Maryland Coastal Bays Aquatic Sensitive Areas Initiative

Technical Report

June 2004
Maryland Coastal Bays Aquatic Sensitive Initiative

Technical Report

Based on information provided by the Coastal Bays Sensitive Areas Technical Task Force

Prepared in Connection with:

Document Prepared by: Mary Conley
Maryland Department of Natural Resources
Coastal Zone Management Division
Acknowledgments

Sensitive Areas Technical Task Force Members

Lenore Bennet – MCBP – CAC – Purdue
Betty Ann Blanchard – DNR – Geographic Information Systems
David Blazer, MCBP
Jim Casey, DNR – Fisheries Service
Mary Conley, DNR – Coastal Zone Management
Katheleen Freeman, DNR – Coastal Zone Management
David Goshorn, DNR – Tidewater Ecosystem Assessment
Mark Homer, DNR – Fisheries Service
David Honick, Worcester County - Planning
Larry Hyman, DNR – Wildlife Division
Julia Mensler, Worcester County - GIS
John Roeder, MCBP – Citizen’s Advisory Committee
Gwynne Schultz, DNR - Coastal Zone Management
Scott Smith, DNR – Heritage
Court Stevenson, UM – Center for Environmental Studies
Eric Stiles, Worcester County - GIS
Brian Sturgis, NPS - Assateague Island
Mitch Tarnowski, DNR – Fisheries Service
Cathy Wazniak, DNR – Tidewater Ecosystem Assessment
Cornelia Pasche Wikar, DNR - Coastal Zone Management
Carl Zimmerman, NPS – Assateague Island

Additional Assistance
Peter Bergstrom, USFWS
Steve Doctor, DNR – Fisheries Service
Doug Forsell, USFWS
Zoë Johnson, DNR – Coastal Zone Management
Mike Naylor, DNR – Tidewater Ecosystem Assessment
Dave Nemazie, UM – Center for Environmental Studies
Tom Parham, DNR – Tidewater Ecosystem Assessment

Maryland Coastal Bays Program Scientific and Technical Advisory Committee
Maryland Coastal Bays Program Implementation Committee
Maryland Coastal Bays Program Citizen’s Advisory Committee
# Table of Contents

<table>
<thead>
<tr>
<th>Title</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Sensitive Areas Identification Process</td>
<td>3</td>
</tr>
<tr>
<td>Sensitive Resources</td>
<td></td>
</tr>
<tr>
<td>Benthic Organisms (non-commercial)</td>
<td>4</td>
</tr>
<tr>
<td>Blue Crab</td>
<td>7</td>
</tr>
<tr>
<td>Colonial Waterbirds</td>
<td>9</td>
</tr>
<tr>
<td>Diamondback Terrapin</td>
<td>11</td>
</tr>
<tr>
<td>Finfish</td>
<td>14</td>
</tr>
<tr>
<td>Horseshoe Crabs</td>
<td>17</td>
</tr>
<tr>
<td>Intertidal Invertebrates</td>
<td>20</td>
</tr>
<tr>
<td>Rare, Threatened and Endangered Species</td>
<td>23</td>
</tr>
<tr>
<td>Seagrasses</td>
<td>25</td>
</tr>
<tr>
<td>Shellfish</td>
<td>28</td>
</tr>
<tr>
<td>Shorebirds</td>
<td>31</td>
</tr>
<tr>
<td>Tidal Wetlands</td>
<td>34</td>
</tr>
<tr>
<td>Sensitive Resources Mapping Exercise</td>
<td>37</td>
</tr>
<tr>
<td>Sensitive Areas Ranking and Mapping</td>
<td>40</td>
</tr>
<tr>
<td>Aquatic Sensitive Areas Maps</td>
<td>44</td>
</tr>
<tr>
<td>Identified Data Gaps</td>
<td>46</td>
</tr>
<tr>
<td>Threats</td>
<td>49</td>
</tr>
<tr>
<td>Resource Bibliography</td>
<td>51</td>
</tr>
<tr>
<td>Appendix A – Aquatic Sensitive Resource Maps</td>
<td>56</td>
</tr>
<tr>
<td>Appendix B – Metadata</td>
<td>67</td>
</tr>
</tbody>
</table>
Introduction

The Maryland coastal bays are a unique ecosystem with an important ecological, recreational and commercial role in Maryland. Located behind the Atlantic coast barrier islands the coastal bays are a shallow water system composed of five bays – Assawoman, Isle of Wight, Sinepuxent, Newport and Chincoteague (Figure 1). The collective watershed of these bays encompasses approximately 175 square miles of Maryland’s coastal plain. It supports rare and threatened plant species, forests and wetlands vital to migratory shorebirds and waterfowl, and numerous important commercial and recreational fin and shellfish species. While the coastal bays have such ecological diversity, the region is also experiencing rapid population increases. The Worcester County population of approximately 40,000 is expected to double by the year 2020. During the summer months, the population of Worcester County swells to over 300,000 each weekend.

It is the balance between management of the coastal bays resources, growth and development that led to the formation of the Maryland Coastal Bays Program (MCBP) in 1996. Over a three-year period, stakeholders from across the state and region evaluated the coastal bays and created a management plan for restoration and protection. In July 1999 the Maryland Coastal Bays Program Comprehensive Conservation Management Plan (CCMP) was approved and signed by Maryland Governor Parris Glendening.

The coastal bays CCMP is comprised of four Action Plans for the long-term restoration and protection of the coastal bays: 1) water quality, (2) fish and wildlife, (3) recreation and navigation, and (4) community and economic development. Each Action Plan contains goals, challenges, solutions, and strategic actions. The implementation of specific action items set forth under Goal 3 of the Recreation and Navigation Action Plan is the subject of this report.

Goal 3 of the Recreation and Navigation Action Plan establishes the need to “balance resource protection with recreational use.” The Action Plan recommends implementation of eight action items to meet the challenge of reducing resource impacts from water-based activities (RN 3.1). Action 1, calls for an interagency task force of resource experts to be convened by the Maryland Department of Natural Resources (DNR). DNR convened the Sensitive Areas Technical Task Force (Task Force) in September 1999.

To date, the Task Force has worked to (1) identify and describe sensitive aquatic resources in the coastal bays, (2) map identified resources, (3) create a map of potentially sensitive areas based on resource rankings, (4) identify gaps in information and (5) evaluate the relationship between...
aquatic resources and water-based threats. This report provides an overview of these activities.

The report contains the following sections:

- Identification Process – Describes the Sensitive Areas Initiative and the efforts currently underway to develop aquatic areas maps and an associated management plan.
- Resource Descriptions – Provides general information on the aquatic sensitive resources identified by the Task Force.
- Resource Mapping – Includes a brief overview of the sensitive resources mapping process.
- Rankings and Mapping – Describes the resource characteristics ranked for development of sensitive areas maps, including data used and information gaps.
- Gap Identification – Lists the gaps identified by the Task Force.
- Threats – Briefly describes the relationship between water-based activities and the aquatic resources.
- Next Steps – Discusses how the sensitive areas initiative will continue through the management and outreach stages.
- Bibliography – Lists resources available for additional information.
- Metadata Appendix – Provides metadata for the sensitive resource mapping exercise.

The purpose of this document is to share the information learned by the Task Force with policy makers, scientists and the public. The information and maps will form the resource basis for upcoming planning and management activities scheduled to take place in the coastal bays and its watershed. It is expected that this document will support multiple projects beyond the original sensitive areas initiative.
Sensitive Areas Identification Process

Coastal Bay Comprehensive Conservation and Management Plan
The Comprehensive Conservation and Management Plan (CCMP) for Maryland’s Coastal Bays is comprised of four Action Plans for the long-term restoration and protection of the coastal bays: Water Quality, Fish and Wildlife, Recreation and Navigation, and Community and Economic Development. Each Action Plan contains goals and actions presented as specific and attainable tasks. Together, these actions “to restore and protect the bays” constitute the program’s goals for managing this vital natural and economic resource (CCMP, 1999).

Sensitive Areas Goal
The Sensitive Areas Initiative stems from Goal 3 of the Recreation and Navigation Action Plan, “to balance resource protection with recreational use.” The challenge identified in the Action Plan, to “reduce impacts from water-based recreational activities” reads as follows:

Certain water-based recreational activities are thought to be incompatible with long-term protection of coastal bays resources. The presence of too many boats and personal watercraft (PWC) in sensitive areas poses threats to natural resources due to pollution, direct impacts and excessive noise. Action is needed to identify sensitive estuarine resources, evaluate the risks from recreational activities, and develop appropriate management tools to mitigate those threats.

This document represents the initial efforts to accomplish the first three actions listed under Recreation and Navigation Goal 3, Challenge RN 3.1:

1) The Department of Natural Resources will convene an interagency Task Force of resource experts to (a) evaluate resource sensitivity and threats and (b) establish priorities for protection, emphasizing activities and locations having the greatest negative impacts.
2) DNR will develop maps of sensitive resource locations throughout the entire bay system.
3) DNR will identify outstanding research/information needs related to recreational activity effects on natural resources.

Sensitive Areas Technical Task Force
The Sensitive Areas Technical Task Force was formed in September 1999. Its membership includes resource experts from county, state and federal agencies and universities, as well as, citizens and Coastal Bays Program personnel. The Task Force was charged with taking a resource-based approach to identifying the sensitive natural resources in the coastal bays. In addition, the Task Force was asked to determine how to map the resources and to identify water-based activity threats. This document contains descriptions of the recognized sensitive resources in the coastal bays, maps of where these resources are located, rankings of resources to identify sensitive areas, gaps in information and data, and an initial review of threats.
Sensitive Resources
The identification of sensitive resources was one of the first steps undertaken by the Task Force. Based on the scope of the initiative, aquatic and tidal resources were considered by Task Force members. During discussion, it was recognized that both species and their related habitats were identified, leading to concern that some resources were being counted multiple times. The resources described below are the final result of Task Force discussions. In most cases the species was kept as a “sensitive resource” while the habitats were considered during the mapping exercises. In some cases, “sensitive resources” could qualify as both species and habitat, i.e. seagrasses and wetlands. Both seagrasses and wetlands were considered priority resources by the Task Force and therefore have been kept. Meeting records provide a more detailed accounting of the decision-making process.

Task Force members prepared a summary for each identified resource. The summaries include: (1) resource identification, (2) resource sensitivity, (3) data availability, (4) gaps in information, and (5) threats.

Benthic Organisms (non-commercial)

Resource Identification:
The coastal bays of Maryland belong to a highly changeable system, with extremes in conditions including both regular, seasonal fluctuations and unpredictable, sometimes catastrophic disruptions. Such natural physical disturbances are recognized as a structuring force in many communities. Since communities can become established in dynamic, naturally disturbed environments such as the Maryland coastal lagoons, they are necessarily adapted to accommodate disruption. For example, many of the species that presently inhabit the coastal bays can rapidly exploit new habitats resulting from disruptions through life history strategies such as high fecundity, larval dispersion, and quick generational turnover. It is within the extremely variable set of conditions existing in the Maryland coastal bays that the benthic faunal community has developed.

The benthic invertebrate communities in much of the Maryland coastal bays are relatively young, only on the order of seventy years old. They formed in the aftermath of the Great Storm of 1933, which tore out an inlet at Ocean City, flooding the brackish bays with ocean water and raising the salinity to levels that had not been seen for several generations. Historically, as inlets were created by storms and filled in again, salinity regimes in the bays rose and fell, with profound consequences for the faunal community. In recent decades this cycle has been interrupted through man’s intervention (e.g. inlet stabilization, breach filling, beach replenishment).

Despite the highly dynamic nature of the coastal bays, they possess a rich diversity of benthic invertebrates - well over three hundred species have been identified to date. The benthic invertebrate community contains representatives of most of the major phyla including but not limited to Porifera (sponges), Cnidaria (anemones), Platyhelminthes (flatworms), Rhynchocoela (ribbon worms), Bryozoa, Mollusca (clams, snails), Annelida (polychaete worms), Arthropoda
Coastal Bays Sensitive Areas
Technical Task Force Report

(crabs, barnacles, horseshoe crabs), Echinodermata (sea stars, sea cucumbers, sea urchins), and Chordata (sea squirts). They range from strictly estuarine to primarily marine species, and are found on or in just about any substrate available to them.

