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of Engineers**  
Waterways Experiment  
Station

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## **Coastal Wetland Restoration Bibliography**

by David J. Yozzo, John P. Titre

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by **David J. Yozzo, John P. Titre**

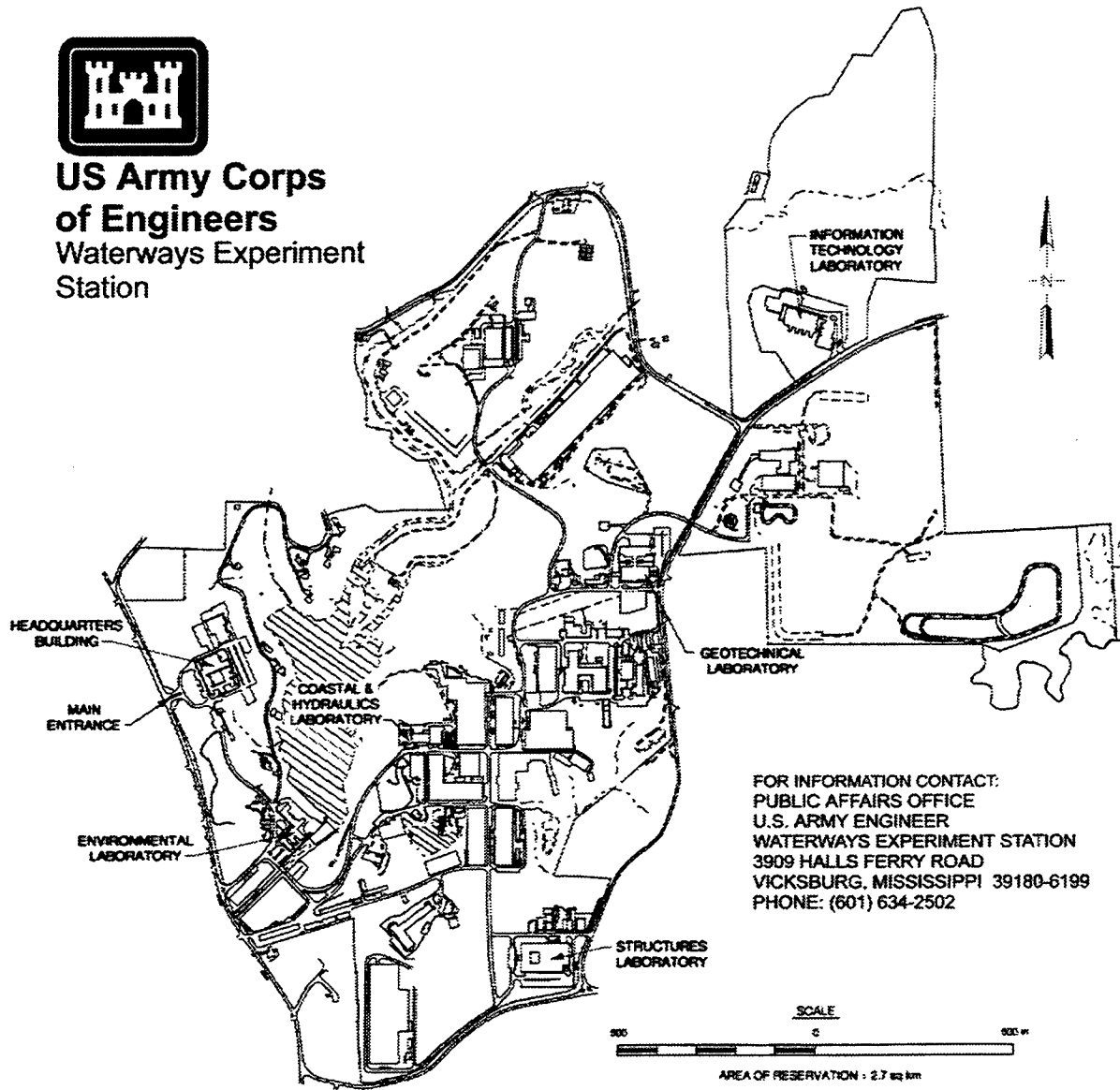
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# Wetland Restoration

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## *Coastal Wetland Restoration Bibliography (TR WRP-RE-20)*

### **ISSUE:**

The restoration of coastal wetlands is an area of increased emphasis within the civil works program of the U.S. Army Corps of Engineers. A comprehensive guide to the diverse literature on coastal wetland restoration is needed by District biologists, engineers, and planners.

### **OBJECTIVES:**

This bibliography was compiled to provide biologists, engineers, and planners at Corps Districts and other agencies/institutions with a guide to the diverse body of literature on coastal wetland restoration. The availability of this information should aid in the development of technically sound restoration plans and guide efforts to evaluate wetland restoration projects in the coastal zone using the best information available.

### **SUMMARY:**

This bibliography consists of 435 literature citations on coastal wetland restoration in the

United States. Sources include scientific journals, conference proceedings, and technical reports from various Federal and State agencies. The bibliography is organized by the following wetland habitat types: (a) tidal marshes, (b) mangroves, (c) seagrasses, and (d) miscellaneous. Selected key citations in each section are briefly annotated, and a subject index is provided.

### **AVAILABILITY OF REPORT:**

This report is available on Interlibrary Loan Service from the U.S. Army Engineer Waterways Experiment Station (WES) Library, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, telephone (601) 634-2355.

To purchase a copy, call the National Technical Information Service (NTIS) at (703) 487-4650. For help in identifying a title for sale, call (703) 487-4780. NTIS report numbers may also be requested from the WES librarians.

### **About the Authors:**

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# Preface

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The work reported herein was authorized by Headquarters, U.S. Army Corps of Engineers (HQUSACE), as part of the Wetland Restoration and Establishment Task Area of the Wetlands Research Program (WRP). Dr. Russell F. Theriot, U.S. Army Engineer Waterways Experiment Station (WES), was the Wetlands Research Program Manager. Dr. Mary C. Landin, WES, was the Task Area Manager. The work was performed under the Technical Standards and Guidance for Wetlands Restoration and Creation Work Unit of the WRP for which Dr. Landin was the Principal Investigator.

The bibliography was compiled by Dr. David J. Yozzo and Mr. John P. Titre, Environmental Laboratory (EL), WES. Dr. Yozzo was supported by a National Research Council-WES Research Associateship.

The authors wish to thank the staff of the WES Library for their assistance in locating and obtaining bibliographic materials. Mr. William Hansen, Institute for Water Resources, provided comments on an earlier draft. Technical reviews were provided by Dr. Landin and Dr. Gary L. Ray, WES.

The report was prepared under the general supervision of Mr. H. Roger Hamilton, Chief, Resource Analysis Branch; Dr. Douglas Clarke, Acting Chief, Coastal Ecology Branch; Dr. Morris Mauney, Chief, Wetlands Branch; Dr. Robert M. Engler, Chief, Natural Resources Division; Dr. Conrad J. Kirby, Chief, Ecological Research Division, and Dr. John Harrison, Director, EL.

At the time of publication of this report, Dr. Robert W. Whalin was Director of WES.

