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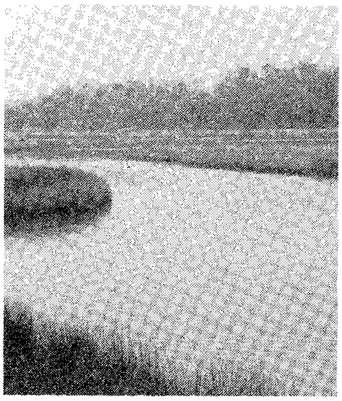

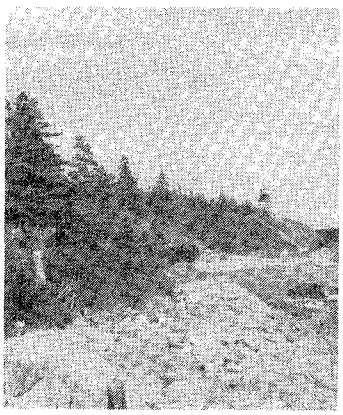

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ASSESSMENT OF HABITAT/RESOURCE EVALUATION METHODS FOR USE IN COMPARING ESTUARINE AND COASTAL HABITATS

by

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13. ABSTRACT *(Maximum 200 words)*

This report summarizes discussions of a working group convened to evaluate methods available for comparison of estuarine and coastal habitat types. Such comparisons are an integral part of the development of so-called "trade-off" values for habitats created and destroyed during mitgation efforts. The working group meeting was held on 10 and 11 October 1991 at the Mississippi State University Gulf Coast Research and Extension Center in Biloxi, MS.

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Preface

The study reported herein was conducted as a part of the Environmental Impact Research Program (EIRP) sponsored by Headquarters, U.S. Army Corps of Engineers (HQUSACE). Technical Monitors were Dr. John Bushman, Mr. David P. Buelow, and Mr. David Mathis of HQUSACE. Dr. Roger T. Saucier, Environmental Laboratory (EL), U.S. Army Engineer Waterways Experiment Station (WES), was EIRP Program Manager.

The report was written by Dr. Mark LaSalle of Mississippi State University Gulf Coast Research and Extension Center, Biloxi, MS, and Dr. Gary L. Ray, Coastal Ecology Group (CEG), Environmental Resources Division (ERD), EL. Dr. Ray was also contract monitor. Work progressed under the general supervision of Mr. Edward J. Pullen, Chief, CEG, ERD; Dr. Conrad J. Kirby, Chief, ERD; and Dr. John Harrison, Chief, EL.

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Contents

ASSESSMENT OF HABITAT/RESOURCE EVALUATION METHODS FOR USE IN COMPARING ESTUARINE AND COASTAL HABITATS

Purpose

1. Determining the impact of construction activities on estuarine and coastal marine ecosystems requires the existence of objective methods for evaluating the physical, chemical, and biological functioning of the habitats which make up these systems. Comparison of the functions of altered and created sites to natural habitats is of particular interest since habitat creation and restoration are often employed as mitigation options for coastal construction projects. Since one habitat type is created at the expense of another (i.e., a habitat "trade-off" takes place), it is important to be able to compare the functioning of the two, often disparate habitat types. For example, seagrass beds are often constructed on previously unvegetated sediments. Both habitats (unvegetated and vegetated sediment) provide habitat and food resources for a variety of organisms. However, they support different life cycle stages of these species and/or relatively different species assemblages. For instance, demersal fish have difficulty feeding in the root mats characteristic of grass beds sediments, whereas larval and juvenile fish will be able to find both food and cover among the grass blades. In this example, a habitat that is essential for the adult has been "traded" for one that is beneficial for survival of the juveniles. In order for the fish population to survive, it is essential to understand what each habitat supplies and how much of each habitat is necessary to ensure its continued survival. At present, little is known about how well altered or created habitats function as compared with undisturbed habitats. The purpose of this paper is specifically to outline potential technically based approaches for evaluating the ecological importance of disparate coastal habitats.