Functionally, benthic invertebrates serve as a key trophic link between primary producers and higher consumers, and can be highly effective predators as well. They are important as biogeochemical agents in benthic-pelagic coupling, with filter-feeders cycling organic matter from the water column to the bottom where deposit-feeders further process the material. In addition, invertebrates can have a pronounced impact on the physical structure of an ecosystem, whether by reworking the sediment, grazing, binding or securing existing substrate through structures such as worm tubes and byssal threads, or building new substrate like oyster reefs. Lastly, many invertebrates are commercially valuable, both directly as a harvestable resource and indirectly as a food source for commercially and recreationally important species including crabs, fish, and waterfowl.

Resource Sensitivity:
The majority of benthic invertebrates are either sedentary or have a limited mobility range. They cannot migrate from areas of unfavorable environmental conditions such as contaminants or low dissolved oxygen levels. Thus, catastrophic events can eliminate entire populations. However, this particular suite of organisms, which is primarily composed of opportunistic species, tends to be adapted to disturbance. Barring some fundamental, long-term change that deleteriously alters the environment of the constituent species (e.g. salinity regime, disease, etc.); these communities are characterized by their rapid recovery in the face of catastrophic disturbance.

Chronic, low-level problems are subtler yet can have significant long-term effects on the benthic community. For example, substrate changes due to shoreline erosion, runoff, or invasion by submerged aquatic vegetation can cause a radical shift in species composition and abundance. Also, most invertebrates are a forage base for higher consumers and bio-accumulated contaminants from runoff, spillage, or leaching can be passed up the food chain. More severe chronic conditions, such as the persistent low dissolved oxygen situation in many of the smaller tributaries and dead end canals that have extensive development, lead to depauperate communities.

Resource Data:
Key sources include:
1. Assateague Ecological Studies, 1969-71. Data are as number per m² and in tables, sample sites are given on maps.
2. MDNR surveys, 1980-81. Most samples from Isle of Wight. Data are in tables (number per unit area) with map of sampling sites.
3. EPA E-MAP Surveys, 1993. Transformed data are given in tables. Sites are depicted on maps. Latitude/longitude sample site information available from EPA.
4. Coastal 2000 Surveys, 2000-03. MDNR sponsored continuation of E-MAP.
5. National Park Service, 1994-96. Box core and trawl samples in Chincoteague and
Sinepuxent Bays. Includes seasonal data. Data available from NPS.

6. MDNR Molluscan Inventory, 1993-96. Population data on individual species (density, distribution, size-frequencies, animal-sediment relationships) and community analyses from Ponar grab and hydraulic dredge samples. Data available with geographic and habitat information.

**Resource Gaps:**
There has never been a synoptic survey of the benthic invertebrate community of the coastal bays. All of the previous studies were limited in geographic, taxonomic or temporal scope, as well as by the gear type employed. A comprehensive survey would require a geographically extensive, seasonally oriented, multiple year effort employing a variety of sampling gears.

Short of such a survey, there are other issues that can be addressed in a more manageable fashion. Foremost is the problem of temporal variability. Most of the studies are essentially snapshots of the community, as it existed at that point in time. None extended beyond three years, so there are no long-term data sets that could be used to detect trends. Furthermore, prior to 1969 very little data is available. The upper bays were not surveyed until about 1980, well after the building boom had gripped Ocean City and the surrounding area. This in effect creates a “rolling baseline”, a baseline of information on an already impacted ecosystem. In addition, only a couple of studies looked at seasonal variability, which appears to be an important factor in species composition and abundance. If trends in the invertebrate community are of concern, the problem of temporal variability must be addressed.

**Resource Threats:**
The benthic community is a diverse assemblage of species, which show a wide range of responses to disturbances. In general terms, threats include shoreline development which may increase sediment and chemical runoff, thereby altering and contaminating the substrate and decreasing dissolved oxygen levels; marinas and marine construction where toxic substances can leach out and small scale oil and other contaminant spills chronically occur (primarily a localized problem in areas with poor water circulation); boat wakes eroding marshy shorelines which alter the subtidal substrate; navigational dredging and spoil dumping; and, large scale oil spills. Perhaps the most insidious threat is the release of potentially destructive non-indigenous species used for bait by recreational fishermen, particularly predators that have the potential to restructure entire communities. The prime example is the green crab, a voracious predator documented to have devastated clam beds in areas of New England, which are often discarded into the bays at the end of a fishing day or manage to surreptitiously escape.

**Resource Indicators:**
Various community attributes or combination of attributes (e.g. density, biomass, species richness and evenness/dominance, species composition, trophic composition) have been used to assess benthic communities. More sophisticated indices, which integrate many of these community parameters have been developed in recent years, such as the EMAP benthic index and the Mid-Atlantic Integrated Assessment Program benthic index of biotic integrity.
Blue Crab

Resource Identification
The blue crab, *Callinectes sapidus*, is a dominant epibenthic predator in estuaries and coastal habitats of the Western Atlantic, Caribbean, and Gulf of Mexico. It is also an economically important resource throughout the region. The coastal bays support an important blue crab fishery that is similar but distinct from the Chesapeake Bay. Fishery independent data from the coastal bays indicate year-to-year variation, but no trends in blue crab abundance. The commercial harvest of blue crabs has also fluctuated without trend. Causes of population fluctuations are poorly understood.

The mean size of blue crabs in the coastal bays is smaller than the mean size of crabs in the Chesapeake Bay. In the coastal bays, 95% of the crabs are less than the minimum legal size of 127mm, while in the Chesapeake Bay, 79.4% of the crabs are below the minimum size. The difference in size can be attributed to higher salinities in the coastal bays. Generally, crabs from higher salinity areas reach maturity at a smaller size than those in lower salinity areas.

Over the last 10 years (1990-1999), annual reported landings have varied from 0.5 million to 1.5 million pounds. In the coastal bays, commercial landings of hard crabs and soft/peeler crabs have been highly variable over the past 26 years.

Resource Sensitivity
Submerged aquatic vegetation (SAV) areas are important nursery habitats for juvenile blue crab for two reasons: (1) SAV provides a refuge from predators. Crabs that are molting are less likely to be spotted and eaten in SAV than in shallow marsh areas without SAV. (2) SAV provides a large abundance of prey.

Resource Data
The Maryland Department of Natural Resources Fishery Service has conducted trawl and seine surveys in the coastal bays since 1972. The primary function of these surveys is to sample the annual relative abundance of juvenile and adult marine species. The annual survey has twenty sites, which are sampled monthly by a 16 foot balloon otter trawl from April through October. Data from the trawl survey is analyzed for trends in abundance and size.

Resource Gaps
The impact of the parasitic dinoflagellate, *Hematodinium perezi* on the blue crab resource in the coastal bays is unknown.

Resource Threats
Threats to the blue crab population:

1) Disease – Adult and juvenile crabs from the coastal bays of the Delmarva peninsula have been found to be infected with an unusual parasitic dinoflagellate, *Hematodinium perezi*.

2) Loss of habitat for over-wintering and molting. This includes seagrass beds and...
marshy, tidal guts.

3) Blue crabs avoid areas with low dissolved oxygen (DO) and are known to leave the water to escape hypoxic (low oxygen) water. Hypoxic water has been shown to effect the recruitment and migratory success of post larval blue crabs.

4) Non-native/invasive species in the coastal bays have the potential to effect blue crab populations. These species include the green crab (Corcinus maenus) and the Pacific Shore Crab (Hemigrapsus sanguineus).

Resource Indicators
Resource indicators include abundance and catch data. A winter crab survey is done annually in the Chesapeake Bay, but does not translate directly to the coastal bays.
Colonial Waterbirds

Resource Identification:
Colonial waterbirds are birds associated with large coastal, lentic or lotic ecosystems, which nest in close proximity to each other, e.g., in colonies. There are 22 species of colonial waterbirds which breed in Maryland, including gulls, terns, herons, night herons, egrets, skimmers, pelicans, ibises and cormorants. The majority of waterbird species nest on or near the ground. Most colonies in the Coastal Bays are associated with bay islands, either natural or dredge spoil, due to the lack of mammalian predators. Within these islands, nests are located on bare sand or shell and in marsh grasses, Phragmites, shrubs and small trees. Colonies may be single species or multiple species, such as mixed heronries. Nests are separated by <1 meter in most species and the largest colonies are >1500 nesting pairs.

Waterbird colonies have been annually surveyed in the Coastal Bays of Worcester County since 1984. Twenty 20 waterbird species currently nest in the Coastal Bays, including the state endangered Royal Tern (Sterna maxima), and the state threatened Least Tern (Sterna antillarum), Gull-billed Tern (Sterna nilotica), and Black Skimmer (Rynchops niger). A number of other species that occur here are considered rare as breeders in Maryland, including Sandwich Tern (Sterna sandvicensis), Laughing Gull (Larus atricilla), Yellow-crowned Night Heron (Nyctanassa violacea), Little Blue Heron (Egretta caerulea) and Tricolored Heron (Egretta tricolor). The only Maryland breeding colonies for Royal Tern, Sandwich Tern and Gull-billed Tern are in the Coastal Bays, and the largest Black Skimmer and Least Tern colonies occur there.

The federally endangered Roseate Tern (Sterna dougalli) nested briefly, from 1933 to 1938, on Assateague Island and dredge spoil islands in Sinepuxent and Chincoteague Bays. In 1987, Brown Pelicans (Pelecanus occidentalis) nested for the first time in Maryland, on a dredge spoil island near South Point. However, due to increasing erosion of the island and the subsequent loss of the young trees used for nesting, most of the pelicans relocated to Smith Island, Virginia in 1994. Only 4 pairs of Brown Pelicans nested on this Coastal Bay dredge spoil island in 1995, which was the last year it was used. Subsequently, these and other pelicans established a new colony on Spring Island in the Maryland portion of the Chesapeake Bay.

Resource Sensitivity:
Colonial waterbirds are excellent biological indicators of the health of aquatic ecosystems. These species serve as indicators of water quality as it relates to prey production. The great diversity of waterbird species feed on an associated diversity of prey items, with fish being the major diet of most waterbirds. Thus, the health of colonies can, in part, be attributed to healthy prey populations. However, most species of colonial waterbird are also sensitive to direct human disturbance to their habitats. With the great human demand for coastal areas to live and recreate, many nesting areas have been destroyed or receive too much disturbance (e.g., beaches and bay islands) for these birds to use for nesting. State regulations were passed in the early 1990's seasonally closing a number of important bay islands and mudflats (foraging areas for some species) to human recreation or other uses. The closure, from April 15 to September 15,
corresponds to the nesting season. Closed areas are marked by buoys and signs and enforced by Natural Resource Police. DNR also employed seasonal “Bird Wardens” during the 1990’s to aid enforcement and educate the public as to the importance of these areas to waterbirds and other species.

The key to continued survival of waterbird colonies is a diversity of undisturbed bay island habitats and a healthy aquatic ecosystem. In addition to their important ecological functions in food webs and energy cycles, colonial waterbirds also provide important aesthetic and economic benefits. They are some of the most identifiable animals that people relate to the beach and coastal habitats, and considerable revenues are generated for Worcester County from ecotourism associated with them.

Resource Data:
The DNR Wildlife & Heritage Services has a Colonial Waterbird database. The information contained in the database has been collected annually since 1984 using aerial surveys, ground censuses and arrival/departure surveys (for large mixed heronries). (Database information will soon be available in ArcView files for GIS).

Resource Gaps:
Excellent data exists on species distributions and population estimates throughout the Coastal Bays. The missing piece of information for most species is annual productivity, e.g., a determination of whether they are “source” or “sink” populations. The impact of increasing gull populations (Herring and Greater Black-backed) on the reproduction of waterbirds and other sensitive animal resources in the Coastal Bays is currently unknown.

Resource Threats:
The major direct threats are disturbance of waterbird colonies and important mudflats during the nesting season by the recreating public, development or other activities, and erosion of important bay island nesting habitats. Other threats include any impact to prey base (e.g., decreased water quality, commercial or recreational overharvest of fish, fish habitat loss through development activities, etc.) or the overall health of the Coastal Bays ecosystem, increased predation on waterbird eggs and nestlings from an increasing gull population, and oil or chemical spills.

Resource Indicators:
The key resource indicators for each colony are species richness (the total number of species present), the presence of rare/endangered species, the total number of nesting pairs, and the use of the island over the past 10 years (represented as % use).
**Diamondback Terrapin**

**Resource Identification:**
The Northern Diamondback Terrapin, *Malaclemys terrapin terrapin*, is one of seven species of diamondbacks found along the Atlantic and Gulf coasts, from Massachusetts to Texas. The subspecies occurs throughout Maryland’s Chesapeake Bay and the Atlantic coastal bays and ranges from Cape Cod to Cape Hatteras. The diamondback is the only North American turtle that lives exclusively in brackish waters. The preferred habitat of the terrapin is coastal marshes, tidal flats, coves, estuaries, and lagoons behind barrier beaches.