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# Introduction

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The restoration of coastal wetlands is an area of increased emphasis within the civil works program of the U.S. Army Corps of Engineers (USACE). Congressional authorities such as Section 404 of the Clean Water Act of 1972, Section 1135 of the Water Resources and Development Act of 1986, and Section 204 of the Water Resources and Development Act of 1992 are providing more opportunities to pursue restoration initiatives and to develop improved techniques for the evaluation of restoration projects and programs in coastal and inland waters. The Corps' Wetlands Research Program (WRP) was initiated in 1991 to address the needs expressed by the national Wetlands Policy Forum Report for protecting and managing wetlands. The purpose of the WRP is to provide environmentally sound, cost-effective techniques to examine and provide information on a variety of wetland research and development topics. This bibliography was compiled under the Technical Standards and Guidance for Wetlands Restoration and Creation Work unit of the WRP. The objective of this work unit was to provide improved technical guidance for new and ongoing wetland restoration and creation efforts, with an emphasis on coastal, herbaceous wetlands.

Coastal wetlands in the United States have historically experienced degradation and loss resulting from various activities, including draining and filling for conversion to uplands; industrial and agricultural pollution; navigation impacts, natural and man-induced erosion, and habitat modification. The recognition of the myriad of benefits of coastal wetlands, including erosion and flood control, maintenance of water quality, and provision of habitat for fish, shellfish, and wildlife prompted efforts to restore or create coastal wetlands. Some of the earliest attempts to create or restore coastal wetlands were initiated by the Corps in the early 1970s, as part of the Dredged Material Research Program. These efforts resulted in the development of new engineering technologies for sediment stabilization and vegetative plantings, and resulted in the identification of new areas for research, such as the comparison of functional equivalency between restored/created and natural wetlands. Additional USACE programs that have included opportunities for coastal wetland restoration include the Dredging Research Program, Dredging Operations and Technical Support Program, Dredging Operations and Environmental Research Program, Wetlands Research Assistance Program, and the Characterization and Restoration Wetlands Research Program. Other Federal and State agencies and institutions have developed restoration initiatives, and Federal legislation (The Coastal Wetlands Planning, Protection, and

Restoration Act of 1990) has been enacted in support of multiagency participation in restoration activities in the coastal zone.

A considerable amount of published material on restoration of coastal wetlands is available, in both the primary and gray literature. The majority of this literature is on the restoration of temperate coastal wetlands, primarily *Spartina alterniflora* marshes; previous investigators have summarized this literature and available resources on this subject (Matthews and Minello 1994a,b). Considerable literature documents the restoration of subtropical and temperate seagrasses. Subtidal seagrass beds are closely linked to emergent coastal wetland systems and are at least as vulnerable as tidal marshes to environmental impacts. Like tidal marshes, seagrass beds provide a high-quality "nursery habitat" in shallow coastal ecosystems and are critical to early life stages of many estuarine and coastal fishery species. Thus, seagrasses are often considered in the restoration and management of coastal wetlands (Fonseca 1990). Mangrove forests are also subject to habitat modification and degradation activities. Few publications document the restoration of mangroves relative to the aforementioned saltmarsh and seagrass ecosystems. Fewer publications document the restoration or creation of tidal freshwater marshes, despite the relative abundance and proximity of these unique and productive wetlands to population centers in the major tributaries along the Atlantic coast and elsewhere.

This bibliography consists of 435 literature citations on coastal wetland restoration in the United States. Sources include scientific journals, conference proceedings, and technical reports from various Federal and State agencies. The bibliography is organized by the following wetland habitat types: (a) tidal marshes, (b) mangroves, (c) seagrasses, and (d) miscellaneous. The last category includes citations that document restoration of multiple or adjacent habitats within a particular geographic region (i.e., restoration of seagrasses and mangroves in Tampa Bay, Florida) and compilations of conference/workshop proceedings on coastal habitat restoration. Selected key citations in each section are briefly annotated. The majority of the citations listed document specific restoration projects. Citations have also been included that describe restoration theory or resource management issues in coastal habitat restoration. Citations on habitat creation, including beneficial-use projects are included, although they may not necessarily document restoration of a particular site or habitat type to "predisturbance" or "historical" conditions. Also included are citations documenting ecosystem-level processes that relate specifically to restoration/creation efforts in coastal wetlands.

This bibliography is intended for a broad range of users. Resource managers, environmental planners, biologists, and engineers at Corps Districts and other Federal and State agencies/institutions who require a comprehensive guide to the complex and diverse body of literature on coastal wetland restoration should benefit from the resources compiled here. The anticipation is that the bibliography will aid in the development of technically sound restoration plans and guide efforts to evaluate wetland restoration projects in the coastal zone using the best information available.

# Tidal Marshes

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## Annotated Entries

Allen, E.A., Fell, P.E., Peck, M.A., Gieg, J.A., Guthke, C.R., and Newkirk, M.D. (1994). "Gut contents of common mummichogs, *Fundulus heteroclitus* L., in a restored impounded marsh and in natural reference marshes," *Estuaries* 17, 462-71.

Gut contents of mummichogs (*Fundulus heteroclitus*) leaving and entering tidal ditches were compared at a restored impounded valley marsh and two nearby reference marshes in Connecticut. Major food items were detritus, algae, amphipods, tanais, copepods and insects. Fish from the restored marsh consumed less food per unit body weight than fish from the reference marshes.

Boesch, D.F., Josselyn, M.N., Mehta, A.J., Morris, J.T., Nuttle, W.K., Simenstad, C.A., and Swift, D.J.P. (1994). "Scientific assessment of coastal wetland loss, restoration and management in Louisiana," *Journal of Coastal Research*, Special Issue No. 20.

This report summarizes the findings of an expert panel commissioned to examine the problem of wetland loss in coastal Louisiana and recommend research and management needs. The report focuses on processes of wetland loss in coastal Louisiana, including human contributions. Management options are discussed and a comprehensive management approach, including provision for wetland restoration under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), is outlined.

Broome, S.W., Seneca, E.D., and Woodhouse, W.W., Jr. (1988). "Tidal salt marsh restoration," *Aquatic Botany* 32, 1-22.

An overview of the ecological functions of coastal salt marshes and techniques for their restoration, particularly following human perturbation such as dredge and fill activities and discharge of toxic materials such as petroleum products. Factors which determine success of vegetation establishment are discussed, including tidal regime, slope, wave exposure, soil physico-chemistry, nutrient supply and salinity. Examples of marsh restorations are provided and illustrate restoration/enhancement of dredged material disposal sites, shoreline stabilization, and

revegetation of a marsh destroyed by an oil spill. Further research is needed to confirm the success of marsh restoration based on ecological functions, including the faunal component.

Fell, P.E., Murphy, K.A., Peck, M.A., and Recchia, M.L. (1991).

“Re-establishment of *Melampus bidentatus* (Say) and other macroinvertebrates on a restored impounded tidal marsh: Comparison of populations above and below the impoundment dike,” *Journal of Experimental Marine Biology and Ecology* 152, 33-48.

