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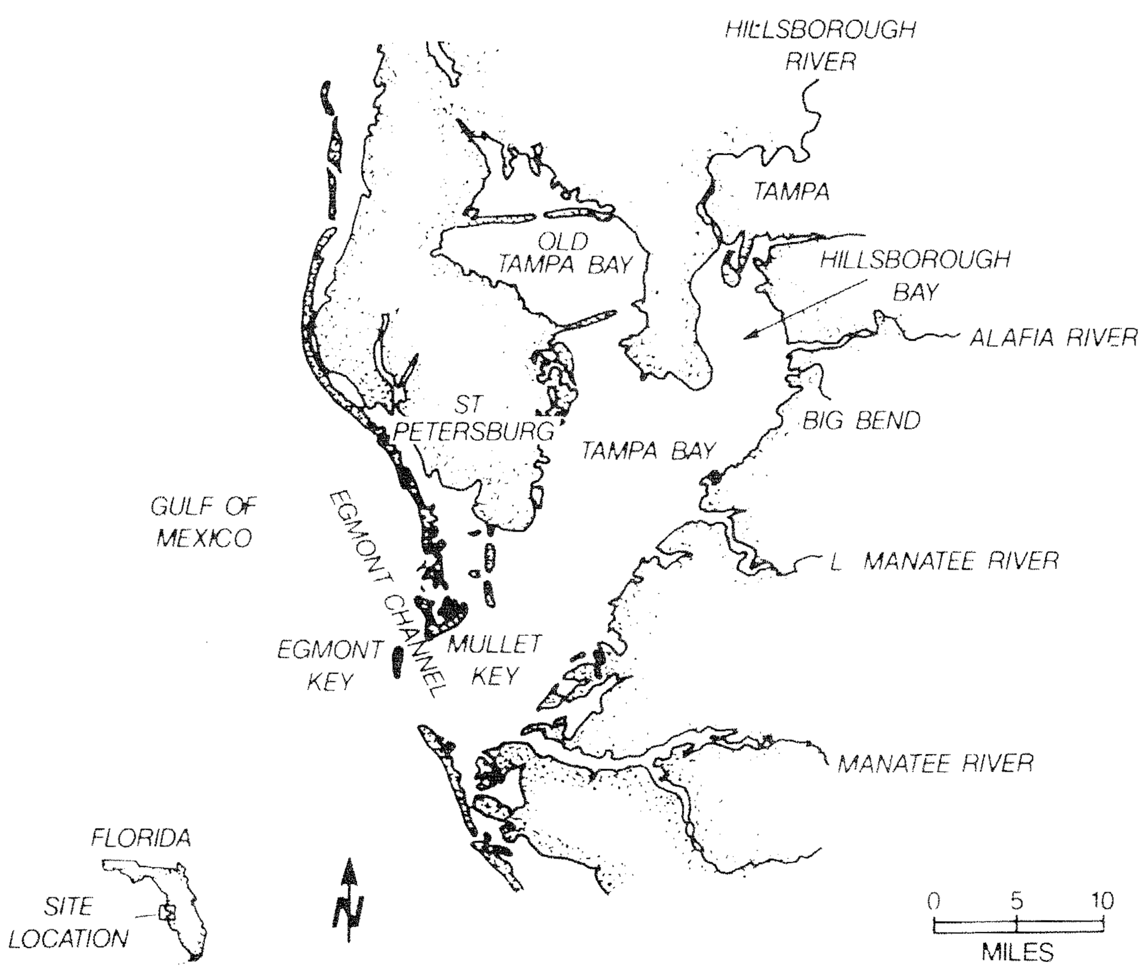

Fish and Wildlife Service

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FISH AND WILDLIFE MITIGATION OPTIONS FOR PORT DEVELOPMENT IN TAMPA BAY: RESULTS OF A WORKSHOP

by

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INTRODUCTION

SCOPE OF REPORT

This report records the results of a workshop held September 25-27, 1983, in Tampa, Florida. The organization of the report closely follows the organization of the workshop itself. The workshop began with a definition of objectives and several presentations providing general background. The context and objectives of the workshop are covered in the INTRODUCTION. A summary of the results of two group discussions is presented in the WORKSHOP RESULTS section. One group identified ways to conduct or locate port development activities in Tampa Bay so as to lessen their adverse impacts; the other group identified ways to compensate for unavoidable impacts by creating or improving important fish and wildlife habitats. Finally, the DISCUSSION section contains the authors' synthesis of more general comments made throughout the workshop, especially during the closing session.

CONTEXT OF WORKSHOP

The U.S. Fish and Wildlife Service and the Tampa Port Authority have recently joined in a cooperative effort to obtain the specific information and analyses needed to develop mitigation alternatives or options for Tampa Bay (Figure 1). There are several objectives of this effort:

PORT OF TAMPA IS LOCATED IN HILLSBOROUGH BAY.

