Section 4

Plan Formulation

This section documents the feasibility phase plan formulation that was conducted for the Poplar Island habitat restoration project. Prior to initiation of the feasibility study, an intense evaluation of potential dredged material management options has been ongoing, conducted by a multi-agency group representing Federal, State, and local governments, members of the academic community, groups concerned with protection of the environment, parties involved in maritime commerce, and parties whose livelihood is dependent upon the quality of Bay waters (Section 2). This effort has included a Governor's Task Force on Dredged Material and the MPA's Dredging Needs and Placement Options Program. Over the past several years, an extensive list of potential alternatives have been developed and, subsequently, refined based on cost, engineering feasibility, and environmental concerns. These options included identifying potential placement sites that would promote fish and wildlife enhancement. In order to meet the short-term dredged material placement needs, three beneficial-use projects were identified: 1. restorations of Poplar and Bodkin Islands, including creation of wetland and wildlife habitats, 2. island restoration, and 3. beach renourishment at HMI. However, of these, only the restoration of Poplar Island remains as a viable alternative. Subsequent to the identification of Poplar Island as a potential project, the MPA contacted USACE, and this feasibility study was initiated. The details of the plan formulation process conducted as part of this study follow.

4.1 Federal Objective

The Federal objective of water and related land resources project planning is to contribute to the national economic development (NED) consistent with protecting the nation's environment pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. This objective was established by the U.S. Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* dated 10 March 1983.

Water and related land resources project plans are to be formulated to alleviate problems and take advantage of opportunities that contribute to this objective. Contributions to NED increase the net value of the national output of goods and services expressed in monetary units (that is, benefits exceed costs). These contributions are the direct net benefits that accrue in the study area and in the rest of the nation. They include increases in the net value of goods and services that are marketed (vendible) and also of those that may not be marketed.

The USACE maintains the 126 miles of Federal navigation channels that serve the Port of Baltimore. Demands for placement areas and funding constraints have caused the existing HMI placement facility to be filled in less time and with a mixture of clean and contaminated material. As a result, the site is expected to reach its capacity, be capped with clean material, and

unavailable for use by the year 1998. A disruption in the maintenance of the Federal project due to lack of placement capacity would result in significant adverse effects to both the local and national economy. The Port handles approximately 350,000 containers of cargo and generates 87,000 jobs. Revenue impact from the Port resulted in earnings of $1.3 billion for firms in the maritime sector, contributes nearly $3 billion in business, and represents one-tenth of Maryland's gross state product. The Poplar Island restoration project represents a cost-effective and environmentally beneficial solution to the dredged material placement problems facing the MPA.

Since benefits of fish and wildlife habitat restoration and creation are not amenable to traditional NED benefit analyses, criteria contained in Policy Guidance Letter No. 24, CECW-PA, March 27, 1991; Engineering Circular (EC) 1105-2-209, CECW-P, March 20, 1995; and Institute of Water Resources Report #95-R-1, May 1995, were used to define the Federal objective. Those criteria include the following:

1. *Project outputs will be primarily for the benefit of fish and wildlife habitat.*

2. *Implementation of projects for ecosystem restoration must be in connection with dredging for construction, operation, or maintenance by the Corps of Engineers of an authorized Federal navigation project including harbors, inland harbors, and inland waterways.*

3. *Project outputs must address significant resources (based on public, scientific, and institutional considerations). Incremental analysis techniques should be used to optimize return on investment.*

4. *Habitat outputs will be documented with qualitative and quantitative procedures such as the Habitat Evaluation Procedure (HEP).*

The Federal objective of restoring fish and wildlife habitat is based on the 31 August 1995, ER entitled *Implementing Ecosystem Restoration Projects in Connection with Dredging*, as well as numerous other Federal laws, regulations, and executive orders.

The problem that has been evaluated in this study is the restoration of fish and wildlife habitat using dredged material from an authorized Federal navigation project. Efforts were undertaken to evaluate opportunities either to restore habitat or to construct new habitat in areas that would provide an appropriate setting for fish and wildlife habitat.

Unlike traditional Civil Works water resource projects, environmental restoration projects need not contribute to national economic development. The Federal objective of environmental restoration for the Corps of Engineers is to restore significant fish and wildlife habitat. As defined by Engineering Regulation (ER) 1105-2-100, significance is based on institutional, public, and technical recognition.

