared to their unmanaged area while some unmanaged areas showed improvement when compared to their managed area. For example, 5 managed areas showed improvement in marsh-to-water ratios when compared to their unmanaged areas, while 3 unmanaged areas showed improvement in marsh-to-water ratios when compared to their managed areas. However, for 50% of the comparisons, there was no difference between the changes occurring at the managed area and those occurring at the unmanaged area.

During the last photographic interval of 1985 to 1988, actively managed marshes sometimes produced improved marsh-to-water ratios (5 of 10 sites), net gains in marsh (2 of 10 sites), and a net change of water to marsh (4 of 10 sites) when compared to nearby unmanaged marshes. Passive management, with very few exceptions, produced no gains in marsh-to-water ratios or marsh acreage.

Field Studies

Field Sites and Methods

The two areas selected were the Fina LaTerre Mitigation Bank site in the delta plain and Rockefeller State Wildlife Refuge and Game Preserve in the chenier plain. These two areas were selected for study because they represent the two main physiographic provinces of the Louisiana coast and they have numerous characteristics in common. Both of these sites are considered premiere examples of structural marsh management utilizing adjustable water control structures that can alter water levels in the marsh seasonally. Also, each site includes the same marsh type (Spartina patens-dominated brackish marsh) in both managed and unmanaged areas. Equally as important as these physical attributes, however, was the fact that the landowners of each site agreed to provide essential logistical support. The managers of the sites provided invaluable support to our field studies in the form of airboats, flatboats, and field personnel (i.e., boat drivers).

At each site we monitored the influence of structural management of water levels on hydrology, production and species composition of emergent vegetation, soil parameters, sediment dynamics, water chemistry, and fisheries. Most of the variables we measured had either not been measured before in a managed marsh or had not been measured simultaneously in both a managed and nearby unmanaged marsh.

Field plots were selected and data collected within managed marsh and nearby unmanaged marsh so that the influence of management on basic ecological processes could be evaluated. All plots were located in marsh areas dominated by Spartina patens. Both areas underwent a drawdown in the spring of 1989 during this study. Details of field sampling design are provided in the final report.

Results and Discussion

This synthesis is based on data collected during a drawdown year only. Drawdowns have occurred usually every fourth year at Rockefeller Refuge, while at Fina LaTerre a drawdown has been implemented every year since management was initiated in 1985. For the Fina LaTerre site, the conclusions pertain only to the southern portion of the managed area and the unmanaged reference area south of Falgout Canal.

Management Effects on Physical Processes -- Fina LaTerre. Water-level management reduced tidal amplitude and frequency in the southern portion of the managed area. The results of the flux and accretion analysis are consistent with this hydrologic pattern and with each other. The amount of water and matter exchanged with the southern portion of the managed area through the drawdown structure was low compared to that of the unmanaged area, and vertical accretion and matter accumulation were uniformly low throughout this region. Rates of vertical accretion and matter accumulation are not sufficient to keep pace with local rates of relative sea level rise in both the managed and unmanaged areas. Water and interstitial soil salinities in the southern portion of the managed area were equal to or higher than water and interstitial salinities in the unmanaged marsh throughout the entire year. Soils were more reduced in the brackish vegetation zone of the managed marsh during the plant growing season but there was no difference in sulfide concentrations. Three months after commencement of

drawdown (May 1989), water levels in the southern portion of the managed area were drawn down to 5-10 cm below marsh level. Analysis of material fluxes and accretionary processes in the northern portion of the managed area is needed in order to understand management effects on the physical processes of the entire management area.

Management Effects on Physical Processes -- Rockefeller Refuge. Water-level management reduced tidal amplitude and frequency in unit 4 at Rockefeller Refuge and the results of the flux and accretion analysis are consistent with this hydrologic pattern and with each other. The flux of water and matter, and the rate of vertical accretion and matter accumulation, were greatly reduced in the managed area. Under certain hydrologic conditions, more sediment may flow out of the managed marsh than flows in. Rates of vertical accretion and matter accumulation are not sufficient to keep pace with local rates of relative sea level rise in the managed marsh. In contrast, the unmanaged marsh experienced regular exchange of matter and accretion rates comparable to local relative sea level rise rates. However, substrate conditions were more conducive to plant growth in the managed marsh. Interstitial soil salinity, soil reduction, and sulfide concentrations all were significantly lower in the managed marsh. Water levels were drawn down 20-30 cm below the marsh surface three months after commencement of drawdown (May 1989) and 1-2 weeks after two of seven flap-gates were opened for a total of four days to allow ingress of shrimp larvae.

Management Effects on Physical Processes -- Summary. The impacts of management on hydrology and sedimentology were similar in the southern portion of the Fina LaTerre site and Unit 4 at Rockefeller Refuge. Management was successful at isolating the managed marsh from most local hydrologic influences and controlling and stabilizing water levels at both field sites. In contrast, the unmanaged marshes were influenced by diurnal tidal variations, winter storms, and lunar tidal effects. Consequently, tidally driven flux and accretion were significantly reduced at both managed sites when compared to the unmanaged sites. The implications for sea level rise effects need to be investigated.

Management Effects on Biological Processes -- Fina LaTerre. The southern portion of the managed area was still dominated by Spartina patens in 1989. The productivity of Spartina patens was lower and substrate conditions were more stressful to plant growth in the brackish vegetation zone of the managed marsh. Plant species diversity was the same in both the southern portion of the managed area and the unmanaged area, although more fish species were collected in the unmanaged area. Total biomass of fish was the same for both the southern portion of the managed area and the unmanaged area. The southern portion of the managed area had significantly more individuals of resident estuarine and freshwater species and significantly fewer individuals of marine transient species than the unmanaged marsh.

Management Effects on Biological Processes -- Rockefeller Refuge.
The productivity of Spartina patens was higher and substrate conditions were less stressful for plant growth in the managed marsh compared to the unmanaged marsh. Plant species diversity was also higher in the managed marsh. There were fewer individuals of both marine transient and resident fish species in the managed marsh. Biomass of resident fish species was also lower in the managed marsh. [The reader is referred to the fisheries study at Rockefeller Refuge conducted

during 1989 (Hoese et al. 1990) for additional information on fisheries species composition and biomass at Rockefeller Refuge.]

Management Effects on Biological Processes -- Summary. Although management effects on hydrology and sedimentology were similar at both sites, management effects on plant growth and stress differed significantly. Growth of Spartina patens and plant species diversity were enhanced at Rockefeller Refuge but not in the southern portion of the managed area at Fina LaTerre. The data suggest that the decreased growth rate of Spartina patens at Fina was related more to reduced soil conditions than to salinity effects.

Implications of Field Monitoring Results

One of the primary purposes of structural marsh management is to restrict tidal exchange and regulate water levels in order to enhance plant production and consequently improve secondary production of waterfowl and wildlife. A review of the file monitoring data demonstrated (chapter 10) that the influence of restricted tidal exchange and regulated water levels on plant growth and the flux of matter into the managed marsh had not been measured before this study. Thus there has been no documentation that the assumed benefits actually occurred. The results of this study of two brackish marsh impoundments indicate that management severely limited both the flux of matter and vertical accretion. The implications of these results for managed brackish marsh in a rapidly subsiding environment are that vegetative growth and organic matter accumulation may be the only means of maintaining marsh elevation. Unfortunately, plant growth may be limited, and organic matter accumulation has been shown to be significantly reduced by management whether or not plant production was enhanced. These findings demonstrate how little is known about the impact of structural management on accretionary and plant growth processes, and ultimately marsh surface elevation. To predict accurately the long- and short-term consequences of using manipulated impoundments in the rapidly subsiding environments of coastal Louisiana, a better understanding of the effects of such techniques on plant growth and marsh accretionary processes must be acquired. Several research topics have been identified and specific issues related to each are discussed below.

Recommendations for Research

Marsh Accretionary Processes. The impact of management on the flux of matter, vertical accretion, accumulation of matter, and plant growth needs to be evaluated for fresh, intermediate, brackish, and saline marsh. In addition, all these variables should be measured during drawdown and non-drawdown years. So far they have been measured only in two brackish marshes and only during drawdown years. These data should be synthesized with data on surface elevation changes in managed and unmanaged marshes.

Plant Growth. The determinants of successful vegetative growth in manipulated impoundments should be isolated by both experimentation and monitoring of natural populations. In particular, the rates of above- and belowground plant production and plant decomposition should be determined.

Fisheries Access. A sizable body of literature indicates that manipulated

impoundments and weir management diminish fisheries access to managed marshes. Future research should be directed at determining the feasibility of retrofitting management structures to allow for ingress and egress of aquatic organisms.

Monitoring Procedures. Standardized monitoring procedures should be developed and used at all managed sites. Standard methodologies should be employed to monitor a prescribed set of variables related to water quality, accretionary processes, substrate conditions, plant growth rates and species composition, and waterfowl, wildlife, and fish production. A standardized monitoring program will facilitate comparison of data collected at different managed sites.

Once databases of sufficient size have been accumulated, computer models should be developed which, in conjunction with the new monitoring data, can be used to develop management plans with the most appropriate designs and schedules of operation.

Cumulative Impacts. To overcome the lack of knowledge about the cumulative effects of structural management, three approaches are recommended. First, the influence of management on adjacent marshes should be investigated. Pre- and post-implementation data collected from managed and unmanaged areas should be compared to determine the effect of management on neighboring marshes. Second, the interaction of structural water-level management with other management techniques, such as fresh water and sediment diversions, should be determined. Techniques should be developed to capture sediment and fresh water in managed marshes at diversion outfalls; otherwise the managed marsh probably will not benefit from the diversions. Third, regional impacts to sediment distribution, water flows and levels, and marsh health should be determined. Computer models should be developed from the standardized monitoring data bases within a basin to facilitate this analysis.

SUMMARY

Wetland Creation Research Program
USEPA Wetlands Research Program

The USAEPA in January 1986 adopted a wetlands research plan to assist the Agency in implementing its responsibilities to protect the nation's wetlands resource. Reflecting a general concern about mitigation, EPA personnel surveyed in the planning process agreed that there was a pressing need to determine how well created and restored wetlands compensate for losses permitted under Section 404. The research proposed in the 1986 plan to meet this need has been implemented under the Wetland Creation Component of the Wetlands Research Program.

The Wetland Creation Component has three goals. They are to:

(1) provide a framework for making permit decisions based on the needs of the 404 permitting process;

(2) provide guidance for the design of projects through improved methods of creating, restoring, and enhancing wetlands and wetland functions; and

(3) develop methods for describing and evaluating natural and created wetlands.

To meet these goals, the research was organized into three tasks. The tasks and the associated projects and outcomes are described below and summarized in Figure 1.

TASK 1: DEVELOP A MITIGATION TRACKING AND ACCOUNTING SYSTEM TO DESCRIBE TRENDS AND PATTERNS IN 404 PERMITTING

A compilation of information from the 404 permit record was initiated for several states to (1) develop and test a method for compiling permit information; (2) characterize patterns and trends in permit-related wetland creation and restoration; and (3) identify potential locations for field studies.

TASK 2: RECOMMEND STANDARDS AND CRITERIA FOR WETLAND CREATION AND RESTORATION

Subtask 1: Synthesize the Scientific Knowledge on Wetland Creation and Restoration

A provisional guidance document reporting the current knowledge on wetland creation and restoration was produced. The goal was to assemble information from as many sources as possible, including personal experience. The document will serve as a handbook for Agency 404 personnel and will be used to set research priorities.

Subtask 2: Compare Created and Natural Wetlands

Completed wetland creation and restoration projects are being treated as "experiments in progress". These field studies are designed to (1) evaluate the project plans; (2) compare the projects with natural wetlands in the same ecological setting; and (3) describe the development of projects over time. Ultimately, the results of these studies will begin defining critical features of projects to create or restore wetlands.

TASK 3: DEVELOP STANDARD METHODS TO DESCRIBE AND EVALUATE NATURAL AND CREATED WETLANDS

The field studies are also being used to develop methods for describing and evaluating natural and created wetlands. A Wetland Characterization Method is being developed and tested. Elements of the approach were repeated in all field studies to evaluate the applicability of the techniques in different regions. Each study also tested unique methods, including, in some cases, measures of functions such as bird use and fisheries habitat potential.

FY91 is a year of transition. Efforts will focus on 1) completing and reporting on the research implemented during previous years; 2) finalizing plans and producing the Final Mitigation Handbook; 3) planning and initiating cooperative studies with the Regions as a form of tech transfer; and 4) planning for the next phase of the program.

FY90 MITIGATION RESEARCH PLAN
U.S. EPA WETLANDS RESEARCH PROGRAM

1.0 INTRODUCTION

The increased use of wetland creation or restoration as compensation for losses permitted under Section 404 of the Clean Water Act has focused attention on the efficacy of this practice.
Concurrently a number of questions have been raised, ranging from: What constitutes appropriate compensation? to Are the ecological functions of naturally occurring wetlands replaced by created and restored wetlands?

The USEPA in January 1986 adopted a Wetlands Research Plan (Zedler and Kentula 1986) to assist the Agency in implementing its responsibilities to protect the nation's wetlands resource. Reflecting a general concern about mitigation, EPA personnel surveyed in the planning process agreed that there was a pressing need to determine how well created and restored wetlands compensate for losses permitted under Section 404. The research proposed in the 1986 Plan to meet this need has been implemented under the Mitigation Component of the Wetlands Research Program.

1.1 Research Goals

The Mitigation Component has three goals. They are to (1) provide a framework for making permit decisions based on the needs of the 404 permitting process; (2) provide guidance for the design of projects through improved methods of creating, restoring, and enhancing wetlands and wetland functions; and (3) develop methods for describing and evaluating natural and created wetlands. At various stages in the research, major findings will be presented in guidance documents for Agency 404 personnel. Interim reports will be submitted to the juried literature.

1.2 Background and Rationale

Wetlands, due to their position in the landscape (i.e., between the aquatic and the terrestrial), are often converted to either aquatic or terrestrial systems, and so to more economically profitable uses. For example, because they are located on the shores of lakes, rivers and oceans, many wetlands are in or near major ports and urban areas. Hence many wetlands have a history of modification and urban encroachment. As the number of prime building sites have decreased, the commercial value of the land has sky-rocketed and conflicting demands have increased. Because of economic pressures

it is often difficult to preserve wetlands in the vicinity of the impacts, let alone find an affordable site for creation or restoration.

The situation for wetlands in rural settings has been similar. In the past, their destruction was encouraged by government programs that subsidized efforts to maximize the amount of land in agricultural production. For example, between 1940 and 1977 under the Agricultural Conservation Program, the Department of Agriculture provided technical assistance and cost-sharing for draining wetlands. Suggesting the impact of such programs, Tiner (1984) reported that 87 percent of wetlands lost between mid-1950 and mid-1970 were lost as a result of agricultural practices. Although funding of wetland conversion has been eliminated, and policies to prevent wetland alteration have been established by some agencies, implementation has not been entirely effective (Office of Technology Assessment 1984). The recently passed Food Security Act of 1985 (better known as the "Swampbuster" Act) is the most recent attempt to discourage wetland conversion for agricultural purposes.

Wetlands are strongly influenced by hydrologic conditions. The hydrology of a site is often difficult and expensive to describe and recreate. Without the establishment of proper hydrologic conditions, wetland creation and restoration cannot succeed. Creating or restoring the hydrology of wetlands supplied predominately by ground water is the most difficult case.

Wetland creation and restoration is also affected by the fact that activities in wetlands are regulated at all levels of government. For example, at the federal level, wetlands are regulated under Section 404 of the Clean Water Act and the Rivers and Harbors Act of 1899. The Endangered Species Act is also relevant because many wetland-dependent species have become rare. Therefore, attempts simply to restore wetlands, even when mitigation for wetland destruction is not involved, may be regulated and subject to public review.

The situations described above are not likely to change greatly in the future. Efforts to protect wetlands will continue as will the economic pressures to develop them. Government agencies will continue to decide when and where wetland destruction can be allowed and when and where wetland creation and restoration will be implemented. Wetland creation and restoration will remain an option for mitigating permitted losses.

The National Wetlands Policy Forum, reflecting current concern about the status of the resource, recently recommended a national wetlands protection policy of "no net loss" of the remaining wetlands (The Conservation Foundation, 1988). The Forum also emphasized that no net loss does not imply that individual wetlands will be untouchable. Therefore, efforts to restore and create wetlands are inherent to attaining no net loss.

The administration of both the 404 program and a no net loss policy requires more information on the ecological functions of wetlands, both individually and in the landscape, and also on the ability to create and restore them. Past and future research in the Wetlands Research Program is designed to meet these needs.

1.3 State of Knowledge

Recent attention on wetland creation and restoration has generated support for a number of quantitative studies of projects. Results of these studies are beginning to be reported (e.g., Owen et al. 1989). However, the overall status of the literature on wetland creation and restoration remains uneven by region and topic. The most quantitative and best documented information is available for Atlantic coastal wetlands. Conversely, information on the creation and restoration of inland freshwater wetlands is spotty, at best.
Most investigations of mitigation are case studies with no sites for comparison (Quammen 1986). Those that rate the success of wetland creation projects most often do so on the basis of compliance with permit requirements, or whether or not the project has been implemented. Furthermore, most are site-specific and do not use reference sites.