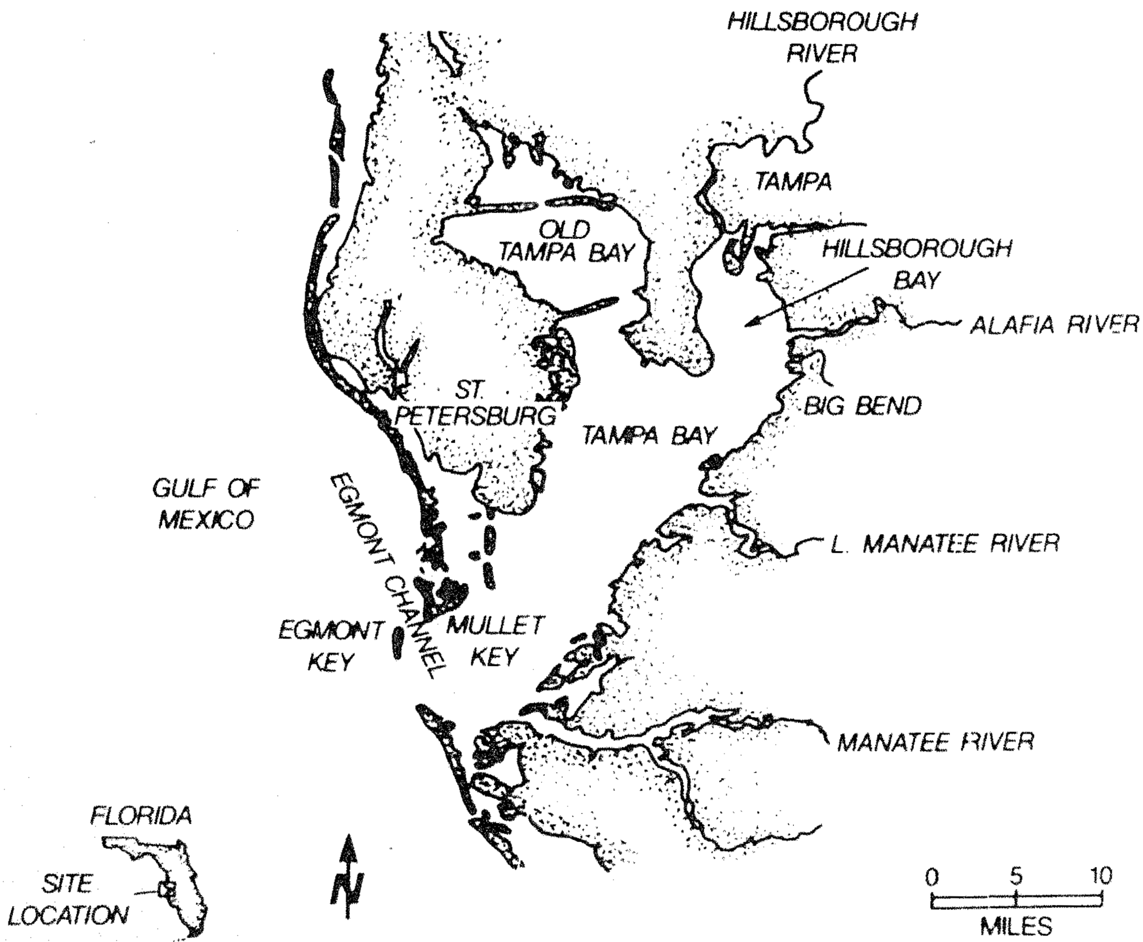

Figure 1. Map of Tampa Bay.

1) To identify management and mitigation options (including mitigation banking) that will allow port development and maintenance to proceed in an environmentally acceptable fashion in Tampa Bay;

2) To develop an information base in map, text, and tabular form that is aimed at analysis and evaluation of mitigation and management options; and

3) To develop a mitigation and management report to guide the Tampa Port Authority and other interests in the development and maintenance of the port facilities in Tampa Bay.

This effort represents an attempt by the agencies to work cooperatively at the intersection of their responsibilities. The Tampa Port Authority was created to develop and manage the Tampa Port facility, coordinate local port development, regulate marine construction in the port, manage sovereign and submerged lands, and act as the local sponsor for Federal navigation projects associated with Tampa Port. The U.S. Fish and Wildlife Service is charged (through the Fish and Wildlife Coordination Act and Estuary Protection Act) with providing recommendations on mitigating adverse impacts on fish, wildlife, their habitats, and uses thereof from water development projects undertaken by a Federal agency or requiring a Federal permit. The policy of the U.S. Fish and Wildlife Service in meeting this responsibility emphasizes habitat value (Federal Register 1981).

Five types of mitigation measures are distinguished in the definition of mitigation used by the President's Council on Environmental Quality in the implementing regulations (40 CFR Part 1508.20, a-e) of the National Environmental Policy Act of 1969:

1) Avoiding the impact altogether by not taking a certain action or parts of an action;

2) Minimizing the impact by limiting the degree or magnitude of the action and its implementation;

3) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;

4) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and

5) Compensating for the impact by replacing or providing substitute resources or environments.

The first four of these types of mitigation correspond to those discussed at the workshop under the heading "Measures to Reduce the Adverse Impacts of Development Actions," whereas the last type was discussed under the heading "Measures to Compensate for Unavoidable Impacts." In general, compensation is recommended only when other mitigating measures are not feasible: "The early provision of information to private and public agencies in a form which enables them to avoid or minimize fish and wildlife losses as a part of initial project design is the preferred form of fish and wildlife conservation" (Federal Register 1981).

The workshop described herein served a scoping function in the cooperative effort between the U.S. Fish and Wildlife Service and Tampa Port Authority. It is not intended that this effort duplicate other scientific syntheses and environmental planning in the Tampa Bay area. Rather, these other activities should increase the effectiveness of the cooperative effort between the U.S. Fish and Wildlife Service and Tampa Port Authority. Important related activities include the Bay Area Scientific Information Symposium (BASIS) and study and planning efforts funded by Coastal Zone Management grants and the Florida Department of Environmental Regulation (e.g., the Tampa Bay Management Study of 1983 and a stormwater impact study conducted as part of the National Urban Runoff Program).

OBJECTIVES OF WORKSHOP

A planning meeting outlined the following objectives for the workshop:

1) To define long-range management scenarios specifying development actions and mitigation actions;

2) To identify concerns of the principal interested parties; and

3) To identify information requirements and availability for evaluating the defined management scenarios.

These objectives were modified somewhat in response to additional input from participants before and during the workshop. By far the most important expectation was that the workshop should identify types of possible mitigation measures and associated opportunities and constraints. Thus, the effort was focused on producing this output. There was also a broadening of scope away from a narrow emphasis on specific actions of Tampa Port Authority. The workshop retained a focus on impacts of port development and maintenance actions, but was not limited to those initiated by Tampa Port Authority. The larger environmental problems of Tampa Bay (from a habitat perspective) were considered in formulating measures that might be used to compensate for port development impacts.

WORKSHOP RESULTS

MEASURES TO REDUCE ADVERSE IMPACTS OF DEVELOPMENT ACTIONS

Participants approached this topic in three steps. First, they listed likely future development actions and associated impacts at a general level. Second, they identified the most important types of impacts, many of which were associated with several types of development actions. Finally, they discussed measures to mitigate the priority impacts of port development by avoiding, minimizing, rectifying, or reducing or eliminating the impact over time.

Potential Impacts

Future development activities and potential impacts identified by participants are presented in Table 1. Participants used a variety of criteria to determine the most important impacts for further discussion. These criteria included the expected magnitude of the development activity; current severity of the problem in Tampa Bay; and sensitivity, scarcity, or importance of the impacted resource or habitat.

Impacts presented in Table 1 are generally direct consequences of development activities (e.g., overall turbidity, nutrient release, loss of marsh). These impacts seem to be well documented and understood. The indirect impacts, however, are less understood. For example, has the approximately 80% decline in seagrass in Tampa Bay been caused by increased turbidity, burial, change in salinity or water quality (nutrients, chemicals, dissolved oxygen), other unknown factors, or the interactions among several factors? Has the decline in fishery landings of certain species been caused by some of these same

Table 1. Impacts associated with various development activities.