Macroinvertebrate communities were compared at an impounded marsh in Stonington, Connecticut, which had been restored from a *Typha*-dominated system to a typical salt marsh within 12 years after the introduction of tidal flooding. Comparison was made to marshes below the impoundment dike, which were dominated by *Spartina patens* and short *S. alterniflora*. *Melampus bidentatus* and other invertebrates have become reestablished on the impounded marsh. Mean density of *Melampus bidentatus* was greater on the marshes below the dike; however, mean snail biomass was greater on the restored impounded marsh.

Frenkel, R.E., and Morlan, J.C. (1991). “Can we restore our salt marshes? Lessons from the Salmon River, Oregon,” *The Northwest Environmental Journal* 7, 119-35.

The progress of salt marsh development was monitored for 10 years following the removal of a dike and restoration of tidal flow to pastures along the Salmon River Estuary, Oregon. Environmental parameters evaluated included elevation, tidal creek morphology, soil characteristics, plant community structure, and above-ground primary production. Guidelines on project construction and monitoring are presented to aid in future marsh restorations in the Pacific Northwest.

Gilmore, R.G., Cooke, D.W., and Donohoe, C.J. (1983). “A comparison of the fish populations and habitat in open and closed salt marsh impoundments in east-central Florida,” *Northeast Gulf Science* 5, 25-37.

Ichthyofauna of two marsh impoundments along the Indian River lagoon were compared: one closed to tidal influence and one opened to the tide via a single 80-cm diameter culvert. The closed impoundment contained a depauperate ichthyofauna consisting of 12 species and was characterized by stressed environmental conditions. The open impoundment contained 41 fish species and exhibited extensive regrowth of typical emergent marsh vegetation.

Josselyn, M., ed. (1982). “Wetland restoration and enhancement in California,” *Proceedings of a Conference, February 1982, California State University, Hayward*. California Sea Grant Report T-CSGCP-007, Tiburon Center for Environmental Studies, Tiburon, CA.

A compilation of papers from a workshop on marsh restoration held at California State University, Hayward, in February 1982. Topics include a summary of restoration projects in California; restoration goal development; legal and institution constraints on wetland restoration; wetland engineering; restoration project

monitoring; vegetation, benthic invertebrate and fish communities of restored wetlands.

Josselyn, M.N., and Buchholz, J. (1984). "Marsh restoration in San Francisco Bay: A guide to design and planning," Technical Report 3, Tiburon Center for Environmental Studies, Tiburon, CA.

This report details the restoration of tidal wetlands in the San Francisco Bay area and provides guidelines to successful habitat design for future restoration projects. The primary emphasis of the report is on biological components of restored habitat; however, considerable information is provided on sedimentation and hydrology, as well. Restoration project objectives and monitoring programs for marsh restorations are discussed. Case studies of previous and ongoing restoration projects in Marin County are provided.

Landin, M.C., Webb, J.W., and Knutson, P.L. (1989). "Long-term monitoring of eleven Corps of Engineers habitat development field sites built of dredged material, 1974-1987," Technical Report D-89-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

This report documents the long-term study of 11 habitat development sites built on dredged materials by the U.S. Army Corps of Engineers Dredged Materials Research Program (DMRP). Summary chapters provide construction details and monitoring results for each site, with comparison to natural reference conditions. Objectives of the monitoring study were to (a) document long-term stability of dredged material disposal sites, (b) determine successional changes, (c) relate site functions and values to natural reference sites, and (d) demonstrate the feasibility of using dredged materials for habitat development projects. Recommendations concerning soils, plant propagation and planting methods, engineering design and construction, and estimating costs are provided for future habitat development and restoration using dredged materials in inland and coastal waters.

Peck, M.A., Fell, P.E., Allen, E.A., Gieg, J.A., Guthke, C.R., and Newkirk, M.D. (1994). "Evaluation of tidal marsh restoration: Comparison of selected macroinvertebrate populations on a restored impounded valley marsh and an unimpounded valley marsh within the same salt marsh system in Connecticut, USA," *Environmental Management* 18, 283-93.

Macroinvertebrate communities on a restored impounded valley marsh were compared with that of a nearby unimpounded valley marsh in Stonington, CT. The snail, *Melampus bidentatus*, and the ribbed mussel, *Guekensia demissa*, were sampled along transects from the marsh edge to the upland and along creek banks and mosquito ditches. Density of *Melampus* was highest on the unimpounded marsh; however, mean snail biomass was greater on the restored impounded marsh. *Guekensia* densities were comparable at creek-bank sites in both marshes; however, total biomass of *Guekensia* was significantly greater on the unimpounded marsh.

Rey, J.R., Shaffer, J., Tremain, D., Crossman, R.A., and Kain, T. (1990). "Effects of re-establishing tidal connections in two impounded subtropical marshes on fishes and physical conditions," *Wetlands* 10, 27-45.

An impounded subtropical salt marsh was reconnected to the Indian River Lagoon in east-central Florida via installation of culverts. Abundance of marsh resident fish species decreased significantly following installation of culverts; however, abundance of transient species increased by nearly two orders of magnitude. Alteration of marsh hydroperiod is the dominant factor influencing patterns of fish utilization, abundance, and species composition.

Roman, C.T., Garvine, R.W., and Portnoy, J.W. (1995). "Hydrologic modeling as a predictive basis for ecological restoration of salt marshes," *Environmental Management* 19, 559-66.

A numerical model was developed to predict tide height levels resulting from various alternatives for a proposed marsh restoration project on the Herring River, Massachusetts. Using the model output and elevation data for flood-prone adjacent areas, ecologically sound and responsible management plans can be formulated. The model was successfully applied to a marsh restoration project in Provincetown, MA, and enables scientists and managers to assign a degree of predictability in marsh restoration planning.

Roman, C.T., Niering, W.A., and Warren, R.S. (1984). "Salt marsh vegetation change in response to tidal restriction," *Environmental Management* 8, 141-50.

Changes in vegetation communities at six Connecticut salt marshes are documented in response to restriction of tidal exchange. Tide gates, causeways, and dikes have historically been employed in this region for purposes of flood control, mosquito management, and salt hay farming. Tidal restriction resulted in a substantial decrease in soil water salinity, lowering of the water table, and a drop in relative marsh surface elevation at each of the six study sites. These factors favor the establishment and spread of invasive species such as common reed (*Phragmites australis*), along with a loss of *Spartina* marsh. Restoration of *Phragmites*-dominated areas is possible following reestablishment of the normal tidal prism. Large-scale regional restoration efforts are recommended.

Shreffler, D.K., Simenstad, C.A., and Thom, R.M. (1990). "Temporary residence by juvenile salmon in a restored estuarine wetland," *Canadian Journal of Fisheries and Aquatic Science* 47, 2079-84.

Movements and marsh residence times were determined for juvenile Pacific salmon utilizing the Lincoln Avenue wetland system in the Puyallup River estuary, Tacoma, WA. Residence times for various species ranged from 1 to 43 days; however, evaluation of the benefit of marsh residency is constrained by lack of data from suitable reference wetlands.

Shreffler, D.K., Simenstad, C.A., and Thom, R.M. (1992). "Foraging by juvenile salmon in a restored estuarine wetland," *Estuaries* 15, 204-13.