The experience associated with the thousands of mitigation projects that have been constructed nationwide represents a store of information to be tapped. Large gains may be realized by describing the influence of 404 permitting on the extent and rate of wetland loss and by studying completed projects to identify critical design features, develop methods for evaluating projects, and determine the functions they perform. Studies of sites and comparisons with naturally occurring wetlands over time would provide a variety of information including rates of revegetation, repopulation by animals, and redevelopment of soil profiles, patterns of succession, and evidence of persistence.

2.0 RESEARCH FRAMEWORK

This section provides the technical rationale and outlines a framework for the research undertaken. A set of questions is presented which must be answered to meet the research goals stated in Section 1.1.

Goal #1 calls for a framework for making permit decisions based on the needs of the 404 permitting process. To meet this goal, one must establish:

What kinds of decisions are being made under Section 404?

Goal #2 calls for guidance for the design of projects through improved methods of creating, restoring, and enhancing wetlands and wetland functions. To meet this goal, one must establish:

> What is known about wetland creation and restoration?
>
> What information is needed to set standards and criteria for wetland creation and restoration projects?

Goal #3 calls for the development of methods for describing and evaluating natural and created wetlands. To meet this goal, one must establish:

> What information is needed to describe and evaluate created and restored wetlands?

3.0 RESEARCH IMPLEMENTATION

The research was organized into three tasks which were designed within the framework described above. The tasks and the associated projects and outcomes are described below and summarized in Figure 1.

TASK 1: DEVELOP A MITIGATION TRACKING AND ACCOUNTING SYSTEM TO DESCRIBE TRENDS AND PATTERNS IN 404 PERMITTING

A compilation of information from the 404 permit record was initiated for several states to (1) develop and test a method for compiling permit information; (2) characterize patterns and trends in permit-related wetland creation and restoration; and (3) identify potential locations for field studies.

TASK 2: RECOMMEND STANDARDS AND CRITERIA FOR WETLAND CREATION AND RESTORATION

Subtask 1: Synthesize the Scientific Knowledge on Wetland Creation and Restoration

A provisional guidance document reporting the current knowledge on wetland creation and restoration was produced. The goal was to assemble information from as many sources as possible, including personal experience. The document will serve as a handbook for Agency 404 personnel and will be used to set research priorities.

Figure 1. The major tasks and the associated projects and outcomes for the Mitigation Research.

Subtask 2: Compare Created and Natural Wetlands

Completed wetland creation and restoration projects are being treated as "experiments in progress". These field studies are designed to (1) evaluate the project plans; (2) compare the projects with natural wetlands in the same ecological setting; and (3) describe the development of projects over time. Ultimately, the results of these studies will begin defining critical features of projects to create or restore wetlands.

TASK 3: DEVELOP STANDARD METHODS TO DESCRIBE AND EVALUATE NATURAL AND CREATED WETLANDS

The field studies are also being used to develop methods for describing and evaluating natural and created wetlands. A Wetland Characterization Method is being developed and tested. Elements of the approach were repeated in all field studies to evaluate the applicability of the techniques in different regions. Each study also tested unique methods, including, in some cases, measures of functions such as bird use and fisheries habitat potential.

4.0 FY88-89 ACCOMPLISHMENTS

Research projects were initiated as described above. This section describes how those projects were implemented and reports on their status. Table 1 lists the products that have been completed during the period.

4.1 Describe Trends and Patterns in 404 Permitting

Trends and patterns in 404 permitting are being analyzed to determine how the permitting process influences the extent and rate of wetland loss, and to locate mitigation projects for evaluation in the field. A data management system (DMS) was designed and used to compile databases containing information on 404 permits. The process of compiling and analyzing the databases was used to test the DMS. Based on the results of these tests, the DMS has been revised to make it faster, more "user-friendly", and intuitive.

Databases were compiled for portions of the 404 permit record in Oregon, Washington, Texas, Arkansas, Missouri, Alabama, Mississippi, Louisiana, and California (Table 2). All the databases have been completed and quality assured. All are in some stage of analysis or reporting.

Table 1. Mitigation Research Products FY88-89.

Scheduled Deliverables

Abbruzzese, B., A.B. Allen, S. Henderson and M.E. Kentula. 1988. Selecting sites for comparison with created wetlands. IN: Proceedings of Symposium '87--Wetlands/Peatlands, compiled by C.D.A. Rubec and R.P. Overend. Edmonton, Alberta, Canada, 1987. pp. 291-297.

Kentula, M.E., J.C. Sifneos, J.W. Good, M. Rylko, and K. Kunz. Trends and patterns in Section 404 permitting in the Pacific Northwest. Submitted to Environmental Management.

Kusler, J.A. and M.E. Kentula (eds.) 1989a. Wetland Creation and Restoration: The Status of the Science. Volume I: Regional Reviews. EPA/600/3-89/038a, U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon. 473 pp.

Kusler, J.A. and M.E. Kentula (eds.) 1989b. Wetland Creation and Restoration: The Status of the Science. Volume II: Perspectives. EPA/600/3-89/038b, U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon. 172 pp.

Kusler, J.A., M.L. Quammen and G. Brooks (eds.). 1988. Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses. Assoc. of State Wetland Managers, New Orleans, Louisiana, 1986. 460 pp.

Extra Products

Henderson, S., A.B. Allen, B. Abbruzzese, M.E. Kentula and R.M. Hughes. 1988. A method for the selection of reference wetlands. IN: Proceedings of the Society of Wetland Scientists' Eighth Annual Meeting, May 1987. Seattle, Washington.

Kentula, M.E. 1988. EPA initiates research in wetland creation and restoration. IN: Proceedings of the National Wetland Symposium: Mitigation of Impacts and Losses, Assoc. of State Wetland Managers, New Orleans, Louisiana, 1986. pp. 437-439.

Kentula, M.E. In press. Wetland mitigation: research opportunities and needs. IN: "Country In the City": Managing Natural Resources in the Urban Environment, February 1988. Portland, Oregon.

Kentula, M.E. In press. Wetlands Evaluation II: The extensive approach--EPA's research program and investigation of an extensive sampling approach to comparing created and natural wetlands. IN: Proceedings of the First Annual Meeting of the Society for Ecological Restoration, January 16-20, 1989, Oakland California.

Table 2. Summary of the 404 permit databases compiled.

State	Information	# Permits	# Wetlands Impacted	# Wetlands Created
OR	All permits requiring mitigation, January 1977-January 1987	58	82	80
WA	All permits requiring mitigation, 1980-86	35	72	52
TX	All permits involving freshwater wetlands and requiring mitigation, 1982-87	47	73	74
AR	All permits involving freshwater wetlands and requiring mitigation, 1982-87	7	8	9
MO	All permits involving freshwater wetlands and requiring mitigation, 1982-87	1	1	1
AL	All permits involving freshwater wetlands and requiring mitigation, 1982-87	19	29	24
MS	All permits involving freshwater wetlands, 1982-87	10	11	6
LA	All permits involving freshwater wetlands, 1982-87	228	260	118
CA	All permits requiring mitigation, 1971-1987	323	368	387

The DMS was used to query each database to answer questions such as "Is it required that wetlands lost be replaced with the same type?", "Is it required that lost functions be replaced?, and "Which functions are impacted most often?". The first results from this effort have been documented in a report on Washington and Oregon (Kentula et al., submitted, Appendix A).

4.2 Provide Provisional Guidance--Synthesis of Scientific Knowledge on Wetland Creation and Restoration

A two-volume synthesis of information on wetland creation and restoration was developed as a provisional guidance document for personnel involved in 404 permitting (Kusler and Kentula 1989a,b; Appendix B). This document is a first step in meeting the needs of wetlands regulators for an analytical framework from which to make decisions concerning wetland creation and restoration. Although intended for use primarily by federal staff involved with the Section 404 program, this status report should prove useful to state regulatory personnel as well as to the private sector.

One volume addresses specific topics (e.g., hydrology, wetland stability, and management techniques). The other volume is a series of regional reviews. Each review summarizes wetland creation and restoration for broadly defined "wetland regions" (e.g., North Atlantic coastal wetlands, wooded wetlands of the Southeast, and riparian habitat of the arid and semi-arid Southwest). The report focuses on scientific issues with restoration and creation, not on policy issues. It identifies the limits of our knowledge and attempts to set priorities for future research.

This status report is not the first attempt to gather information on wetland creation and restoration. Previous works are cited throughout the report. The purpose of this endeavor was to build upon the previous work, not to duplicate it. An effort was made to capture information not published elsewhere and incorporate it with published literature to produce a unique resource.

The amount and quality of information available to the authors was uneven by region and topic, so the papers vary in length and level of detail. This is particularly apparent in the regional reviews. The most quantitative and best documented information was available for Atlantic coastal wetlands, consequently, the reports on these systems heavily cite the juried literature. The information on the creation and restoration of inland freshwater wetlands was spotty, at best, so the authors drew more heavily on personal experience. The Executive Summary is found in Appendix B.

4.3 Evaluation of Created Wetlands and Development of Methods

Field studies were conducted to evaluate project design, compare created and natural wetlands, describe the development of projects over time, and develop methods for describing and evaluating wetlands. Pilot studies comparing created and natural wetlands and testing a Wetland Characterization Method have been conducted in Oregon, Washington, Florida, and Connecticut. In addition, an evaluation of the success of a marsh enhancement more than 20 years after its initiation is being conducted in Iowa. Dr. Milton Weller of Texas A & M is re-sampling the Elk Creek Marsh enhancement project repeating the pre-impoundment study done by him and his graduate students.

EVALUATION OF PROJECT DESIGN

Project design is being evaluated to assist in developing recommendations for setting standards and criteria for wetland creation and restoration projects. The outcomes of what has been done in the past will be used to provide guidance for future projects.

Plans for created wetlands are being studied in Oregon, Florida, and Connecticut. Permit requirements are being compared with the site plans and the "as built" conditions measured in the field. Project size and slopes, and vegetation are being examined. Preliminary results from the Oregon study are presented in Appendix C.

COMPARISON OF NATURAL AND CREATED WETLANDS

Created wetlands are being compared with natural wetlands in the same ecologcial setting. Such comparisons will be used to develop recommendations for setting standards and criteria for wetland creation and restoration projects. The similarities and differences between created and natural wetlands will be used to guide future projects.

This section presents an overview of the approach used in studies conducted in Oregon (both in Portland and Seaside), Washington, Florida, and Connecticut. Elements of the approach were repeated in all the studies to evaluate the applicability of the techniques in different regions and wetland types. However, each study also tested unique methods, including, in some cases, measures of function, e.g., bird use, fisheries habitat potential. All field work has been completed and the data are being analyzed.

Choosing an Approach

Early in the process of designing the research to evaluate wetland creation and restoration a choice was made between using an extensive or an intensive sampling approach. An extensive approach was chosen for three reasons. First, there had been no systematic, large scale evaluations of wetland creation and restoration in freshwater systems. Quammen (1986) reviewed studies of wetland mitigation and found that most rated the success of projects either on the basis of compliance with permit requirements, or simply on the basis of whether or not the projects had been implemented. Moreover, most were site-specific case studies not employing comparison sites. Second, an intensive approach could provide detailed process information and a higher degree of temporal resolution, but only a limited number of sites could be studied due to the cost of the detailed studies. Furthermore, without a knowledge base from which to frame such studies and to place the results in a context, there would be limits to the general applicability of the results obtained. Third, the EPA Wetlands Research Program is national in scope. Therefore, information from site-specific studies with limited applicability to wetlands generally would not meet Agency needs.

The research described above will lead to testable hypotheses about factors important to the creation of wetlands and their associated ecological functions. These should be tested in manipulative experiments conducted in the field--i.e., an intensive approach. The applicability of the results produced by the detailed, site specific, intensive work can then be tested utilizing an extensive sampling approach. Therefore, the two approaches are not mutually exclusive but complementary. Ultimately both are necessary if we are to make the most of information obtained by either one.

Although an extensive approach was favored during this period, some intensive studies were also implemented. The Connecticut study is over a two year period. Water levels were monitored during the entire period. The first year, the vegetation was inventoried, the soils were described, and animal use documented. During the second year vegetation was re-inventoried and studies of soil mycorrhizae, and the effects of highway salt on revegetation were initiated. The Seaside study involved measurements over a growing season. It focused on tracking water levels, dissolved oxygen, aquatic insect populations, and bird use. Thus, we will be able to evaluate the cost/benefit of the different approaches and the types of information they provide.

Defining the Populations to be Sampled

The target population was defined as all wetlands located in the area of interest that were created in the course of mitigating for impacts permitted under Section 404 of the Clean Water Act. The 404 permit databases were used to list all the created wetlands in the target population.

Defining the appropriate comparison population was more difficult. The initial tendency was to use the "best" wetlands in the region. However, criteria established to define the "best", often directed the selection to the most pristine areas. Since the target population tended to be located in developing areas, a comparison of these created wetlands with natural wetlands in pristine areas might not be defensible. The ecological performance of a wetland in an urban landscape might be very different from that of one in a pristine landscape. Therefore, it was concluded that created wetlands should be evaluated in terms of their potential performance in their ecological setting. The comparison population was defined as the naturally occurring wetlands of the same type and similar size, in the same ecoregion and ecological setting as the created wetlands.

For example, in a pilot study in Oregon, a population of 12 created, palustrine emergent wetlands 1-ha or less in size was identified using the permit database. Because of its small size, the entire population was sampled. All these wetlands were located in the Portland metropolitan area. Therefore, the comparison population was defined as all the naturally occurring, palustrine emergent wetlands of 1-ha or less in the Portland metropolitan area. A random selection of naturally occurring wetlands meeting those criteria was made from National Wetlands Inventory maps (Abbruzzese et al. 1988). Suitability of sites was verified in the field. Sites were rejected if they were the wrong wetland type or size, if conditions at or adjacent to the site would be hazardous to the field team, or if access was denied. Hazardous conditions encountered included use of heavy machinery on the site, and active dumping of rubbish into the site.

Accounting for the Effect of Environmental Setting

Since an urban environment supports a variety of land uses, the description of the ecological setting of each site was further refined by including an estimate of the proportion of the area adjacent to the site in particular land uses. The proportion of the site subject to human disturbance was calculated by summing the estimates of the proportion of the area adjacent to the site in land uses involving human activity--e.g., commercial, highway, housing, or agriculture. Analysis of these estimates indicated that comparison sites used in the Oregon study were subject to the same amount of human disturbance as the created wetlands ($p=0.53$). However, the analysis also revealed that urban and agricultural land uses occurred in the vicinity of the sites. Since the impacts to wetlands from these two land uses are likely to differ, the proportion of land in urban, agricultural, and undeveloped (natural) uses surrounding each wetland should be considered during site selection.

The field work also identified a basic problem of evaluating created wetlands in a landscape dominated by human activity. Since both the comparison and created

wetlands were located in an urban environment, both were subject to a number of activities that suggested the ecological setting was impacting their quality--e.g., dumping, use by off-road vehicles, and inputs of petroleum products from motor vehicles. Even those with little evidence of on-site disturbance, were set in landscapes dominated by human activities and were subject to noise, runoff, and other perturbations from the surrounding area. Consequently, a number of questions were raised. Did the ecological setting limit the quality of both the created and naturally occurring wetlands? Would the conclusions reached about the ability to create wetlands change if the studies were carried out in a less disturbed setting? Can disturbed landscapes be managed to improve the quality of the wetlands in them? Should wetlands created to compensate for permitted losses be constructed in disturbed landscapes?

A subsequent study in Florida was designed to begin answering these questions. Observations of the developing landscape throughout Florida over many years have revealed that negative impacts on wetlands decrease with distance from urbanized areas (Brown, 1986). To measure the variations associated with increasing development intensity, a landscape development index (LDI) was calculated for potential comparison wetlands (Brown and Kentula, in prep.). The LDI was generated by estimating from aerial photographs the percentage of land surrounding each wetland in each of three categories of development intensity (i.e., urban, agricultural and undeveloped). An LDI value for each wetland was calculated from a formula which gives the greatest weight to urban uses, then agriculture, and the least weight to undeveloped area. Therefore, the higher the value of the index calculated for a wetland, the higher the development intensity in the surrounding landscape. The LDI values were then used to categorize the randomly selected comparison sites according to degree of human disturbance. In this way, the effects of ecological setting on the characteristics of the wetlands being studied could be examined.

Characterizing Wetlands in the Field

The wetlands were described through measurements of major biological, physical, and chemical parameters. Sites were mapped to scale and the maps annotated with notes on the features of the site and the surrounding area. Basin morphology was described and the relative elevations within the site were related to the measurements of other parameters. Vegetation was inventoried and cover estimates for each species made. Site hydrology, soils, and water quality were also described.

DEVELOPMENT OF METHODS

The third task was to develop standard methods that could be used to describe and evaluate both natural and created wetlands. The field studies are being used to

develop and test methods that can be used nationwide with known accuracy, precision, and comparability. Elements of the approach were repeated in all the studies to evaluate the applicability of the techniques in different regions and wetland types. Standard quality assurance procedures were used to both assess data quality and to evaluate the methods used. Preliminary results of this evaluation are presented in Appendix D.