Development activity	Potential impacts
Maintenance dredging	Siltation and turbidity[a]
	Loss of channel benthic community
	Nutrient release[a]
Disposal of maintenance material	
• Upland disposal	Nutrient release[a]
	Chemical (toxic) contamination[a]
	Burial of upland habitat
	Increase in groundwater salinity
	Creation of breeding habitat for mosquitoes
	Creation of sinkholes
• Gulf disposal	Increased turbidity[a]
	Chemical contamination[a] and bioaccumulation
	Burial of benthic communities[b]
Construction dredging	Loss of marsh[a]
	Alteration of circulation[a]
	Loss of benthic community (including seagrass)[a]
	Creation of anaerobic environment
	Alteration of salinity
	Loss of mangroves

(Continued)

Table 1. (continued)

Development activity	Potential impacts
Disposal of construction material	
• Upland disposal	Nutrient release[a]
	Burial of upland habitat
	Increase in groundwater salinity
	Creation of breeding habitat for mosquitoes
	Creation of sinkholes
• Gulf disposal	Increased turbidity[a]
	Burial of benthic communities[c]
• Bay disposal	Alteration of circulation[a]
	Siltation and turbidity[a]
	Burial of benthic communities[b]
	Loss of water column
	Creation of navigation hazard
	Change in sediment grain size distribution
	Potential increase in feeding and nesting habitat for birds on created nearshore habitats
	Potential increase in shallow water communities
Bulkheading	Loss of nearshore sublittoral habitat[a]
	Loss of marsh[a]
	Reflected wave action

(Continued)

Table 1. (continued)

Development activity	Potential impacts
Riprap	Loss of nearshore sublittoral habitat[a] Potential increase in hard-bottom communities
Pile supported structures	Loss of nearshore sublittoral habitat[a] Creation of rocky shoreline Shading
Fill operations	Loss of nearshore sublittoral habitat[a] Loss of marsh[a] Siltation and turbidity[a] Burial of upland habitats Increase in groundwater salinity
Point-source discharges	Nutrient release[a] Change in circulation and salinity[a] Chemical release (oil, acids, pesticides, heavy metals)[a] Change in water temperature from thermal discharges
Nonpoint-source discharges	Nutrient release[a] Chemical release[a] Siltation and turbidity[a] Change in sediment grain size distribution

(Continued)

Table 1. (concluded)

Development activity	Potential impacts
Mosquito control	Loss or change in marsh habitat[a] Increase in nutrient loading[a] Freshwater pulsing[a]
Water withdrawal	Entrainment and impingement of biota
Boat traffic	Loss of seagrass[a] Siltation and turbidity[a] Injury to biota (including turtles and manatees)[c] Pollutant spillage (gas and oil) and discharge (human and fish waste)[c]

[a]Identified by participants as a priority impact.
[b]Identified in review process as a priority impact.
[c]Added in review process.

factors or has it primarily been caused by overfishing? Will the decline in certain nearshore estuarine habitats affect wading or shore bird populations, or are other factors limiting their numbers? The relationships of development activities to indirect impacts such as these must be better understood as a basis for rational mitigation decisions.

Maintenance dredging. Maintenance dredging operations are conducted throughout Tampa Bay. Projects discussed during the workshop included maintenance in the upper bay, the lower bay, St. Petersburg, Port Manatee, and C-135 (Four Rivers Basins). Impacts of concern from maintenance dredging are siltation, turbidity, and nutrient release (especially ammonia). While the release of ammonia may be a short-term problem (associated with physical disruption of sediments), participants believed that dredging and confined disposal may result in a long-term decrease in ammonia release from bay sediments (because of the removal of ammonia-contaminated sediments). Also, the contribution of maintenance dredging to eutrophication in Tampa Bay may be fairly minor in comparison to point- and nonpoint-source discharges. Because channel bottoms do not provide very good benthic habitat, disturbance of these areas was not considered of great importance.

Disposal of maintenance material. Maintenance dredging operations will likely generate 1 to 3 million cubic yards of material per year for disposal. Because this material is predominantly fine-grained (and thus hard to stabilize) and because of potential problems with siltation and nutrient and chemical loads, disposal in the bay was not considered by participants.

Primary concerns associated with upland disposal of this material involve possible nutrient release and chemical contamination of fresh surface waters. Burial of upland habitat may have some indirect impacts on wildlife; disposal on existing farmland would have social and economic impacts to the extent that the land was less suitable for agriculture. Other impacts include a potential increase in groundwater salinity due to seepage of saline waters from disposed material, creation of mosquito breeding habitat, and creation of sinkholes.

The ranking of impacts associated with disposal in the Gulf of Mexico is probably an artifact from doing the prioritization without reference to specific geographic areas. At the workshop, chemical contamination and increased turbidity were ranked as more important general concerns than burial of benthic communities. However, burial of benthic communities may in fact be the primary concern at gulf sites. The extent of any of these impacts would depend on the biotic assemblages at a specific dump site and the current velocities and resuspension events that would tend to disperse the material. Environmental impacts and mitigation measures associated with offshore disposal were not discussed in any detail at the workshop.

Construction dredging. The construction dredging projects discussed at the workshop are in various stages of planning. Thus, their extent is generally less certain than that of the maintenance of existing channels. Construction projects include widening or deepening Port Manatee, Port Tampa, Port Sutton, East Bay, Hooker's Point, Cut D, and the Alafia River and Big Bend channels and side channels. Construction of new berths at East Bay and Hooker's Point, channels to the proposed Tampa Electric Company (TECO) power plant, and refuge anchorage areas at unspecified locations were also discussed.

Participants felt the cutting of new channels or deepening of existing channels could alter circulation and flushing in Tampa Bay, though the biological consequences of these changes were not discussed in any detail. Direct losses of marshes and benthic communities, including seagrass beds, were also considered important impacts. Impacts on seagrass beds are of great concern because these habitats are less abundant and reestablishment procedures are not as well developed or successful as those for marshes. Other impacts discussed included creation of anaerobic environments, alteration of salinity, and loss of mangroves.

Disposal of construction material. The channel-deepening projects listed above could generate 25 to 30 million cubic yards of material for disposal. Because this material contains more rock, sand, and shell, and presumably lower concentrations of nutrients and chemical contaminants than maintenance spoil, there are more disposal options. Additionally, much of this material may be suitable for some of the compensation options discussed later.