Background

2. In a review of existing procedures for evaluating coastal habitats, Bowen and Small (1992) found that most methods consider only a subset of possible habitats or their functions. Consequently, no single evaluative method is appropriate for use in all habitat types. The major difficulty in comparing disparate habitats is that each habitat type is characterized by a

different suite of physical and biotic attributes (and associated functions), and some of these attributes cannot be readily compared. Another short-coming of existing methods is that they do not account for the contribution that a habitat has to the functioning of other habitats or how altering the relative proportions of habitats in an ecosystem may affect the system as a whole.

3. These and other issues of habitat assessment were addressed by an interdisciplinary working group of estuarine scientists (Table 1) convened at the Mississippi State University Gulf Coastal Research and Extension Center (Biloxi, MS) on 10 and 11 October 1991. The group was asked to: (a) evaluate the usefulness of existing habitat evaluation methods (as reviewed by Bowen and Small 1992) for addressing habitat comparisons and trade-offs; and (b) recommend an approach toward addressing these issues, either through the use of selected methods, or an outline of alternate approaches.

Table 1

List of Working Group Members and Affiliations

Ms. Marcia Bowen, Normandeau Associates, Inc.

Dr. Douglas G. Clarke, US Army Engineer Waterways Experiment Station

Dr. Robert J. Diaz, Virginia Institute of Marine Sciences College of William and Mary

Dr. Courtney T. Hackney, University of North Carolina at Wilmington

Dr. Mark W. LaSalle (Moderator), Mississippi State University, Gulf Coastal Research and Extension Center

Dr. Nancy Rabalais, Louisiana Universities Marine Consortium

Dr. Gary Ray, US Army Engineer Waterways Experiment Station

Mr. Charles Simenstad, University of Washington, Fisheries Research Institute

Existing Evaluative Methods

4. The objective of the survey of existing methods (Bowen and Small 1992) was to determine what methods are available for evaluating and comparing different coastal habitat types and to discuss their relative strengths and

weaknesses. Of the 15 methods identified from the scientific literature, all focused on a limited number of functions within one or a few coastal habitat types. Applied on an individual basis, these methods are of limited use in comparing disparate habitats because of differences in the suite of functions and attributes across habitat types.

5. A successful method needs to incorporate measures for a diversity of both habitat types and functions. One approach to designing such a method would be to combine features of existing techniques from different habitats. For example, methods for evaluating intertidal flats (Diaz 1982), unvegetated bottoms (Rhoads and Germano 1982), seagrass beds (Fonseca 1989), and fisheries utilization of benthos (Lunz and Kendall 1982) might be combined to more accurately assess both vegetated and bare unconsolidated substrate habitats. The Puget Sound protocols (Puget Sound Estuary Program 1990) contain a review of many of the types of sampling procedures and ecological functions that need to be considered for incorporation into an agglomerative method. Such an approach would also need to account for regional differences in the values for individual functions or habitat types. An example of this is found in the "Diaz" method (Diaz 1982) where infaunal abundances are evaluated on the basis of regional variability in densities.

6. Another factor to consider in developing a workable method is that not all habitats actually need to be taken into consideration or given the same degree of effort in all regions. Obvious examples of this situation are that coral reefs are uncommon in Maine, and rocky intertidal habitats are rare in Florida. Likewise, not all habitats are equally amenable to either creation or sacrifice in the restoration or enhancement process. Most habitat trade-off's occur among a relatively small number of habitat types. Thus, a series of methods tailored to particular regions and comparatively small numbers of habitats might be devised.

A System-Wide Approach

7. A limitation of any direct measure of habitat function is the difficulty in assessing qualitative as well as quantitative differences in individual habitat attributes. For instance, estimates of primary production may be derived from several possible sources (e.g., vascular plants, algae, phytoplankton). Each source may account for a variable proportion of the total

primary production depending on the habitat, and different temporal, environmental (e.g., salinity regime), and geographic scales.

8. The direct approach to habitat comparison may not always be the most appropriate since comparing individual sites often ignores their role within the system as a whole, their relationships with other habitats, and the current or historical conditions within the system. Although decisions about habitat creation may be assessed by using an appropriate habitat-specific evaluative method, situations involving trade-off's may be more appropriately addressed by considering the relative proportion of various habitat types at the ecosystem level and how the proposed alteration of this condition will affect the system. For example, the creation of a particular habitat type within an ecosystem which has lost much of its previous acreage of that type may be appropriate regardless of the issue of relative functional levels of created versus natural sites. On the other hand, in a relatively pristine system the creation of a "commonly" occurring habitat type at the expense of a "rare" habitat might be ill-advised.