5.0 FY90 RESEARCH PLAN

FY90 is a year of transition. Efforts will focus on 1) completing and reporting on the research implemented during previous years; 2) finalizing plans and producing the Final Mitigation Handbook; 3) planning and initiating cooperative studies with the Regions as a form of tech transfer; and 4) planning for the next phase of the program. A summary of the research effort and the associated budget is presented in Table 3.

Most of the research conducted during the past two years is nearing completion. As a result, a number of reports are anticipated (Table 4).

The Final Mitigation Handbook, which will summarize the significant findings of the first five years of research, is due in March 1991. Early in 1990 the Office of Wetlands Protection and EPA Regions will be asked for input into designing the format and framework for the document. Then the remainder of the year will be spent producing the document.

Increased effort will be given to planning and initiating cooperative studies with the Regions. Whenever possible the EPA Regions have been involved in the Mitigation Research. For example, the Connecticut, Washington, and Seaside field studies were co-funded with EPA Regions. During the coming year, the program will work closely with the Regional Liaison to plan and implement additional cooperative studies. Meetings with representatives of Regions I and IX are planned to discuss "demonstration projects".

Planning for the next phase of the program will be initiated. Three areas will be considered. First, experimental work to relate the structural features measured in the field studies to wetland function is needed. The results of the work done to date can be used to set priorities for this effort. Second, the proposed research must be set in relation to the work ongoing in other components of the research program. As the program's research has progressed and new components have been added, increased interrelationships between components have been recognized and discussed, and information has been shared (Figure 1). These interrelationships will be stronger in

the coming years as need for common information increases, e.g., requirements for indicators of function.

Finally, the proposed research must also look to support a no net loss policy. In its report, The National Wetlands Policy Forum emphasized that the goal of no net loss does not imply that individual wetlands will be untouchable (The Conservation Foundation 1988). Therefore, a substantial increase in efforts to restore and create wetlands is inherent to attaining the objective. Considering that practical experience and the available science base on restoration and creation remain limited for most types andvary regionally, the research prescribed in the original EPA Wetlands Research Plan (Zedler and Kentula 1986) continues to be timely.

Table 3. Summary of FY90 Mitigation Research and Budget

TASK	COST ($K)
Complete & Report on Previous Research	
Mitigation tracking & accounting system; 404 permitting patterns & trends	30
Comparison of created & natural wetlands	70
Development of standard methods	40
Finalize Plans & Produce Final Mitigation Handbook	90
Plan & Initiate Cooperative Studies with Regions	12*
Plan for Next Phase of Program	30
TOTAL	272

* Anticipate additional funds from the Office of Wetlands Protection and the Regions involved.

Table 4. Mitigation Research Deliverables.

Journal Article: Use of the Landscape Development Index to Select Comparison Sites in an Evaluation of Created Wetlands	~~08~~/90 completed
Project Report: Use of the Wetland Characterization Method to Verify Compliance with Permit Conditions--An Example from Oregon	4/90 ~~04/90~~ completed
Project Report: A Simple Technique for Monitoring Wetland Hydrology	04/91 ~~05/90~~
Journal Article: Trends and Patterns in Section 404 Permitting in Texas	02/91 ~~06/90~~
Journal Article: A Comparison of Created and Naturally Occurring Wetlands in Oregon	06/91 ~~06/90~~
Project Report: Comparability of Techniques Used to Characterize Created Wetlands	08/91 ~~07/90~~
Journal Article: A comparison of created and naturally occurring wetlands in Florida	03/91 ~~08/89~~
Journal Article: A Comparison of Created and Naturally Occurring Wetlands in Connecticut	03/91 ~~10/90~~
Journal Article: Trends and Patterns in Section 404 Permitting in Louisiana	02/91 ~~10/90~~
Journal Article: Trends and Patterns in Section 404 Permitting in California	11/90 completed
Journal Article: An Evaluation of an Early Marsh Development Project in Northern Iowa	02/91 ~~12/91~~
Project Report: Final Handbook on Mitigation (#7859)	06/91 ~~03/91~~

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PART II: WETLAND MITIGATION PROJECT FOLLOW-UP STUDY SUMMARIES

Kirk Stark

Mitigation in the Corps of Engineers Regulatory Program

I. Regulatory Cites

A. Corps Permit Regulations - 33 CFR 320.4(r).

B. Section 404(b)(1) Guidelines - 40 CFR 230.10 (Feb. 7, 1990 Section 404 Mitigation MOA between Army and EPA provides additional clarification).

C. CEQ NEPA Implementing Regulations - 40 CFR 1508.20

II. Mitigation MOA

A. Pertains to Section 404 discharges; does not establish new policy; Corps makes decision on appropriate and practicable mitigation on a permit-by-permit basis.

B. Clarifies Guidelines policy; applicable only to individual Corps permits.

C. Reiterates sequence of first avoiding impacts (without compensatory mitigation), then minimizing impacts and compensating for unavoidable impacts based on the functions and values of the resources at issue.

D. Requires appropriate and practicable mitigation ["practicable" defined in 40 CFR 230.3(q) as available or capable of being done after taking into consideration costs, existing technology and logistics]; recognizes that no-net-loss of wetlands will not be achieved in every case because mitigation may not be feasible,, practicable, or would accomplish only inconsequential reductions in impacts.

E. Contains preferential sequence of mitigation approaches; on-site preferred to off-site (close proximity, same watershed); restoration of existing wetlands should be first option considered because higher probability of success and impacts to potentially valuable uplands reduced.

F. Assessment of Values - Wetlands Evaluation Technique (WET), Habitat Evaluation Procedure (HEP), other generally recognized aquatic site assessment techniques, best professional judgment of federal and state agency representatives.

G. Safeguards

1. 1:1 for wetlands recommended, based on functions and values and/or acre for acre; compensatory mitigation should provide an adequate margin of safety to reflect expected degree of success.

2. Monitoring - important, especially in areas of scientific uncertainty

   a. determine whether permit conditions complied with;

   b. determine whether permit conditions achieved desired mitigation results;

   c. Corps should pursue enforcement activities when non-compliance determined.

3. With scientific uncertainty, long-term monitoring, reporting and potential remedial actions, should be required through permit conditions.

H. If mitigation plan necessary to ensure Guidelines compliance is not reasonably implementable or enforceable, the permit shall be denied.

I. Additional guidance will be formulated on mitigation banking and preservation as compensatory mitigation approaches (preservation to be accepted as compensatory mitigation only under exceptional circumstances).

III. Corps Regulatory Policy [33 CFR 320.4(r)]

A. Corps mitigation policy pertains to all types of activities regulated by the Corps; is not a substitute for Guidelines compliance criteria.

B. Both Corps mitigation policy and Army-EPA Mitigation MOA list CEQ NEPA Implementation criteria of avoiding, minimizing, rectifying, reducing and compensating.

C. Mitigation policy states that impacts will be avoided to the extent practicable.

D. Mitigation (on-site and off-site) generally falls into three categories:

1. Project modifications to minimize impacts (feasible);

2. to satisfy legal requirements such as the Guidelines;

3. to mitigate for public interest impacts.

E. Mitigation provided for above circumstances (see III. D. above) for significant resource losses which are specifically identifiable, reasonably likely to occur and of importance to the human or aquatic environment.

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

7 FEB 1990

CECW-OR

MEMORANDUM FOR SEE DISTRIBUTION

Subject: **Section 404 Mitigation Memorandum of Agreement**

1. On 15 November 1989, the Department of the Army and the Environmental Protection Agency (EPA) signed a memorandum of agreement (MOA) that clarifies the procedures to be used in determining the type and level of mitigation necessary to demonstrate compliance with the Clean Water Act Section 404(b)(1) Guidelines. The MOA becomes effective on 7 February 1990. A copy of the MOA is enclosed. This represents the official version and reflects the changes made to the 15 November 1989, MOA previously provided to you.

2. The MOA represents several years of hard work by both EPA and the Army Corps of Engineers. It, along with other recent accomplishments such as the new Federal wetlands delineation manual, are good examples of the renewed spirit of cooperation between EPA and the Corps at the Headquarters level. I am encouraged by these initiatives and committed to ensuring that the Corps Regulatory Program is undertaken in a manner fully consistent with the goals of the Clean Water Act and the Section 404(b)(1) Guidelines. I expect no less from each FOA Commander, Office of Counsel, and Regulatory staff.

3. The MOA is consistent with the President's goal of no overall net loss of wetlands and affirms the Corps existing policy of striving to avoid adverse impacts and offset unavoidable adverse impacts to aquatic resources. I fully support these initiatives and will work to ensure that they are integrated into all Corps activities. This includes site selection, plan development, maintenance, and operation of Corps projects, as well as the Regulatory Program. It is important to emphasize, however, that while the MOA's implementation can contribute to a goal of no overall net loss of the nation's remaining wetland base, the MOA does not establish a no net loss policy. In fact, the MOA expressly recognizes that achieving no net loss of wetlands values and functions is not possible for every permit action. The President's Domestic Policy Council Interagency Working Group on Wetlands is currently developing policy on no overall net loss of wetlands.

4. The MOA interprets and provides internal guidance and procedures to the Corps and EPA field personnel for implementing existing Section 404 permit regulations. The MOA does not change substantive regulatory requirements but instead provides a

procedural framework for considering mitigation so that all Corps and EPA field offices will follow consistent procedures in determining the type and level of mitigation necessary to ensure compliance with the Section 404(b)(1) Guidelines. The MOA clarifies requirements contained in the Section 404(b)(1) Guidelines in response to questions that have arisen on these requirements. Moreover, the MOA does not establish any new mitigation requirements beyond those currently found in the Guidelines or modify the existing Guidelines requirements. The MOA also maintains the flexibility of the Guidelines by expressly recognizing that no net loss of wetlands functions and values may not be achieved in each and every permit action.

5. As a result of recent conversations between Headquarters and FOA regulatory staffs, several questions have consistently been raised. In response, the Regulatory Branch staff has prepared the enclosed "Q's and A's" which address many of the issues raised. These Q's and A's have been reviewed and agreed to by EPA. EPA will send the Q's and A's, as well as a similar memo to all EPA Region Offices.

6. The Mitigation MOA represents a most significant and positive step in emphasizing our commitment to accomplishing our mission of restoring and maintaining our valuable aquatic resources. Further, I am confident that the MOA will facilitate continued improvement in our daily relations with EPA, as well as other resource agencies.

7. Additional questions or comments may be directed to Dr. John Hall, Acting Chief, Regulatory Branch, at (202) 272-1785 or Mr. Michael Davis, the Regulatory Branch POC, at (202) 272-0201.

Encls

H. J. HATCH
Lieutenant General, USA
Commanding

DISTRIBUTION:
(see Page 3)

MEMORANDUM OF AGREEMENT BETWEEN THE ENVIRONMENTAL PROTECTION AGENCY AND THE DEPARTMENT OF THE ARMY CONCERNING THE DETERMINATION OF MITIGATION UNDER THE CLEAN WATER ACT SECTION 404(b)(1) GUIDELINES

I. Purpose

The United States Environmental Protection Agency (EPA) and the United States Department of the Army (Army) hereby articulate the policy and procedures to be used in the determination of the type and level of mitigation necessary to demonstrate compliance with the Clean Water Act (CWA) Section 404(b)(1) Guidelines ("Guidelines"). This Memorandum of Agreement (MOA) expresses the explicit intent of the Army and EPA to implement the objective of the CWA to restore and maintain the chemical, physical, and biological integrity of the Nation's waters, including wetlands. This MOA is specifically limited to the Section 404 Regulatory Program and is written to provide guidance for agency field personnel on the type and level of mitigation which demonstrates compliance with requirements in the Guidelines. The policies and procedures discussed herein are consistent with current Section 404 regulatory practices and are provided in response to questions that have been raised about how the Guidelines are implemented. The MOA does not change the substantive requirements of the Guidelines. It is intended to provide guidance regarding the exercise of discretion under the Guidelines.

Although the Guidelines are clearly applicable to all discharges of dredged or fill material, including general permits and Corps of Engineers (Corps) civil works projects, this MOA focuses on standard permits (33 CFR 325.5(b)(1))[1]. This focus is intended solely to reflect the unique procedural aspects associated with the review of standard permits, and does not obviate the need for other regulated activities to comply fully with the Guidelines. EPA and Army will seek to develop supplemental guidance for other regulated activities consistent with the policies and principles established in this document.

This MOA provides guidance to Corps and EPA personnel for implementing the Guidelines and must be adhered to when considering mitigation requirements for standard permit applications. The Corps will use this MOA when making its determination of compliance with the Guidelines with respect to mitigation for standard permit applications. EPA will use this MOA in developing its positions on compliance with the Guidelines for

[1]Standard permits are those individual permits which have been processed through application of the Corps public interest review procedures (33 CFR 325) and EPA's Section 404(b)(1) Guidelines, including public notice and receipt of comments. Standard permits do not include letters of permission, regional permits, nationwide permits, or programmatic permits.

proposed discharges and will reflect this MOA when commenting on standard permit applications.

II. Policy

A. The Council on Environmental Quality (CEQ) has defined mitigation in its regulations at 40 CFR 1508.20 to include: avoiding impacts, minimizing impacts, rectifying impacts, reducing impacts over time, and compensating for impacts. The Guidelines establish environmental criteria which must be met for activities to be permitted under Section 404.[2] The types of mitigation enumerated by CEQ are compatible with the requirements of the Guidelines; however, as a practical matter, they can be combined to form three general types: avoidance, minimization and compensatory mitigation. The remainder of this MOA will speak in terms of these more general types of mitigation.

B. The Clean Water Act and the Guidelines set forth a goal of restoring and maintaining existing aquatic resources. The Corps will strive to avoid adverse impacts and offset unavoidable adverse impacts to existing aquatic resources, and for wetlands, will strive to achieve a goal of no overall net loss of values and functions. In focusing the goal of no overall net loss to wetlands only, EPA and Army have explicitly recognized the special significance of the nation's wetlands resources. This special recognition of wetlands resources does not in any manner diminish the value of other waters of the United States, which are often of high value. All waters of the United States, such as streams, rivers, lakes, etc., will be accorded the full measure of protection under the Guidelines, including the requirements for appropriate and practicable mitigation. The determination of what level of mitigation constitutes "appropriate" mitigation is based solely on the values and functions of the aquatic resource that will be impacted. "Practicable" is defined at Section 230.3(q) of the Guidelines.[3] However, the level of mitigation determined to be appropriate and practicable under Section 230.10(d) may lead to individual permit decisions which do not fully meet this goal because the mitigation measures necessary to meet this goal are not feasible, not practicable, or would accomplish only inconsequential reductions in impacts. Consequently, it is recognized that no net loss of wetlands functions and values may not be achieved in each and every permit action. However, it remains a goal of the Section 404 regulatory program to contribute to the national goal of no overall net loss of the nation's remaining wetlands base. EPA and Army are committed to working with others through the Administration's interagency task force and other avenues to help achieve this national goal.

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[2](except where Section 404(b)(2) applies).

[3]Section 230.3(q) of the Guidelines reads as follows: "The term practicable means available and capable of being done after taking into consideration *cost, existing technology, and logistics in light of overall project purposes.*" (Emphasis supplied)

C. In evaluating standard Section 404 permit applications, as a practical matter, information on all facets of a project, including potential mitigation, is typically gathered and reviewed at the same time. The Corps, except as indicated below, first makes a determination that potential impacts have been avoided to the maximum extent practicable; remaining unavoidable impacts will then be mitigated to the extent appropriate and practicable by requiring steps to minimize impacts and, finally, compensate for aquatic resource values. This sequence is considered satisfied where the proposed mitigation is in accordance with specific provisions of a Corps and EPA approved comprehensive plan that ensures compliance with the compensation requirements of the Section 404(b)(1) Guidelines (examples of such comprehensive plans may include Special Area Management Plans, Advance Identification areas (Section 230.80), and State Coastal Zone Management Plans). It may be appropriate to deviate from the sequence when EPA and the Corps agree the proposed discharge is necessary to avoid environmental harm (e.g., to protect a natural aquatic community from saltwater intrusion, chemical contamination, or other deleterious physical or chemical impacts), or EPA and the Corps agree that the proposed discharge can reasonably be expected to result in environmental gain or insignificant environmental losses.

In determining "appropriate and practicable" measures to offset unavoidable impacts, such measures should be appropriate to the scope and degree of those impacts and practicable in terms of cost, existing technology, and logistics in light of overall project purposes. The Corps will give full consideration to the views of the resource agencies when making this determination.

1. **Avoidance.**[4] Section 230.10(a) allows permit issuance for only the least environmentally damaging practicable alternative.[5] The thrust of this section on alternatives is avoidance of impacts. Section 230.10(a) requires that no discharge shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact to the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. In addition, Section 230.10(a)(3) sets forth rebuttable presumptions that 1) alternatives for non-water dependent activities that do not involve special aquatic sites[6] are available and 2) alternatives that do not involve special aquatic sites have less adverse impact on the aquatic environment.

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[4]Avoidance as used in the Section 404(b)(1) Guidelines and this MOA does not include compensatory mitigation.

[5]It is important to recognize that there are circumstances where the impacts of the project are so significant that even if alternatives are not available, the discharge may not be permitted regardless of the compensatory mitigation proposed (40 CFR 230.10(c)).