The diamondback terrapin may live as long as 50 years, which is important considering its life cycle and low hatchling survival rate. The male terrapin is considered mature at seven years, while the female is not mature until 12 years. Studies have shown that adult terrapins may remain in a rather small area for most of their life.

Terrapin mating occurs in May. Eggs are laid in nests during June and July on shore in sand or loam and then covered. The sex of the hatchling is determined by the temperature of the nest, with higher temperatures producing more females. Only 1-3% of the eggs that are laid produce a hatchling, the survival rate of hatchlings in the wild is currently unknown, but is thought to be equally low.

Two other species of turtle are present in the coastal region. The loggerhead turtle, *Caretta caretta*, is an occasional visitor to the coastal bays and has been seen swimming in the vicinity of the Ocean City inlet. They are occasionally injured or killed by collisions with powerboats. The snapping turtle, *Chelydra serpentina serpentina*, is also common in the region, but is restricted to the fresher waters of the upper reaches of the coastal tributaries. Others, like the leatherback and green turtle, are rare visitors to the area.

**Resource Sensitivity:**
One of the primary influences on the terrapin population has been commercial fishing. Over the past 300 years, humans for survival and as a delicacy have eaten the terrapin. During colonial times, the terrapin’s habitat was intact, its natural predators few, and its abundance legendary. However, through the years, harvesting of terrapin depleted the population and management became necessary. A historical overview of these activities is provided below.

- In 1868, laws were passed to limit coastal harvest to residents of Worcester County. Terrapins were shipped live to the most exclusive restaurants generating high prices and creating a directed fishery.
- In 1878, size and season limits were established.
- In 1891, the first year harvest data are available - 89,000 pounds of terrapin were taken from Maryland waters.
- By 1893, the fishery had collapsed due to overharvesting.
- By 1897, the Maryland harvest had dropped to 7,300 ponds.
- By 1901, the Maryland harvest had dropped to 1,600 pounds.
A resurgence of harvest to meet post war demands occurred in the late 1940's resulting in landings of 436,000 pounds (This tremendous increase in catch over the previous periods is most likely the result of increased reporting of catch).

Similar to the landings of the 1800's, these catches also declined, yielding only 140,000 pounds in 1951 and 34,000 pounds in 1954.

The terrapin fishery again collapsed and remained generally below 11,000 pounds annually statewide since 1956.

During the 1990's, demand increased once more, largely centered in the Asian-American markets of major cities like New York.

Over the past 10 years, there has been no reported commercial catch of terrapin in the coastal bays. What has been reported were low, intermittent catches from the Chesapeake.

In addition to over-fishing, the diamondback terrapin population is sensitive to changes in habitat and water quality. The ideal tidal nesting habitat is being diminished by natural erosion, development and some shore erosion protection methods. Increasing boat traffic is also a threat as terrapin cannot out swim a speedboat. Finally, shallow water crab pots, without specialized exclusion devices, can cause the terrapin to be trapped and drowned.

Resource Data:
Since 1972, the Fisheries Service of the Maryland Department of Natural Resources has conducted trawl and seine surveys to monitor the distribution and abundance of finfish and crabs in the coastal bays. Diamondback terrapin are caught infrequently during the survey and when encountered, are recorded. The majority of terrapin are encountered in the seine survey as the species prefers the protected waters nearshore and in tributaries.

The gear used is designed to catch finfish and shellfish, not necessarily terrapin. However, sampling efforts over the period of 1988 to 1999 have remained consistent, though catch is low. This suggests that the figures may give a relative indication of the population. Prior to 1988, incomplete coverage in some areas where terrapin occur makes it difficult to create a longer timescale. Sampling suggests that the population level is low, but relatively stable.

There are efforts in the state, including Terrapin 2000 Research, to: (1) document the persistence of breeding populations in various location, (2) estimate the population in select systems, (3) examine movements and behavior in select populations, (4) document the use of habitat throughout the lifecycle, (5) identify threats and impediments to persistence and recovery and (6) recommend management measures.

In June 2002, Governor Glendening announced several conservation measures for terrapin. This included completing a population and habitat assessment of the Diamondback Terrapin in Maryland with the cooperation of the U.S. Geologic Survey, Maryland Sea Grant, and other partners.
Resource Gaps:
Surveys conducted in the coastal bays have been of short duration or limited in scope, precluding any substantive data on the terrapin resource. Quantitative data needs for this species include stability and abundance, reproduction, nesting success, predation and mortality rates.

Resource Threats:
A number of reasons may account for the lack of a detectable increase in population levels. These reasons have also been suggested for the Chesapeake populations:
• The loss of terrapin nesting beaches. The increased use of waterfront bulk heading and stone rip-rap prevent terrapin from reaching their traditional nesting beaches.
• Predation of eggs. Foxes, skunks, otter and raccoon are predators of terrapin eggs and actively seek out nesting sites during the egg-laying period (in Maryland, from May to early August). An explosion in the raccoon population may be the greatest threat to nesting success. Much of this predation can be attributed to the collapse of the fur market and subsequent decline in fur harvest.
• The use of near shore crab pots. Terrapin generally do not stray far offshore from coastal marshes and associated tidal streams so they may not be impacted as much as commercial crab pots set in coastal bay waters. Most commercial pots are set well offshore, though they remain in use in some shallow water creeks. Shallow shoreside waters of Maryland’s coastal bays usually have large populations of sublegal crabs making it unprofitable to set commercial pots in these areas. However, waterfront landowners can legally set up two pots from their property, which puts the pots close to shore and within the general habitat of terrapin. In the Chesapeake and other states where pots can be set in proximity to the shore, terrapin mortalities may be significant. Terrapin excluders, a small rectangular frame placed in the entrance funnels of crab pots, are successful in excluding significant numbers of terrapin without affecting the catch of crabs. Publicity on their benefits has been limited and may over time have a substantial effect on reducing terrapin mortalities in crab pots.
• Powerboats. Impacts by powerboats may, in some areas, be an important source of mortality. Recent studies indicate that 20-30% of turtles had damage from power boats in the Patuxent River, MD and New Jersey waters.
• Commercial fishing. A small commercial fishery still exists in Maryland, but appears intermittent at best with no catches reported from the coastal bays during the last 10 years. There is no directed fishery, but given it is a marketable resource, some catch may be going unreported.

Resource Indicators:
Average catch/site, trawl and seine, could be used as an indicator of population. In addition, data is available from 1988 to 1999 for catch of terrapin by trawl and seine.
Finfish
Over 115 species of finfish have been identified in the Maryland coastal bays, including juvenile gamefish, such as summer flounder, weakfish, bluefish, spot, black sea bass, Atlantic croaker, striped bass, northern puffer, black drum, tautog and sheepshead. Over 40 species of fish are harvested commercially, while over 20 species are sought by sportfishers in Maryland’s coastal bays and near-shore Atlantic Ocean. The harvest of fish from these waters by both groups has a long and varied history extending back over three centuries.

Today, the number of sportsfishing trips estimated for the tidal waters of Maryland is significant. In 2001, a total of 370,000 saltwater anglers fishing in the tidal waters of Maryland’s Chesapeake and Coastal Bays, fished 3.2 million days and generated $240 million in trip and equipment related expenditures. An economic impact study of coastal bay related activities in 2001 put a dollar value on Worcester County’s coastal bays of $181 million to the local coastal economy.

Current recreational fishing consists of approximately 70 transient and 20 resident charter vessels, four ocean and three coastal bays headboats, and numerous private boats. The commercial fishery consists of trawlers, gill netters and surf clammers operating out of the commercial harbor in West Ocean City. The number of commercial vessels can be highly variable, depending on stock availability, harvest regulations in other states and Maryland, and seasonal fish movements. Currently, about 30 species of finfish and 8 species of shellfish are commercially harvested.

A single long-term study exists that examines characteristics of the coastal bays fish community over time. While the fish community of the coastal bays has changed over the past two decades, the observed changes provide little evidence for systematic declines in environmental quality. Although the abundance of most fish species has fluctuated, the numerically most abundant species in the coastal bays 20 years ago (bay anchovy, Atlantic silverside, spot, and Atlantic menhaden) remain the most abundant species in both Chincoteague Bay and the northern bays today. Scientists have noted some increases and decreases in individual species. Year-to-year fluctuations in abundance of fish species are a prominent feature in the fish community of the coastal bays. Long-term seine and trawl data show several important fish species (including summer flounder, bluefish, Atlantic croaker, spot, and American eel) have declined in the coastal bays. None of these species spawn within the coastal bays, and so declines in the seine and trawl data reflect more regional population trends.

Resource Sensitivity
Factors important to the health of coastal bays fish populations are habitat and water quality. Degradation of benthic habitat from eutrophication, reduced light penetration, chemical contamination and impacts from boating, including commercial harvest, affect some juvenile finfish species. Chemical contamination in dead end canals, which receive contaminated runoff from developed areas, pilings and boats also contribute to degraded sediment quality. Hard shoreline stabilization methods reduce the amount of natural shoreline habitat, which are
essential habitat for small fish and other aquatic resources.

Recreational and commercial fishing can also have an impact on populations. Management controls are in place to help limit the impact of fishing. In addition, due to their mobile nature, coastal bays abundance is heavily influenced by the regional population trends. Several of the species do not spawn in the coastal bays.

**Resource Data**
The Maryland DNR Fisheries Service has maintained a fish population monitoring project in the Maryland coastal bays since 1972. Objectives of the Coastal Bays Finfish Investigation Project include: (1) characterizing stocks and estimating annual relative abundance of juvenile and adult marine species in the coastal bays and near-shore Atlantic Ocean and (2) delineating areas of high value as spawning and nursery areas for finfish in order to protect against habitat loss and degradation.

The juvenile trawl and seine survey focuses on target species, including summer flounder, horseshoe crabs, squid, butterfish, weakfish. Abundance of forage species was examined by the creation of a forage index. The index is based on four forage species, including Atlantic menhaden, spot, Atlantic silversides, and bay anchovy caught in the juvenile trawl survey. These species are valuable sources of forage for many sought-after game fish and are potential indicators of habitat change within the bays. There has been a long-term decline in the number of spot, Atlantic menhaden and bay anchovy in the coastal bays. All three of these species, along with Atlantic silversides, comprise the major forage fish species of the coastal bays. There are links between higher and lower trophic levels. The reason for the decline is not clear.

A volunteer angler survey was initiated in 2002, which tracked the success of summer flounder anglers throughout the state. This survey supplied data on the catch of anglers fishing for summer flounder in the coastal bays and the length of fish caught, both legal and released sublegals. This survey supplements another survey initiated by the Maryland Saltwater Sportsmen Association.

Marine Recreational Fisheries Statistical Survey supplies some information on a statewide basis on the annual catch of finfish. While it is sometimes problematic to separate out the coastal bays finfish data out of this survey, it provides useful data on the catch of important recreational species within the state, including the coastal bays.

**Resource Gaps**
In order to determine the health of commercial and recreational species, including summer flounder, reliable catch and effort data need to be collected. Currently, commercial catch and effort data is routinely compiled from licenses, catch reporting, and other regulated limits on the commercial fishery. Although the National Marine Fisheries Service and DNR collect recreational surveys in Maryland waters, recreational catch and effort still represent a gap in information.
Resource Threats
Overfishing, watershed development/degraded water quality, pollution, and habitat destruction have impacted many fish species sought by both recreational and commercial interests. Human population growth and watershed development are encroaching on the coastal bays. Along with the development comes increased septic tank leachates, bulkheading, demands for improved county infrastructure, increased recreational facilities and the dredging of access channels. Shoreline development and the concurrent loss of marsh habitat is a threat to the food chain supporting the organisms, which feed juvenile fish.

Resource Indicators
The Coastal Bays Finfish Investigation Project (CBFI) annual trawl and seine survey collects many species of interest to commercial and recreational activities, including summer flounder, horseshoe crabs, squid, butterfish, weakfish. Other finfish species that are forage for the larger fish are also encountered in the survey. Catch per unit effort data on individual species tracked from year to year can be used as an indicator of year class strength.

Using data from the CBFI, trends among different fish guilds can be examined for indications about the quality of the fish life in the coastal bays. Numbers and sizes of all species caught by the CBFI are documented.