The significance of the fish and wildlife resources of the Chesapeake Bay is widely recognized by the institutional, public, and technical sectors, both within the Chesapeake Bay watershed and also in a larger regional context as evidenced by the new emphasis on the tributary strategies to restore the Chesapeake Bay. Over the past 20 years, extensive efforts have been expended to support natural resources management and restoration plans in the Chesapeake Bay region.

Wetland and island habitats support a number of nationally significant species such as anadromous fishes and waterfowl. Island habitats are significant because they provide isolated areas devoid of human disturbance and they have fewer predators than mainland habitats. Significance based on institutional recognition means that the importance of an ecological resource is acknowledged in the laws or policy statements of public agencies or private organizations. From an institutional focus, the significance of wetland functions is nationally recognized, and wetlands are now protected by various executive orders and Federal, state, and local laws and regulations.

Some of the numerous Federal laws, regulations, and executive orders that recognize the significance of aquatic, bottomland, and wetland habitats and their related species include the following:

- Anadromous Fish Conservation Act
- Emergency Wetlands Resources Act of 1986
- Fish and Wildlife Coordination Act of 1958
- Migratory Bird Conservation Act
- Migratory Bird Treaty Act of 1969
- National Environmental Policy Act of 1969
- Executive Order 11990 Protection of Wetlands (1977)
- Watershed Protection and Flood Prevention Act (as amended, 1986)
- Federal Water Pollution Control Act of 1987 (Clean Water Act)
- Land and Water Conservation Act of 1987
- Coastal Zone Management Act of 1990
- President's Initiative - Protecting America's Wetlands: A Fair, Flexible and Effective Approach, August 24, 1993

There are also a broad range of regulations that reflect the significance of aquatic, bottomland, and wetland ecosystems on the regional and local level. Some of these include the following:

- State of Maryland Critical Areas Law (1989)
- State of Maryland Title 8, Subtitle 05, Chapter 9 Wetlands Regulations (1990)
- State of Maryland Nontidal Wetlands Protection Act (1990)

In addition, the charters, by-laws, and formal policy statements from private groups also indicate intense interest from citizens. Some of these groups are listed below:

- Alliance for the Chesapeake Bay
- Chesapeake Bay Foundation
- Ducks Unlimited, Inc.
- Save our Streams
- Trust for the Public Lands

These lists demonstrate the substantial Federal, regional, local, and private significance placed on the restoration, enhancement, and preservation of these types of habitats.

Significance based on public recognition means that some segment of the general public recognizes the importance of an ecological resource. Public recognition of the significance of the resources within the study area is demonstrated in the formation of local citizens groups and in the willingness of the public to be involved in activities designed to restore or enhance environmental resources. Non-profit organizations such as Save the Bay have organized programs to educate citizens on ways to protect and improve the Chesapeake Bay. Through this program, volunteers have participated in activities such as storm drain stenciling, reminding everyone that the drains ultimately connect with the Chesapeake Bay. Public support for the restoration of the Chesapeake Bay is very strong today and continues to grow each year.

Maryland's participation in the Chesapeake Bay Partnership Agreement is further evidence of the importance the state attaches to the restoration of the living resources of the Chesapeake Bay. This agreement has resulted in the development of the State Tributary Strategies, which has as its goal a 40-percent reduction in the amount of nitrogen and phosphorous entering the Bay by the year 2000. On the Federal level, the development of the Federal Agency Ecosystem Agreement is evidence that a Federal interest exists in successfully restoring ecosystems. This agreement, which has been signed by numerous Federal agencies, has as its goal the development of cross-agency ecosystem planning and management in order to restore and protect the ecological integrity, the productivity, and the beneficial uses of the Chesapeake Bay system.

Further evidence of the significance of this project is provided by the wide support it has received from various public agencies and groups: the Alliance for the Chesapeake Bay, the Chesapeake Bay Foundation, the Chesapeake Bay Program, DNR, EPA, the Maryland Charter Boat Association, MDE, MES, MPA, the Maryland Saltwater Sportfishermens Association, the Maryland Watermen's Association, NMFS, NOAA, the Talbot County Council, and USFWS.

The technical significance of wetland, bottomland, and aquatic functions are nationally recognized and are now protected by various executive orders and by Federal, state, and local laws and regulations, as shown above. Significance based on technical recognition means that the importance of an ecological resource is based on scientific or technical knowledge or on critical resources characteristics. The scientific community has documented the importance of the restoration of wetlands, streams, and riparian corridors through research conducted to develop the goals of the Chesapeake Bay Agreement.