[6]Special aquatic sites include sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs and riffle pool complexes.

Compensatory mitigation may not be used as a method to reduce environmental impacts in the evaluation of the least environmentally damaging practicable alternatives for the purposes of requirements under Section 230.10(a).

2. **Minimization.** Section 230.10(d) states that appropriate and practicable steps to minimize the adverse impacts will be required through project modifications and permit conditions. Subpart H of the Guidelines describes several (but not all) means for minimizing impacts of an activity.

3. **Compensatory Mitigation.** Appropriate and practicable compensatory mitigation is required for unavoidable adverse impacts which remain after all appropriate and practicable minimization has been required. Compensatory actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands) should be undertaken, when practicable, in areas adjacent or contiguous to the discharge site (on-site compensatory mitigation). If on-site compensatory mitigation is not practicable, off-site compensatory mitigation should be undertaken in the same geographic area if practicable (i.e., in close physical proximity and, to the extent possible, the same watershed). In determining compensatory mitigation, the functional values lost by the resource to be impacted must be considered. Generally, in-kind compensatory mitigation is preferable to out-of-kind. There is continued uncertainty regarding the success of wetland creation or other habitat development. Therefore, in determining the nature and extent of habitat development of this type, careful consideration should be given to its likelihood of success. Because the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, restoration should be the first option considered.

In the situation where the Corps is evaluating a project where a permit issued by another agency requires compensatory mitigation, the Corps may consider that mitigation as part of the overall application for purposes of public notice, but avoidance and minimization shall still be sought.

Mitigation banking may be an acceptable form of compensatory mitigation under specific criteria designed to ensure an environmentally successful bank. Where a mitigation bank has been approved by EPA and the Corps for purposes of providing compensatory mitigation for specific identified projects, use of that mitigation bank for those particular projects is considered as meeting the objectives of Section II.C.3 of this MOA, regardless of the practicability of other forms of compensatory mitigation. Additional guidance on mitigation banking will be provided. Simple purchase or "preservation" of existing wetlands resources may in only exceptional circumstances be accepted as compensatory mitigation. EPA and Army will develop specific guidance for preservation in the context of compensatory mitigation at a later date.

III. Other Procedures

A. Potential applicants for major projects should be encouraged to arrange preapplication meetings with the Corps and appropriate federal, state or Indian tribal, and local authorities to determine requirements and documentation required for proposed permit evaluations. As a result of such meetings, the applicant often revises a proposal to avoid or minimize adverse impacts after developing an understanding of the Guidelines requirements by which a future Section 404 permit decision will be made, in addition to gaining an understanding of other state or tribal, or local requirements. Compliance with other statutes, requirements and reviews, such as NEPA and the Corps public interest review, may not in and of themselves satisfy the requirements prescribed in the Guidelines.

B. In achieving the goals of the CWA, the Corps will strive to avoid adverse impacts and offset unavoidable adverse impacts to existing aquatic resources. Measures which can accomplish this can be identified only through resource assessments tailored to the site performed by qualified professionals because ecological characteristics of each aquatic site are unique. Functional values should be assessed by applying aquatic site assessment techniques generally recognized by experts in the field and/or the best professional judgment of federal and state agency representatives, provided such assessments fully consider ecological functions included in the Guidelines. The objective of mitigation for unavoidable impacts is to offset environmental losses. Additionally for wetlands, such mitigation should provide, at a minimum, one for one functional replacement (i.e., no net loss of values), with an adequate margin of safety to reflect the expected degree of success associated with the mitigation plan, recognizing that this minimum requirement may not be appropriate and practicable, and thus may not be relevant in all cases, as discussed in Section II.B of this MOA.[7] In the absence of more definitive information on the functions and values of specific wetlands sites, a minimum of 1 to 1 acreage replacement may be used as a reasonable surrogate for no net loss of functions and values. However, this ratio may be greater where the functional values of the area being impacted are demonstrably high and the replacement wetlands are of lower functional value or the likelihood of success of the mitigation project is low. Conversely, the ratio may be less than 1 to 1 for areas where the functional values associated with the

[7]For example, there are certain areas where, due to hydrological conditions, the technology for restoration or creation of wetlands may not be available at present, or may otherwise be impracticable. In addition, avoidance, minimization, and compensatory mitigation may not be practicable where there is a high proportion of land which is wetlands. EPA and Army, at present, are discussing with representatives of the oil industry, the potential for a program of accelerated rehabilitation of abandoned oil facilities on the North Slope to serve as a vehicle for satisfying necessary compensation requirements.

area being impacted are demonstrably low and the likelihood of success associated with the mitigation proposal is high.

C. The Guidelines are the environmental standard for Section 404 permit issuance under the CWA. Aspects of a proposed project may be affected through a determination of requirements needed to comply with the Guidelines to achieve these CWA environmental goals.

D. Monitoring is an important aspect of mitigation, especially in areas of scientific uncertainty. Monitoring should be directed toward determining whether permit conditions are complied with and whether the purpose intended to be served by the condition is actually achieved. Any time it is determined that a permittee is in non-compliance with mitigation requirements of the permit, the Corps will take action in accordance with 33 CFR Part 326. Monitoring should not be required for purposes other than these, although information for other uses may accrue from the monitoring requirements. For projects to be permitted involving mitigation with higher levels of scientific uncertainty, such as some forms of compensatory mitigation, long term monitoring, reporting and potential remedial action should be required. This can be required of the applicant through permit conditions.

E. Mitigation requirements shall be conditions of standard Section 404 permits. Army regulations authorize mitigation requirements to be added as special conditions to an Army permit to satisfy legal requirements (e.g., conditions necessary to satisfy the Guidelines) [33 CFR 325.4(a)]. This ensures legal enforceability of the mitigation conditions and enhances the level of compliance. If the mitigation plan necessary to ensure compliance with the Guidelines is not reasonably implementable or enforceable, the permit shall be denied.

F. Nothing in this document is intended to diminish, modify or otherwise affect the statutory or regulatory authorities of the agencies involved. Furthermore, formal policy guidance on or interpretation of this document shall be issued jointly.

G. This MOA shall take effect on February 7, 1990, and will apply to those completed standard permit applications which are received on or after that date. This MOA may be modified or revoked by agreement of both parties, or revoked by either party alone upon six (6) months written notice.

2/6/90

Robert W. Page (date)
Assistant Secretary of the Army
(Civil Works)

LaJuana S. Wilcher 2/6/90

LaJuana S. Wilcher (date)
Assistant Administrator for Water
U.S. Environmental Protection Agency

SECTION 404(b)(1) GUIDELINES MITIGATION MOA
"QUESTIONS AND ANSWERS"

Q1. Is the MOA a wetlands mitigation policy?

A1. No. The purpose of the MOA is to provide general guidance to Corps and EPA field offices on 404(b)(1) Guidelines mitigation requirements for standard permit applications in all waters of the United States, including wetlands. As such, the guidance reflects agency policy and procedures but does not itself, establish new policy.

Q2. Does the MOA establish a No Net Loss of wetlands policy?

A2. The MOA is not, in itself, a no net loss policy and neither the Section 404 program in general, nor the MOA in particular, is designed to achieve the national goal of no overall net loss of wetlands. EPA and the Corps will strive to achieve the President's goal of no net loss; however, the MOA clearly recognizes that mitigation which is not appropriate or practicable will not be required, nor will each permit be required to achieve no net loss of wetlands.

Q3. What is mitigation sequencing?

A3. In the context of the Guidelines and the MOA it means first avoiding impacts through the selection of the least damaging practicable alternative; second, taking appropriate and practicable steps to minimize impacts; and finally compensating for any remaining unavoidable impacts to the extent appropriate and practicable.

Q4. Does sequencing mean you have to first pass 230.10(a), then 230.10(b), then 230.10(c), and finally 230.10(d)?

A4. No. While sequencing (i.e., avoidance, minimization, compensation) incorporates the requirements of Sections 230.10 (a) and (d), the requirements identified at Sections 230.10 (b) and (c) are not components of mitigation under the Guidelines.

Q5. What does the one for one functional replacement signify?

A5. The objective of wetlands compensatory mitigation is to provide, at a minimum, one for one functional replacement to achieve no net loss of wetland values. In the absence of more definitive information on the functions and values at a specific site, a minimum of 1 to 1 acreage replacement may be used as a reasonable surrogate for no net loss of functions and values. However, the MOA recognizes that this ratio may vary on a case-by-case basis and may not be appropriate and practicable in all cases.

Q6. Is it possible to issue a permit that causes a net loss of wetlands?

A6. Yes. Once a project passes 230.10(a),(b), and (c) of the Guidelines (also reference question number 4), a wetlands loss may occur when mitigation measures are not feasible, practicable or would accomplish only inconsequential reductions in impacts. However, it should be emphasized that a project that causes or contributes to significant degradation of the waters of the United States will fail 230.10(c) notwithstanding the exceptions for 230.10(d) noted in the above sentence.

Q7. Have the definitions of the terms "appropriate" and "practicable" been changed?

A7. No. Section 230.3(q) of the Guidelines defines the term practicable as meaning "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." Since the term appropriate is not explicitly defined in the Guidelines or Corps regulations, its meaning was clarified in the MOA to mean "appropriate to the scope and degree" of environmental impacts of a project (also reference question number 8).

Q8. Is appropriate mitigation based solely on the values and functions of the aquatic resource that will be impacted?

A8. Yes. A key objective of the Guidelines and the MOA is to offset unavoidable adverse impacts to aquatic resources. The determination of what level of mitigation constitutes "appropriate" mitigation is based solely on the values and functions of the aquatic resource that will be impacted. Further, under the Guidelines, appropriate

mitigation is required only to the extent that it is practicable. Public interest characteristics such as need and societal value are not factored into a determination of appropriate mitigation as determined by the Guidelines. Such considerations are, however, taken into account during the public interest review process.

Q9. Is there a preferred method for assessing functional values of aquatic resources?

A9. Not at this time. The Wetland Evaluation Technique (WET) considers a broad range of ecological functions and its use will likely increase. We realize that WET needs additional refinement and regionalization, both of which are underway. However, the best professional judgment of the Corps, EPA and resource agencies' representatives must continue to play a vital role in all resource assessments.

Q10. Is there sufficient flexibility built into the MOA to reflect the technical challenges represented in Alaska?

A10. Yes. EPA and the Corps recognize that the physical characteristics associated with wetlands underlain by permafrost pose scientific challenges regarding compensatory mitigation. Permafrost conditions, hydrology and climatic factors create technical problems which may make opportunities for wetlands creation and restoration not always practicable. The MOA states (see Section II.B.) that only appropriate and practicable mitigation is required under the Guidelines and, as a result, no net loss of wetlands functions and values may not be achieved in each and every permit action. This technical uncertainty emphasizes the need for Corps and EPA staff in Alaska to coordinate through established procedures such as the Abbreviated Permit Process and pre-application consultations to identify what is appropriate and practicable compensatory mitigation on a case-by-case basis.

Q11. Are there other areas of the country that also represent special challenges in the implementation of the MOA?

A11. Yes. In developing the MOA, the Corps and EPA recognized that the flexibility built into the Guidelines must also be incorporated into the provisions contained in the MOA in order to be responsive to varying ecological conditions that exist nationwide. An issue that has been

brought to our attention is how the MOA will affect certain environmental projects in Louisiana (projects where the specific purpose is to enhance the environment). The MOA recognizes these situations by providing that where EPA and the Corps agree, it may be appropriate to deviate from the mitigation sequence in circumstances "necessary to avoid environmental harm (e.g., to protect a natural aquatic community from saltwater intrusion...)."

Q12. Will mitigation banks and preservation of existing wetlands be allowed?

A12. The MOA recognizes that mitigation banking may be an acceptable form of compensatory mitigation. EPA and Army are developing additional guidance on this subject. In the meantime, mitigation banks will be considered for approval on a case-by-case basis as they have been in the past. Simple purchase or "preservation" may be acceptable only in exceptional circumstances. EPA and the Corps will develop specific guidance for preservation in the context of compensatory mitigation at a later date.

Q13. How will the MOA affect applications in process?

A13. It doesn't. It applies to completed applications which are received on or after 7 February 1990.

Q14. Must an alternatives analysis and/or compensatory mitigation plan be completed before a public notice can be issued?

A14. No. The Corps regulations and application form are fairly specific about what information is needed to find an application complete. Information necessary to conduct a complete Guidelines or Public Interest Review is not required for the issuance of a public notice. If such information is provided by the applicant, however, it should be summarized and presented in the public notice.

Q15. Is it necessary to issue a new public notice for discharges of fill material associated with a compensatory mitigation plan, or part of a plan, that was not included in the original notice?

A15. Generally no. However, this is a judgment call and if the proposed changes result in a substantial increase in the scope of the overall project or there has been a demonstrated interest by the public, an additional notice may be required.

Q16. To what extent must the Corps coordinate changes in a proposed project, including mitigation plans, with the resource agencies?

A16. In general, all substantive changes should be coordinated. The Corps is responsible for determining the appropriate amount of coordination, keeping in mind that insufficient coordination is a criterion for permit elevation under the 404(q) MOAs.

Q17. Is the Corps still responsible for determining compliance with the 404(b)(1) Guidelines on a permit-by-permit basis?

A17. Yes. As in the past, Guidelines compliance determinations are the responsibility of the Corps. EPA will continue to respond to public notices as it has in the past using the MOA to develop its position (recommendations) on projects.

Q18. Does the MOA require the Corps to take an enforcement action whenever it discovers non-compliance with the mitigation requirements of a permit?

A18. No. The Corps is required to take action in accordance with 33 CFR Part 326 which establishes a discretionary responsibility regarding the initiation of enforcement actions. The Corps, as part of a new emphasis on permit compliance, is strongly encouraged to take appropriate action to ensure compliance with all permit conditions, particularly conditions imposed to satisfy the Guidelines. The MOA does not affect this initiative.

Q19. Does the MOA apply to after-the-fact applications?

A19. Yes.

Q20. How does the MOA affect Corps civil works projects?

A20. While the MOA focuses on the Section 404 regulatory program, the Corps plans to integrate the mitigation framework provided in the MOA into all Corps activities.

ENVIRONMENTAL MITIGATION IN CORPS OF ENGINEERS WATER RESOURCE DEVELOPMENT PROJECTS

Presented at the
National Ocean Pollution Policy Board's Habitat Loss and Modification Working Group Workshop on Federal Efforts to Evaluate Coastal Habitat Mitigation

San Diego State University
San Diego, California
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by

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I. BACKGROUND

The U.S. Army Corps of Engineers (Corps) civil works program includes many water resources development projects in the coastal areas of the United States. In these coastal areas, Corps projects are generally for navigation improvements, beach erosion control, shore protection, or other storm damage protection purposes. Over 350 million cubic yards of dredged material is disposed of annually during the maintenance of Corps navigation projects. Unfortunately, such projects can entail damages to the environment, such as loss or modification of fish and wildlife habitat or adverse impacts on water quality or wetland resources. These adverse project effects require some sort of mitigative response to lessen the impact. Such responses are generically called "mitigation," or, sometimes, compensation.

The Corps authorization to carry out its mitigation responsibilities comes primarily from two Federal laws: the Fish and Wildlife Coordination Act of 1958, as amended (FWCA); and the Water Resources Development Act of 1986 (WRDA 86). The Corps is also required to include appropriate mitigation in the selected plan by the Council on Environmental Quality's (CEQ) Regulations for Implementing the National Environmental Policy Act of 1969 (NEPA), when the Corps has determined that mitigation is necessary. The NEPA regulations specify that mitigation will be addressed for significant adverse impacts while the WRDA 86 directs that a mitigation plan will be developed for those adverse impacts on fish and wildlife resources that are more than negligible.

The Corps determines its mitigation responsibility by comparing the baseline environmental conditions, determined at the time the project is being studied, to the conditions expected to occur when the project has been constructed. The baseline

environmental condition is also compared to anticipated future conditions without the Federal project. This comparison is made over the project's economic period of analysis, which is usually fifty years for most coastal projects.

When the "with and without" project analysis shows that there will be an adverse impact on the environment that can be attributed to the Corps project, then a determination must be made as to whether or not this impact is significant and whether it is more than a negligible impact. The subtleties between these two terms may seem unimportant, but they both have their basis in public law (NEPA and WRDA 86). The distinctions between the two terms are still evolving within the Corps planning and policy guidance.

II. MITIGATION IN PROJECT PLANNING

The Corps guidance on mitigation in the planning of water resource development projects is in planning regulation ER 1105-2-100, "Planning Guidance," dated 15 September 1990 (draft). In planning Federal projects, the Corps follows the sequence of mitigation activities as presented in the CEQ NEPA Regulations; i.e., first avoid adverse impacts, then minimize adverse impacts if they cannot be avoided, and thirdly, compensate for unavoidable adverse impacts. In any case, the selected plan shall contain sufficient mitigation to ensure, to the extent justified, that the selected plan will not have more than negligible adverse impacts on fish and wildlife resources.

The issue of "how much mitigation is appropriate" has been an area of controversy for a long time. The Corps current policy is that justification of mitigation features shall be based on a finding that the combined monetary and non-monetary values of the last increment of losses prevented, reduced, or replaced is at least equal to the combined monetary and non-monetary costs of the last added increment so as to reasonably maximize overall project benefits. This has been Corps policy for several decades.