The abundance of forage fish in the bays for the last 31 years could be used as an indicator of the health of the coastal bays. Forager species are valuable food sources for many game fish and are potential indicators of habitat change. Analysis indicates changes in the abundance of forage species; including Atlantic menhaden, spot, Atlantic silversides, and bay anchovy; using juvenile trawl survey data. There has been a long-term decline in the number of spot, Atlantic menhaden, and bay anchovy in the coastal bays. All three of these species, along with Atlantic silversides, comprise the major forage fish species of the coastal bays. The reason for the decline is not clear, but monitoring the abundance of forage species on a long-term basis would serve as one indicator of coastal bays health.
**Horseshoe Crabs**

**Resource Identification:** The horseshoe crab, *Limulus polyphemus*, is a benthic or bottom-dwelling arthropod that utilizes both estuarine and continental shelf habitats. The horseshoe crab is an ecological generalist and although it is called a "crab", it is not a true crab, but rather an arthropod, most closely related to a spider. Horseshoe crabs range from the Yucatan peninsula to northern Maine. Maryland’s Coastal Bays serve as an important spawning and nursery habitat for the horseshoe crab. Each spring adult horseshoe crabs migrate into the coastal bays from offshore overwintering areas to spawn on sandy beaches and, to a lesser extent, subtidal habitats. Spawning occurs on the spring high tides from May through early August, gradually increasing prior to each full and new moon, peaking on the day of or after each full and new moon, then gradually decreasing. The annual peak in spawning activity generally occurs around the full and new moon in mid June. Eggs are buried approximately six inches beneath the sand at the water’s edge and hatch in two to four weeks. Juvenile horseshoe crabs generally spend their first and second summer on the intertidal flats, usually near breeding beaches. Older individuals move out of intertidal areas to deeper bay waters, and eventually to nearshore waters offshore. Some adult horseshoe crabs reside in the coastal bays year-round. Horseshoe crabs don’t reach sexual maturity until 9 to 11 years of age, and can live to 20+ years.

Horseshoe crabs were traditionally used for fertilizer and livestock food in the late 1800s and early 1900s. During this period of time, harvest was substantial (over 4 million crabs were landed annually in Delaware Bay). This fishery subsided in the 1940s because of the development of synthetic fertilizers and a decrease in the abundance of horseshoe crabs due to overfishing. In the 1980s there was a renewed commercial interest in horseshoe crabs as primary bait in the American eel pot fishery, conch pot fishery, and use of horseshoe crab blood by the biomedical industry. Horseshoe crabs are also an important food source for shorebirds, finfish, and Atlantic loggerhead turtles, a species federally listed as threatened in the Endangered Species Act. The Delaware estuary is the largest staging area for shorebird in the Atlantic flyway and is the second largest staging site in North America. Migratory shorebirds converge on the Delaware Bay, and to a significantly lesser extent in the Maryland Coastal Bays, at the peak of horseshoe crab mating to feed on horseshoe crab eggs and rebuild energy reserves before continuing their migration to arctic breeding grounds.

The available horseshoe crab data do not provide for any conclusions regarding trends in the horseshoe crab population along the Atlantic coast. No trend could be identified in the data. It is also not possible to identify whether the increase in landings has had an impact on the horseshoe crab population. Although no coastwide trends can be identified, several cases of apparent localized declines were noted in the Delaware Bay spawning, egg count and trawl surveys. While these cannot be extrapolated to the entire coast, they are cause for concern. This is especially true given the increase in catch and effort in the horseshoe crab fishery in these same areas.

**Resource Sensitivity:** Beach areas that provide spawning habitat for adults is considered
essential habitat for the horseshoe crab. In addition, nearshore, shallow water, subtidal flats are considered essential habitat for the development of juvenile horseshoe crabs. Deep water areas are used by larger juveniles and adults to forage for food but is not considered essential habitat. Of these habitats, the beaches are the most critical. The primary threats to habitat include continuing coastal erosion and human development along the Atlantic Coast.

**Resource Data:** The key sources of data for horseshoe crabs in Maryland’s Coastal Bays include an annual spawner beach survey, and finfish trawl survey. The spawner survey is currently being used to identify important spawning habitats and may eventually be capable of detecting trends in abundance. The finfish trawl survey is of little to no value in assessing trends in abundance because this a multispecies finfish survey that was not designed for horseshoe crabs. The trawl gear precludes the effective capture of horseshoe crabs. For this reason captures are infrequent and produce uninformative data.

**Resource Gaps:** Delineation of spawning and juvenile habitats are needed to facilitate the implementation of a statistically valid spawner beach survey to monitor trends in abundance, and protect these areas from being degraded (i.e. bulkheaded). Genetic stock identification of Maryland’s coastal bays horseshoe crab population is needed to facilitate management decisions.

**Resource Threats:** Protection of essential habitat such as spawning beaches and juvenile nursery habitat is vital to the continued survival of horseshoe crabs. Impacts on beaches from development and related infrastructure (e.g., bulkheads, groins, revetments, and seawalls) continue to degrade essential horseshoe crab habitat. Erosion and shoreline protection structures compromise the integrity of essential habitat through both the erosional process itself and interference with natural beach migration. The impacts of hydraulic clam dredging on and near important spawning and nursery habitats are unknown but may have the potential of impacting this resource. However, the height of the spawning season occurs outside of the legal clamming season. Channel dredging and overboard spoil disposal are common throughout the Atlantic coast, but effects on horseshoe crabs are currently unknown.

Horseshoe crabs are relatively tolerant of petroleum hydrocarbons, but the tolerance decreases with increasing temperature. However, there is a report that high density number 6 oil resulted in adult horseshoe crab mortality in New Hampshire possibly due to fouling of the book gills. Exposure to oil and chlorinated hydrocarbons resulted in delayed molting and elevated oxygen consumption in horseshoe crab eggs and juveniles. Red tide events may result in significant mortality, particularly to juveniles inhabiting intertidal areas and tidal flats.

**Resource Indicators:** An annual index of female horseshoe crab spawners is currently used to monitor the abundance of horseshoe crabs in the Delaware Bay. This survey had been done uniformly for the past three years (2000-2002). A trawl survey was conducted by Virginia Polytechnic Institute in 2001 and 2002. This is currently the best indicator of population size in the Carl Shuster Sanctuary area and should be continued if possible. However, this survey does not have a continuous funding source and procurement of a continuous funding source will
greatly facilitate the long term monitoring of population trends for this species. A volunteer spawner survey has been ongoing to a limited extent since 1994; however, at this time it does not yield data that would be meaningful for the creation of indicators. However, it is useful in the delineation of habitats.
Intertidal Invertebrates (oysters and ribbed mussels)

Resource Identification:
When Lt. Yates conducted his survey of the oyster bars of Chincoteague Bay in 1907, conditions in the coastal bays were very different. The inlet at the southern end in Chincoteague, Virginia was the only inlet for the entire system. Consequently, salinities were much lower in the upper bays, unsuitable for growing oysters. Even in the northern portion of Chincoteague Bay, oysters were subjected to occasional killing freshets, and poor growth and sporadic spatfalls were the norm. This is in sharp contrast to the period following the Civil War, when an inlet at Green Run was open. Oystermen, practicing a rudimentary form of oyster cultivation by planting seed on their own lots, found their endeavors so lucrative that they named the location Greenback after the recently introduced paper currency. Unlike other areas in Maryland, oyster farming became the standard practice in the coastal bays throughout the history of the industry. The late 1800's were boom years around Chincoteague Bay. The newly constructed railroad vied with sailing ships to carry the prized Chincoteague oyster to the high end markets of New York and Philadelphia, with some even reaching Europe. Eventually, Green Run Inlet filled in and production slowly declined to the point where most activity was restricted to the southern half of Chincoteague Bay. When the Ocean City Inlet opened in 1933 salinities throughout the bays quickly rose and there was a scramble to obtain leases for oyster growing bottom. This optimism was short lived, however, as a host of problems associated with increased salinities ultimately proved ruinous to the oyster industry. The elevated salinities allowed predators, particularly drills, to flourish. Fouling organisms that compete for food and hard substrate also found conditions more suitable. Although the natural oyster populations rapidly declined, the culture based industry still managed to exist for some time longer. The death knell of the oyster industry sounded when disease came to the coastal bays in the late 1950's. The last recorded landings were in 1983.

Presently, the Chincoteague oyster no longer inhabits the subtidal bars of the bay. To a large extent the bars themselves have been buried by sediment or smothered by fouling organisms, greatly reducing this ecologically important habitat. Relict populations of oysters still exist intertidally, with occasional spatfall on man-made structures such as riprap, pilings and bridge supports. Despite the long-term absence of significant oyster populations, two oyster diseases, Dermo and SSO, are still active in Chincoteague Bay.

Shoreline surveys found the intertidal zone to be numerically dominated by the ribbed mussel, Geukensia demissa, where it is ecologically important in processing nutrients and binding substrate, especially in salt marshes. These were found at densities of up to 5200 per square meter. The distribution, abundance, and population structure of this species has been documented in Chincoteague Bay. The ribbed mussel is possibly one of the most ecologically important molluscs in the coastal bays because of their beneficial association with salt marshes. The mussels live along the fringe of the marsh, where they filter algae from the water column when the tide inundates them. They promote growth along the marsh’s edge by fertilizing the grasses and increasing the sedimentation rate with their waste products. In addition, their network of
byssal threads, which the mussels use to secure themselves to the substrate, helps to stabilize the sediment and reduce erosion, such as from wave action.

**Resource Sensitivity:**
Both species are habitat dependent, requiring suitable substrate within the intertidal zone. For oysters this is hard substrate, although this can vary from wood bulkheads to concrete bridge supports to stone rip-rap. Although ribbed mussels prefer marsh embankments, they can also be found on hard substrate, providing it has nooks or crevasses for protection from predators.

Since both species live intertidally, they are remarkably hardy. Nevertheless, their position on the shoreline leaves them vulnerable to floating contaminants that might wash ashore. Like most bivalves, oysters are susceptible to petroleum products. They are also sensitive in varying degrees to other classes of contaminants such as pesticides, chlorine compounds, and heavy metals. Both species can accumulate heavy metals far in excess of ambient concentrations. Embryos and larvae tend to be more susceptible to toxic contaminants. Because these species are adapted to the turbid estuarine environment, they can tolerate heavy sediment loads. The embryo and larval life stages are susceptible to suspended sediments, albeit at levels considerably higher than normally encountered.

**Resource Data:**
Key sources include:
1. Yates oyster bars survey of 1907.
3. MDNR oyster bars survey of 1994. Revisits the old Yates bars. Data include surface shell per 1.5 minute dredge tow and associated species. No oysters were found.
4. MDNR 1994-95. Intertidal survey of Chincoteague Bay. Data include molluscan species, abundance (live and dead), and sizes per 0.25 m² quadrant.
5. MDNR 1994-95. Oyster survivorship study in Chincoteague Bay. Data include survivorship, growth, disease, and predation from arrays of suspended bags containing hatchery reared oysters.
6. MDNR 1999-present. Dynamics of an intertidal oyster population in West Ocean City. Data include density of live and dead, recent or old boxes, height-frequency distributions, spat settlement, presence of drill holes, number of drills, presence of other species, and disease analysis.

**Resource Gaps:**
Population information for intertidal species is dated in Chincoteague Bay and lacking elsewhere. Information on temporal variability is limited, save for two small oyster populations that have been tracked over time.
Resource Threats:
Loss of intertidal habitat, especially the salt marsh fringe inhabited by ribbed mussels, is probably the primary threat to these species in the coastal bay (see Tidal Wetlands section of this report). Although ribbed mussels can utilize man-made intertidal structures, densities are much higher in marsh embankments. Such structures can provide scarce hard substrate as a supplement, but not as a substitute, for existing natural shoreline. Certainly oysters benefit from these structures in certain locations, as they are the only source of hard substrate available in the intertidal zone.

Specific threats to both species include landward development which may cause habitat loss and increased chemical runoff; marinas and marine construction where toxic substances can leach out and small scale oil and other contaminant spills chronically occur (primarily a localized problem in areas with poor water circulation); boat wakes which erode marshy shorelines, washing mussels into the subtidal zone where they would be smothered or consumed; low dissolved oxygen levels which could impact the planktonic embryos and larvae; and, large scale oil spills. Given their accessibility, oysters may be subjected to recreational overharvesting at some locations. Some of the recently introduced non-indigenous crab species, such as the green crab used as bait by recreational anglers, are intertidal dwellers that could have a serious impact on these species, which utilize the intertidal zone as a refuge from subtidal predators.