Foraging by juvenile chum salmon (*Oncorhynchus keta*) and fall chinook salmon (*O. tshawytscha*) was studied in a restored estuarine wetland in the Puyallup River, Washington. Juvenile salmon fed primarily on chironomid insects (midge, larvae, pupae, and adult life stages). Although the restored wetland provided abundant forage for juvenile salmonids during estuarine residency, the functional equivalency of restored estuarine habitats relative to natural habitats remains untested.

Simenstad, C.A., and Thom, R.M. (1996). "Functional equivalency trajectories of the restored Gog-Le-Hi-Te estuarine wetland," *Ecological Applications* 6, 38-56.

Analysis of 16 functional attributes of the restored Gog-Le-Hi-Ti (Lincoln Avenue) wetland in the Puyallup River estuary, Tacoma, WA, was conducted in order to test the ability to predict long-term trends and patterns in the development of a wetland restoration. Only a few of the attributes demonstrated functional trajectories towards equivalency in comparison with natural reference wetlands. Natural variability among reference sites hampered the interpretation of expected patterns of development. The lack of long-term data sets for restoration projects combined with the natural variability inherent to reference wetlands is a significant constraint to the ability of wetland managers to assess the benefits of compensatory mitigation measures. Alternative approaches to functional assessment of wetlands, such as controlled manipulative experiments, may be necessary in order to assess the performance of wetland restorations.

Sinicrope, T.L., Hine, P.G., Warren, R.S., and Neiring, W.A. (1990). "Restoration of an impounded salt marsh in New England," *Estuaries* 13, 25-30.

Vegetation communities were studied at a restored impounded marsh in Stonington, CT. Prior to reintroduction of tidal flooding, freshwater conditions prevailed and the marsh was dominated by *Typha angustifolia*. Ten years after reintroduction of tidal flooding, coverage of *Typha* and other brackish species had decreased from 74% to 16%. The salt marsh species *Spartina alterniflora* increased in coverage from <1% to 45%. Additional salt marsh species covered an additional 20% of the marsh. *Phragmites australis* was not affected by reintroduction of salt water, and coverage of this brackish species has increased.

Zedler, J. (1984). "Salt marsh restoration: A guidebook for southern California," California Sea Grant Report T-CSGCP-009.

A detailed "how-to" manual for the restoration and enhancement of salt marshes in southern California based on 6 years of intensive study in the Tijuana Estuary, Los Peñasquitos Lagoon, and the San Diego River. Definition of project goals and objectives are covered, as well as construction techniques, selection/planting of salt marsh vegetation, monitoring, and storage/dissemination of project data. Additional sections provide information on regional coastal management policies, invasive exotics, and endangered species.

Zedler, J. B. (1996a). "Coastal mitigation in southern California: The need for a regional restoration strategy," *Ecological Applications* 6, 84-93.

The historic functioning of southern California coastal wetland systems is summarized, and four recent wetland mitigation case studies are used to document specific concerns and potential pitfalls. A regional strategy for restoration of coastal wetlands in southern California is proposed, along with recommendations for landscape-scale planning and implementation.

Zedler, J.B., Principal Author. (1996b). "Tidal wetland restoration: A scientific perspective and southern California focus," Report T-038, California Sea Grant System, University of California, La Jolla, CA.

This book represents an overview and synthesis of tidal wetland restoration in southern California. Examples of restoration projects, an overview of problems in wetland restoration, and recommendations for improved project planning and implementation (including discussion of the role of adaptive management) are presented. Considerable attention has been given to providing specific recommendations for data acquisition and monitoring of restored tidal wetlands.

## Additional Entries

Abbe, T., Andrews, B., and Faber, P. (1991). "The physical evolution of a wetland restoration." *Coastal Zone '91, Proceedings of the Seventh Symposium on Coastal and Ocean Management, July 8-12, 1991, Long Beach, California*. O.T. Magoon, H. Converse, V. Tipple, L.T. Tobin, and D. Clark, eds., American Society of Civil Engineers, New York, 1732-46.

Abbe, T., Williams, P., and Faber, P. (1991). "Monitoring the physical evolution of tidal wetland restoration projects." *Coastal Zone '91, Proceedings of the Seventh Symposium on Coastal and Ocean Management, July 8-12, 1991, Long Beach, California*. O.T. Magoon, H. Converse, V. Tipple, L.T. Tobin, and D. Clark, eds., American Society of Civil Engineers, New York, 3618-26.

Adams, D.D., Darby, D.A., and Young, R.J. (1978a). "Habitat development field investigations, Windmill Point marsh development site, James River, Virginia. Appendix F: Environmental impacts of marsh development with dredged material: sediment and water quality. Vol. I: Characteristics of channel sediment before dredging and effluent quality during and shortly after marsh habitat development," Technical Report D-77-23, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Adams, D.D., Darby, D.A., and Young, R.J. (1978b). "Habitat development field investigations, Windmill Point marsh development site, James River, Virginia. Appendix F: Environmental impacts of marsh development with dredged material: sediment and water quality. Vol. II: Substrate and chemical flux characteristics of a dredged material marsh," Technical Report D-77-23, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

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# Mangroves

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## Annotated Entries

Teas, H.J. (1977). "Ecology and restoration of mangrove shorelines in Florida," *Environmental Conservation* 4, 51-58.

The life-history and ecological role of mangroves in south Florida is summarized. Significant acreage of mangroves has been lost in south Florida, primarily due to dredge and fill activities, and restoration of impacted areas is necessary to reestablish lost functions. Several efforts to transplant mangroves are described. Important factors in the successful reestablishment of planted mangroves include plant size and source, salinity regime, shoreline energy, water depth, root-parasite prevalence, and vandalism. Cost estimates for planting various mangrove species are provided.

Vose, F.E., and Bell, S.S. (1994). "Resident fishes and macrobenthos in mangrove-rimmed habitats: Evaluation of habitat restoration by hydrologic modification," *Estuaries* 17, 585-96.

Fish and macrobenthic communities were studied at a mangrove-dominated impoundment (Cabbagehead Bayou, Tampa Bay, Florida) and at a nearby reference site (Double Branch Bay). Faunal samples were collected 13 months prior and 22 months after removal of a berm. Fish abundance, biomass, and species richness decreased in Cabbagehead Bayou as a result of berm removal. Macrofaunal response was variable among taxa, but amphipod and polychaete abundances increased following berm removal. Community similarity of fish and polychaete and amphipod assemblages between the two sites increased during the second year of postrestoration monitoring, but generally remained low. Although a distinct faunal response to alteration of tidal regime may be detectable within 2 years, the authors recommend that future studies which attempt to document faunal recovery of restored wetlands may benefit from extended duration of monitoring.

## Additional Entries

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# Seagrasses

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## Annotated Entries

Fonseca, M.S., and Fisher, J.S. (1986). "A comparison of canopy friction and sediment movement between four species of seagrass with reference to their ecology and restoration," *Marine Ecology Progress Series* 29, 15-22.