9. Evaluating and comparing various habitat types within any given ecosystem requires a broad understanding of existing habitats, their interrelationships, and their contributions to the ecosystem as a whole. Proposed changes to the makeup of a given ecosystem should be made on a system-by-system basis and should consider how cumulative losses or gains will affect or have affected the existing ecosystem. A "system-wide" approach should be based on the recognition that these ecosystems are made up of a variety of closely linked habitat types, each of which has a distinct suite of physical and biotic characteristics, but across which organisms may actively move. Each habitat type may provide a number of both physical and biotic functions, with some functions shared among habitat types.

10. For example, intertidal marshes and intertidal and subtidal seagrass beds provide sources of primary productivity and habitat for fishes and shellfishes. The physical structure, hydrography, and environmental conditions of each are, however, unique. Many of these coastal habitat types interface with one another and with adjacent terrestrial habitats; together they constitute a broadly defined ecosystem. Each habitat type may appear to stand alone in the ways and means by which it serves the ecosystem or a suite of organisms; but, in reality, habitats function as "part" of a more interactive "system."

11. In the previous example, intertidal marshes serve as habitat for both terrestrial and aquatic organisms while providing shoreline protection and flood storage capacity. Habitat types bordering on either the upland or subtidal side of marshes serve as corridors for many of the organisms utilizing marshes. In their own right, these adjacent habitats may provide similar functions and support some of the same organisms, but usually in different ways and to different extents. For example, some fishes and shellfishes may feed preferentially in intertidal marshes during periods when they are flooded, but rely on subtidal habitats as both secondary feeding areas and refuges during periods when they cannot access the marsh surface. Other organisms may feed in one habitat type and breed in another.

12. From an ecosystem viewpoint, alterations to a single habitat type do not affect only that habitat type or adjacent types and need to be placed in a context of how a given alteration will affect the entire system. Such an approach would provide a framework within which decisions concerning habitat protection, restoration, enhancement, or creation can be based on system-specific conditions and overall goals. Adequate methods are still lacking for comprehensive assessment of the functional level of each major habitat type. However, comparisons between sites could be based on an objective assessment of the suite of "functions" contributed by each habitat type to the overall ecosystem.

13. This approach would require several important components, including: (a) an information base adequate for development of a management plan, (b) a means to integrate collected information at the ecosystem level, (c) a mechanism to identify and select goals which best reflect ecosystem-specific characteristics, and (d) methods for measuring success or failure of individual activities (e.g., habitat restoration or creation).

Design and Applications

14. A successful evaluative technique needs to incorporate methods based on both direct and system-wide approaches. Separately, neither approach can address all of the issues involved in habitat restoration and creation. Methods based on the direct approach are needed to provide data on the performance of specific habitat sites while methods based on the system-wide approach are necessary to place this performance into an ecosystem perspective. The techniques we are devising should provide a mechanism for

determining what type of habitat is most appropriate for attaining a particular ecosystem management goal (system-wide approach) and a means for measuring the ecological success of individual projects (direct approach).

15. A successful evaluative technique should also be flexible enough to provide information on the ecological soundness of a diverse range of potential management goals. Identifying management goals for estuarine or coastal marine ecosystems is a major component of any coastal zone management program. These goals reflect basic philosophies concerning directions which would be followed in managing these ecosystems and are dependent upon the needs and conditions of individual systems. Some goals may be more appropriate during the early periods of a management scheme and may become less important as situations change. Other goals may simply not apply or may be applicable only on a limited basis because of the current or historical conditions of a given system. Where these goals are specified, decisions about what type of habitat to create or replace may be directed toward one or more ecologically based goals for the system as a whole. Examples of such ecologically based ecosystem management goals include: (a) maximization of habitat diversity, (b) attainment of historical habitat proportions, (c) protection and enhancement of spatially limited habitats, and (d) removal or reduction of man-made stresses.