Impacts associated with upland or gulf disposal of construction material were the same as for maintenance material except that chemical contamination was not considered to be a problem with construction material. Participants believed the most important impacts of disposal in the bay would be alteration of circulation due to construction of new islands or sills along channels, and increased siltation and turbidity from unconfined or poorly confined fine-grained material. Indirect consequences of these impacts to biota were not discussed. Burial of nearshore benthic communities, change in sediment grain size distribution, loss of water column, and creation of navigation hazards were also discussed but considered to be of lesser importance. Two potential positive impacts of disposal within the bay were identified: an increase in feeding and nesting habitat for birds on created nearshore habitat and an increase in shallow-water communities.

Bulkheading. No major bulkheading projects were discussed during the workshop. The cumulative impact of a number of small, private bulkheading projects, however, could have major consequences, primarily through the loss of marsh or nearshore sublittoral habitat. For purposes of the workshop, nearshore sublittoral habitat was defined as the area from the intertidal zone down to 1 fathom. The increase in reflected wave action resulting from bulkheads could also damage nearshore communities.

Riprap. Riprap can be associated with a number of other development actions such as bulkheading and construction of pile-supported structures. While riprapping may destroy some nearshore sublittoral habitat, it also creates hard-bottom communities. Whether this change is positive or negative is subjective, and participants expressed both points of view. In the past, there has generally been more interest in offshore artificial reefs than in artificial hard-bottom habitat in the bay.

Pile-supported structures. Pile-supported structures include docks, buildings, and bridges. The tradeoff between loss of nearshore sublittoral habitat and creation of hard-bottom communities is discussed above. Shading was considered to be a problem only if the pile-supported structure is built directly over an important community such as a seagrass bed.

Fill operations. Fill operations to "create" land for development were not envisioned in the near term. Sufficient private bayside land is available for purchase for these needs. However, if these lands are used for other purposes in the future, some fill operations may become necessary. If filling does occur, important habitats most likely to be destroyed are marshes and nearshore sublittoral. These operations could also contribute to existing siltation and turbidity problems in the bay.

Point-source discharges. The impacts of point-source discharges in Tampa Bay are highly dependent on the type of discharge. Nutrient and chemical releases are of primary concern with sewage treatment plants, while thermal effects are of more concern with power plant discharges. Although diverting sewage treatment discharges away from the bay might help alleviate nutrient and chemical impacts, these discharges also represent major freshwater inflows to the bay and their diversion could cause potentially significant salinity changes in estuarine areas.

Nonpoint-source discharges. Nonpoint-source discharges are extremely difficult to assess or control because they are so diffuse. Nutrients, chemicals, and sediments carried into the bay in stormwater runoff contribute to existing problems, and some participants believed that these discharges are the primary source of the bay's water quality problems.

Mosquito control. Although mosquito control may not be considered a major development activity, all of its identified impacts were considered important by participants. These include loss or change in marsh habitat, increase in nutrient loading to the bay, and freshwater pulsing into the bay. These impacts are due to dikes and constructed channels that change a predominantly overland flow of water through marshes to a predominantly channelized flow.

Water withdrawal. There are several power plants that withdraw water from Tampa Bay. The only water withdrawals that were discussed, however, were those associated with Tampa Electric Company's power plant. Fine-mesh screens are or will be used on intake structures at some of these facilities to minimize entrainment and impingement impacts.

Boat traffic. Boat traffic in Tampa Bay, both commercial and recreational, can contribute to the loss of seagrass beds and increased siltation and turbidity. The magnitude of these impacts is unknown.

Mitigation Options

Options identified by participants to avoid, minimize, or rectify the important impacts noted in Table 1 are presented in Table 2. Opportunities and constraints associated with these mitigation options were also discussed and are presented below. Economic and potential institutional constraints (e.g., cost and maintenance requirements and responsibilities) were discussed for almost all options, but are not listed separately for each.

Nutrient release from dredging. Participants generally believed that eutrophication was a major problem in Tampa Bay, but the extent to which nutrient release from dredging contributes to this problem is not known. The increased nutrient levels in the bay have resulted in algal blooms and extremely productive assemblages of phytoplankton. This can have both positive and negative effects. For example, although increased productivity at the base of the food chain may support a higher biomass of fish in the bay, there may be associated shifts in species composition away from assemblages of desirable fish species. It has been hypothesized that one cause of seagrass decline may be competition with micro- and macroalgae. Shifts in species composition may be occurring in other vegetation communities as a result of the changing nutrient regime. Two activities may help assess these nutrient loading problems. First, the Florida Department of Environmental Regulation (DER) is developing 25-year dredging permits that include provisions for water quality monitoring. Second, a waste load allocation study is currently underway to assess the assimilative capacity of the bay.

Table 2. Mitigation options for important impacts.

Impact	Options
Nutrient (ammonia) release from disruption of sediment	None identified
Siltation and turbidity	Upland or confined disposal[a] Protection of disposal areas (e.g., riprap)[a] New dredging technology (onboard computers)[a] Turbidity curtains and flocculents[a] No overflow from hopper dredges[a] Closed clamshell and barge[a]
Other chemical release	Same mitigation options as for siltation and turbidity[a]
Change in circulation and salinity	Circulation cuts Removing dikes and blocking mosquito control ditches Removing sill along Big Bend channel
Loss of marsh	No dredging, disposing, or filling in marshes[a] Bridging over marshes for dock construction[a]
Loss of near-shore sublittoral habitat including seagrass	No dredging, disposing, or filling in sublittoral zone[a] Planting seagrass in sublittoral areas currently without seagrass Grading toe of new or existing disposal islands to reestablish some of sublittoral areas buried Protecting seagrass beds from excessive wave action[a]

[a]These options should be considered as good management practices.

No mitigation measures (except avoidance) were identified for ammonia release associated with the physical disruption of sediments from dredging. Several participants expressed the opinion that although ammonia release may be a short-term problem during dredging, the removal and confinement of maintenance spoil material may lead to a long-term reduction in release. While participants generally believed that nutrient problems in Tampa Bay resulted primarily from point- and nonpoint-source discharges, they did not believe that mitigation for these discharges was within the bounds of the workshop; therefore, such actions were not discussed in any detail. Participants did express the opinion that FWS mitigation recommendations should be a part of a larger bay rehabilitation effort focusing on these impacts.