Scarcity, a measure of a resource's relative abundance within a specified area, is one of the many criteria that may assist in determining technical significance. Offshore islands are a unique ecosystem component in the Chesapeake Bay watershed. These valuable island habitats are becoming more and more scarce throughout the Chesapeake Bay. In the last 150 years, it has been estimated that 10,500 acres have been lost in the middle eastern portion of the Chesapeake Bay alone. Uplands are very significant for migratory birds, waterfowl, and shorebirds. These species need both uplands and wetlands. Within the study area, islands and wetlands are rapidly becoming scarce.

The concepts of scarcity and significance also play important roles in determining whether or not it is in the Federal interest to undertake a project, and what priority a particular project will have. Recommendations for USACE environmental restoration actions are based on the scarcity and the significance of the environmental resources impacted, as well as on the feasibility of restoring or creating the affected resource.

4.2 Planning Objectives and Constraints

Planning objectives and constraints are expressions of public and professional concerns about the use of water and land-related resources in a particular study area. These planning objectives and constraints result from the analyses of existing and future conditions within the context of the physical, environmental, economic, and social characteristics of the study area. They are used to guide the formulation of alternatives and to evaluate the effectiveness of those alternatives.

The planning objective of the Poplar Island Restoration Study is to use clean dredged material to protect, restore, and create aquatic and ecologically related habitat at Poplar Island, Maryland. The project proposes to use approximately 38 million cubic yards of clean dredged materials beneficially to recreate fish and wildlife habitat.

The main constraint on the study was the requirement to utilize sediments dredged from the Baltimore Harbor and Channels Federal navigation project. Only "clean material" from these channels (i.e., the southern approach channels) is to be used for this restoration project. Due to the shortage of placement site capacity for the Baltimore Harbor and Channels project, as well as other channels serving the Port of Baltimore, there is a lot of pressure to maximize capacity with this project. However, the objective is to maximize the quality and quantity of fish and wildlife habitat being created, and any additional capacity gained by the plan that maximizes outputs is incidental. In weighing the environmental outputs of alternative plans, it was also necessary to balance the type of habitat being created against the type of habitat being lost as a result of the construction of this project. The involvement of the multi-agency DNPOP working group helped to ensure that objectives and constraints were fully considered during the plan formulation process.

4.2.1 Environmental Objectives and Constraints

The primary environmental objective for this project is to restore remote island habitat. Not only is this type of habitat scarce and significant, but so is the opportunity to restore and protect this type of habitat. At least thirteen remote islands have been lost in their entirety to erosion and only seven or so that remain, all further from the target channels than Poplar Island. Opportunities for establishment of remote island habitat in the Bay are rare. The capability of the created upland to interact with the substantial adjacent wetlands acreage increases the value of this opportunity.

Several environmental goals were identified for the restoration: (1) creating bare or sparsely vegetated islands as nesting habitat for colonial waterbirds such as terns, (2) creating vegetated islands for waterbirds such as egrets and herons, (3) creating tidal marsh to provide habitat for fish and wildlife and to provide food web support for the Chesapeake Bay ecosystem; (4) create a diversity of habitats to benefit a wide range of fish and wildlife; (5) creating quiescent conditions for SAV recovery; and (6) minimize and offset loss of benthic habitat.

4.2.2 Engineering Objectives and Constraints

The primary engineering objective is to protect and enhance the remnant islands of the archipelago that have waterbird colonies. An initial assumption was that the project would consider restoration of Poplar Island to approximately its 1847 footprint.

4.2.3 Economic Objectives and Constraints

The primary economic objective is to ensure that the recommended plan is the most cost-effective at accomplishing the other objectives. Selection of the preferred alternative weighs the environmental benefits to be derived versus the need to minimize the cost.

4.3 Formulation and Evaluation Criteria

The formulation process used to develop and evaluate alternatives is based on the consideration of measures with the potential for addressing the planning objective and meeting technical, environmental, and socio-economic criteria. These included the following:

4.3.1 Formulation Criteria

Engineering and Design Criteria

- Ensure that alternative plans are complete, efficient, safe, and feasible.
- Ensure that alternatives are designed in a cost-effective manner.
- Coordinate designs and layout of alternatives with the MPA and the environmental community.

Environmental Criteria

- Avoid detrimental impacts to the environment and/or include features to mitigate any adverse effects.
- Minimize impacts to recreation.
- Minimize aesthetic impacts.
- Provide alternatives that are acceptable to other Federal, state, and local environmental agencies.