The ability of seagrasses to modify the hydrodynamic environment is well-documented and may affect the observed distribution of fauna associated with existing or newly developing seagrass meadows. Comparisons of canopy friction and sediment dispersal were made for four species of seagrasses (*Thalassia testudinum*, *Halodule wrightii*, *Zostera marina*, and *Syringodium filiforme*) under 27 combinations of velocity, water depth, and plant density in an experimental flume. All species except *S. filiforme* lost friction (through canopy compression) with increasing current velocity. Canopy fraction was positively correlated with the percent of the water column occupied by seagrasses. *Thalassia testudinum* provide the greatest protection of the sediment surface from erosion; *H. wrightii* and *Z. marina* provided intermediate levels of protection; and *S. filiforme* provided the least protection. Nursery and refuge characteristics of the four species are likely to vary directly with their influence on canopy friction and sediment movement. Future studies of seagrass fauna should consider hydrodynamic factors.

Fonseca, M.S., Kenworthy, W.J., and Courtney, F.X. (1996). "Development of planted seagrass beds in Tampa Bay, Florida, USA. I. Plant components," *Marine Ecology Progress Series* 132, 127-39.

This paper documents the study of floral attributes of planted seagrass beds (*Halodule wrightii* and *Syringodium filiforme*) in Tampa Bay, Florida. Planting Unit (PU) survival, change in areal shoot density, plant morphometrics and associated macroalgae were monitored for 3 years (1987-90), with comparison to nearby, natural reference beds. An average loss of 47 percent PU was documented, although subsequent survival and persistence indicate that many areas of Tampa Bay are now suitable for restoration. Many plantings exhibited little growth during year one, and then expanded rapidly in year two of the study. Conservation of remaining seagrass beds provides a more certain basis for maintaining the resource than mitigation through planting.

Fonseca, M.S., Kenworthy, W.J., Colby, D.R., Rittmaster, K.A., and Thayer, G.W. (1990). "Comparisons of fauna among natural and transplanted eelgrass *Zostera marina* meadows: Criteria for mitigation," *Marine Ecology Progress Series* 65, 251-64.

In this paper, abundance, composition, and size distributions of fish and shrimp were compared among unvegetated, transplanted, recently seed-colonized, and mature, natural eelgrass (*Zostera marina*) habitats in order to determine the functional equivalence of transplanted beds to natural counterparts. Fish and shrimp were most abundant in natural eelgrass beds, and least abundant in unvegetated habitats. Epibenthic faunal development was closely coupled with eelgrass bed development. Areas characterized by poor transplant success exhibited reduced abundance and different taxonomic composition relative to natural beds. Animal abundance in a successful 1.9-year-old transplanted bed and a 6-month-old seed-developed bed was indistinguishable from that of mature, natural beds. Areal shoot density may serve as a convenient diagnostic parameter to determine functional equivalency in transplanted eelgrass beds. Restoration of eelgrass habitats may contribute substantially to fish and shrimp production, provided the habitats persist.

Fonseca, M.S., Meyer, D.L., and Hall, M.O. (1996). "Development of planted seagrass beds in Tampa Bay, Florida, USA. II. Faunal components," *Marine Ecology Progress Series* 132, 141-56.

This paper documented changes in shrimp, fish, and crab abundance and composition and size distribution in planted *Halodule wrightii* and *Syringodium filiforme* beds in Tampa Bay, Florida. Faunal samples were collected using 1-m<sup>2</sup> dropnets over a 3-year period (1987-90) with comparison to unvegetated habitats and nearby natural reference beds. Planted *H. wrightii* beds exhibited animal densities and species composition comparable with that of natural beds 1.8 years after planting. Comparison of *S. filiforme* and *S. filiforme/H. wrightii* mixed beds were unavailable due to failure of several planting areas. Macroepifauna in planted *H. wrightii* beds exhibited an asymptotic relationship with areal shoot density, with animal densities equaling natural beds at shoot densities of one-third that of natural beds. This pattern corroborates the existence of a threshold for habitat structure influencing numerical abundance of associated animal communities in seagrass beds.

McLaughlin, P.A., Treat, S.F., Thorhaug, A., and Lemaitre, R. (1983). "A restored seagrass (*Thalassia*) bed and its animal community," *Environmental Conservation* 10, 247-54.

The animal community of a restored *Thalassia* bed in south Biscayne Bay, Florida, was sampled quarterly to determine whether recolonization would be similar to a natural *Thalassia* bed, unaffected by thermal effluent or other pollutants. Significant differences in abundance and species composition were found in comparison of the restored *Thalassia* bed to a nearby, unvegetated area. No statistically significant differences were observed in comparison to the unimpacted control site. Certain animal groups (*Penaeus duorarum*, caridean shrimps,

juvenile fishes) were more abundant in the restored bed relative to the unimpacted control site.

Orth, R.J., Luckenbach, M., and Moore, K.A. (1994). "Seed dispersal in a marine macrophyte: Implications for colonization and restoration," *Ecology* 75, 1927-39.

Field and laboratory experiments on seed dispersal in eelgrass (*Zostera marina* L.) were conducted in the York River, Virginia. Results showed that seeds settle rapidly, with dispersal distances of only a few meters from broadcast sites, and are rapidly incorporated into the substrate. Small-scale topographic features (burrows, mounds, etc.) may shield seeds from the effects of bottom currents. The limited dispersal capabilities of seeds and landscape-scale implications for eelgrass patch dynamics and establishment/recolonization should be considered in the formulation of eelgrass restoration goals.

Thom, R.M. (1990). "A review of eelgrass (*Zostera marina* L.) transplanting projects in the Pacific Northwest," *The Northwest Environmental Journal* 6, 121-37.

This paper reviews 17 eelgrass transplanting projects conducted on the U.S. west coast from northern California to British Columbia. Key factors influencing the success of eelgrass transplanting projects are discussed, and specific recommendations to increase planting success are summarized. Research is needed on the functional performance of transplanted eelgrass beds in the Pacific northwest. Development of a comprehensive regional database on eelgrass transplanting projects is recommended.

Thorhaug, A. (1986). "Review of seagrass restoration efforts," *Ambio* 15, 110-17.

This review paper documents human and natural perturbations affecting seagrass habitats, discusses the primary ecological functions of seagrasses, and outlines the various methods that have been used to restore seagrass habitat. Over 165 restoration attempts worldwide were considered in this review; of these, 75 were considered to be successful. Factors in the recovery process are discussed, and cost estimates for various restoration methods are given. Management implications and policy recommendations for seagrass habitat restoration, including the protection of existing resources, are suggested.

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Addy, C.E. (1947a). "Germination of eelgrass seed," *Journal of Wildlife Management* 11, 279.

Addy, C.E. (1947b). "Eelgrass planting guide," *Maryland Conservationist* 24, 16-17.

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# Miscellaneous

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## Annotated Entries

NRC. (1994). *Restoring and protecting marine habitat: The role of engineering and technology*. National Academy Press, Washington, DC.

This report addresses the role of technology in protecting and restoring marine habitat, with emphasis on coastal wetlands. Scientific and engineering perspectives on habitat protection and restoration are presented, along with an analysis of the state of the art in coastal engineering technology. Impediments to implementation of engineering technology are discussed, along with a summary of institutional constraints, research needs, and methods for the evaluation of project success. Several case studies illustrate the application of engineering technology to habitat protection and enhancement in the coastal zone.