Resource Indicators:
Key indicators for both species are geographic-specific density, observed mortality, and size information.
Rare, Threatened and Endangered Species

Resource Identification:
Maryland passed its first Endangered Species Act in 1971. This law placed the authority within the Department of Natural Resources to manage and protect rare species. This was modified in 1975 as the Nongame and Endangered Species Conservation Act. This law mandated the investigation, management and protection of threatened, endangered and nongame animal and plant species. The main categories of rarity, as defined in the Code of Maryland Regulations (COMAR) 08.03.08, are as follows:

Endangered (E)-a species whose continued existence as a viable component of the State’s flora or fauna is determined to be in jeopardy. These are typically species with 5 or fewer populations in Maryland or are listed as endangered by the federal government.

Threatened (T)- a species of plant or animal that appears likely, within the foreseeable future, to become endangered in Maryland. These are typically species with 6 to 20 populations or are listed as threatened by the federal government.

In Need of Conservation (I)-an animal species whose populations are limited or declining in Maryland such that it may become threatened in the foreseeable future if current trends or conditions persist. This legal status only applies to animal species, typically with 21-100 populations in Maryland.

The status of native Maryland species are continually assessed through data gathered from numerous sources, including DNR biologists and ecologists, museum and private collections, university researchers, scientific literature, unpublished documents and reports from zoologists, botanists and amateur naturalists. Species are primarily tracked through the Biological Conservation Database (BCD), maintained by the Wildlife & Heritage Service, which was developed in partnership with The Nature Conservancy.

In the Coastal Bays, there are currently 24 animal species tracked in BCD (see attached table; 7 E, 5 T, 3 I, 2 extirpated, 7 state rare-no legal status) of which 3 species are also listed as federally endangered (Atlantic Leatherback Turtle, *Dermochelys coriacea*; Red-cockaded Woodpecker, *Picoides borealis*, which was last observed in 1939; Roseate Tern, *Sterna dougallii*, which was last observed in 1938) and 3 species listed as federally threatened (Atlantic Loggerhead Turtle, *Carretta carretta*; Piping Plover, *Charadrius melodus*; Bald Eagle, *Haliaeetus leucocephalus*). A third species is a federal candidate for listing (pine snake, *Pituophis melanoleucus*). There are currently 84 plant species tracked in BCD in the Coastal Bays (43 E, 10 T, 15 extirpated, 16 state rare-no legal status) of which 1 species is federally listed as endangered (Seabeach Amaranth, *Amaranthus pumilus*) and 1 species is federally listed as threatened (Chaffseed, *Schwalbea americana*).

Rare species are defined by the unique habitats where they are found. In the Coastal Bays,
unique habitats include coastal sandy beaches, salt and brackish marshes, fresh-tidal marshes, alluvial hardwood forests, pine flatwoods, pine barrens/savannahs, Delmarva bays (seasonal depressional freshwater nontidal wetland), seepage slope herbaceous communities, bogs and sea-level fens.

**Resource Sensitivity:**
These resources are sensitive due to their rarity and threat with extirpation. Most species are restricted to very specific habitats that are also rare and/or unique. They are important components of the state’s biodiversity and in some cases are globally rare species.

**Resource Data:**
The Biological Conservation Database maintained by the Wildlife & Heritage Service, and associated GIS applications.

**Resource Gaps:**
Most of the private land within the Coastal Bays watershed has not been surveyed for rare species due to lack of funds to hire highly trained zoologists, botanists and ecologists.

**Resource Threats:**
The list of threats is long and at times specific to the rare habitats where certain species are found. However, the prevailing threat is human destruction, degradation or disturbance of unique habitats and the coastal and aquatic ecosystems for which these species are components.

**Resource Mapping:**
The Wildlife & Heritage Service provided ArcView shape file polygons for all rare, threatened or endangered species within 1.5 miles of the Coastal Bays. All point locations are buffered by ~500 feet.
**Seagrasses (Submerged Aquatic Vegetation)**

**Resource Identification:**
Submerged Aquatic Vegetation (SAV) are vascularized, rooted plants that remain entirely, or almost entirely, beneath the surface of the water. Although there are many species of SAV in the Mid-Atlantic, there are only two primary species found in Maryland’s Coastal Bays; eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*).

Both Coastal Bays SAV species provide a wide variety of functions essential to the ecological health of the bays. Perhaps foremost among them is as prime nursery habitat for many fish and shellfish species. The young of many commercially, recreationally, and ecologically important species depend upon the grass beds for protection and feeding. Young blue crabs have been documented to be approximately 30 times more abundant in SAV beds than in similar unvegetated areas. Young scallops, a species formally abundant in Maryland’s Coastal Bays, require eelgrass blades on which to settle and initiate their juvenile development. Many other fish and shellfish species also occupy the beds during both their juvenile and adult stages. In addition to their value as nursery habitat, SAV beds also carry out the important ecological functions of recycling nutrients, providing dissolved oxygen to the water, stabilizing sediments, and protecting shorelines from erosion. Finally, SAV species serve as a valuable food source for many waterfowl species. For all these reasons, SAV serve a critical role in the Coastal Bays ecosystem as both a species in their own right and as a habitat upon which many other species depend.

Best evidence indicates that Maryland’s Coastal Bays supported large populations of both SAV species during the early part of the 1900's. The shallow, protected nature of the bays lends themselves well to population by underwater grasses. During the early 1930's, however, a wasting disease struck many eelgrass populations throughout the Atlantic and Pacific coasts and virtually eliminated the grasses from Maryland’s Coastal Bays. Since that time, populations have been slowly recovering, with widgeon grass generally populating an area first, then followed by eelgrass. Consistent data on SAV coverage in Maryland’s Coastal Bays has been collected annually since the mid 1980's. Although this data demonstrates a steady and significant increase in grass coverage over time, scientific consensus is that human impacts continue to prevent grasses from recovering to levels similar to those of the early 1900's.

**Resource Sensitivity:**
Submerged Aquatic Vegetation species are very sensitive to human impacts. Certainly the greatest anthropogenic threat to bay grasses comes from increased sediment and nutrient contributions to the bays that result from human activities on land and in the water. Like any plant, SAV require sunlight to grow and reproduce. Sediment in the water increases the turbidity of the water and directly reduces the amount of light reaching the plants. Similarly, excess nutrients (nitrogen and phosphorus) contribute to growth of algae both in the water and on the leaves of the plants that, in turn, reduce the amount of light reaching the grasses. Submerged Aquatic Vegetation beds are also sensitive to physical destruction by activities such as dredging, recreational boating in shallow water, and some commercial fishing activities. Finally, there is some concern (not yet proven) that the habitat value of SAV beds can be significantly reduced if there is a large amount of human activity in the vicinity that may disturb feeding and spawning.
fish and shellfish, even if the plants themselves are not destroyed.

**Resource Data:**
The primary source of data for Coastal Bays SAV comes from the aerial survey that has been conducted annually by the Virginia Institute of Marine Sciences (VIMS). This survey, funded jointly by the federal and state governments, has been conducted since 1986 and represents one of the best data sets available on living resources of Maryland’s Coastal Bays. High resolution photographs are taken by professional aerial contractors, interpreted by technical experts at VIMS, and groundtruthed by VIMS researchers and trained volunteers. The data (coverage and density) is made available in GIS format throughout the Coastal Bays.

**Resource Gaps:**
One of the greatest gaps for SAV data in Maryland’s Coastal Bays is understanding the relationship between SAV coverage and habitat quality. Much work has been done in the Chesapeake Bay to understand that suite of habitat conditions (water clarity, nutrient levels, etc) necessary for healthy SAV growth. Unfortunately, the considerable amount of work that has been done in the Chesapeake is not necessarily applicable to SAV in the Coastal Bays. A better understanding of the relationship between water quality, sediment type, etc and SAV growth would enable us to better understand where SAV cannot grow versus where it is not currently growing due to human impacts.

Another gap in our understanding of SAV in Maryland’s Coastal Bays is ground-truthing of the aerial photographs. On the scene confirmation of what is observed in the aerial photographs is important in order to identify species and measure density. The amount of ground-truthing has increased considerably in recent years, although more would always be helpful.

**Resource Threats:**
The major threats to the SAV resource in the Coastal Bays are increased sediment and nutrient inputs to the bays as a result of human activities in the watershed. These increased lead to light limitations to the seagrass beds. Sediment may run off the land and into the water anytime the land is disturbed during agricultural and construction related activities. Sediment may also be added to the water through any water-based activity that disturbs the bottom sediment and resuspends it into the water column. Examples of such activities include dredging, heavy boating in shallow waters, some commercial fishing activities, and use of hard bulkheads. Nutrients reach the water through runoff and groundwater originating from fertilized agricultural, residential, and commercial lands, waste-water treatment plants, septic tanks, and the atmosphere. Additional causes of light limitations include macroalgae and brown tide.

Physical destruction of SAV beds poses a secondary, yet still significant, threat to Coastal Bays SAV beds. Sources of physical destructions include propeller scarring and groundings resulting from operating recreational boats in shallow waters, certain commercial fishing activities (i.e. hydraulic clam dredging), and dredging for channel maintenance. In addition to physical destruction, these activities may also harm SAV beds by resuspending sediment (see above), and potentially reducing their habitat value by disturbing fish and shellfish utilizing the beds as a refuge and spawning area.
**Resource Indicators:**
The key indicators would be maps of the coverage, simple bay specific bar charts depicting acreage changes over time, the percentage of historic SAV, and maps identifying which areas of the Coastal Bays are and are not meeting the habitat requirements necessary for healthy grass beds.
Shellfish (Hard Clams and Scallops)

Resource Identification:
The hard clam (*Mercenaria mercenaria*) is one of the species that flourished in the coastal bays after the Ocean City Inlet opened in 1933. Prior to that time, the population was confined to the southern portion of Chincoteague Bay where salinities exceeded the species’ minimum requirement of about 15 ppt. An exception was during the 1920's, when an ephemeral inlet existed below Ocean City for several years, allowing hard clams to get established and proliferate to the point that a profitable fishery developed. This inlet closed up in 1929, and clams were subsequently added to the list of stocks that crashed that year. The benefits to the seafood industry of a second inlet was not lost upon state conservation officials, scientists, and most importantly, legislators. Significantly, the improvement of commercial shellfish resources was one of the primary rationales for allocating funds to construct and stabilize a new inlet. In 1933, a hurricane serendipitously breached the island at the southern edge of Ocean City, which the Army Corps of Engineers quickly stabilized.

Clam harvests climbed steadily through the 1940's, then followed a roller coaster ride of peaks and declines, reflecting changes in fishing effort, gear type, and market. The introduction of the hydraulic escalator dredge in 1967 was followed by a sharp increase in landings, despite the concomitant imposition of daily catch limits, minimum size limits, and harvesting seasons. This surge in harvests lasted only four years, when the chowder market became flooded with a cheap and abundant supply of surf clams. From the mid-1970's to the mid-1990's, hard clam stocks were extremely stable but low in comparison with other regions and historic levels, with a minimum of commercial harvesting activity. Severe predation, particularly by blue crabs, aggravated by the disappearance of oyster shell as a protective cover, may have been the primary factor in limiting recruitment to the population. Since 1996 an increase in small hard clams has been observed, coincident with a disease that has reduced blue crab populations. The result has been the highest commercial catches in a quarter of a century.

There have been three periods of stock assessments over the past half-century. The first surveys in the early 1950's found generally low densities of hard clams relative to other regions, with the population dominated by the larger chowder sizes. Results from the surveys of the late 1960's were remarkably similar. Since 1993, the MDNR Shellfish Program has been conducting hard clam surveys on an annual basis. Initially, the findings were that of a depleted population of mostly older individuals. In recent years the population has increased (though not to the levels of the previous surveys), with a higher percentage of smaller clams. The 2002 survey found highest densities in Sinepuxent, Isle of Wight, and southeast Chincoteague Bays. Clams were generally more abundant in shelly and sandy substrates rather than mud. Recruitment appears to be most consistent in Sinepuxent and Isle of Wight Bays.