Siltation and turbidity. Increased turbidity in the bay can limit light penetration to submerged aquatic vegetation and thereby eliminate it from deeper areas where it was previously found. Siltation can bury organisms or change sediment grain size distribution. These effects can cause not only direct mortality of existing organisms but also shifts in the biotic assemblages that use the affected area. As with nutrients, the extent to which these problems are related to dredging vs. upland runoff is unknown. Additionally, some of the turbidity in the bay may be a biological (i.e., algal biomass) rather than a geological (i.e., suspended sediment) problem.

Numerous mitigation options were identified for dredge-related siltation and turbidity problems. Upland or confined disposal is effective, but there are constraints involving land availability. There are other problems, as well as opportunities, associated with creating disposal islands. For bay disposal, protection of disposal areas with riprap would decrease subsequent erosion. New onboard computers for dredges can reduce overdredging and may allow skimming in multiple passes to segregate different types of material for construction or habitat creation projects. Turbidity curtains and flocculents can effectively reduce siltation and turbidity but only in shallow, calm water. Regulations preventing overflow from hopper dredges or requiring closed clamshell and barge operations would probably involve increased costs.

Chemical release. Chemicals released from dredged material may be toxic to some organisms; bioaccumulation of these chemicals is also of concern. Mitigation measures to reduce the effects of siltation and turbidity could also reduce the release of potentially toxic chemicals.

Change in circulation and salinity. Circulation and flushing in portions of Tampa Bay have been altered by construction of channels and associated disposal islands and sills. Changes in circulation and freshwater inflows to the bay can affect salinity, especially in estuarine areas. One of the primary changes in freshwater inflow has been associated with mosquito-control dikes and channels. These structures have resulted in channelized, pulsed freshwater inflows as opposed to predominantly overland flow. This has affected the quality and timing of freshwater inflows to the bay and changed the vegetation communities, such as marshes, that formerly received the freshwater inflows.

It is possible to remove dikes and block mosquito-control ditches to reestablish overland flow through marshes. Mosquito-control ponds, which have proven very effective, could be built. Although chemical control could be used, it presents other potential environmental problems. Circulation could be improved to some extent by making circulation cuts through old disposal areas. A specific project proposed was to remove the sill along the Big Bend channel while the channel is being deepened.

Loss of marsh habitat. Marsh habitat has been lost or altered in the past as a result of a number of development activities. Direct losses have occurred from bulkheading, fill operations, and channel cuts through the marshes. Habitat alterations may have resulted from changes in water quality and from mosquito-control measures. The effects of these changes on populations of organisms using the marshes have not been evaluated. The most obvious mitigation alternative is to avoid dredging, channelizing, diking, filling, or disposing of dredged material in marshes. The obvious constraint is the lack of suitable alternate sites. Many of the above points concerning loss of marsh habitat and possible mitigation also apply to mangrove forest habitat. Bridging over marshes for dock construction was discussed but is applicable for only a limited number of facilities, not for general cargo docks.

Loss of nearshore sublittoral habitat. A number of factors may be contributing to the loss of nearshore sublittoral communities such as seagrass beds. These include dredging and disposal of dredged material, siltation and turbidity, degraded water quality, and recreational boating. Because many of these factors were previously discussed, participants limited discussions of mitigation alternatives to those associated with dredging and disposal of dredged material. Again, the obvious mitigation measure is to avoid dredge, disposal, or fill operations in these areas. Planting seagrass in disturbed areas was suggested as a measure to rectify impacts, but similar projects in other bays have been only marginally successful. Also, there were questions raised as to whether current water quality and turbidity conditions in the bay would preclude seagrass survival even if viable techniques were found to establish seagrass initially.

MEASURES TO COMPENSATE FOR UNAVOIDABLE IMPACTS

Participants approached this aspect of the workshop in three steps. First, they listed the major habitats in the Tampa Bay area, their general historic trends (where possible in terms of both quantity and quality), and their expected future trends. Second, they identified the most important of these habitats in terms of desirability of preservation and enhancement, partially on the basis of the historic and expected future trends. Finally, they discussed measures to compensate for unavoidable impacts to these important habitats, the expected results of those measures, and criteria for assessing their applicability.

Important Habitats

The habitats and trends identified by workshop participants are shown in Table 3, along with some general reasons for the historic and expected future trends. The habitats judged to be most important in terms of preservation or enhancement are identified with an "a." Several vegetative types are further subdivided on the basis of location (e.g., mangrove-island vs. mangrove-shore,

Table 3. Status and trend of habitats in the Tampa Bay area. A (-) indicates declining area or quality, a (+) indicates increasing area or quality, and a (0) indicates static conditions.

Habitat type	Historic trend	Causes of historic trend	Probable future trend	Probable causes of future trend
Marsh-shore[a]	Area (-)	Navigation development Residential development Flood control	Area (0)	Regulation of development
	Quality (-)	Reduced freshwater inflows	Quality (-)	Reduced freshwater inflows
Marsh-island[a]	Area (+)	Construction of spoil islands	Area (+)	Construction of spoil islands
			Area (-)	Erosion Sea level rise
Mangrove-shore[a]	Area (-)	Navigation development Residential development Flood control	Area (0)	Regulation of development
	Quality (-)	Reduced freshwater inflows Ditching for mosquito control	Quality (-)	Reduced freshwater inflows Ditching for mosquito control
Mangrove-island[a]	Area (-)	Development	Area (+)	Construction of spoil islands
			Area (-)	Erosion Sea level rise

(Continued)

Table 3. (continued)

Habitat type	Historic trend	Causes of historic trend	Probable future trend	Probable causes of future trend
Seagrass-shore[a]	Area (-)	Water quality Dredge and fill	Area (-)	Water quality Erosion (smaller beds less stable)
Seagrass-midbay[a]	Area (-)	Water quality Dredge and fill	Area (-)	Water quality Erosion (smaller beds less stable)
Oyster bars	Area (-?)	Dredge and fill Siltation	Area (0)	Regulation
			Quality (-)	Water quality Urban runoff
Sand bottom-subtidal	Area (-)	Dredge and fill Conversion to mud bottom due to siltation and decreased tidal flushing	Area (?)	
Mud bottom-subtidal	Area (+)	Conversion from sand bottom due to siltation and decreased tidal flushing	Area (0,+)	Continued sedimentation of newly dredged areas
	Quality (-)	Poor water circulation and depth		
Sand bottom-intertidal	Area (+)	Construction of causways and spoil islands	Area (-)	Riprapping
	Area (-)	Dredge and fill		

(Continued)

Table 3. (continued).