In the case of wetlands, particularly in the context of a national goal of no net loss of wetlands, the roles of mitigation, restoration, and enhancement in Federal water resources projects will necessitate new definitions for Corps policies. It is safe to say, however, that whatever final policies do evolve, justification of what the Corps does will still be required.

While the Corps Planning Guidance Notebook (ER 1105-2-100) does not proscribe any units of measurement for mitigation, most mitigation analyses are currently carried out using the U.S. Fish and Wildlife Service's "Habitat Evaluation Procedures" (HEP). Consequently, most Corps proposals for mitigation are based on "habitat units" and any recommendations for acquisition of separable lands are derived by determining the amount of land needed to provide these habitat units. The Corps does not use any

predetermined ratios, such as 2:1, 3:1, etc., for the replacement of wetland acreage lost to a Corps project.

The Corps subjects mitigation proposals in its water resource projects to an incremental cost effectiveness analysis. This is done to identify the least costly way of carrying out the mitigation and has been effective in focusing more attention on the alternative ways to accomplish mitigation in the project.

III. MITIGATION IN PROJECT OPERATIONS AND MAINTENANCE

Requirements for the operation and maintenance (O&M) of Corps projects, including mitigation of project damages, are determined during project planning and are included in the report that goes to Congress for authorization. If there is a change in the authorized project during the O&M of that project, such as a new dredged material disposal area, any environmental damages associated with the change are assessed. If the impacts are significant, the project's original NEPA documentation is supplemented and any new mitigation requirements are determined.

If the O&M of a project are the responsibility of a non-Federal sponsor, then that local sponsor is usually responsible for carrying out any new mitigation requirements. Such requirements would include the acquisition of additional lands, if needed. If the O&M is a Federal responsibility, then any land acquisition for mitigation would require preparation of a report to go to Congress for authorization of such acquisition. This can be a lengthy process.

IV. IMPLEMENTATION AND MONITORING OF MITIGATION

The typical Corps project must complete the planning phases, be approved by the Administration and authorized by the Congress, and then wait until an appropriations bill is passed and signed into law before construction can start. Consequently, a considerable amount of time can go by before any mitigation features of the project are implemented. About ten years ago, the average time between initiation of a project's planning and its construction was 17 years. The Corps has streamlined the planning and review process and there are mechanisms to allow the project to continue into engineering and design while waiting for an appropriations bill. The goal is to reduce this time to 11 years.

Section 906(a) of the WRDA 86 does require that mitigation of fish and wildlife damages be carried out prior to, or concurrent with, project construction. Sufficient time can go by, however, between a project's planning and its construction that the issues originally related to the mitigation feature can become lost in the shuffle. As a result of concern for environmental compliance and inclusion of authorized mitigation in the constructed project,

the requirement for follow through on environmental commitments has been included in the Corps "project management" process (ER 5-7-1, in draft). Environmental compliance has been made a part of the Project Manager's responsibilities in oversight of a project from start to finish. This project management process is relatively new, however, and has not yet been tested to see how well mitigation commitments have been carried out.

Monitoring the implementation of mitigation features, where applicable, is required by the CEQ NEPA regulations. Corps policy is that the term monitoring will be interpreted as that oversight activity necessary to insure that required mitigation measures are implemented. The Corps does not, however, routinely and periodically evaluate whether or not mitigation that has been implemented is continuing to produce the desired results. Corps policy does require that authorized mitigation features receive appropriate inspection during operation and maintenance of the project to see that they are being maintained as required.

If the effectiveness of a given mitigation feature is considered uncertain during planning, a proposal for post-construction studies can be included in the authorization report going to Congress. Otherwise, it has been Corps policy that studies for determining the effectiveness of mitigation features should be undertaken through the Corps Research and Development Program. In the past, such studies have had a low priority in the R&D Program.

The responsibility for operating and maintaining Corps projects is shifting more and more to non-Federal local sponsors, depending on the nature of the project. Consequently, long-term and often expensive monitoring of mitigation added on to a local sponsor's responsibilities after planning and construction will not be looked upon favorably, nor is it equitable to the sponsor. In many instances, it may not even be possible to do so. To ensure that mitigation for project damages is functioning properly over the life of the project, more attention must be given to the technical certainty and adequacy of the mitigation proposals up front in the planning stages.

In summary, the Corps and the other Federal and state resource agencies must work together to find ways to avoid and minimize adverse project impacts on coastal habitats while enabling environmentally sustainable development needed by the nation to proceed. Where adverse impacts cannot be avoided, the Corps and resource agencies must work together to identify the best mitigation measures to restore the loss. If the mitigation plan contains uncertainties, then an estimate of the studies and costs needed after construction to monitor the effectiveness of the mitigation must be identified during planning. These studies and costs must be laid out in the authorization report.

Arthur Barnett

HABITAT EVALUATION

of the proposed

PIER J LANDFILL, PORT OF LONG BEACH

and the proposed

WETLAND RESTORATION, ANAHEIM BAY

OCTOBER 1985

For:
The Fish and Wildlife Service
The National Marine Fisheries Ser.
The Calif. Dept. of Fish and Game
The Port of Long Beach

EXHIBIT A

INTRODUCTION

The Port of Long Beach, in the City of Long Beach, County of Los Angeles, proposes to increase the throughput capacity of an existing container terminal at Pier J to meet the demands of an expanding shipping industry. In order to satisfy the projected container throughput demand, the Port considers the construction of a new landfill at Pier J essential. Their economic evaluation indicates that a minimum usable land area of 135 acres would be necessary. See Figure 1.

The Port of Long Beach would create the new 135-acre landfill along the southerly margin of Pier J by constructing containment dikes in the waters of San Pedro Bay and discharging about 11.6 million cubic yards of dredge spoil and fill material into the containment area. The material to construct the landfill would be obtained by hydraulic dredging of bottom sediments from "borrow sites" and navigation channels in the outer Long Beach Harbor and possibly from landside sources (such as the mitigation site). The landfill would occur in waters about 40 feet deep. The "borrow sites" and channels, which would be dredged, are between 40 and 60 feet deep and would be deepened to depths approaching 80 feet. The bottom footprint of the proposed landfill would total about 142 acres, the net change in rock dike surface would be about +6 acres, and about 450 acres of bay bottom would be disturbed by dredging.

In 1984, the Port provided interested agencies the findings of their one-year biological survey of outer Long Beach Harbor. The report, Outer Long Beach Harbor - Queensway Bay Biological Baseline Surveys October 1984 by MBC Applied Environmental Sciences, presented the qualitative and quantitative findings of various sampling techniques of fish and observations of birds during 1983-1984. A Notice of Preparation of a Draft Environmental Impact Report was published in January 1985.

In early 1985, the Port of Long Beach (PoLB) requested the participation of the Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), and the California Department of Fish and Game (CDFG) in the assessment of biological impacts of the proposed project and in the formulation of a biological mitigation plan. The fish and wildlife impact assessment and mitigation plan would be pertinent to the California

Environmental Quality Act, and the subsequent consideration of the necessary Corps of Engineers permit(s) (River and Harbor Act Section 10, and Clean Water Act Section 404) and the California Coastal Act Port Master Plan Amendment and Harbor Development Permit.

The marine, coastal embayment habitats of outer Long Beach Harbor are of value to nearshore marine fishes, many species of water-associated birds, and some waterfowl. No significant terrestrial habitats were influenced by the harbor development. The Port proposes to compensate for project-related losses of these habitat values by creating tidally influenced wetland and water habitats out of low habitat value "weedy uplands" at Anaheim Bay. Waters and wetlands thus created, would be of high value to nearshore marine/estuarine fishes and migratory birds. The compensation sites under consideration are all within the boundaries of the Seal Beach National Wildlife Refuge, which itself lies within the Seal Beach Naval Weapons Station, Orange County, California. The port landfill site and the compensation site are about 6 miles apart.

The involved agencies (FWS, NMFS, CDFG, and PoLB) agreed to cooperate in the preparation of the fish and wildlife impact assessment and compensation plan. We further agreed to employ a modified Habitat Evaluation Procedure.

METHODOLOGY

A modified version of the 1980 Habitat Evaluation Procedure was used to direct and document the biological evaluation. The evaluation team of biologists consisted of Jack Fancher - FWS, Jim Slawson - NMFS, Dick Nitsos - CDFG, and Margaret Wallerstein - PoLB. Not all team members had previously received formal HEP training. Time and budget constraints necessitated the use of a modified version of the 1980 HEP. No pertinent species models were available and preparation of species models was not feasible under the circumstances. No candidate, proposed, or listed threatened or endangered species were included in the evaluation.

Each participant was responsible for familiarity with the existing biological information and studies pertinent to Outer Long Beach Harbor, Anaheim Bay, and other appropriate coastal embayment habitats. All parties were very familiar with the Long Beach Harbor - Pier J project site and no additional field analysis was necessary. The PoLB provided appropriate maps and engineering drawings. The first of several field investigations at the Anaheim Bay compensation sites occured in February 1985. The FWS provided some base maps, aerial photos, and figures while the PoLB provided more detailed information supported by limited survey findings, for the Anaheim Bay compensation sites.

All important activities, assumptions, and conclusions, directly related to the habitat evaluation, were discussed or conducted mutually and cooperatively by the evaluation team. The process utilized in this habitat evaluation included the following general steps:

a) determination of proposed project scope;
b) fish and wildlife resources likely to be significantly impacted;
c) establishment of mitigation goal;
d) definition of harbor cover type(s);
e) compensation site identification;
f) conceptual design of compensation area construction;
g) harbor evaluation species list development;
h) listing of compensation site evalution species;
i) formulation of project and compensation site habitat suitability indices;
j) determination of project area habitat units and compensation area habitat units;
k) determination of the necessary size of the compensation area.

Relative value indices were not used. The evaluation period was chosen to be fifty years.

The fish and wildlife resource of concern in the project vicinity were water-associated migratory birds, such as many gull species, several tern species, cormorants, brown pelican, grebes, mergansers, and surf scoters, and coastal marine fishes such as several croaker species, several surfperch species, California halibut, northern anchovy, sand basses, bay sharks and rays. Semi-enclosed, coastal embayments, including San Pedro Bay, have become relatively scarce, but are renowned for their biological productivity.

There is little commonality between the different "mitigation policies" of the various agencies. However, for the subject project, the mitigation goal was identified as "no net loss of in-kind or ecologically equivalent habitat value." The selected evaluation species included exclusively fishes and birds, but fishery resources would not be "traded" for avian resources, or vice versa.

The evaluation species were chosen for the harbor site and the compensation site because they were either common to both systems or considered ecologically equivalent. For example, California tonguefish and California killifish were considered matchups, even though neither is significantly present in both systems, because of their abundance and productivity contributions to the forage base of each system.

Only a few habitat compensation measures are presently considered feasible for offsetting habitat losses of harbor landfills. The principle measure consists of creating tidally influenced and subtidal wetland and coastal embayment habitats out of low value

upland habitat. In order to assess the habitat value gains likely to be afforded by a particular compensation measure, a "restoration concept plan" had to be formulated. Anaheim Bay was selected as a potential location due to the existance of tidal sloughs and salt marsh with adjacent "upland" or diked areas which could be returned to tidal influence through excavation and improved tidal conduits. Three parcels, totalling about 120 acres, were identified. In their present condition, the Anaheim Bay parcels which would be restored, have virtually no biological value to any evaluation species.

The restoration concept included the construction or improvement of culverts and channels to assure the permanent unimpeded flow of tidal waters, plus the excavation of earth to lower the overall grade of the parcel to shallow subtidal and intertidal elevations. The area of any given parcel would include the following proportions of elevations: not less than 50 percent at -3 feet (Mean Lower Low Water, MLLW), 35 percent between -3 and +2.5 feet MLLW, and 15 percent between +2.5 and +5.5 feet MLLW, if isolated in an island configuration. There would be about five such islands within each restored parcel. A requirement for not less than six mounds (10 foot base diameter and top elevation at +8.5 feet MLLW) per island was included to assure suitable light-footed clapper rail nesting locations.

The selected cover types were: Long Beach Harbor water surface area measured at the mean high water line, +4.8 feet mean lower low water, irrespective of depth or bottom substrate; and Anaheim Bay water surface area measured at +5.5 feet MLLW, and with the above depth distribution.

The 20 selected evaluation species or groups, for both the Pier J landfill site in Long Beach Harbor and the restoration sites in Anaheim Bay, are listed on Table 1. The habitat suitability indices for each species at the existing Long Beach Harbor Pier J site (Table 2) and the restored Anaheim Bay parcels (Table 3) were determined by the judgement of each team member and averaged. (See Figure 2 for a diagram of the evaluation process and related forms.)

Each phase of the proposed project was evaluated for the existing condition, target year 0, for target year 1, and target year 50. The landfill and the restoration construction were assumed to be concurrent. The habitat loss in the Pier J landfill site was assumed to be total and to have occurred between year zero and year one. Similarly, the Anaheim Bay habitats in the areas to be restored were assumed to have no value for evaluation species, but that full predicted habitat value development was complete after the first year, following restoration.

For the WITHOUT project condition (no Pier J landfill), the harbor landfill site was assumed to have the same habitat value at the end of fifty years as in the baseline year (Table 4, Form B, Outer Harbor - Pier J Without Project). Similarly, for the WITHOUT project condition at Anaheim Bay (no excavation or

restoration of tidal influence), each area was consider to have no habitat value for evaluation species during the entire fifty year evaluation period.

The Pier J landfill area, following construction, was judged to have no habitat value for the evaluation species in the WITH project condition, since the marine habitat would have been converted into land. Whereas, the Anaheim Bay restoration, in the first year, would develop substantial new habitat value (Table 5, Form B, Restored Anaheim Bay, With Project).

The predicted habitat value losses over the 50-year evaluation period at the Pier J landfill can be tabulated by comparing the habitat value of the existing condition to the habitat value after the landfill is completed (Table 6, Net Change in Habitat Units, Pier J). Also, the predicted habitat value gains over 50 years at the Anaheim Bay restoration site can be tabulated by comparing the with and without project conditions (Table 7, Net Change in Habitat Units, Anaheim Bay).

Finally, the net result, from comparing habitat unit changes at Pier J "with and without" the landfill to the habitat unit changes "with and without" Anaheim Bay restoration, indicates a requirement for 102.5 acres of restored area in Anaheim Bay to offset the habitat loss at Pier J, Long Beach Harbor. Habitat unit gains and losses for the twenty listed evaluation species are the units of measure and are exchanged on a unit for unit basis. As shown on Table 8., Pier J landfill habitat losses would be equally offset by Anaheim Bay habitat unit gains.

In summary, for each acre of Pier J landfill constructed, about 0.759 acre of compensating coastal embayment created at Anaheim Bay would offset the loss. Conversely, for each 1.32 acres of Long Beach Harbor marine habitat at Pier J that is filled, 1 acre of Anaheim Bay wetland should be created out of upland. In order to offset the habitat value loss of the Pier J landfill, 102.5 acres Anaheim Bay upland should be converted to tidal embayment/wetland habitat.

Should more than the required 102.5 acres be restored at Anaheim Bay, each acre created in the above manner, would provide a total 12.96 habitat units for the 20 evaluation species. These habitat unit gains can be weighed against Long Beach Harbor landfill habitat unit losses.