Socio-Economic Criteria

- Protect public health, safety, and well being.
- Respond to sponsor concerns and desires.
- Identify alternatives preferred by the Baltimore maritime and environmental community.
- Identify alternatives that maximize placement capacity and minimize placement costs.

Specific solutions were selected and analyzed based on the measure most likely to demonstrate that a feasible plan of improvement exists. In addition, the District evaluated potential base plans for maintenance dredging in order to define the incremental project costs.

Alternatives were formulated and evaluated on the basis of technical, economic, and environmental criteria. These criteria allow for the development of options that best respond to the planning objective. In order to evaluate the technical benefits of the various alternatives formulated, a detailed field investigation and modeling analysis was performed. In order to evaluate the economic benefits of the various alternatives formulated, a cost comparison was made.

4.3.2 Evaluation Criteria

To evaluate the alternatives formulated, a list of species and species associations as indicators of the Chesapeake Bay's ecological condition was considered. Alternative restoration configurations and habitat to be produced by each alternative were defined and details regarding specific attributes for each habitat type (e.g., low marsh characteristics) and a comprehensive list of species expected to utilize each habitat type were prepared. Selection of the preferred alternative weighs the environmental benefits to be derived versus the need to minimize the cost. In order to evaluate how well each alternative met these environmental objectives, it was necessary to quantify or rank the value of the environmental outputs that would be produced by each configuration. A cost-effective analysis was completed with the above information.

The Chesapeake Bay Program initially identified an extensive list of species to represent all aquatic habitats, salinity and depth zones, and trophic levels. They then selected indicator species from the larger list based upon commercial, recreational, ecological and aesthetic significance. The indicator species were selected to characterize all habitat types and trophic levels in the Chesapeake Bay with a manageable subset of representative species. Not all species are meant as indicators of recovery; rather, the abundance of some species reflect the habitat quality, quantity or diversity of the area. Therefore, the species on the list may have commercial

and/or recreational importance and due to abundance, productivity or distribution, are important in the flow and accumulation of energy through various trophic levels of the Chesapeake Bay ecosystem. The species are intended to be surrogates for the larger bay ecosystem through their habitat and food chain requirements and ecological associations. Maintenance of these indicator species should help ensure the ecological "wellness" and diversity of the Chesapeake Bay ecosystem.

A subset of the Chesapeake Bay Program's species indicator list, which will benefit from the proposed Poplar Island restoration, was provided. These species require the types of aquatic, forest/shrub, and/or wetland habitat that are proposed in this study. The key indicator species are as follows:

Birds

Nesting

American Black Duck *(Anas rubripes)*
Snowy Egret *(Egretta thula)*
Little Blue Heron *(Egretta caerulea)*
Least Tern *(Sterna antillarum)*
Common Tern *(Sterna hirundo)*
Bald Eagle *(Haliaeetus leucocephalus)*

Feeding and Roosting

American Black Duck *(Anas rubripes)*
Snowy Egret *(Egretta thula)*
Little Blue Heron *(Egretta caerulea)*
Dowitchers *(Limnódromus* spp.*)*
Whimbrels *(Numénius phaéopus)*

Reptiles

Nesting

Diamondback Terrapin *(Malaclemys terrapin)*

Fish

Open Water

Spot *(Leiostomus xanthurus)*
Black Drum *(Pogonias cromis)*
Weakfish *(Cynoscion regalis)*
Spotted Sea Trout *(Cynoscion nebulosus)*
Blue Fish *(Pomatomus salatrix)*
Striped Bass *(Morone saxatilis)*
Summer Flounder *(Paralichthys dentatus)*
Winter Flounder *(Pleuronectes americanus)*

Low Marsh

Spot *(Leiostomus xanthurus)*
Killifish *(Fundulus* spp.*)*

High Marsh

Mummichog *(Fundulus heteroclitus)*
Rainwater Killifish (*Lucania parva*)
Sheepshead Minnow *(Cyprinodon variegatus)*

Jetties

Bluefish *(Pomatomus saltatrix)*
Striped Bass *(Morone saxatilis)*

Invertebrates

Low Marsh	High Marsh
Palaemonid Shrimp	Palaemonid Shrimp
Penaid Shrimp	
Blue Crab (*Callinectes sapidus*)	

All the species potentially can use or are using the Chesapeake Bay watershed at some point in their life histories. The restoration of Poplar Island will benefit these significant indicator species. Therefore, if these species will benefit, the Chesapeake Bay ecosystem should be improved. The following is a brief description of several of these species and their habitat requirements, taken from *Habitat Requirements for Chesapeake Bay Living Resources* (Funderburk, *et al*, 1991) and various U.S. Department of the Interior, Fish and Wildlife Service, Biological Reports.