Habitat type	Historic trend	Causes of historic trend	Probable future trend	Probable causes of future trend
Mud bottom-intertidal	Area (+)	Reduced circulation and residential canal construction	Area (0)	Regulation of development
	Area (-)	Dredge and fill		
Open water	Area (-)	Reduced tidal prism due to skyway	Area (0)	No further construction
	Quality (-)	Water quality	Quality (-)	Urbanization
Tidal creek-euryhaline[a]	Area (-) and quality (-)	Channelization Flood control Dredge and fill Exotic species invasion	Area (0?) Quality (-)	 Increased freshwater withdrawals
Tidal creek-stenohaline	Area (-) and quality (-)	Channelization Flood control Dredge and fill Exotic species invasion	Area (0?)	Rotary ditching
Live bottom-euryhaline[a]	Area (-)	Dredge and fill	Area (0)	Regulation
	Quality (-)	Turbidity	Quality (-)	Turbidity
Live bottom-stenohaline	Area (-)	Dredge and fill	Area (0)	Regulation
	Quality (-)	Turbidity	Quality (-)	Turbidity
Estuarine beach-shore	Area (-)	Dredge and fill Bulkheading	Area (0)	Regulation

(Continued)

Table 3. (concluded)

Habitat type	Historic trend	Causes of historic trend	Probable future trend	Probable causes of future trend
Estuarine beach-island	Area (+)	Construction of spoil islands	Area (+)	Construction of spoil islands
			Area (-)	Erosion
			Quality (-)	Human access Exotic species invasion
Drift algae	Area (+) and quality (-)	Eutrophication	Area (+) and quality (-)	Eutrophication
High marsh	Area (-)	Ease of development Lack of regulation	Area (-)	Ease of development Lack of regulation Ditching for mosquito control

[a]Identified by participants as an important habitat.

seagrass-midbay vs. seagrass-shore). These distinctions were made because the same vegetative type can provide habitat for a different faunal assemblage, or better habitat for a similar faunal assemblage, depending on location. For example, mangrove-island communities provide better habitat for colonial nesting birds than do mangrove communities associated with the shore of the bay because of differences in predation and human disturbance. Subtidal and intertidal sand and mud bottoms are distinguished for similar reasons, as are euryhaline and stenohaline tidal creeks and live bottoms. The information in Table 3 should be considered neither definitive nor exhaustive at this time; rather, it should be considered a preliminary effort that can and should be expanded and improved as additional information becomes available.

Mitigation Options

Alternative measures that may be useful in compensating for losses of the most important habitat types are shown in Table 4. The remainder of this section describes some of the opportunities and specific constraints associated with these options. In addition, participants identified several general constraints that are applicable to all or most of the options.

1) Cost: Many of the options, especially those requiring heavy equipment to move materials, will be expensive. Cost will thus be an important factor in determining feasibility.

2) Life span: The desirability of any option is, in part, a function of the expected life span of the resulting habitat. Preservation in perpetuity is the ultimate goal. Any of the options would therefore be more desirable and should be considered first on lands already in public ownership or on lands where there is an opportunity to acquire fee title interest or a long-term easement.

3) Maintenance: Many of the options would require maintenance (e.g., control of erosion, control of exotic species invasion) for some period of time beyond implementation. Maintenance requirements should be considered in the initial planning.

Table 4. Mitigation options for the most important habitats in the Tampa Bay area.

Habitat type	Options
Marsh-shore	Fill submerged borrow pits Construct marsh along artificial shoreline, near mouths of channelized tidal creeks, or near stormwater outfalls Construct marsh for erosion control along channelized streams and tidal creeks Construct marsh by removing open, undiked spoil or lowering elevation of uplands Remove flood control dikes along channelized streams
Marsh-island	Construct islands using dredged materials
Mangrove-island	Construct islands using dredged materials Stabilize existing islands
Mangrove-shore	All options shown for marsh-shore Remove spoil piles from areas ditched for mosquito control
Seagrass-shore	Fund basic research
Seagrass-midbay	Fund basic research
Tidal creeks-euryhaline	Restore altered tidal creeks Convert ditches to more natural tidal creeks
Live bottom-euryhaline	Construct artificial reefs and other hard bottoms

4) Public acceptance: Some alternatives and locations that are otherwise feasible may need to be rejected simply because of lack of public acceptance. Educational programs may be useful in overcoming this obstacle.

5) Monitoring: The success of the mitigation action needs to be monitored to assess if the affected habitat is functioning according to the goals stated in the initial planning. Specific goals regarding biological and physical characteristics expected in the final habitat should be stated as should the time needed for them to occur.

Marsh-shore. Several opportunities for creating marsh around the shoreline of Tampa Bay were identified. The first involves use of spoil material to fill existing borrow pits, followed (probably) by artificial revegetation. Such pits are often anaerobic on the bottom, at least at some periods during the year, and thus are not presently very important habitats. Sites that are not being used for navigation, are adjacent to the shoreline, near a source of freshwater runoff, and are close to a supply of dredged material of appropriate quality are preferred. Appropriate quality dredged material probably means construction grade sand and rock. There is some possibility, however, that lesser quality material could be used in the bottom of such pits, followed by a cap of better quality material. There are questions as to whether materials used in this manner would remain segregated, or whether "soupy" bottom material might be displaced when the top layer is added. Although answers to these questions are not presently available, similar layering techniques have been used successfully on upland disposal sites. Regardless of the technique used, low energy locations are likely to be preferable in order to minimize problems with containment and erosion. Although this option is technically feasible, and perhaps even highly desirable in offering a mechanism for simultaneously disposing of spoil and creating habitat, the opportunities are not large, perhaps numbering only half a dozen in the entire bay.

Suitable quality spoil material could also be used to construct marsh along artificial shoreline or near the mouths of channelized tidal creeks and stormwater outfalls. This option would use the spoil to raise the elevation of (presumably) less desirable bay bottom. Marsh located near stormwater outfalls and channelized tidal creeks would likely remove some pollutants, although maintenance would be required to prevent blockage of storm drains by vegetation. Opportunities for implementing this option are probably few and are likely to be further limited by political and social constraints.

The banks of channelized streams and tidal creeks offer another opportunity for marsh construction. This option would provide two direct benefits: habitat improvement and erosion control. However, it is not likely to allow for disposal of dredged material. On the contrary, additional material requiring disposal might be created because of the necessity of grading banks to a lesser slope. Opportunities for implementing this option are probably large in a linear sense, but the total acreage is likely to be small.