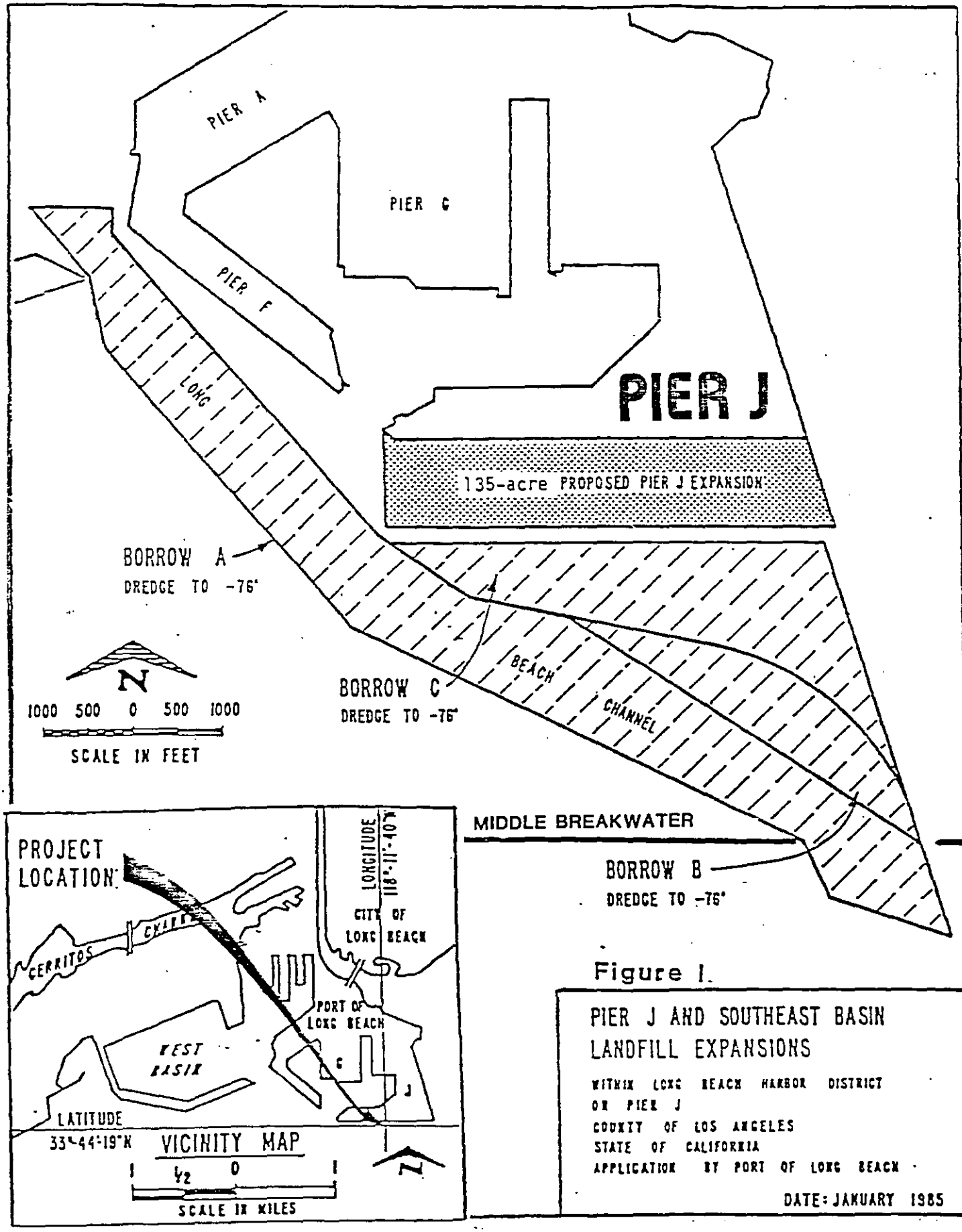


Figure 1.

PIER J AND SOUTHEAST BASIN LANDFILL EXPANSIONS

WITHIN LONG BEACH HARBOR DISTRICT
ON PIER J
COUNTY OF LOS ANGELES
STATE OF CALIFORNIA
APPLICATION BY PORT OF LONG BEACH

DATE: JANUARY 1985

FIGURE 2. Habitat Evaluation Process Flow Diagram

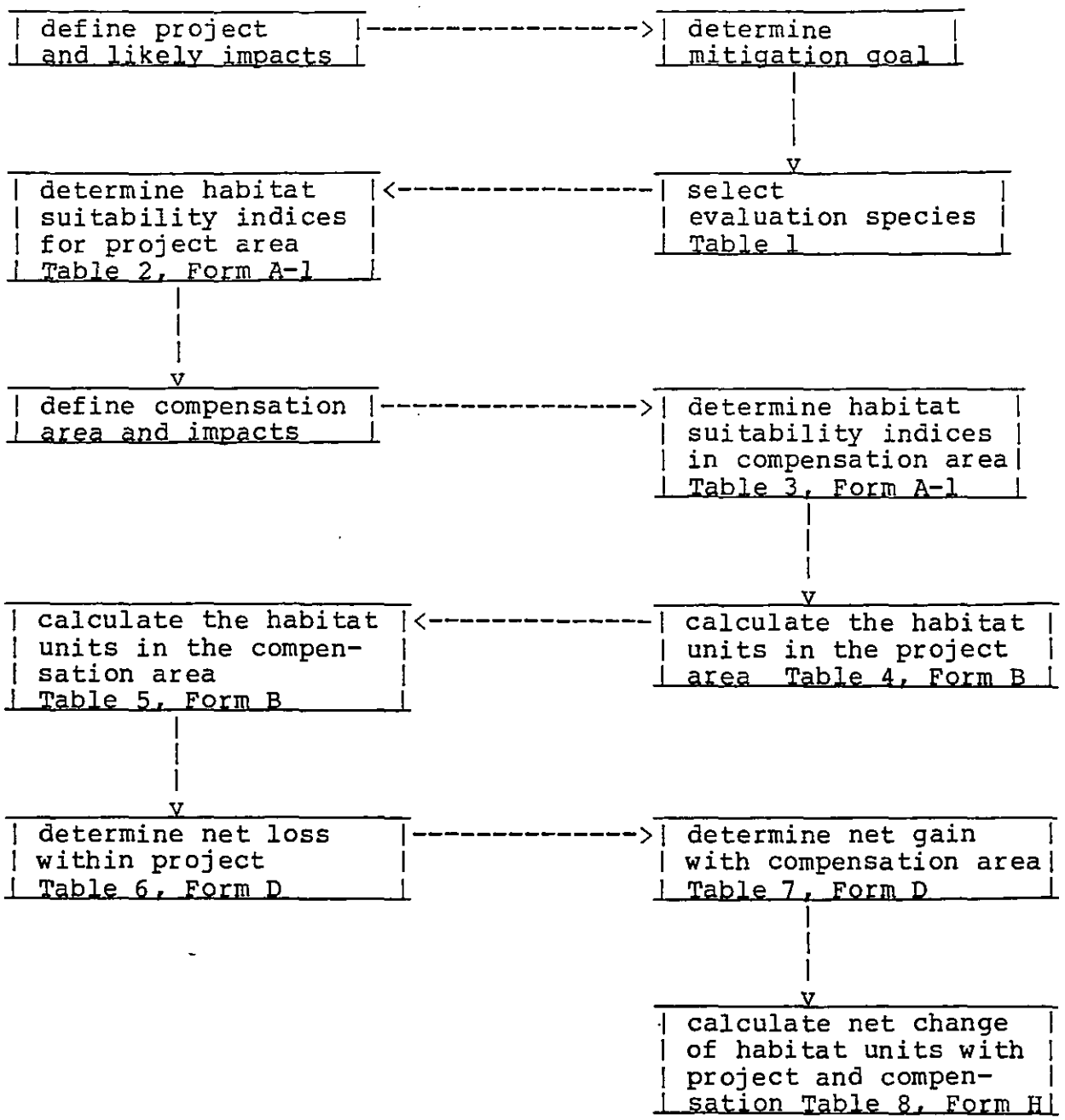


TABLE 1. EVALUATION SPECIES AND GROUPS FOR THE PIER J LANDFILL AND ANAHEIM BAY RESTORATION PROPOSAL

1.	California halibut	*Paralichthys californicus*
2.	White croaker	*Genyonemus lineatus*
3.	Gobiedae	(bay, arrow, cheekspot, long-jaw mudsucker)
4.	Diamond turbot	*Hypsopsetta guttulata*
5.	Bat ray	*Myliobatis californica*
6.	Bay sharks	(leopard shark and smoothhounds)
7.	California corbina	*Menticirrhus undulatus*
8.	Anchovy species	(northern, slough, and deepbody)
9.	Queenfish	*Seriphus politus*
10.	Topsmelt	*Atherinops affinis*
11.	Barred sand bass	*Paralabrax nebulifer*
12.	Shiner surfperch	*Cymatogaster aggregata*
13.	Bonito/barracuda	
14.	White surfperch	*Phanerodon furcatus*
15.	California killifish	*Fundulus parvipinnis*
16.	Spotted sand bass	*Paralabrax maculatofasciata*
17.	California tonguefish	*Symphurus atricauda*
18.	Striped mullet	*Mugil cephalus*
19.	Diving ducks	(scoters, mergansers, ruddy, bufflehead)
20.	Gulls/terns/cormorants	

TABLE 2. Long Beach Harbor Pier J Habitat Suitability Indices (HSI)
Existing and Future Condition Without Landfill (Form A-1)

Cover Type: Water Surface Area at +4.8 Feet MLLW

Evaluation Species	HSI Samples*				Mean HSI
	FWS	NMFS	CDFG	PoLB	
1. California halibut	0.5	0.4	0.6	0.3	0.45
2. White croaker	1.0	1.0	0.8	0.8	0.90
3. Gobiedae	0.8	0.4	0.75	0.4	0.59
4. Diamond turbot	0.2	0.1	0.25	0.3	0.21
5. Bat ray	0.5	0.5	0.5	0.2	0.42
6. Bay sharks	0.7	0.5	0.5	0.3	0.50
7. California corbina	0.2	0.2	0.3	0.2	0.22
8. Anchovy species	0.9	0.8	1.0	0.6	0.82
9. Queenfish	1.0	1.0	0.75	1.0	0.94
10. Topsmelt	0.3	0.3	0.7	0.5	0.45
11. Barred sand bass	0.2	0.5	0.25	0.5	0.36
12. Shiner surfperch	0.7	0.4	0.75	0.2	0.51
13. bonito/barracuda	0.5	0.7	0.5	0.5	0.55
14. White surfperch	0.7	0.8	0.5	0.1	0.52
15. California killifish	0.0	0.0	0.0	0.0	0.00
16. Spotted sand bass	0.2	0.1	0.25	0.2	0.19
17. Cal. tonguefish	1.0	0.8	0.8	1.0	0.90
18. Striped mullet	0.1	0.1	0.0	0.0	0.05
19. Diving ducks	0.5	0.5	0.5	0.5	0.50
20. Gulls/terns/cormorants	0.7	0.8	0.75	0.8	0.76
Total Scores	10.7	9.9	10.4	8.4	9.84
Mean HSI	0.53	0.49	0.52	0.42	0.492

* The HSI can range from 0.0 for no habitat suitability to 1.0 for complete habitat suitability. The values in this table were developed by professional biologists using the best available information.

TABLE 3. Anaheim Bay Compensation Area Habitat Suitability Indices (HSI) Future Condition Following Restoration (Form A-1)

Cover Type: Water Surface Area at +5.5 Feet MLLW

Evaluation Species	HSI Samples*				Mean HSI
	FWS	NMFS	CDFG	PoLB	
1. California halibut	1.0	1.0	0.5	1.0	0.88
2. White croaker	0.1	0.3	0.2	0.2	0.20
3. Gobiedae	1.0	1.0	1.0	1.0	1.00
4. Diamond turbot	1.0	1.0	1.0	1.0	1.00
5. Bat ray	0.5	0.5	0.6	0.5	0.53
6. Bay sharks	0.7	0.7	0.5	0.6	0.63
7. California corbina	0.6	0.8	0.5	0.8	0.68
8. Anchovy species	0.9	0.6	1.0	1.0	0.88
9. Queenfish	0.1	0.2	0.25	0.2	0.19
10. Topsmelt	1.0	0.8	1.0	1.0	0.95
11. Barred sand bass	0.6	0.5	0.5	0.2	0.45
12. Shiner surfperch	1.0	0.8	0.75	1.0	0.89
13. bonito/barracuda	0.0	0.1	0.0	0.0	0.03
14. White surfperch	0.3	0.7	0.3	0.3	0.40
15. California killifish	1.0	1.0	1.0	1.0	1.00
16. Spotted sand bass	0.8	0.7	0.5	0.5	0.63
17. Cal. tonguefish	0.0	0.0	0.0	0.2	0.05
18. Striped mullet	0.6	0.8	1.0	1.0	0.85
19. Diving ducks	0.8	0.7	0.75	0.8	0.76
20. Gulls/terns/cormorants	1.0	0.8	1.0	1.0	0.95
Total Score	13.0	13.0	12.4	13.3	12.96
Mean HSI	0.65	0.65	0.62	0.67	0.648

* The HSI can range from 0.0 for no habitat suitability to 1.0 for complete habitat suitability. The values in this table were developed by professional biologists using the best available information.

TABLE 4. Existing Habitat Units at Pier J, Long Beach Harbor
(Form B)

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	CALIFORNIA HALIBUT	135.00	0.45	60.7
2	WHITE CROAKER	135.00	0.90	121.5
3	GOBIEDAE	135.00	0.59	79.6
4	DIAMOND TURBOT	135.00	0.21	28.3
5	BAT RAY	135.00	0.42	56.7
6	BAY SHARKS	135.00	0.50	67.5
7	CALIFORNIA CORBINA	135.00	0.22	29.7
8	ANCHOVY SPECIES	135.00	0.82	110.7
9	QUEENFISH	135.00	0.94	126.9
10	TOPSMELT	135.00	0.45	60.7
11	BARRED SAND BASS	135.00	0.36	48.6
12	SHINER SURFPERCH	135.00	0.51	68.8
13	BONITO/BARRACUDA	135.00	0.55	74.2
14	WHITE SURFPERCH	135.00	0.52	70.2
15	CALIFORNIA KILLIFISH	135.00	0.00	0.0
16	SPOTTED SAND BASS	135.00	0.19	25.6
17	CALIF. TONGUEFISH	135.00	0.90	121.5
18	STRIPED MULLET	135.00	0.05	6.7
19	DIVING DUCKS	135.00	0.50	67.5
20	GULLS/TERNS/CORMORNT	135.00	0.76	102.6

TABLE 5. Predicted Habitat Units at Anaheim Bay Compensation Areas (Form B)

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	CALIFORNIA HALIBUT	102.50	0.88	90.
2	WHITE CROAKER	102.50	0.20	20.
3	GOBIEDAE	102.50	1.00	102.
4	DIAMOND TURBOT	102.50	1.00	102.
5	BAT RAY	102.50	0.53	54.
6	BAY SHARKS	102.50	0.63	64.
7	CALIFORNIA CORBINA	102.50	0.68	69.
8	ANCHOVY SPECIES	102.50	0.88	90.
9	QUEENFISH	102.50	0.19	19.
10	TOPSMELT	102.50	0.95	97.
11	BARRED SAND BASS	102.50	0.45	46.
12	SHINER SURFPERCH	102.50	0.89	91.
13	BONITO/BARRACUDA	102.50	0.03	3.
14	WHITE SURFPERCH	102.50	0.40	41.
15	CALIFORNIA KILLIFISH	102.50	1.00	102.
16	SPOTTED SAND BASS	102.50	0.63	64.
17	CALIF. TONGUEFISH	102.50	0.05	5.
18	STRIPED MULLET	102.50	0.85	87.
19	DIVING DUCKS	102.50	0.76	77.
20	GULLS/TERNS/CORMORNT	102.50	0.95	97.

TABLE 6. Comparison and Net Change of Habitat Units for Pier J With and Without the Landfill (Form D)

Period of Analysis: 50 years

Evaluation Species ID#	Name	HU's With Action	HU's Without Action	Net Change
1	CALIFORNIA HALIBUT	0.61	60.75	-60.14
2	WHITE CROAKER	1.21	121.50	-120.28
3	GOBIEDAE	0.80	79.65	-78.85
4	DIAMOND TURBOT	0.28	28.35	-28.07
5	BAT RAY	0.57	56.70	-56.13
6	BAY SHARKS	0.67	67.50	-66.83
7	CALIFORNIA CORBINA	0.30	29.70	-29.40
8	ANCHOVY SPECIES	1.11	110.70	-109.59
9	QUEENFISH	1.27	126.90	-125.63
10	TOPSMELT	0.61	60.75	-60.14
11	BARRED SAND BASS	0.49	48.60	-48.11
12	SHINER SURFPERCH	0.69	68.85	-68.16
13	BONITO/BARRACUDA	0.74	74.25	-73.51
14	WHITE SURFPERCH	0.70	70.20	-69.50
15	CALIFORNIA KILLIFISH	0.00	0.00	0.00
16	SPOTTED SAND BASS	0.26	25.65	-25.39
17	CALIF. TONGUEFISH	1.21	121.50	-120.28
18	STRIPED MULLET	0.07	6.75	-6.68
19	DIVING DUCKS	0.67	67.50	-66.83
20	GULLS/TERNS/CORMORNT	1.03	102.60	-101.57

TABLE 7. Comparison of Net Change of Habitat Units for Anaheim Bay Compensation Area, With and Without Restoration (Form D)