Thayer, G.W. (1992). *Restoring the Nation's marine environment*. Maryland Sea Grant, College Park, MD.

This book is a compilation of selected papers from a NOAA-sponsored symposium on habitat restoration, held in Washington, DC, on September 25-26, 1990. Salt marshes in California and North Carolina, urban estuaries, seagrass meadows, coral reefs, kelp beds, and mangroves are among the many habitats covered. Transcripts of panel discussions on current U.S. efforts to restore habitat and future directions and research needs in habitat restoration are included.

## Additional Entries

Ashe, D.M. (1982). "Fish and wildlife mitigation: Description and analysis of estuarine applications," *Coastal Zone Management Journal* 10, 1-52.

Banner, A. (1977a). "Revegetation and maturation of restored shoreline in the Indian River, Florida." *Proceedings of the 4th Annual Conference on Restoration of Coastal Vegetation in Florida, May 14, 1977, Hillsborough Community College, Tampa, Florida*. R.R. Lewis III and D.P. Cole, eds., 13-43.

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 Lunz 1978  
 Silberhorn and Barnard 1977  
 Virginia Institute of Marine  
 Science 1978  
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 Ternyik 1980
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 Maguire and Heuterman 1978  
 Ternyik 1980
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 Lefor et al. 1987  
 Shisler 1990  
 Woodhouse 1979  
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 Sinicrope et al. 1990
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 Beeman 1992  
 Chabreck 1990  
 Dial et al. 1985  
 Garbisch et al. 1975  
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 Roberts 1989, 1991  
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 Moy and Levin 1991
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 Science 1978  
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 Chabreck 1990  
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 Hawes 1984, 1990  
 Landin 1984  
 Snyder 1982  
 Eleuterius 1975  
 Gunn 1987  
 Kruczynski 1982  
 LaSalle 1996
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 Gunn 1987  
 Landin 1984  
 Hawes 1984, 1990
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 Landin 1984, 1986  
 Stout and Heck 1989  
 Landin and Webb 1986  
 Webb et al. 1984, 1988
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 Abbe et al. 1991  
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 Lewis 1990

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 Zedler 1988
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 Beeman 1992
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 Stephen 1983
- neuston  
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 Shisler 1990
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 Matsil and Bergen 1995  
 Shisler 1990  
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 Moy and Levin 1991
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 Matsil and Bergen 1995  
 Shisler 1990
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 1986a  
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 Wilsey et al. 1992

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 Dias et al. 1978
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 Matsil and Bergen 1995  
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 Hartman et al. 1994  
 Maiero et al. 1978  
 Touchette et al. 1992
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 Diaz and Boesch 1978
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 Blomberg 1987  
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 Cutshall and Johnson 1977  
 Frenkel and Morlan 1991  
 Heilman et al. 1978  
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 Landin and Webb 1986  
 LaRoe 1979  
 McConnell et al. 1978  
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 Smith 1978, 1980  
 Thom 1990  
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 Crawford and Edwards 1978  
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 Good 1987  
 Kentula 1986  
 Landin 1986, 1993  
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 McVay et al. 1980  
 Simenstad and Thom 1992  
 Ternyik 1978, 1980  
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 Garbisch et al. 1975

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 Clark 1992  
 Knutson and Woodhouse 1983
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 Garbisch and Coleman 1978  
 Lunz et al. 1978  
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 Shisler 1990
- phosphorus  
 Broome et al 1975a,b  
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 Kraus and Kraus 1986  
 Kruczynski 1982  
 Roman et al. 1984  
 Shisler 1990  
 Steinke 1988  
 Woodhouse and Knutson 1982  
 Eleuterius and McClellan 1976  
 Knutson and Woodhouse 1983  
 Kraus and Smith 1986  
 LaPerriere and Farmer 1988  
 Rozsa 1988  
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 Woodhouse 1979
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 Allen et al. 1978  
 Barko and Smart 1976  
 Boone and Hoepfel 1976  
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 Cintron-Molero 1992  
 Clark 1989  
 Crawford and Edwards 1978  
 Crewz and Lewis 1991  
 Derrenbacker and Lewis 1982  
 Durako and Moffler 1981, 1984  
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 Banner 1977  
 Barko et al. 1977  
 Broome 1990  
 Broome et al. 1986, 1988  
 Churchill et al. 1978  
 Clairain et al. 1978  
 Cole 1978  
 Crewz and Moffler 1984  
 Darovec et al. 1975  
 Dunstan et al. 1975  
 Eleuterius 1975  
 Environmental Laboratory 1978
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 Heilman et al. 1978  
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 Krebs and Tanner 1981a,b  
 Lewis 1982a,b; 1987; 1990a,b  
 Maguire and Heuterman 1978

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1986; 1990
- van Breedveld 1975
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- Webb et al. 1988
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- Zimmerman et al. 1981
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1980a,b,c; 1982
- Phillips et al. 1978
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- Ristich et al. 1976
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- Seneca et al. 1976
- Stout and Heck 1989
- Teas 1977, 1981
- Thayer et al. 1985a
- Thorhaug and Austin 1976
- Webb 1982
- Webb et al. 1984
- Woodhouse 1979
- Woodhouse et al. 1972a,b; 1974
- Zedler 1984
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Garbisch and Coleman 1978
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Craft et al. 1991
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Batiuk et al. 1992  
Smith 1978, 1980
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Kollar 1985
- Puerto Rico  
Lewis 1990a
- Puget Sound  
Clark and Francisco 1995  
Phillips 1974; 1980a,b  
Shreffler and Thom 1993  
Simenstad et al. 1991
- Puyallup River  
Shreffler et al. 1990, 1992  
Thom et al. 1987
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Miner 1994
- Reithrodontomys raviventris*  
Miner 1994
- Reimold et al. 1978
- Palermo and Ziegler 1976, 1977
- Landin 1993  
Phillips and Lewis 1983  
Simenstad and Thom 1992
- Simenstad and Thom 1992, 1996
- Zedler 1996a

*Rhizophora mangle*

Banner 1977  
Carlton and Moffler 1978  
Crewz and Moffler 1984  
Dial et al. 1985  
Knutson and Woodhouse 1983  
Lewis and Dunstan 1975  
Lewis et al. 1979  
Pulver 1976  
Stephen 1983  
Thorhaug 1990  
Vose and Bell 1994

Birkitt 1983  
Crewz and Lewis 1991  
Darovec et al. 1975  
Hoffman et al. 1985  
Lewis 1979, 1981, 1982c, 1990b  
Lewis and Haines 1981  
Markley et al. 1992  
Shirley 1992  
Teas 1977, 1980, 1981  
Touchette et al. 1992  
Woodhouse 1979

Rhode Island

Shisler 1990

Rookery Bay

Shirley 1992

*Ruppia maritima*

Clark 1989  
Fonseca 1994  
Phillips 1980a,b,c  
Thorhaug 1986

Darovec et al. 1975  
Lewis et al. 1982  
Thayer et al. 1985a,b

*Sagittaria* spp.

Maguire and Heuterman 1978  
Shisler 1990

*Salicornia* spp.