Disposal of material is also a constraint in removing old, open, undiked spoil piles or in lowering the elevation of uplands to create areas suitable for marsh. In the case of uplands, existing habitat and economic values must also be considered. Acquisition of suitable areas can be expensive, and existing habitat values must be weighed against the habitat value of the marsh that is to be created. In a geographic sense, opportunities for implementing this option are probably relatively numerous, but perhaps somewhat constrained by the need to locate marshes in areas where there is tidal influence.

In addition to creating new marsh, there are also limited opportunities to improve the quality of existing marshes (and mangroves) by removing flood control dikes along channelized streams. New marsh could be created in place of dikes, and the additional freshwater inflow to existing marshes would reduce salinity and thereby enhance their productivity and utility as nursery areas. This option would be easier to implement in cases where the dikes are directly connected to the shore; otherwise barge-mounted equipment would be necessary. Other constraints include disposal of the material resulting from dike removal, difficulty of maintenance once the berm is removed, and loss of some recreation access now provided by certain dikes.

Marsh-island. The workshop did not specifically consider the construction of island marshes as a compensation measure. It is well established that such habitats can be created, given proper design and a supply of appropriate quality spoil material. It is possible, however, that available spoil material is better used for construction of mangrove islands (see below) and that marsh construction should be considered only as a successional precursor in this process.

Mangrove-island. Experience to date indicates that construction of mangrove islands is a feasible mitigation alternative when good quality dredged material is used with proper design and construction techniques. Such islands provide useful nesting habitat for a variety of colonial birds. Vegetation is usually established by planting *Spartina* and then either planting mangroves in the established *Spartina* or allowing naturally produced mangrove seedlings to invade and eventually replace the *Spartina*. Since mangroves require a fairly stable substrate, low energy situations are preferred unless stabilization is included as part of the design. The potential for blocking tidal flow may also be a constraint in terms of locating suitable sites. In addition, islands should be constructed with a surrounding barrier of fairly deep (perhaps 6 ft) water to prevent access by predators. Post-construction management needs include control of human access and control of exotic species of vegetation. Small islands (e.g., 10 to 30 acres) close to existing nesting colonies may be preferable in some cases. The extent of the opportunity for creating such islands is unknown at this time. The key question is whether additional nesting habitat would be used by colonial birds or whether some other resource is limiting their populations.

A second mitigation option involves stabilization of existing islands (e.g., Fish Hook Spoil Island). This would have dual benefits: increasing the probability that vegetation would succeed to mangroves and, since these islands are often located next to shipping channels, reducing erosion in areas where maintenance dredging is required.

Mangrove-shore. All options discussed for shoreline marsh could also be used to create or enhance the quality of shoreline mangrove communities. An additional constraint, though, is that mangroves on shore are much more susceptible to freezing.

An additional option involves improving the quality of mangrove habitat by removing spoil piles from areas ditched for mosquito control. While this option could potentially be applied to extensive areas, applications may be limited by engineering feasibility. Recently developed rotary ditching technology may prove useful in the future.

Seagrass-shore and seagrass-midbay. Although there was strong agreement that seagrasses constitute one of the most important habitats in Tampa Bay, participants also agreed that there are presently no viable restoration techniques available for Tampa Bay. Lack of such techniques is primarily a result of poor understanding of the basic causes of seagrass decline (e.g., water quality, physical damage by boats). Some of the participants recommended that funding for research in these areas be considered as a mitigation option. Once the basic causes of seagrass decline are better understood, there will likely be fairly widespread support for mitigation options directed at those causes, as well as for restoration efforts if viable techniques can be developed.

Tidal creeks-euryhaline. Restoration of altered tidal creeks is an option that offers an opportunity to improve a habitat that may be critical to certain species (e.g., snook). This option would require removing spoil piles to reopen original meanders while leaving straightened channels for flood control and navigation. Regrading, replanting, and removing exotic vegetation might be necessary in some cases. Disposal of spoil would also be a constraint in certain areas. Opportunities for implementing this option may be large in a linear sense, but the total acreage involved is likely to be small.

Similar techniques could likely be used to convert ditches to more natural tidal creeks. The constraints involved would be similar to those for restoration of natural creeks, but the opportunities are apt to be fewer.

Live bottom-euryhaline. Mitigation options involving creation of live bottom habitats received little attention at the workshop. However, it is well established that such habitats can be created and, in fact, some artificial reefs already exist in the bay. Should it be deemed desirable to create additional live bottoms, the biggest constraint will likely be competition for supplies of suitable construction material.

Other. In addition to the above options related to specific important habitats, participants briefly discussed several other measures that may be useful under some circumstances. Flow improvement facilities such as cuts, culverts, and one-way gates may be useful in improving circulation patterns in certain areas. General water quality problems could be addressed through measures involving improved sewage treatment, erosion control, and improved handling of stormwaters (e.g., sediment traps) and other nonpoint sources of pollution. While measures such as these are not usually related directly to specific development actions, they may ultimately play a significant role in restoring the quantity and quality of habitats in the Tampa Bay area and should be promoted as good management practices.

DISCUSSION

CONNECTION BETWEEN DEVELOPMENT ACTIONS AND MITIGATION MEASURES

A rational and fair approach to mitigation requires a connection, on a quantitative basis, between development actions and mitigating actions. The mitigation policy of the U.S. Fish and Wildlife Service (Federal Register 1981) stresses the establishment of connections in terms of habitat value. Application of modeling approaches such as the Habitat Evaluation Procedures (U.S. Fish and Wildlife Service 1980) can put the evaluation and association of project impacts and mitigating measures on a quantitative basis.

Several problems and opportunities were discussed at the workshop concerning the connections between current and future development actions in Tampa Bay and the associated mitigation options.

Effects Assessment

Most of the discussion at the workshop concerned the importance of habitat types (e.g., island marsh or euryhaline tidal creeks). A lack of knowledge concerning species-habitat relationships in Tampa Bay may limit the use of habitat requirements of a particular species in the evaluation of positive and negative effects of the proposed mitigation action. The Habitat Evaluation Procedures used by the U.S. Fish and Wildlife Service to estimate the value of habitat for particular species have not been extensively applied in estuarine areas.