Period of Analysis: 50 years

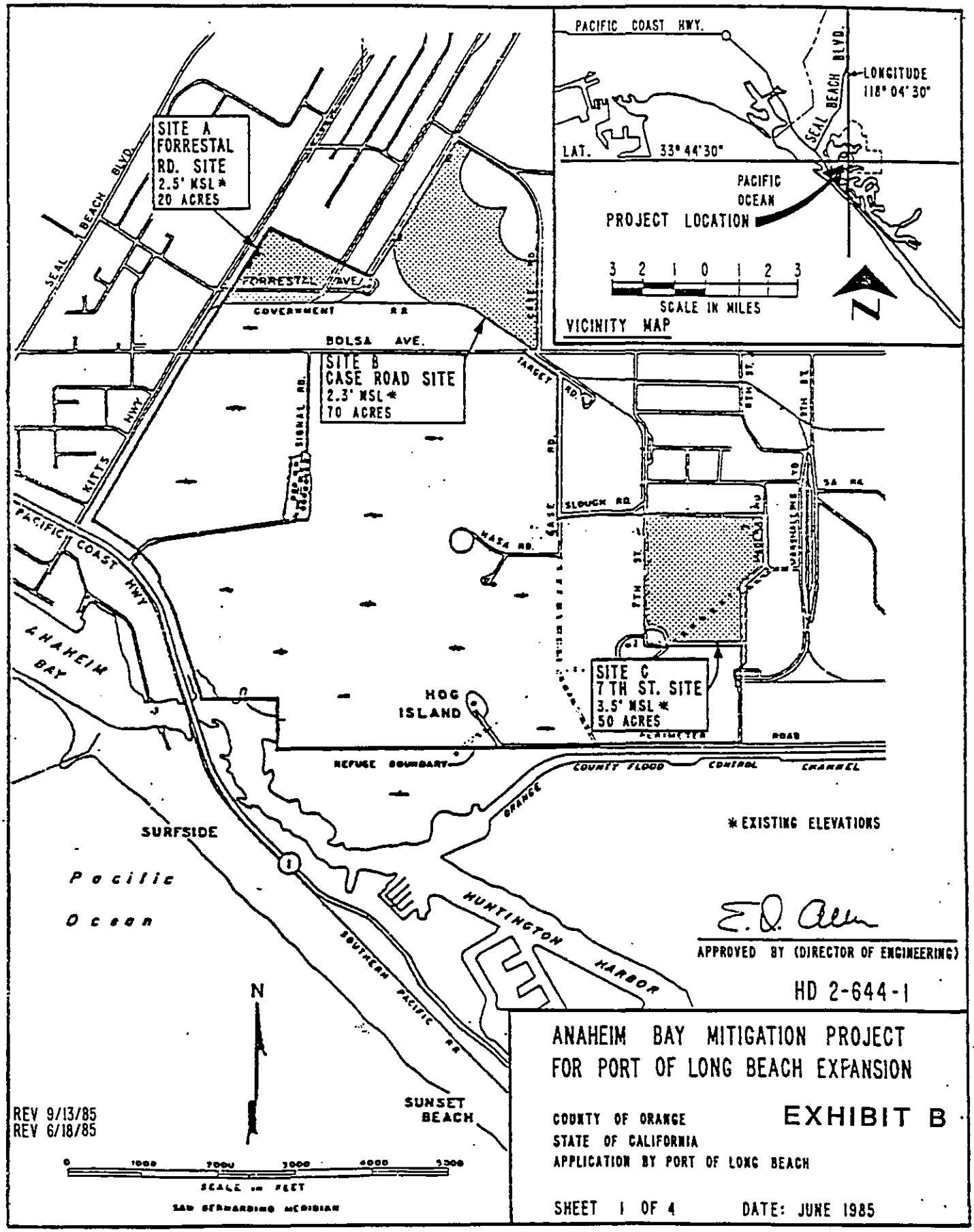
Evaluation Species ID#	Name	HU's With Action	HU's Without Action	Net Change
1	CALIFORNIA HALIBUT	89.30	0.00	89.30
2	WHITE CROAKER	20.30	0.00	20.30
3	GOBIEDAE	101.48	0.00	101.48
4	DIAMOND TURBOT	101.48	0.00	101.48
5	BAT RAY	53.78	0.00	53.78
6	BAY SHARKS	63.93	0.00	63.93
7	CALIFORNIA CORBINA	69.00	0.00	69.00
8	ANCHOVY SPECIES	89.30	0.00	89.30
9	QUEENFISH	19.28	0.00	19.28
10	TOPSMELT	96.40	0.00	96.40
11	BARRED SAND BASS	45.66	0.00	45.66
12	SHINER SURFPERCH	90.31	0.00	90.81
13	BONITO/BARRACUDA	3.04	0.00	3.04
14	WHITE SURFPERCH	40.59	0.00	40.59
15	CALIFORNIA KILLIFISH	101.48	0.00	101.48
16	SPOTTED SAND BASS	63.93	0.00	63.93
17	CALIF. TONGUEFISH	5.07	0.00	5.07
18	STRIPED MULLET	86.25	0.00	86.25
19	DIVING DUCKS	77.12	0.00	77.12
20	GULLS/TERNS/CORMORNT	96.40	0.00	96.40

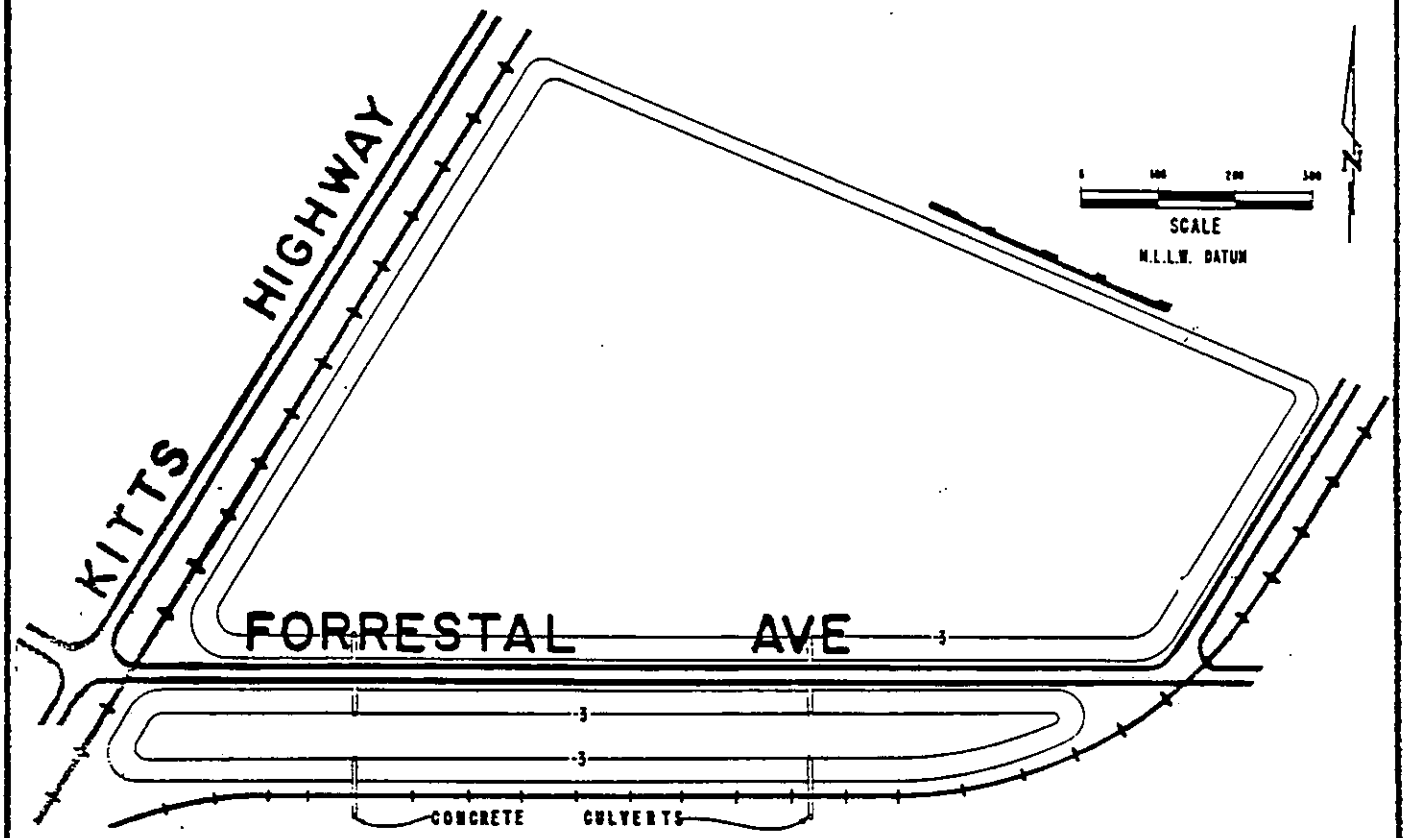
TABLE 8. Net Change in Habitat Units Resulting From the Pier J Landfill and Anaheim Bay Restoration (Form H)

Pier J Landfill 135 acres
Anaheim Bay Restoration 102.5 acres

Evaluation Species ID#	Name	Net Change in Habitat Units: Pier J Landfill	Net Change in Habitat Units: Anaheim Bay Restoration
1	CALIFORNIA HALIBUT	-60.14	89.30
2	WHITE CROAKER	-120.29	20.30
3	GOBIEDAE	-78.85	101.48
4	DIAMOND TURBOT	-28.07	101.48
5	BAT RAY	-56.13	53.78
6	BAY SHARKS	-66.83	63.93
7	CALIFORNIA CORBINA	-29.40	69.00
8	ANCHOVY SPECIES	-109.59	89.30
9	QUEENFISH	-125.63	19.28
10	TOPSMELT	-60.14	96.40
11	BARRED SAND BASS	-48.11	45.66
12	SHINER SURFPERCH	-68.16	90.81
13	BONITO/BARRACUDA	-73.51	3.04
14	WHITE SURFPERCH	-69.50	40.59
15	CALIFORNIA KILLIFISH	0.00	101.48
16	SPOTTED SAND BASS	-25.39	63.93
17	CALIF. TONGUEFISH	-120.29	5.07
18	STRIPED MULLET	-6.68	86.25
19	DIVING DUCKS	-66.83	77.12
20	GULLS/TERNS/CORMORNT	-101.57	96.40
		Loss Total -1315	Gain Total +1315

NET CHANGE 0 HABITAT UNITS


SITE A
FORRESTAL
RD. SITE
2.5' MSL*
20 ACRES
SITE B
CASE ROAD SITE
2.3' MSL*
70 ACRES
SITE C
7TH ST. SITE
3.5' MSL*
50 ACRES
PACIFIC COAST HWY.
LONGITUDE
118° 04' 30"
LAT. 33° 44' 30"
PACIFIC
OCEAN
PROJECT LOCATION
SCALE IN MILES
VICINITY MAP
SEAL BEACH BLVD.
FORRESTAL AVE.
GOVERNMENT
BOLSA AVE.
SIGNAL RD.
KITTS
HWY
SLOUGH RD.
NASA RD.
7TH ST.
HOG
ISLAND
REFUGE BOUNDARY
COUNTY FLOOD CONTROL CHANNEL
ANAHEIM
BAY
SURFSIDE
Pacific
Ocean
HUNTINGTON
HARBOR
SOUTHERN PACIFIC RR
SUNSET
BEACH
N
SCALE IN FEET
SAN BERNARDINO MERIDIAN
* EXISTING ELEVATIONS
E. O. Allen
APPROVED BY (DIRECTOR OF ENGINEERING)
HD 2-644-1
ANAHEIM BAY MITIGATION PROJECT
FOR PORT OF LONG BEACH EXPANSION
COUNTY OF ORANGE
STATE OF CALIFORNIA
APPLICATION BY PORT OF LONG BEACH
EXHIBIT B
SHEET 1 OF 4
DATE: JUNE 1985
REV 9/13/85
REV 6/18/85



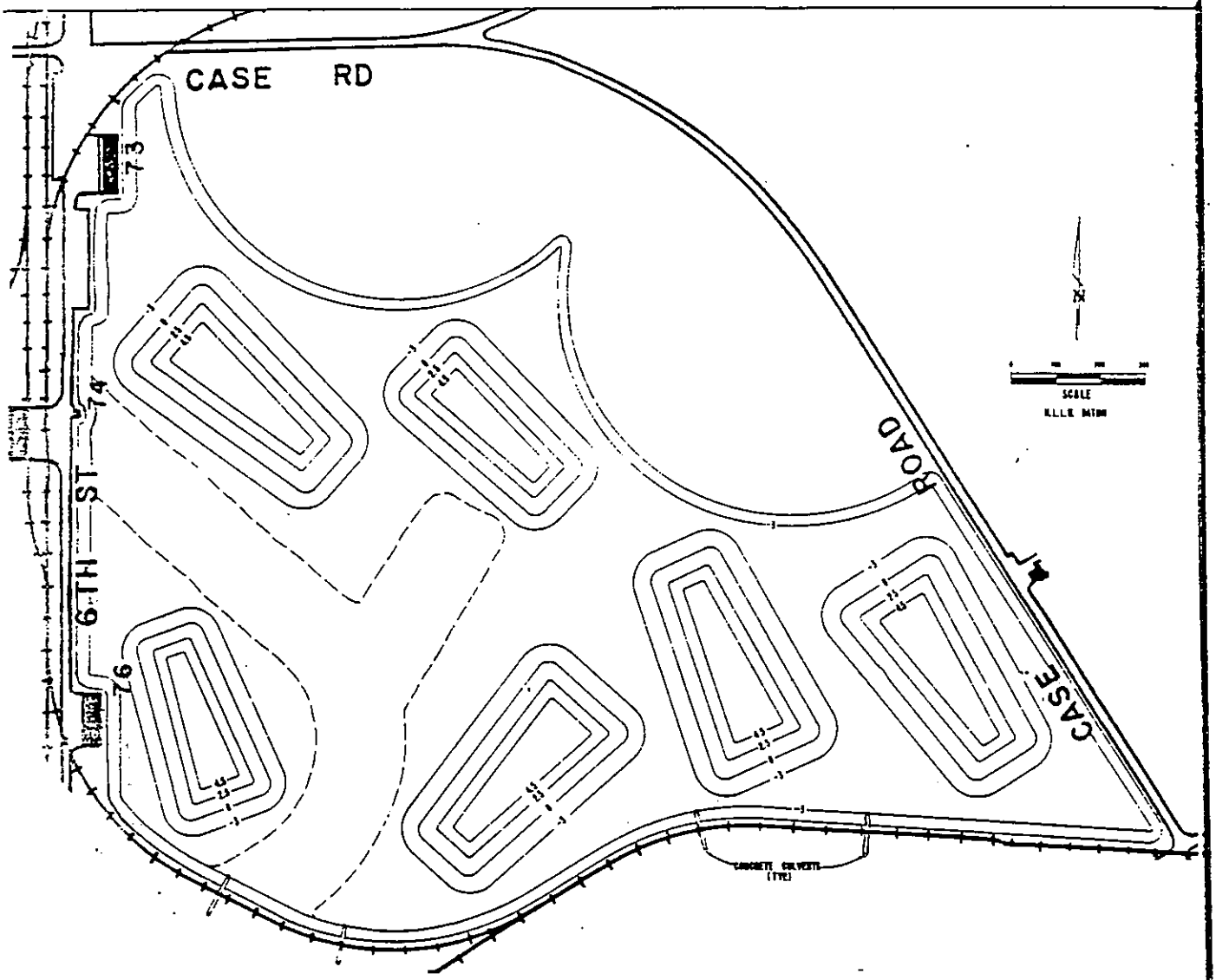
HD 2-644-2

ANAHEIM BAY MITIGATION PROJECT
FOR PORT OF LONG BEACH EXPANSION
SITE A - FORRESTAL AVE.

EXHIBIT C

COUNTY OF ORANGE
STATE OF CALIFORNIA
APPLICATION BY PORT OF LONG BEACH
SHEET 2 OF 4 DATE: JUNE 1985

REV. 9/13/85



HD 2-644-3

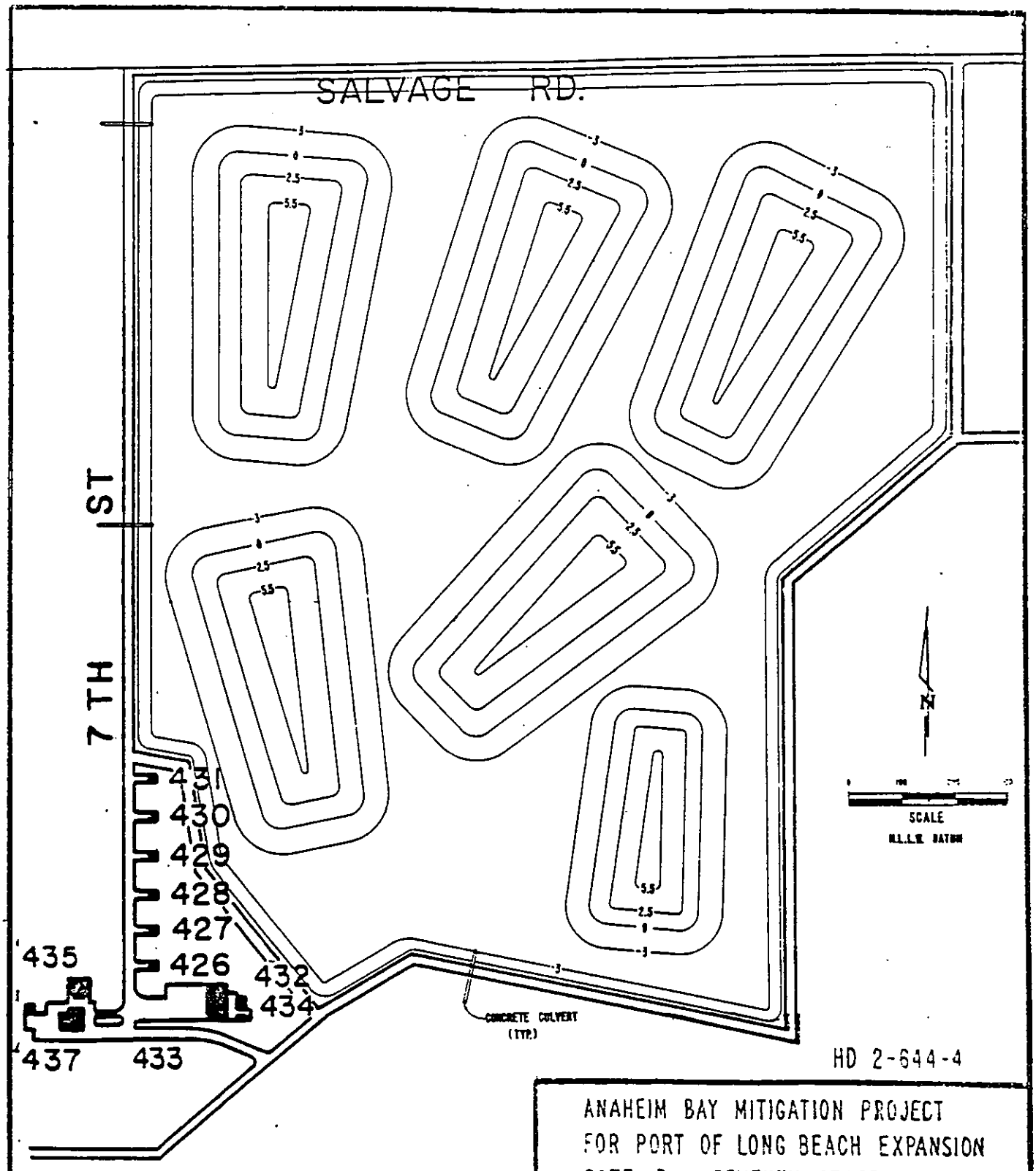
ANAHEIM BAY MITIGATION PROJECT
FOR PORT OF LONG BEACH EXPANSION
SITE B - CASE ROAD