Abbe et al. 1991  
Birkitt 1983  
Faber et al. 1988  
Knutson 1976  
Landin et al. 1991  
Maguire and Heuterman 1978  
Sinicrope et al. 1990  
Zedler 1996a

Abbe et al. 1991  
Cuneo 1987  
Frenkel and Morlan 1991  
Knutson and Woodhouse 1982  
LaPerriere and Farmer 1988  
Shisler 1990  
Woodhouse 1979

Salmon River

Frenkel and Morlan 1991  
Simenstad and Thom 1992

Kentula 1986

salt ponds

Cogswell 1981  
Landin 1986  
Morris et al. 1978  
Niesen and Lyke 1981  
Woods 1981

Josselyn and Perez 1981  
Landin et al. 1991  
Niesen and Josselyn 1981  
Smith 1978

San Diego Bay

Boone and Hoeppel 1976  
Josselyn and Bucholz 1982  
Zedler 1988; 1992; 1996a,b  
Zentner 1988

Gibson et al. 1994  
Langis et al. 1991  
Zedler and Langis 1991

San Francisco Bay

Abbe et al. 1991  
Barker et al. 1993  
Coats and Williams 1980  
Cuneo 1987  
Faber et al. 1988  
Gale and Williams 1988  
Haltiner and Williams 1987  
Josselyn and Perez 1981  
Josselyn et al. 1987  
Landin 1984, 1986, 1993  
Marcus 1993  
Miner 1994  
Morrison and Williams 1988  
Niesen and Lyke 1981  
Siegel 1989  
Sorensen et al. 1979  
Wittenberg 1990  
Zentner 1988

Abbe et al. 1991  
Boyd 1982  
Cogswell 1981  
Environmental Laboratory 1978  
Faber 1991  
Goodwin and Williams 1992  
Harvey and Josselyn 1986  
Josselyn and Bucholz 1982,1984  
Knutson 1976  
Landin et al. 1991  
Mason 1980  
Morris et al. 1978  
Niesen and Josselyn 1981  
Race 1985, 1986  
Smith 1978, 1980  
Wakeman 1982  
Woods 1981

Santa Ana River

Newling 1982

Sarasota Bay

Edwards 1994

Sauers 1981

*Scirpus* spp.

Abbe et al. 1991  
Barko and Smart 1976  
Garbisch et al. 1975  
Maguire and Heuterman 1978  
Ternyik 1980

Abbe et al. 1991  
Barko et al. 1977  
Lunz et al. 1978  
Shisler 1990  
Woodhouse 1979

sedimentation

Barker et al. 1993  
Faber 1991  
Krone 1982  
Williams and Harvey 1983

Boumans et al. 1993  
Josselyn and Bucholz 1984  
Ray and Woodroof 1986

seed dispersal

Orth et al. 1994

*Sesuvium portulacastrum*

Beeman 1992

shoreline/substrate stabilization

Broome 1990  
Cammen 1975  
Eleuterius 1975  
Ensminger and Binet 1993  
Fonseca et al. 1985  
Garbisch 1977  
Josselyn 1986  
Knutson and Innskeep 1982  
Knutson et al. 1981  
Phillips et al. 1978  
Seneca et al. 1976  
Tanner and Dodd 1985  
Webb et al. 1984  
Woodhouse and Knutson 1982

Broome et al. 1983, 1986  
Chabreck 1990  
Eleuterius and McClellan 1976  
Fonseca et al. 1982, 1987  
Garbisch et al. 1975  
Josselyn and Bucholz 1984  
Knutson 1977  
Knutson and Woodhouse 1983  
Lewis 1990b  
Seneca 1974, 1980  
Seneca et al. 1985a  
Webb 1982  
Woodhouse 1979  
Woodhouse et al. 1972b, 1974

Snohomish River

Simenstad and Thom 1992

soils

Adams et al. 1978a,b  
Barko and Smart 1976  
Broome 1990  
Broome et al. 1988  
Chabreck 1990  
Craft et al. 1991  
Garbisch 1977  
Heilman et al. 1978  
Langis et al. 1991  
Lindau and Hossner 1982  
Lunz et al. 1978  
Moy and Levin 1991  
Shisler 1990  
Virginia Institute of Marine  
Science 1978  
Wetzel and Powers 1978

Allen et al. 1978  
Barko et al. 1977  
Broome et al. 1975a  
Cammen 1975  
Clairain et al. 1978  
Currin et al. 1996  
Gibson et al. 1994  
Krone 1982  
Lewis 1990  
Lunz 1978  
Lunz et al. 1978  
Reimold et al. 1978  
Shisler and Charette 1984a  
  
Webb et al. 1978

*Solidago sempervirens*

Bongiorno et al. 1984  
Frankowski et al. 1977

South Carolina

LaSalle et al. 1991

*Spartina alterniflora*

Allen et al. 1994  
Barko and Smart 1976  
Beeman 1992  
Boumans et al. 1993  
Broome et al. 1973, 1974, 1975a,b

Banner 1977  
Barko et al. 1977  
Bongiorno et al. 1984  
Broome 1990  
Broome et al. 1983, 1986

Broome et al. 1988  
 Cammen 1976a,b  
 Chabreck 1990  
 Craft et al. 1988, 1991  
 Currin et al. 1996  
 Delaune et al. 1984  
 Dunstan et al. 1975  
 Earhart and Garbisch 1983  
 Fell et al. 1991  
 Garbisch et al. 1975  
 Havens et al. 1995  
 Hoffman et al. 1985  
 Knutson and Woodhouse 1983  
 Kraus and Kraus 1986  
 Kruczynski 1982  
 Larimer 1968  
 LaSalle et al. 1991  
 Lewis and Lewis 1977  
 Lewis 1982b, 1990b  
 Lunz et al. 1978  
 Markley et al. 1992  
 Matthews and Minello 1994a,b  
 Minello and Webb 1993  
 Minello et al. 1987  
 Moy and Levin 1991  
 Peck et al. 1994  
 Rennie 1990  
 Roman et al. 1984  
 Seidensticker 1994  
 Seneca and Broome 1992  
 Seneca et al. 1976  
 Shisler 1990  
  
 Sinicrope et al. 1990  
 Steinke 1988  
 Terry et al. 1974  
 Touchette et al. 1992  
 Webb and Newling 1985  
 Webb et al. 1984  
 Webb et al. 1988  
 Woodhouse 1979  
 Woodhouse et al. 1972a,b; 1974

*Spartina cynosuroides*

Broome 1990  
 Garbisch et al. 1975  
 Kruczynski 1982  
 Maguire and Heuterman 1978

Cammen 1975  
 Cammen et al. 1976  
 Clark 1992  
 Crewz and Lewis 1991  
 Darovec et al. 1975  
 Dial et al. 1985  
 Earhart 1988  
 Eleuterius and McClellan 1976  
 Ferrigno et al. 1987  
 Hartman et al. 1994  
 Hoffman and Rodgers 1981  
 Knutson and Innskeep 1982  
 Kraus and Smith 1986  
 Krebs and Tanner 1981a,b  
 LaPerriere and Farmer 1988  
 LaSalle 1996  
 Lefor et al. 1987  
 Lewis et al. 1979  
 Linthurst and Seneca 1980  
 Maguire and Heuterman 1978  
 Matsil and Bergen 1995  
 Meyer et al. 1993  
 Minello and Zimmerman 1992  
 Minello et al. 1994  
 Patrick et al. 1984  
 Reimold et al. 1978  
 Roberts 1989, 1991  
 Rozsa 1988  
 Seneca 1974, 1980  
 Seneca et al. 1975  
 Seneca et al. 1985a,b  
 Shisler and Charette 1984a,  
 1986a  
 Sipocz 1994  
 Tanner and Dodd 1985  
 Thayer et al. 1989  
 Webb 1982  
 Webb et al. 1978  
 Webb et al. 1984  
 Wilsey et al. 1992  
 Woodhouse and Knutson 1982