American Black Duck *(Anas rubripes)*

The black duck is a dabbling duck that inhabits inland and emergent wetlands throughout Chesapeake Bay to migrate, breed, and winter, principally around the mid-Eastern Shore and Western Shore of Virginia. Black ducks are omnivores, consuming small fish, mollusks, and a variety of vegetation, including SAV and agricultural crops. SAV is extremely important to black duck nesting in brackish and salt marshes. Black ducks provide a valuable link between herbaceous plants and invertebrates and higher predators, including bald eagles, foxes, and great horned owls. During the 1950's, a large portion (20 percent) of the continental population of black ducks wintered on Chesapeake Bay. Up to 224,000 birds used the Bay then, whereas now the annual wintering population averages about 30,000. In order to replenish the population of black duck, refuges should be expanded and SAV restored.

Colonial Wading Birds (Herons and Egrets)

Six species of colonial nesting wading birds -- the great blue heron, great egret, snowy egret, little blue heron, green-backed heron, and black-crowned night heron -- are prominent avian residents of the Chesapeake Bay region. Colonial wading birds are extremely predaceous, feeding mostly on small fish, amphibians, crustaceans, and aquatic insects in a variety of aquatic habitats. All six species breed in the Chesapeake Bay and migrate south in the winter, although some are year-round residents. Most birds begin to arrive on the Chesapeake breeding grounds from mid-March to mid-June. Nesting habitat common to all six species includes the presence of woody vegetation and isolation from human and animal predators. Great blue herons prefer tall trees (7-10 m), either live or dead, inhabit both hardwoods and evergreens, and avoid areas with human activity. The largest colonies are found in the upper reaches of the Bay in woodland swamps adjacent to large tributaries. Black-crowned night herons, great and snowy egrets, and little blue herons tend to nest on islands with shrubby vegetation, often in mixed-species colonies. Green-backed herons are the most solitary nesters of the group, but at times can be found with other herons and egrets. They use both shrubs and small trees and can often be found nesting on duck blinds. Populations of these species appear to be stable, with the

exception of the little blue heron, which has declined. Numbers of great blue herons may actually be increasing, although higher population counts may be attributable to expanded inventory areas. The Bay region contains the five largest Atlantic Coast colonies of great blue herons. There are several factors of concern for this population. These include (1) loss of water quality necessary to support SAV beds (hence loss of good nursery areas for fish and crabs); (2) loss of wetlands due to siltation, agriculture, and sea level rise; (3) disturbance at islands or other colony sites by boaters and other types of human activity.

Least and Common Tern *(Sterna antillarum* and *Sterna hirundo)*

These terns breed along coastal and freshwater habitats of North America. Breeding habitat is generally characterized as open sand, soil, or dried mud in the proximity of a lagoon, estuary, or river. Terns in marine environments nest on islands, peninsulas, beaches, sandbars, and isolated sandpits, usually between the high tide line and the area of dune formation. On the Atlantic coast, terns commonly nest on dredged material. The terns have suffered a significant loss of nesting and feeding habitat from human activities, including recreational use and habitat modification due to development. Development of island habitat would help to offset this loss.

Bald Eagle *(Haliaeetus leucocephalus)*

Bald eagles are predators known for their fish-eating habits. They are also opportunistic scavengers, consuming a variety of species. In the Chesapeake Bay, adult eagles generally remain in their nesting territories throughout the year. They nest along the undeveloped shorelines of the Bay, usually within 1 km of the water. Nesting densities are greatest along the Potomac and Rappahannock Rivers and in Dorchester County, Maryland. The habitat required by eagles can be described as shoreline with minimal human disturbance, having large old-growth forest stands with large (50 cm diameter) trees adjacent to undisturbed waters that harbor abundant fish and waterfowl. Chesapeake Bay may once have provided habitat for as many as 3,000 pairs of bald eagles but due to habitat destruction, shooting, and contamination by chemicals, the population declined to a low of 80 to 90 breeding pairs in 1970. Following a ban on the use of dichloro-diphenyl-trichloro-ethane (DDT), the population increased to 185 pairs in Maryland and Virginia by 1989. The greatest threat to the Chesapeake eagle today is the loss of shoreline forests that they need for nesting, roosting, and perching. These forests are rapidly being developed for human use.