EXHIBIT D

COUNTY OF ORANGE
STATE OF CALIFORNIA
APPLICATION BY PORT OF LONG BEACH

SHEET 3 OF 4 DATE: JUNE 1985

REV. 9/13/85



HD 2-644-4

ANAHEIM BAY MITIGATION PROJECT
FOR PORT OF LONG BEACH EXPANSION
SITE C - SEVENTH STREET

COUNTY OF ORANGE
STATE OF CALIFORNIA
APPLICATION BY PORT OF LONG BEACH

EXHIBIT E

SHEET 4 OF 4 DATE: JUNE 1985

REV. 9/13/85

MEMORANDUM OF UNDERSTANDING
AMONG
THE BOARD OF HARBOR COMMISSIONERS OF THE CITY OF LONG BEACH,
THE CALIFORNIA DEPARTMENT OF FISH AND GAME,
THE NATIONAL MARINE FISHERIES SERVICE, AND
THE FISH AND WILDLIFE SERVICE,
TO
ESTABLISH A PROCEDURE FOR COMPENSATION
OF MARINE HABITAT LOSSES
INCURRED BY PORT DEVELOPMENT LANDFILLS
WITHIN THE HARBOR DISTRICT OF THE CITY OF LONG BEACH,
BY MARINE HABITAT CREATION AT ANAHEIM BAY.

THIS MEMORANDUM OF UNDERSTANDING (MOU) is entered into by the UNITED STATES OF AMERICA, acting by and through the FISH AND WILDLIFE SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR, ("FWS"), and the NATIONAL MARINE FISHERIES SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, UNITED STATES DEPARTMENT OF COMMERCE, ("NMFS"), and the STATE OF CALIFORNIA, acting by and through the DEPARTMENT OF FISH AND GAME, RESOURCES AGENCY, ("CDFG"), and the CITY OF LONG BEACH, acting by and through its BOARD OF HARBOR COMMISSIONERS, ("BOARD").

WHEREAS, the BOARD is mandated to foster the orderly and necessary development of the Port of Long Beach, including the creation of new land in the Harbor District of the City of Long Beach ("Harbor District") by landfill; and

WHEREAS, the FWS has as its primary mandate, in this matter, the conservation, protection, and enhancement of marine fish and migratory birds and their habitats, including the planning of

biological loss avoidance, minimization, and compensation; the CDFG has as its primary mandate, in this matter, the conservation, protection, and enhancement of marine fish and migratory birds and their habitats, including the prevention of project-caused losses to fish and wildlife resources; and the NMFS has as its primary mandate, the conservation, protection, and enhancement of marine fisheries resources, including the planning of biological loss avoidance, minimization, and compensation; and

WHEREAS, port development landfills are subject to State regulation pursuant to the California Coastal Act and the California Environmental Quality Act (CEQA) and Federal regulation pursuant to the River and Harbor Act and Clean Water Act and the National Environmental Polict Act (NEPA); and

WHEREAS, the BOARD contemplates an imminent harbor development within the Harbor District, consisting of a landfill at Pier J, totaling approximately 135 acres; and

WHEREAS, the contemplated Harbor District landfill is expected to be necessary and a water-dependent port improvement, and the minimum landfill to fulfill the purpose; and

WHEREAS, the contemplated Harbor District landfill will eliminate marine habitat value that FWS, CDFG, and NMFS want to be replaced; and

WHEREAS, delay in implementing port developments and their mitigation serves no public interest and the parties would like to facilitate permit processing for the contemplated landfill, which would permanently eliminate marine habitat, by providing habitat loss compensation for the impacts on the marine environment in advance of or concurrently with the habitat losses predicted for the contemplated landfill; and

WHEREAS, the parties concur that creation of appropriate fish and wildlife habitat values in advance of or concurrently with the loss would require an accounting procedure whereby habitat losses which will be incurred by specified landfill developments in the Harbor District could be charged against the habitat credits; and

WHEREAS, the parties concur that creation of new habitat value within the Harbor District to offset habitat losses within the Harbor District could render some other future, necessary harbor developments more difficult; and

WHEREAS, shallow, estuarine coastal embayment habitat in Southern California, with its relatively high value to marine fishes and migratory birds, has been reduced in area at a greater rate than that of deep water habitat, NMFS, CDFG, and FWS judge that compensation for adverse project impacts upon the marine ecosystem should emphasize the creation of shallow water, coastal embayment habitat;

NOW, THEREFORE, IT IS AGREED THAT:

1. The habitat evaluation reported in Exhibit "A", attached hereto and by this reference made a part hereof, has established the fish and wildlife habitat value losses to result from the 135-acre Pier J landfill construction (measured at +4.8 feet Mean Lower Low Water, MLLW) and the fish and wildlife habitat value gains to result from the coastal embayment creation at Anaheim Bay. No net loss of habitat values shall occur.

2. The BOARD, at its cost, shall restore tidal influence to three specified areas in Anaheim Bay, along the northern and northeastern regions of the FWS Seal Beach National Wildlife Refuge ("SBNWR"), located within the Seal Beach Naval Weapons Station, County of Orange, California, as shown as Area A, Area B, and Area C on Exhibit "B", attached hereto and by this reference made a part hereof.

3. The BOARD'S work conducted in Areas A, B, and C of Exhibit "B" will restore to tidal influence, wetland areas of approximately 20, 50, and 50 acres, respectively. The perimeter boundary of each site will be the contour line at +2.5 feet MLLW. Restoration work within this boundary of each site will result in not less than 50 percent of the area being excavated to an average elevation of -3.0 feet MLLW, not more than 15 percent of the area will remain as islands with elevations between +2.5 and +5.5 feet MLLW, and not more than 35 percent of the area will form slopes within +2.5 feet and -3.0 feet MLLW, between the

islands and deeper portions of each site. In addition, not less than 6 mounds, with a base diameter of about 10 feet and a height of about +8.5 feet MLLW shall be constructed on each of the islands. Culverts will be constructed under existing roadbeds to provide permanent unimpeded flushing of each parcel by tidal waters. Exhibits "C", "D", and "E", attached hereto and by this reference made a part hereof, depict the tidal elevation contours and culvert locations and dimensions for each area.

4. The BOARD shall be responsible for all aspects of the restoration work including sediment sampling, appropriate archeologic survey, environmental documentation (CEQA and NEPA) acquisition of permits and contractor selection and supervision. The FWS, the NMFS, and the CDFG agree to cooperate with and assist the BOARD, procedurally, with the acquisition of permits or approvals for the restoration work and for an appropriate dredge spoil disposal site.

5. All restoration work performed by the BOARD at SBNWR pursuant to this MOU will be conducted in accordance with a FWS Refuge Use Permit and with the approval of the Commander, U.S. Navy, Seal Beach Naval Weapons Station, subject to a U. S. Navy Siting Approval.

6. The BOARD agrees that its work will be scheduled and conducted so as not to incur significant habitat loss or degradation elsewhere within the SBNWR and so as not to adversely

impact any State or Federal endangered species which utilizes the SBNWR, including the California Least Tern, the Light-footed Clapper Rail, California Brown Pelican, Belding's Savannah Sparrow, or Salt Marsh Bird's Beak.

7. Construction of the Pier J landfill, including the rock containment dike and its associated activities, may not begin before construction of the SBNWR restoration site has begun. However, should the BOARD decide to use the fill excavated from the restoration site to provide partial fill at the Pier J site, construction of the first phase of the rock containment dike may precede the start of wetland restoration. The completion of the SBNWR restoration work, as certified below, shall be on the same date or prior to the date which the BOARD accepts as completed the fill phase of the Pier J landfill thereby authorizing the final payment of the fill contract, and shall precede any surface improvement work on the fill. The SBNWR restoration work shall be inspected and certified complete and consistent with the conditions of this MOU, by the Director of Engineering, Design and Development of the Harbor Department of the City of Long Beach and the FWS, and approved by the directorate of CDFG and NMFS.

8. In order to offset the predicted fish and migratory bird habitat value loss of the 135-acre Pier J landfill (measured at +4.8 feet MLLW), not less than 1Ø2.5 acres shall be restored in Anaheim Bay (see Exhibit "A") in accordance with paragraphs 2 through 7 above and Exhibits "B" through "E", inclusive.

9. The BOARD, at its option and with the approval of the FWS, may restore more than the required 102.5 acres within Areas A, B, and C, which would create additional excess habitat units, in accordance with the values set forth in Exhibit A. These excess habitat value units would be credited to the BOARD and will be based upon the actual additional acreage restored, as determined by a final as-built survey.

10. Excess habitat value units (those habitat value units not required to offset the impacts of the Pier J Landfill) may be used, with the approval of all parties, to offset fish and migratory bird habitat losses calculated in accordance with Exhibit A, which may result from other port development landfill projects proposed by the BOARD within the Harbor District that are shown to be necessary, the minimum possible, and water dependent and port related. Such approval shall be indicated in an official and public manner, during completion of the environmental review process required under the California Environmental Quality Act, National Environmental Policy Act, and/or the regulatory process required under the California Coastal Act, the River and Harbor Act, or the Clean Water Act.

11. The BOARD may be allowed to transfer excess habitat value units to other Port Districts in the Southern California Bight that are applicants for a Corps of Engineers permit or California Coastal Act permit or Master Plan Amendment after such district has consulted with FWS, CDFG, and NMFS and obtained a written approval for the use of those units from each agency. The habitat value units thus transferred may only be used to

compensate for fish and wildlife losses incurred as a result of port district projects. Responsibility for habitat value assessment and tradeoff analysis rests with FWS, CDFG, NMFS. Such approval is to be granted in accordance with the applicable policies and guidelines of each agency. Transfer and use of such habitat value units shall not result in the net loss of fish and wildlife values. These habitat value units shall not be used to offset the impacts of any project which fills or otherwise adversely affects wetlands. (Wetlands are defined according to FWS publication FWS/OBS-79/31, Classification of Wetlands and Deepwater habitats of the United States, L. Cowardin, V. Carter, F. Golet, E. LaRoe, Dec. 1979). The BOARD shall notify all parties of this MOU, officially and publicly, in writing of acceptance or rejection of any such proposal to transfer habitat value credits.

12. The BOARD shall have no responsibility for maintenance or monitoring of the SBNWR restored area following completion, since it has been determined by the FWS that, in this case, the operation and maintenance of the restoration sites would not add significantly to the present management costs of the SBNWR.

13. Should the SBNWR restoration work be completed and should the Pier J Landfill not be initiated, all habitat value gains shall be considered excess and may be used in accordance with paragraphs 10 and 11. This MOU shall remain valid until the balance of habitat value credits has been consumed or until rescinded by written consent of all parties.

THIS MEMORANDUM OF UNDERSTANDING SHALL BE IN FULL FORCE AND EFFECT FROM THE DATE WHICH ALL PARTICIPANTS HAVE SIGNIFIED AGREEMENT BY SIGNATURE OF THE DESIGNATED REPRESENTATIVE.

THE CITY OF LONG BEACH, acting by and through its Board of Harbor Commissioners

By: _____ _____
James H. McJunkin
Executive Director
Date

THE FISH AND WILDLIFE SERVICE,
U.S. Department of Interior

By: _____ 2-12-86
for Richard J. Myshak
Regional Director, Region I
Date

THE DEPARTMENT OF FISH AND GAME,
The Resources Agency of California

By: _____ 1-16-86
W. C. Parnell
Director
Date

THE NATIONAL MARINE FISHERIES SERVICE,
NOAA, U.S. Department of Commerce

By: _____ 1-13-86
E.C. Fullerton
Regional Director
Date

Christopher T. Mobley, Fishery Biologist
National Marine Fisheries Service Habitat Conservation Branch
Southwest Region, Northern Area Office
777 Sonoma Avenue, Room 325
Santa Rosa, CA 95404
(707)578-7513

Efforts to Improve Mitigation Tracking in Northern California

The Habitat Conservation Branch of NMFS has a Northern Area Office located in Santa Rosa, California. One of the chief duties of this office is to review and comment on Corps of Engineers (COE) Section 404 and Section 10 permits, Federal Energy Regulatory Commission (FERC) permits, and Environmental Impact Statements/Reports (EIS/EIR). This process frequently involves comparing project impacts to proposed mitigation in an attempt to achieve a goal of "no net loss" to either wetland/riparian acreage or value.

However, many agencies have recognized that although projects are thoroughly investigated at the permit application stage, they are not carefully monitored to ensure permit compliance. Further, even if the terms of a permit are met, this does not necessarily translate into full biological functionality of the mitigation wetlands.

The EPA/state agency sponsored San Francisco Estuary Project (SFEP) is a multi-agency assessment of the state of the San Francisco Bay/Delta Estuary and an attempt to develop a Comprehensive Management Plan for the Bay region. In the SFEP's draft Wetlands Status and Trends Report, it is noted that mitigation has resulted in the restoration or enhancement of 2,332 acres of wetlands as part of Federal and State permitted projects. However, this is generally the conversion of one type of wetland to another, such as from diked seasonal freshwater wetlands to intertidal brackish wetlands. Of all the projects reviewed in this comprehensive report, only 2 acres of upland were converted to wetland.

BCDC (Bay Conservation and Development Commission) prepared a recent evaluation of 14 mitigation projects, and found that 43% of them provided both permit compliance and the creation of valuable wetland resources, 37% of them did not fully meet specific permit requirements but did create effective wetland habitat, and 21% of them failed to meet permit requirements and/or failed to create valuable bay habitat.

Forthcoming recommendations of the SFEP include better planning of mitigation projects, better monitoring of mitigation projects, and better enforcement of mitigation requirements.

Our office is taking a number of measures to meet these goals. First, to improve our overall assessment of permit impacts and the potential for successful mitigation, we are working to obtain access to available resource planning databases. Available databases include:

EPA San Francisco- ARCINFO GIS database which includes the National Wetlands Inventory and will soon be include toxics, site remediation, and regulatory information.

CDFG Monterey- Larry Espinosa is developing a dBase IV wetlands database that covers the whole California Coast. It is designed primarily to help oil spill response efforts by identifying critical resources, and to aid in later damage assessment.

CDFG Sacramento- John Ellison runs the Non-Game Heritage Database, which is an endangered/threatened species distribution database. It is on dBase IV, but will soon be converted to a GIS system.

UC Davis- Dr. Peter Moyle has a Paradox database which includes species and habitat data for the Russian, Eel, Central Valley, and North Coast streams.

UC Berkeley- Dr. Robert H. Twiss is developing a GIS database that includes the National Wetlands Inventory, ABAG land use file, historic marshlands, Delta lowlands, County Plans, hydrologic features, runoff and contaminant loading, and a number of other useful map layers.

There are problems associated with gaining access to these databases- different software, different caretakers, different hardware requirements, etc. Clearly, one task that the federal resource agencies may wish to pursue is to promote data standards for GIS databases and to promote some system of distribution and access for these databases. Mike Thabault and I have met with many of the database developers to discuss potential standards for hardware, software, and habitat data, and it appears that there is some consensus as to possible acceptable standards.

Second, our office is developing a new office database system to better track permits after they have been reviewed. The above databases may help at the planning stages, but are not designed to follow specific projects. Every project that includes mitigation will be entered into our database, and will include such information as required acreages/habitat types to be created; applicant name, address and phone number; exact location of project site and mitigation site; and dates that various project milestones are to be met. We envision a system design that will include daily notification of projects to be reviewed- for example, if a project included an annual report of mitigation progress, then the database would notify us on the reports's due date that the report was overdue.

We will continue to work with the COE, EPA, USFWS, and CDFG as we refine our permit follow-up. If we find that a project is out of compliance with the original permit application, then we will ask the COE to enforce the permit requirements. As we increase our efforts to monitor and enforce permits, new working relationships with the otherother resource agencies will have to evolved.