16. The goal of maximization of habitat diversity is based on the assumption that the maximization of habitat diversity will have the potential to improve the system as a whole. It is also generally believed that organisms are adapted to the historical structure of the system and that when habitats are lost or reduced, their abundances and diversity may decline as well. It may not be necessary, however, to create or restore certain habitat types in order to reestablish functions attributable to that habitat type. For example, fringing intertidal marshes may be established primarily for shoreline stabilization or aesthetic reasons without the expectation that they will also contribute to fisheries production. Furthermore, it may not be practical to attain the same level of habitat types that may have existed historically.

17. This goal also includes the consideration of maximizing the diversity of sources (i.e., habitat-specific) of both primary and secondary production within the system as a whole. For example, major sources of primary production within most estuarine systems include large macrophytes (e.g., marsh grasses and seagrasses) and microscopic benthic and planktonic algae and

diatoms. These organisms are indicative of a variety of estuarine habitat types and may be proportionately important to a variety of other organisms. Increasing the sources of primary production has the potential to increase secondary production.

18. The restoration of habitat types and proportions toward historical physiographic, hydrographic, and hydrologic conditions might be another management goal. Restoration of the total acreage present historically, however, may not be practical. In the case of highly altered systems, attainment of historical proportions is simply not possible. Plans for attaining this goal should include consideration of restoring historical connections or corridors between coastal habitat types and adjacent upland habitats, since these connections may be important links between habitats. Such efforts should also be integrated with the goals and activities of any upland habitat management plans.

19. Particular habitat types may be critical to the survival of or presence of certain organisms and may be restricted to specific areas within the estuary (e.g., oyster reefs, herring spawning sites, eelgrass beds). If these habitat types have been lost from the system as a whole, their reestablishment may lead to the reestablishment or increase of associated organisms as well.

20. The reduction of man-made stresses, such as point sources of pollution, or runoff, may improve both public and ecosystem health. Improved habitat and water quality conditions can facilitate natural recruitment processes and enhance establishment of natural assemblages. This goal recognizes the fact that the presence of physical habitat alone, in the absence of other habitat quality conditions (e.g., water quality), may not provide a full suite of functions.

Conclusions and Future Work

21. Regardless of approach (direct or system-wide), the design of any new method for comparing habitat types and for making decisions concerning habitat creation or trade-offs would require the consideration of a broad range of functions for all habitats present. Such a method would also need to recognize regional differences in the relative contributions of each function. The diversity of functions to be considered can be depicted by creating a matrix of known functions for each habitat type.

22. A critical step in the process will be the development of a series of habitat profiles which describe the biological and physical attributes of selected habitats and their functional contributions. When appropriate, profiles should be prepared for environmental and geographic areas (e.g., New England, Mid-Atlantic, Gulf of Mexico). To a large extent, much of this information currently exists in the U.S. Fish and Wildlife Service's Community Profile series covering a variety of estuarine and marine habitats. Additional profiles or modified documents should be prepared as needed. An attribute/function matrix can then be prepared for each region of the country.

23. This matrix would be utilized in combination with the matrix of characteristics of individual habitat evaluation methods (Bowen and Small 1992) to choose appropriate measures for a direct method and to serve as a guide in identifying key structural and functional characteristics of habitats for the system-wide approach.

24. Testing both approaches will be necessary since neither one provides the full extent of information necessary in the evaluation of disparate habitats. The direct approach suffers from the difficulty in comparing qualitative as well as quantitative habitat attributes, while the system-wide approach does not provide site-specific information or a readily determined level of success. Methods using both approaches need to be developed since each is important at a different stage in the process of restoring or enhancing a coastal habitat. The system-wide approach is most appropriate in the planning stage of a project where the decision of what type of habitat to construct is of major importance. The direct approach is required for monitoring relative success of a completed project.

25. In addition to continued development of the strategies described above, the working group, in conjunction with the U.S. Army Engineer Waterways Experiment Station, will identify possible sites for testing and refining the resulting methods. Appropriate data will be compiled and applied on a hypothetical basis in order to evaluate the appropriateness of the overall approach.

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