In contrast, the bay scallop, *Argopecten irradians*, which also requires higher salinities (>20 ppt), has been unable to exploit the new areas available to it after the opening of the Ocean City inlet. This is because its preferred habitat, eelgrass beds, had been largely eliminated by “wasting disease” during the early 1930's. Prior to that event, Maryland scallops were probably limited to the southern portion of Chincoteague Bay, close to Chincoteague, Va., which during the 1920's was the center of a small but lucrative bay scallop fishery. Scallops made a brief return to the
coastal bays during the late 1960's but soon disappeared, most likely because the seagrass beds were not extensive enough to sustain a population.

In an attempt to jump start a natural population in Chincoteague Bay, MDNR Shellfish Program planted over one million bay scallops and raised them to reproductive age during 1997 and 1998. At the same time, wild scallops of unknown origin appeared in the vicinity of the Virginia state line. To date, scallops have been caught in all of the coastal bays save Newport Bay. In 2002, for the first time scallops were recorded north of the Ocean City Inlet, both in Isle of Wight and Assawoman Bays. Considering the inadequate habitat conditions for this species that had existed in the upper bays until recently (low salinity prior to 1933, absence of eelgrass beds afterwards), these scallops are possibly the first to occur in this area in well over a century. Although the long-term viability of the bay scallop population is still in question, the extraordinarily rapid range expansion is a major step toward their establishment in the coastal bays.

**Resource Sensitivity:**

Hard clams are an extremely hardy species, which can endure a wide range of adverse environmental disturbances. However, environmental degradation can have an impact, such as in the St. Martin River, which has extremely low hard clam densities despite a harvesting prohibition, probably because of substrate alterations. The adults can tolerate large body burdens of toxic contaminants, bioaccumulating these substances at much higher concentrations than in the environment. The early life history stages, particularly embryos and larvae, are sensitive to certain toxins as well as high sediment loads. The long life span of the hard clam allows the population to persist through several successive years of poor recruitment.

Bay scallops, on the other hand, are a considerably more sensitive species. Most importantly, they are habitat dependant. Although bay scallops can be found on shelly and sandy substrate, the overwhelming majority inhabit eelgrass beds. Any disturbance that adversely impacts eelgrass will have an indirect effect on the scallop population. Bay scallops are prone to smothering and have a low tolerance for heavy sediment loads. The sensitivity of early life stages is probably similar to other bivalves, including hard clams. Because bay scallops have a short life span, the loss of a year class could be catastrophic to the population.

**Resource Data:**

Key sources include:

1. Md. Department of Research and Education. 1952-53. System-wide hard clam study includes density, distribution, size structure, and habitat.
2. University of Maryland Assateague Ecological Studies. 1969-70. Same data classes as above, but limited to eastern Chincoteague Bay.
3. Md. Department of Chesapeake Bay Affairs; MDNR. 1968-71. Surveys of commercial hard clam areas.
5. MDNR Shellfish Program. 1993-present. System-wide hard clam surveys includes density, distribution, size structure, habitat and other organisms. Bay scallops are included in this survey, in addition to limited surveys dedicated to them.
Resource Gaps:
Reliable harvest data is the biggest gap for hard clams, both commercial and recreational. In addition, age-structure information is lacking for this species in the coastal bays.

The origin of the bay scallops inhabiting the coastal bays is currently uncertain. Genetic analysis of these scallops is necessary to evaluate the MDNR scallop planting project and to better understand recruitment processes. The present extremely low density of bay scallops, combined with the limited directed survey effort and the sensitivity to sampling in seagrass beds, make good abundance estimates difficult. Trends in population abundance can only be followed in a very general manner.

Resource Threats:
Threats to the early life stages and in some cases to the adults of both species include shoreline development which may increase sediment and chemical runoff, thereby increasing water column sediment loads, altering and contaminating the substrate, and decreasing dissolved oxygen levels; marinas and marine construction where toxic substances can leach out and small scale oil and other contaminant spills chronically occur (primarily a localized problem in areas with poor water circulation); boat wakes which increase sediment loads and erode marshy shorelines, altering the subtidal substrate; navigational dredging and spoil dumping; and large scale oil spills. In addition, threats to the seagrass habitat can impact bay scallop populations (see Submerged Aquatic Vegetation - Seagrasses section of this report). Overharvesting is not an issue biologically for hard clams, as the seagrass beds, which are closed to commercial dredging, serve as de facto brood stock sanctuaries. However, there are currently no regulations concerning the taking of bay scallops, especially younger individuals that have not yet spawned. Finally, the introduction of non-indigenous species through recreational fishing, especially the green crab, a notorious molluscivore, may pose a threat to these species.

Resource Indicators:
Key indicators for both species are geographic-specific density, observed mortality, and size information.
Shorebirds

Resource Identification:
Shorebirds are a diverse group of wading and swimming birds, typically with long legs and pointed wings, which feed along shorelines and on mudflats, shallow tidal pools, marshes, dunes and beaches. A total of 42 species of shorebirds have been recorded in coastal Worcester County. This includes plovers, killdeer, oystercatchers, stilts, avocets, yellowlegs, sandpipers, willets, whimbrels, curlews, godwits, turnstones, knots, sanderlings, stints, dunlins, ruffs, dowitchers and phalaropes.

Shorebirds are remarkable flyers, boasting some of the longest migrations of any bird group. Shorebirds species are only observed for two periods annually: April to early May, when they pass through on their way from overwintering sites as far south as Tierra del Fuego, Argentina to breeding areas as far north as the Arctic; and again from the end of July through September, as they travel from northern breeding sites to southern overwintering areas. They stop on both segments of their journey in the Coastal Bays to refuel on abundant invertebrates.

A small number of shorebird species stay in the coastal bays and surrounding area during the breeding season. These include the state endangered and federally threatened Piping Plover (*Charadrius melodus*), whose only Maryland breeding area is on the ocean beaches and dunes of Assateague Island, where the population has remained stable at about 60 pairs for the past 8 breeding seasons (1996-2003). This was from a population low of 14 breeding pairs in 1990. At one time Piping Plovers nested in the Ocean City-Fenwick Island area but have not been recorded nesting there for >40 years due to intense development and disturbance of the beaches and former dunes.

The Wilson’s Plover (*Charadrius wilsonia*), a state endangered species, is an infrequent and rare breeder on open washes/sand flats, beaches and dredge spoil mounds in the Assateague Island-Sinepuxent Bay area. It has not been observed breeding in Maryland for >10 years. It is also limited by human disturbance of nesting habitat.

The American Oystercatcher (*Haematopus palliates*) is a state watchlist species as a breeder only. Critical nesting habitat is isolated bay and marsh islands that are free of mammalian predators and human disturbance. Within these islands, oystercatchers make a nest scrape on sand or shell beaches, or open wrack areas along marsh edges. About 50 pairs nested in coastal Worcester County in 2003, the stronghold for this species in Maryland.

The Spotted Sandpiper (*Actitis macularia*) is also a state watchlist species as a breeder only. Critical nesting habitat is isolated bay and marsh islands that are free of mammalian predators and human disturbance. Within these islands, oystercatchers make a nest scrape on sand or shell beaches, or open wrack areas along marsh edges. About 50 pairs nested in coastal Worcester County in 2003, the stronghold for this species in Maryland.

The remaining breeding shorebirds in the Coastal Bays are the fairly common Killdeer (*Charadrius vociferous*) and the ubiquitous and noisy Willet (*Catoptrophorus semipalmatus*).
The Killdeer nests on bare open ground, while the Willet nests in salt marshes.

The barrier islands and coastal bays of Worcester County and contiguous areas on the eastern shore of Virginia are internationally recognized as an important migratory stopover habitat for shorebirds, and have been designated as an International Shorebird Reserve unit (called “Barrier Islands”) within the Western Hemisphere Shorebird Reserve Network. International Shorebird Survey results show that of 600 sites east of the Rocky Mountains, this area ranks second in species diversity during spring and fall migrations, and is among the top ten for maximum number of shorebirds. It is estimated that >500,000 migrant shorebirds pass through annually.

Resource Sensitivity:
Shorebirds are excellent biological indicators of the health of aquatic ecosystems. These species serve as indicators of water quality as it relates to prey production. Shorebirds feed on a diversity of invertebrate prey items: annelid, sand and other marine worms; horseshoe crab eggs; small crabs; shrimp; mollusks; snails; beetles; flies; spiders; centipedes; and other aquatic insects. Some species also feed on small fish, tender roots and seeds.

Most species of shorebird are sensitive to direct human disturbance to their habitats, both nesting and foraging. With the great human demand for coastal areas to live and recreate, many nesting areas have been destroyed or receive too much disturbance (e.g., beaches and bay islands) for these birds to use for nesting. State regulations were passed in the early 1990’s seasonally closing a number of important bay islands and mudflats, foraging areas for most shorebird species, to human recreation or other uses. The closure, from April 15 to September 15, corresponds to the Piping Plover nesting season and peak shorebird migration. Closed areas are marked by buoys and signs and enforced by Natural Resource Police. DNR also employed seasonal “Bird Wardens” during the 1990’s to aid in enforcement and educate the public as to the importance of these areas to shorebirds and other species.

The Coastal Bays and surrounding area make a great contribution internationally as shorebird migratory stopover habitat. A diversity of undisturbed barrier beach, bay island and mudflat habitats and a healthy aquatic ecosystem are critical to continued nesting by rare shorebirds and foraging by migrating shorebirds. Migrating shorebirds also have an important function as a high-energy food source to migrating birds of prey, which likewise concentrate along the coast during migration. Shorebirds, by feeding on a diversity of prey items, also play a role in food webs, and nutrient and energy cycling within the coastal bays. In addition to these important ecological functions, shorebirds also provide important aesthetic and economic benefits. Every year, thousands of beachgoers enjoy watching sanderlings and other “peeps” prancing ahead of the surf. Bird watching and eco-tourism activities associated with observing shorebirds enhance local economies.

Resource Data:
The Biological Conservation Database maintained by DNR Wildlife & Heritage Services contains information for only rare, threatened and endangered shorebird species. During the 1990’s, DNR collected April-August shorebird use of select mudflats in Sinepuxent Bay. The
National Park Service (NPS) has data for the same time period from their “beach bird survey”, which was restricted to bird use of beach habitats. DNR and NPS have cooperatively monitored the Assateague Island Piping Plover population from 1986 to present, collecting data on number of nesting pairs, nest success and productivity. DNR has infrequently surveyed American Oystercatcher breeding pairs since the mid-1980’s, with a complete Worcester County census completed in 2003. Christmas Bird Counts, guided by the National Audubon Society and other groups include some areas of the Coastal Bays and Assateague. This data is published annually.

**Resource Gaps:**
There is no comprehensive annual survey of migratory shorebird use of the entire coastal bays nor identification of key foraging areas (mudflats, etc.). We have no data on annual productivity for any nesting species except Piping Plover.

**Resource Threats:**
The major direct threats are disturbance to nesting and foraging shorebirds by the recreating public; erosion of bay islands, shorelines and/or mudflats; and development and associated activities. Any activities that negatively affect water quality and result in lowered invertebrate prey availability or contaminated prey would also be a direct threat. A contaminant or oil spill in the Coastal Bays or adjacent Atlantic Ocean during peak shorebird migration or the Piping Plover nesting season could have serious long-term repercussions.

**Resource Indicators:**
The key resource indicators are species diversity (particularly of migrants); the presence of rare, threatened or endangered species; nest success and productivity; the total number of nesting pairs; and island or mudflat use over the past 10 years (represented as % use) by nesting/migrant shorebirds.
Tidal Wetlands

Resource Identification:
Wetlands are important because of the functions they perform, such as food chain support, flood attenuation, fish and wildlife habitat, nutrient cycling, pollutant removal, wave action protection, recreational use and aesthetics. They are important economically, recreationally, and ecologically. Wetlands support, both directly and indirectly, a myriad of species such as crabs, fish, waterfowl, wading birds, shorebirds, turtles, snakes, mollusks, muskrats, amphibians, etc. For example, wetlands are a key breeding area for black ducks. One of the last national stands of black ducks is in the Maryland, Delaware and Virginia coastal bays.

Tidal wetlands in the Maryland Coastal Bays are primarily marshes. A marsh is an open grassland lacking trees. A swamp on the other hand, is a wooded wetland. The presence of salt in the water and the soil are the primary inhibitors of tree growth, maintaining the open grassland character of the coastal marsh. A defining character of all wetlands is the absence of oxygen in the soil due to saturation by water. Only plants with special adaptations can grow there. Lack of oxygen in the soil retards the decay of vegetable matter causing the accumulation of peat. Therefore marshed are often storage sites for significant quantities of organic carbon. Tidal wetlands may be defined as high phase or low phase. There are several more descriptive classification systems for wetlands, but the Cowardin system, or U.S. Fish & Wildlife National Wetlands Inventory Map System (NWI), is the most often used. It defines a wetland according to its hydrology, moisture regime or degree of tidal influence, vegetative type, and degree of anthropogenic alteration. With the exception of maps generated for a particular project, the maps utilizing this system are not precise but perhaps the best available.