Accurate and precise assessment of the effects of a particular development or mitigation action in Tampa Bay is further complicated by the importance of broad-scale water quality variables. Participants stressed the significance of water quality (turbidity and nutrient levels), both as an indicator of the currently degraded condition of Tampa Bay and as a limitation on how much the system can be improved by actions that do not improve water quality. Reduction of point-source discharges (WORKSHOP RESULTS section) was even suggested as a possible compensating measure for unavoidable impacts. Not all of the water quality problems are due to recent actions. The location of facilities in combination with poor circulation, accumulation of nutrients from sewage discharge, and changes in sediment composition and distribution related to dredging represent a legacy from the past. Thus, it is difficult to assess the contribution of any specific development action to the overall problem. Furthermore, the contribution of many of the proposed port development actions may be small in relation to the overall water quality problem. Although these issues complicate assessment of the effects of development and mitigation actions, they do not eliminate the need for mitigation or for establishing a connection between development actions and the nature and extent of the associated mitigation recommendations.

Cumulative Mitigation

The individually small effects of many small development actions can combine to produce a significant overall change in the system. Appropriate mitigation for these small actions can thus become as important as mitigation for a small number of large development actions. Some participants suggested the Tampa Port Authority serve as a possible focal point for the development of a bay-wide mitigation plan for small, individual actions. A number of workshop participants identified the need for mitigation planning in Tampa Bay to encompass small actions so as to minimize their cumulative impact. Some of the concepts of island biogeography were discussed in the context of establishing minimum levels at which certain kinds of compensation or enhancement measures might be effective. Reasonable habitat use often requires certain patch sizes and configurations. Thus, small mitigation actions for small individual development actions might better be combined into larger mitigation projects to be effective.

Mitigation Banking

The concept of mitigation banking provides flexibility in time. Under a mitigation bank, compensating measures for unavoidable impacts can be taken before the development actions that will require mitigation. The approach of combining mitigation measures from many small development actions (i.e., "cumulative mitigation") could involve a mitigation bank. Mitigation banking was discussed at the workshop as a possibility for implementing measures that might require a relatively large-scale, long-term effort to be effective. Mitigation banking is a conceptual structure in which such a program could be developed if flexibility in time is required. Such a program would still include establishing mitigation goals, assessing effects, and establishing connections between effects of development actions and mitigation actions.

Mitigation Goals

The goal of most mitigation activity is to keep the system as close to unchanged as possible in terms of fish and wildlife and their habitat. Adverse impacts of development are to be avoided or minimized and unavoidable impacts are to be compensated. The goal of minimizing change is clear and reasonable when the resource is important or unique, or when the current condition of the system is desirable. However, workshop participants strongly expressed the view that the current, degraded environmental status of Tampa Bay was not desirable and needs to be enhanced. The general mitigation policy of the Fish and Wildlife Service clearly provides the flexibility of mitigation actions intended to move the system towards some more desirable state. The problem in general, and in Tampa Bay in particular, is to decide what that more desirable state is (or what the goal is). This is particularly difficult because any goal except the current condition implies making decisions that some species and habitats are more important than others. The primary objective of the workshop reported herein was to identify mitigation options. Some of the discussions at the workshop concerned relative values (e.g., identification of most important habitats). However, a full discussion and the establishment of consensus on goals (or criteria for choosing among options) were beyond the scope of the meeting.

INFORMATION NEEDS

The workshop did not attempt a systematic identification or prioritization of information needs, but a number of information needs were noted during discussions. Many of these have been described in the preceding sections in connection with specific mitigation options. The information needs can be generally grouped into two types: assessment needs and basic scientific understanding.

The assessment needs are primarily concerned with the location and extent of development activities and various environmental resources. These needs include better information on bathymetry and sediment composition, better habitat mapping (e.g., location of various communities, location of submerged borrow pits in the bay), clearer definition of dredged material disposal capacities and needs, and more detailed analysis of the location of potential development actions relative to various habitats.

Several areas were identified as needing additional basic scientific and engineering understanding. The desirability of various island configurations, the engineering technology of secondary and tertiary rehandling of dredged material, and circulation patterns within the bay were all raised as important questions, with some discussion about the sufficiency of what is currently known. The important need for research on the basic ecology of seagrass in Tampa Bay was also discussed. Participants felt that the causes of seagrass decline in Tampa Bay are not well enough understood to allow any confidence in the success of reestablishment measures. Finally, the basic sediment and nutrient regimes in the bay are not well understood; participants suggested that better knowledge of these budgets would allow a concentration of effort on the most important aspects of the problem.

Although the workshop did not focus on identifying research needs, some participants recommended that the Fish and Wildlife Service consider the acquisition of some of the information described above as a possible mitigation measure. The resulting understanding could then be used to rectify the primary sources of the problems rather than focusing on habitat replacement. Several representatives of the Fish and Wildlife Service responded by stating that they did not, in general, consider research to be appropriate mitigation for habitat loss.

RELATIONSHIP OF MITIGATION TO ENVIRONMENTAL MANAGEMENT IN TAMPA BAY

The single strongest conclusion from the workshop was that the environmental problems of Tampa Bay and appropriate corrective actions transcend the more limited questions of mitigating current and future port development actions. The current environmental status of Tampa Bay was not considered to be acceptable by the participants. The need is for a larger effort to develop and implement a restoration and enhancement plan for Tampa Bay. A related need is for a local institution to take a lead role in the restoration effort. The Tampa Port Authority was suggested as a possible candidate for this lead role because of its unique position as both a development and regulatory-owner agency. Some other organization (e.g., Tampa Bay Regional Planning Council) might be more appropriate. Regardless, the need for a comprehensive environmental management and restoration plan was clear at the workshop.

The implication for the Fish and Wildlife Service is that mitigation recommendations need to be compatible with and contribute to accomplishing the goals of a larger restoration and enhancement effort. Participants suggested that a continued involvement of local representatives in analyzing the options developed at the workshop would help in this respect.

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16. Abstract (Limit: 200 words)

The results of a workshop to identify mitigation options for the effects of port development and maintenance in Tampa Bay are reported. The types of mitigation were divided into two classes; 1) those which reduce the impacts of development actions, and 2) those that compensate for unavoidable impacts. Impacts associated with various types of development activities were identified and mitigation options for these were discussed. The habitats considered important for functioning of the bay and those which have been most affected by past development actions were suggested and historic needs and probable future trends in quality and area of habitat were discussed. Mitigation options to prevent further loss in these habitats were proposed. A recognition that the environmental problems of Tampa Bay transcend those resulting from port development and the need for an agency to have responsibility for addressing these problems was expressed.

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