Diamondback Terrapin *(Malaclemys terrapin)*

The diamondback terrapin occurs in a narrow strip of salt and brackish water habitats along the Atlantic and gulf coasts of the United States from Cape Cod, Massachusetts, to Corpus Christi Bay, Texas. Diamondback terrapins along the Atlantic coast have been reported in brackish estuarine environments including salt marshes, tidal flats, and creeks, sounds behind barrier islands, and brackish lagoons and impoundments. Terrapins live in coastal marshes, tidal creeks and channels, coves, estuaries, and lagoons behind barrier beaches. Marsh grass or cord grass *(Spartina alterniflora)* is the typical vegetation associated with the aquatic habitats of diamondback terrapins along the Atlantic coast. The alteration of estuarine areas, however, poses an imminent threat to many populations today.

Spot *(Leiostomus xanthurus)*

Spot is an abundant marine and estuarine bottom-foraging species. These fish occupy all areas of the Bay except in winter, when they migrate to coastal waters or concentrate in deep-water refuges in the Bay. Spot are tolerant of a range of environmental conditions, generally preferring brackish to saline waters above mud substrates in the Bay, although they can be found at all water depths. They are short-lived coastal spawners with excellent reproductive capacity; major predators of shallow benthic invertebrate communities in the Bay; and important prey to a host of predatory fish. The larvae consume zooplankton. Spot support a modest commercial fishery.

Weakfish *(Cynoscion regalis)*

Weakfish occur along the Atlantic coast of the United States from southern Florida to Massachusetts Bay. They are one of the most abundant fishes in the estuarine and nearshore waters of the Atlantic coast. It is a valuable recreational species and a major component of the gill-net, pound-net, haul-seine, and trawl fisheries along the coast. The Chesapeake Bay region (Maryland and Virginia) contributed most to the coasts total weakfish landings in the 1940's. However, total weakfish landings have dropped off significantly since that time.

Spotted Seatrout *(Cynoscion nebulosus)*

Spotted seatrout are distributed mainly in coastal estuaries of the western Atlantic Ocean from New York to Florida. The species is commercially valuable from Virginia to Mexico. The following are important habitat suitability factors for spotted seatrout: (1) the presence of large areas of shallow, quiet, brackish water; (2) the absence of predators; (3) the absence of competitors; (4) the presence of large areas of SAV; and (5) an abundance of grazing crustaceans and fishes. Spotted seatrout prefer water of low turbidity. High turbidity has been attributed to increased mortality.

Bluefish *(Pomatomus salatrix)*

The bluefish is abundant in estuarine and continental shelf waters of the east coast of North America from Nova Scotia southward to Florida. The bluefish is an important recreational and commercial fish along the Atlantic seaboard. Due to their abundance and high trophic level, bluefish play a major ecological role in estuarine and continental shelf waters and are dependent on these habitats for spawning and nursery areas. No other Atlantic coast species is as abundant throughout such a wide range and variety of habitats.

Striped Bass *(Morone saxatilis)*

The striped bass or rockfish is a large anadromous fish that is found along the entire East Coast of North America. Most of the Atlantic coastal migratory stock originates in the Chesapeake Bay. Striped bass are voracious predators who feed on a variety of fish. Early life stages are important prey for other species. Striped bass previously supported a major fishery throughout the Atlantic Coast states, although declining populations have forced restrictive harvest regulations in the Chesapeake Bay. The decline in striped bass stocks began in the mid-1970's,

primarily because of overfishing. Recently, increased stocks and stronger recruitment have resulted in the limited commercial and recreational fisheries being reopened. Suggested measures to assist in the continued repopulation of the species include increasing DO, reducing turbidity, and improving water quality habitat in spawning habitats.

Summer and Winter Flounder *(Paralichthys dentatus* and *Pleuronectes americanus)*

The summer flounder is found along the Atlantic coast from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina, while the winter flounder is most common in estuaries between the Gulf of St. Lawrence and the Chesapeake Bay. Both types of flounder are an important commercial and recreational species along the Atlantic seaboard of the United States.

Killifish and Mummichog *(Fundulus* spp. and *Fundulus heteroclitus*)

Killifish and mummichog are found the entire length of the Mid-Atlantic region close to shore. Although they are not valued as commercial or sport fishes, they are important in the food chain because of their distribution and abundance. These fish are the major prey for wading birds, piscivorous ducks, and many predatory fishes. These predators include herons, egrets, terns, striped bass, and bluefish.

Section 5 describes in more detail how the various formulation and evaluation criteria outlined above were applied.