Tidal fluctuations replace nutrients in the marsh soil within the zone immediately affected by the water level changes. These plants often grow more vigorously than plants further inland from tidal exchange and are referred as high phase while shorter inland grasses of the same species are referred to as low phase. During early settlement marshes were often used as pasture part of the year and were cut as hay (Spartina patens is commonly known as salt marsh hay for this historic use). At other times, usually in the Fall when the grass had dried, the marshes were burned to open them up for hunting. Most marshes are able to withstand this level of disturbance in the absence of other stresses.

During the Great Depression large areas of coastal marshes were ditched to remove surface water to interfere with the breeding of mosquitoes. This ditching also drained water from the upper layer of soil to the depth of the bottom of the ditch allowing oxygen into the soil. This had multiple negative effects on the ecological health of the salt marsh. First, decomposition of marsh vegetation became aerobic thus eliminating the accumulation of peat and preventing the marsh from adjusting to sea level rise. Second, more oxygenated soil allowed the invasion of species, which were not adapted to the original conditions. This appears to be a significant factor in the spread of the common reed (Phragmites australis). Third, the ditches alter the tidal exchange regime and thus the distribution of nutrients derived from the bay water. More recently still, marshes have been filled as building sites for the water views provided by the lack
of trees. Tidal wetland protection and the requirements for a permit to fill or dredge these
marshes have considerably slowed this particular form of loss.

**Resource Sensitivity:**
Tidal wetlands are created and destroyed by natural processes in nature. However, human
activities have altered these natural processes. While tidal wetlands have been lost to erosion and
changes in sea level, this process has been accelerated by filling, dredging or excavating
activities for various developments and water dependent activities. This has been especially true
in the northern Coastal Bays area. Wetlands are vulnerable because slight changes in elevation or
vegetative cover, dramatically alter their functions.

**Resource Data:**
The key sources of wetlands data are NWI Maps and DNR Tidal Wetlands Maps. These maps
are snapshots in time, derived from aerial photography. They provide no information about the
condition of the wetland ecosystem. One useful way of looking at data from the
Hydrogeomorphic classification (HGM) is direction of the surface water flow; in flow (flooding,
land is a sink), outflow (wetland is a source), or bi-directional (tidally flushed). Most tidal
marshes are bi-directional but wetlands along water courses further inland are often
predominately sources of ground water to the stream, even in tidal portions of the stream. In
flow, or sink wetlands, were once a dominant feature of the landscape in the coastal bays, but
have nearly all been drained for agricultural use.

**Resource Gaps:**
Wetlands are dynamic and complex. While they may appear to be easily identified and typed at
any given time, their functions are not easily determined without site-specific study. For
example, the relationship between a selected species and a wetland site may not be determined
without on-site observations. For sensitive plant and animal species, field data is essential.

Recent mapping by the National Wetland Inventory of the U.S. Fish and Wildlife Services
produces a cross walk of the Cowarden (vegetation-based) classification with the
Hydrogeomorphic (landform-based) classification system so that the classification of wetlands in
the coastal bays is richer than most of the rest of the state. What is missing from these
classification schemes, however, is information on the condition of the wetland given that
classification. Is the marsh healthy and diverse or is it stressed and degraded from a history of
grazing, ditching and burning? Has adjacent marina construction and channel dredging
significantly altered the tidal regime bringing nutrients into the marsh? Is the marsh eroding
from boat wake activity? These questions can only be answered by on-the-ground inspections of
the site at periodic intervals.

The draining of sink wetlands has reduced somewhat the recharge of freshwater to the surficial
aquifer although the extent of this has not been measured or determined. The long-term effect of
reducing recharge of ground water is a reduction of the pressure of keeping the saltwater from
the estuary from intruding into the ground water. Eventually, saltwater will move inland through
the soil rendering some well unusable because of the increased salt content. An assessment of
drainage activities would improve our tidal wetland knowledge base.

Another essential data set, which is incomplete or lacking, is the location and extent of ditching done for mosquito control in previous decades. These features are often too small to show up on aerial photography.

**Resource Threats:**
Many wetland functions are adversely affected by human activities. Some activities affect wetlands directly, such as those development activities pursued earlier in the mid-century. One technique, termed the "Florida Lagoon" system, involved digging canals in wetlands and using the spoil to fill adjacent wetlands. This practice destroyed acres of tidal wetlands and degraded others by altering the ecology of those wetlands left behind. While these practices of digging and filling on a large scale have been mostly eliminated, mosquito ditches remain and new threats to wetlands still exist. Certain recreational activities alter the functions of wetlands, including: jet skis, nutrient discharges, boating activities, feral horses, and an increasing number of docks and piers crossing tidal wetlands. While wetland functions may be adversely affected, it is still not known whether or not the overall cumulative loss of tidal wetlands both natural and anthropogenic exceeds wetland creation. It is also unknown what effects the various activities that degrade tidal wetlands are ultimately going to have on the aquatic ecology of the Coastal Bays ecosystems. It is believed that at present the degree of impact on these wetland systems is a function of location, wetland type, and human population density. Wetlands in the northern bays are, at present, more at risk. Their value for certain functions such as pollutant removal, aesthetics, or wave action buffering, therefore may be considered greater. This may be magnified by the fact that many acres of wetlands in this area have already been lost. Other functions, such as wildlife habitat, might also be considered lower due to the disturbance factor. Once again site-specific information is necessary.

In addition, there is interest across Maryland in identifying the significance of *Phragmites* as a primary component of wetlands. There are some thoughts that this species limits the diversity within wetlands and could have an influence on the overall ecosystem. *Phragmites* is an invasive species in the coastal bays area.

**Resource Indicators:**
The high organic content of a wetland leaves a distinctive “footprint” on the soil color and structure even after the water has been removed. Soils that have been saturated for long enough historically to develop these characteristics are called *Hydric* soils. These represent the traces of wetlands of the past, which have been converted to other land uses through hydraulic modification, such as drainage. Below the depth of plowing, the hydric soil signature remains. These areas have been mapped for the entire coastal bays watershed. The extent of hydric soil not currently recognized as a wetland is an indictor for the extent of wetland loss in a given area and represents a quantitative measure of the extent of lost wetland function within each watershed. It is as important to know how much wetland a given watershed contained, as it is to know how much is left (i.e. current wetland acreage).


**Sensitive Resources Mapping Exercise**

Following the identification of sensitive aquatic resources, the Task Force concentrated on the geographic representation of the resources. This was a complicated task due to variations in geographically relevant resource-based information. Although data is collected regularly for some resources, information is often location-based and difficult to translate for the entirety of the coastal bays. Therefore, a geographic domain was created for each resource. Domains were based on both resource specific data and habitat-based information. Specific information on the Geographic Information System (GIS) layers used in the creation of the sensitive resources maps can be found in Appendix A.

Following is abbreviated information on the layers used. The datasets are based on cumulative seasonal use, unless otherwise noted. As additional geographic information becomes available, the resource layers can and should be updated. Resource maps can also be found in Appendix A, as noted below.

**Benthic Organisms (non-commercial)** – Non-commercial benthic communities were not mapped during the planning process. The majority of benthic data is point source and is difficult to map geographically. Also, the opportunistic nature of benthic organisms in the coastal bays make them less sensitive to many of the threats considered. However, because of their role as a trophic link between primary producers and higher consumers they should be taken into consideration later.

**Blue Crab** - Blue crab data is generally gathered at specific locations, making it difficult to map across the coastal bays. In addition, blue crabs have a natural mobility that must be taken into account. The general blue crab dataset used in this mapping exercise is based on depth. According to resource experts, areas less than three feet deep are especially significant to juveniles, while areas greater than three feet are more utilized by adult populations. This general breakdown represents cumulative seasonal use. Season specific locations such, as over-wintering grounds, will be added as information becomes available. (Maps 3, 4, 7 and 8)

**Colonial Waterbirds** - Data is available for colonial waterbirds from 1985 to 1999. This data includes nesting locations. Colonial waterbird locations are associated with bay island and beach habitats. The GIS layer represents cumulative use based on the information from survey conducted between 1985 and 1999. Point location data was provided with associated metadata. An improvement to this layer would be Global Positioning System (GPS) mapping of each island outline and inclusion of specific areas used by nesting colonial waterbirds. (Maps 7 and 8)

**Diamondback Terrapin** - Some data has been collected from terrapin sightings. In addition, sandy beaches are identified as being a key habitat for terrapin nesting sites. These two pieces of information were combined to create the terrapin GIS layer. Ground-truthing of the sandy beaches would improve the dataset until a complete survey of nesting areas is done. (Maps 1 and 2)
Finfish - Most available finfish data for the coastal bays is point specific. This fact, in addition to the natural mobility of finfish, made it difficult to create a geographically based dataset. The resource experts determined that in general, areas less than three feet deep are especially important to juvenile finfish, while areas greater than three feet are more utilized by adult finfish. The general dataset represents cumulative seasonal use and therefore does not break out the seasonality of certain areas. Some specific seasonal breakouts of this dataset are included as separate layers. These include white perch spawning areas, elver runs, and striped bass spawning areas. As additional seasonal information and other habitat characteristics are identified, details will be added to the finfish layer. (Map 5, 6, 7 and 8)

- **Foragers and grazers** - Due to the mobility of foragers and grazers and the point source location data that is available, the resource experts determined that areas less than three feet deep are most important (Map 1 and 2).
- **White Perch Spawning Areas** (seasonal) - White perch spawn from approximately March 1 to May 15 each year. This is a time they are particularly sensitive. Spawning areas were mapped based on local knowledge and available data. (Maps 3 and 4)
- **Elver Runs** (seasonal) - Elver runs occur from March 1 to June 10 each year. This is a time when the coastal bays eel population is particularly sensitive. Elver runs are located in the upper tributaries of the coastal bays. (Maps 9 and 10)
- **Striped Bass** (seasonal) - Certain areas in the coastal bays are used seasonally as striped bass spawning areas. The spawning season is between March 1 and June 10. Areas were identified through local knowledge and available data. (Maps 3 and 4)

Horseshoe Crabs - Though some known horseshoe crab breeding beaches have been identified within the coastal bays, a complete survey has not been done. The known sites have been mapped. In addition, the Task Force recognized that horseshoe crabs are dependent on sandy beaches for breeding. The data layer created for this mapping exercise includes identified sandy beach areas, based on the Maryland Geologic Survey (MGS) shoreline data set. This layer could be improved through ground-truthing and additional sitings of breeding grounds. (Maps 5 and 6)

Intertidal Invertebrates (Oysters and Ribbed Mussels) – As with other benthic organisms, the data for intertidal invertebrates is primarily point source. For mapping purposes, emphasis was placed on locations with tidal wetland and/or substrate. These are habitats where both oysters and ribbed mussels are more regularly found. (Maps 3 and 4)

Rare, Threatened and Endangered Species - The Maryland Department of Natural Resources, Heritage Division, maintains a database of known rare, threatened and endangered species. The dataset, used in the sensitive resources mapping exercise, includes all such sites within ½ mile of the coastline. The Wildlife & Heritage Division provided ArcView shape file polygons for all rare, threatened or endangered species within 1.5 miles of the Coastal Bays. All point locations are buffered by ~500 feet. (Maps 9 and 10)

Shellfish (hard clams and scallops) – Hard clam data is primarily location specific. Resource experts reviewed the available data to determine if there is a correlation with the substrate. Bottom sediment data is available across the coastal bays. Hard clams are found in most
sediment types, but tend to be more abundant in sandy or shelly substrates. Data showed that hard clams utilize the entire coastal bays, with the exception of the St. Martin River. The dataset represents cumulative seasonal information. (Maps 9 and 10)

*Shorebirds* - Though no complete sampling of shorebird locations has been completed, the Task Force recognized the relationship between shorebirds and exposed mudflats. The layer created is based on mudflat areas identified in the National Wetlands Inventory. This information could be improved upon through ground-truthing and inclusion of sightings data. (Maps 1 and 2)