Eleuterius and McClellan 1976  
 Knutson and Woodhouse 1983  
 Lunz et al. 1978  
 Reimold et al. 1978

Shisler 1990  
Woodhouse and Knutson 1982

Woodhouse 1979

*Spartina foliosa*

Abbe et al. 1991  
Barko and Smart 1976  
Faber et al. 1988  
Gibson et al. 1994  
Josselyn and Bucholz 1982, 1984  
Knutson 1976  
Knutson and Woodhouse 1982, 1983  
Langis et al. 1991  
Woodhouse 1979

Abbe et al. 1991  
Barko et al. 1977  
Faber 1991  
Josselyn 1986  
Josselyn and Perez 1981  
Knutson and Innskeep 1982  
Landin et al. 1991  
Maguire and Heuterman 1978  
Zedler 1983, 1992, 1996a

*Spartina patens*

Allen et al. 1994  
Barko et al. 1977  
Bongiorno et al. 1984  
Chabreck 1990  
Earhart 1988  
Eleuterius and McClellan 1976  
Ferrigno et al. 1987  
Garbisch et al. 1975  
Hoffman et al. 1985  
Kruczynski 1982  
Larimer 1968  
Lewis 1990b  
Patrick et al. 1984  
Reimold et al. 1978  
Roman et al. 1984  
Shisler and Charette 1984a, 1986a  
Slavin et al. 1978  
Steinke 1988  
Webb 1982  
Webb et al. 1984  
Woodhouse 1979

Barko and Smart 1976  
Beeman 1992  
Broome 1990  
Darovec et al. 1975  
Earhart and Garbisch 1983  
Fell et al. 1991  
Frankowski et al. 1977  
Havens et al. 1995  
Knutson and Woodhouse 1983  
LaPerriere and Farmer 1988  
Lefor et al. 1987  
Maguire and Heuterman 1978  
Peck et al. 1994  
Rennie 1990  
Shisler 1990  
Sinicrope et al. 1990  
Slavin and Shisler 1983  
Thayer et al. 1989  
Webb et al. 1978  
Webb et al. 1988  
Woodhouse and Knutson 1982

*Sporobolus virginicus*

Beeman 1992

St. Andrews Bay

Fonseca et al. 1987

St. Joseph Bay

Phillips 1977

Phillips et al. 1978

*Streblospio benedicti*

Moy and Levin 1991

Suisan Bay

Sorensen et al. 1979

*Syringodium filiforme*

Darovec et al. 1975  
Eleuterius and McClellan 1976  
Fonseca and Fisher 1986  
Fonseca et al. 1987  
Fonseca et al. 1996  
Hoffman et al. 1985  
Lewis and Phillips 1981  
Phillips 1980a,b,c; 1982  
Thorhaug 1985, 1986, 1990  
Zieman et al. 1984

Eleuterius 1975  
Fonseca 1990, 1994  
Fonseca et al. 1984  
Fonseca et al. 1987  
Fonseca et al. 1996  
Lewis 1987  
Lewis et al. 1982  
Thayer et al. 1985a, 1990  
Thorhaug and Austin 1976

Tampa Bay

Clark 1989, 1992  
Dial and Deis 1986  
Fonseca et al. 1996  
Fuss and Kelly 1969  
Hoffman et al. 1985  
Lewis 1982a  
Lewis and Lewis 1977  
Lewis et al. 1982  
Pulver 1976  
van Breedveld 1975

Dial et al. 1985  
Durako and Moffler 1981  
Fonseca et al. 1996  
Hoffman and Rodgers 1981  
Kelly et al. 1971  
Lewis and Dunstan 1975  
Lewis et al. 1979  
Phillips 1980  
Robison 1995  
Vose and Bell 1994

Texas

Allen et al. 1978  
Chabreck 1990  
Environmental Laboratory 1978  
Landin 1984, 1986  
Lindau and Hossner 1981, 1982  
Lyon and Baxter 1978  
Minello and Zimmerman 1992  
Minello et al. 1994  
Pitre 1981  
Rozas and Zimmerman 1994  
Sipocz 1994  
Tanner and Dodd 1985  
Webb 1982  
Webb et al. 1978  
Webb et al. 1988

Bass 1995  
Dodd et al. 1978  
Kindle 1994  
Landin and Webb 1986  
Lunz et al. 1978  
Minello and Webb 1993  
Minello et al. 1987  
Phillips 1980a,b  
Rennie 1990  
Seidensticker 1994  
Smith 1978a,b; 1980  
Thayer et al. 1989  
Webb and Newling 1985  
Webb et al. 1984

*Thalassia testudinum*

Austin and Thorhaug 1977  
Derrenbacker and Lewis 1982  
Eleuterius 1975  
Fonseca 1994

Darovec et al. 1975  
Durako and Moffler 1981, 1984  
Eleuterius and McClellan 1976  
Fonseca and Fisher 1986

- Fonseca et al. 1987  
 Fonseca et al. 1990  
 Fonseca et al. 1996  
 Fuss and Kelly 1969  
 Kelly et al. 1971  
 Lewis and Phillips 1981  
 McLaughlin and Thorhaug 1978  
 Phillips 1976; 1980a,b,c; 1982  
 Sauers 1981  
 Thorhaug 1974; 1976; 1979a,b; 1980a,b;  
 1983; 1985; 1986; 1990  
 Van Breedveld 1975
- Tijuana River  
 Florsheim et al. 1991  
 McCreary and Zentner 1983  
 Zentner 1988
- Timbalier Bay  
 Hartman et al. 1994
- Triglochlin maritima*  
 Barko and Smart 1976  
 Kentula 1986  
 Woodhouse 1979
- Typha* spp.  
 Fell et al. 1991  
 Lunz 1978  
 Ristich et al. 1976  
 Shisler 1990
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<b>13. ABSTRACT (Maximum 200 words)</b>  This bibliography was compiled to provide biologists, engineers, and planners at Corps Districts and other agencies/institutions with a guide to the diverse body of literature on coastal wetland restoration. The availability of this information should aid in the development of technically sound restoration plans and guide efforts to evaluate wetland restoration projects in the coastal zone using the best information available.  This bibliography consists of 435 literature citations on coastal wetland restoration in the United States. Sources include scientific journals, conference proceedings, and technical reports from various Federal and State agencies. The bibliography is organized by the following wetland habitat types: (a) tidal marshes, (b) mangroves, (c) seagrasses, and (d) miscellaneous. Selected key citations in each section are briefly annotated, and a subject index is provided.				
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