*Seagrasses* - Seagrasses are mapped annually in the coastal bays by aerial survey. For this mapping exercise the 1999 aerial photography data was used. The SAV coverage and density maps generated as part of the annual aerial survey were used in the sensitive areas mapping exercise with increasing importance assigned to beds with greater densities. Although this data is extremely valuable, the exercise could be improved by including historic (pre 1930's) distribution as a means of viewing the current versus the potential grass coverage. Efforts are underway to generate these historic maps. (Maps 5 and 6)

*Tidal Wetlands* - The Maryland Department of Natural Resources has Wetland Guidance Maps. Tidal wetlands were pulled out from the full set of guidance maps to create the data layer for this mapping exercise. This dataset could be improved upon by ground-truthing. Maps already exist and are useful, but for more precise and accurate data, new maps or ground truthing will be needed. Because of costs and the need to have timely, on site descriptions, maps will probably be generated to suit a given project purpose, rather than covering the entire bays. (Maps 5 and 6)
Aquatic Sensitive Areas Ranking and Mapping

The identification and mapping of resource-based aquatic sensitive areas, described in the previous two sections, was the initial goal of the Coastal Bays Sensitive Areas Technical Task Force. The next step in the process was the identification of management and/or education gaps and opportunities that could be used to balance the identified resources with water-based activities such as boating and fishing. In order to do this, the Task Force ranked the identified sensitive resources in the coastal bays on a scale of one to five. These rankings were based on Task Force member expertise, available data and known research. Resources were not compared to one another, but rather individual resource parameters were given rankings. The following table describes the data and ranking used for decision-makings. Definitions of the column headers are also provided.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rank</th>
<th>Data Set</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benthic Invertebrates (non-commercial)</td>
<td>N/A</td>
<td>Several sampling data sets are available electronically and as hard copies.</td>
<td>At this time, non-commercial benthic invertebrates are associated across the entire coastal bays. It may be possible to use the available data at a later date to assess sensitivity using abundance, population structure, etc.</td>
</tr>
<tr>
<td>Blue Crabs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juvenile (&lt;60 mm)</td>
<td>3</td>
<td>Depth was delineated using NOAA Bathymetric Data. Over-wintering areas were identified based on data and by the research experts.</td>
<td>Due to the mobile nature of blue crabs, the maps are fairly generic. Bathymetric data may be updated with completion of a new bathymetric survey. Future efforts: adding habitat characteristics such as seagrasses, tidal wetlands, algal mats, and vegetated shorelines.</td>
</tr>
<tr>
<td>Depth less than 3 feet</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth greater than 3 feet</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult (&gt;60 mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth greater than 3 feet</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth less than 3 feet</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over-wintering Areas</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Rank</td>
<td>Data Set</td>
<td>Status</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Colonial Waterbirds</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence</td>
<td>5</td>
<td>Polygons were created using available point source data.</td>
<td>Bay islands are considered key habitats for colonial waterbirds. At this time colonial waterbirds were mapped based on known locations. Additional possibilities include: (1) mapping known islands, (2) creating subrankings based on species richness, colony size and density, (3) ranking potential habitat (bay islands) by size, number of vegetated zones, and remoteness. These items would require additional data and/or the review of aerial photos.</td>
</tr>
<tr>
<td>Bay Islands</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Diamondback Terrapin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confirmed presence</td>
<td>5</td>
<td>Polygons were created based on known sitings by DNR biologists. As potential nesting areas, sandy beaches were designated using the shoreline characterization.</td>
<td>Additions can be made as additional sitings become available. The mapping of potential habitat (sandy beaches) could be expanded to include naturally vegetated shoreline, isolated to semi-isolated beaches or beachlets.</td>
</tr>
<tr>
<td>Sandy beaches</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Endangered, threatened and rare species</strong></td>
<td></td>
<td>Polygons are based on the DNR Heritage Service dataset.</td>
<td>Information will be updated as it becomes available.</td>
</tr>
<tr>
<td>Presence</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Finfish</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juvenile (incl. Eels)</td>
<td>3</td>
<td>Depth was delineated using NOAA Bathymetric Data.</td>
<td>Due to the mobile nature of finfish, these maps are fairly generic. Bathymetric data may be updated and improved in the upper bays with completion of a new MGS bathymetric survey. Future efforts could include adding additional habitat characteristics such as seagrasses, wetlands, and vegetated shoreline near deeper waters.</td>
</tr>
<tr>
<td>Depths less than 3 ft</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depths greater than 3 ft</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depths greater than 3 ft</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depths less than 3 ft</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foragers/Grazers (i.e. silversides, gobies)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth less than 3 ft</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth greater than 3 ft</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elver Runs, White Perch</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spawning Areas, Stripped Bass Spawning Areas</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Rank</td>
<td>Data Set</td>
<td>Status</td>
</tr>
<tr>
<td>----------------------------</td>
<td>------</td>
<td>---------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Coastal Bays Sensitive Areas</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Technical Task Force Report</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parameter</strong></td>
<td><strong>Rank</strong></td>
<td><strong>Data Set</strong></td>
<td><strong>Status</strong></td>
</tr>
<tr>
<td>Horseshoe crabs</td>
<td>5</td>
<td>Confirmed sitings of horseshoe crab spawning areas were mapped as polygons. In addition, sandy shorelines were designated as an important potential spawning area.</td>
<td>Additional issues that could be considered for future mapping of horseshoe crabs are seasonality, wave energy, protection level and beach drainage.</td>
</tr>
<tr>
<td>Sandy beaches</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intertidal Invertebrates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ribbed Mussels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Spartina</em> Marshes – west shore</td>
<td>5</td>
<td>Locations for ribbed mussels are based on sampling data and identified habitats. Mapping of oysters is based on the actual distribution found when sampling.</td>
<td>Oyster populations at this time are based on their actual sampled distribution. This is a conservative approximation. Small relic populations of oysters may be more widely distributed. Potential habitat for oysters could include anthropogenic structures.</td>
</tr>
<tr>
<td><em>Spartina</em> Marshes – east shore</td>
<td>3</td>
<td>Data for ribbed mussels is from MDNR surveys conducted 1994-1995. Oyster bar surveys were conducted in 1994-1995; population studies started in 1994 and are ongoing.</td>
<td></td>
</tr>
<tr>
<td>Anthropogenic structures</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oysters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shantytown Riprap</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>George I. Ldg. Riprap</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Route 50 and 90 bridge supports</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salt marsh creeks</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seagrass (<em>Zostera</em> and <em>Ruppia</em>)</td>
<td>5</td>
<td>Data is taken from the annual aerial survey of seagrass beds, done by VIMS. The density breakout is a component of the survey. The 1999 data set was used in this mapping exercise.</td>
<td>At this time, the species of seagrasses have not been separated. <em>Zostera</em> has been evaluated as a more important habitat. In addition, efforts continue to identify potential seagrass habitat. This work is being led by STAC and could be added later.</td>
</tr>
<tr>
<td>Presence of a dense bed (70-100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of a moderate bed (40-70%)</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of a sparse bed (10-40%)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of a very sparse bed (0-10%)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shellfish</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hard Clams</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assawoman</td>
<td>3</td>
<td>Hard Clam polygons were created for each of the identified bays based on watershed maps. Chincoteague Bay was subdivided through the middle. Rankings are based on available data and benthic resource managers’ experiences.</td>
<td>The majority of shellfish data is point source based. These categories were identified by the shellfish resource experts based on that data and their experience. The data set could be improved with the addition of age-structure information and harvest figures, both commercial and recreational.</td>
</tr>
<tr>
<td>St. Martin</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isle of Wight</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinepuxent</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newport</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NW Chincoteague</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NE Chincoteague</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW Chincoteague</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE Chincoteague</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western Bays</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scallops</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Zostera</em> beds in:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chincoteague Bay</td>
<td>3</td>
<td>Scallop polygons were created to represent the areas identified by resource experts. These areas were based on monitoring data and restoration activities.</td>
<td></td>
</tr>
<tr>
<td>Sinepuxent Bay</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assawoman Bay/Isle of Wight</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shell bottom:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chincoteague Bay</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shorebirds</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mudflat/Sandflat Size</td>
<td>1</td>
<td>Because of their role as important shorebird habitat, sandflats and mudflats were identified using National</td>
<td>At this time, shorebird species data is available for three mudflats. Additional information on species and locations could improve the</td>
</tr>
</tbody>
</table>
Medium Large 3 5 Wetlands Inventory (NWI) data. A frequency analysis was then completed to separate the areas based on size. Additional information that could be used to improve the data set are: (1) juxtaposition of the areas, (2) additional mapping during annual surveying to identify and ground-truth areas, and (3) gaining additional species data to consider presence, richness, and density.

**Tidal Wetlands Presence**

<table>
<thead>
<tr>
<th>5</th>
</tr>
</thead>
</table>

This is a subset of primarily tidal wetlands taken from the Department of Natural Resources Wetland Guidance Maps. Ground-truthing would need to be done to determine type. Future information could include the type of wetland (i.e. phragmites) as a priority.
Figure 2: Northern Coastal Bays Aquatic Sensitive Areas Ranking Map. Maps were created using an additive grid system based on the rankings described above. Additional information on the map is available in Appendix B.
Figure 3: Southern Coastal Bays Aquatic Sensitive Areas Ranking Map. Maps were created using an additive grid system based on the rankings described above. Additional information on the map is available in Appendix B.
Identified Gaps

The Sensitive Areas Technical Task Force identified information gaps throughout the planning process. Gaps are defined as issues that need additional research, updated data, and/or more ground-truthing. Although the Task Force determined that it was important to proceed with the information available, this list will be looked upon as a resource to determine what to do next. As gaps are filled the information, data, and GIS layers that identified sensitive resource locations and led to sensitive areas ranking will be updated and modified. Following is a list of these gaps:

Consideration of Delaware and Virginia: Because Maryland Coastal Bays and their watersheds are directly linked to those in Delaware and Virginia, it is important to consider them in future activities. Efforts along these lines have been started in other Maryland Coastal Bay Program initiatives. The Citizens Advisory Committee has met with the Delaware Citizens and the Assateague Coastal Trust sponsored a conference in 1999 that included representatives from all three states.

Using a long-term perspective: Much of the data and information used for the sensitive resource maps was based on specific time-based data that focused on one year of data collection. Task force members indicated that having a greater historical reference for the data would be beneficial. The Task Force also recommended that historical information on coastal bays species be documented. Historical information could be used to identify potential habitat sites and increase knowledge on where species are located that move from year to year.

Identification of potential seagrass sites: At this time, only current seagrass locations and density are mapped as “sensitive resources.” Potential seagrass locations should also be identified since seagrasses have such an important role in the bays. Work has been initiated to gain a better understanding of potential seagrass bed locations. This work is ongoing and activities include: mapping of historical seagrass locations from aerial photography, additional bathymetry data, and artificial seagrass work.

Inclusion of water quality: Task Force efforts to date were focused on sensitive resources in the coastal bays. Water quality, however, is an important component to be included in the future for the purposes of evaluating watershed influences on sensitive resources and to determine restoration opportunities. Water quality data is available for the bays, including a map of dissolved oxygen.

Inclusion of biological threats: This report stems from a goal in the Comprehensive Conservation Management Plan that establishes the need to look at the relationship between recreational boating activities and sensitive resources. The Task Force recognized that there are many additional threats to the resources, which are not related to boating or water-use activities that may outweigh such recreational impacts. The Task Force acknowledged a need to gather additional information on threats such as macroalgae, harmful algal blooms, non-indigenous species and disease. This work would require additional research and monitoring.
**Difficulty in mapping:** Point-source data and species mobility added to the complexity of the mapping process. As a result, the sensitive resource maps are based predominantly on a species habitat rather than the sensitive species themselves. As new information becomes available, the maps should be updated.

**Relationship between resources and threats:** The Task Force established a relationship between sensitive resources and a variety of threats (see threats chapter). While data exists to support some of the relationships others have little to none known about them. Information should continue to be gathered to support these relationships.

**Ground-truthing of wetlands data:** *Spartina* was identified as the most important species in tidal wetland habitat. Though the data used in the sensitive resource mapping exercise identifies the location of tidal wetlands based on the National Wetlands Inventory (NWI) and Department of Natural Resources Wetlands Inventory, it would require additional ground-truthing to determine the type of plants at each site. The Task Force recommends that this should be done on a site-by-site basis as issues arise.

**Additional habitat information for the bay islands:** At this time bay islands and in turn colonial waterbirds have been identified based on their known presence. However, this could be further defined and used to identify potential habitat sites by analyzing habitat information for the bay islands. A wide range of habitats on a single island, in addition to the size of the island may increase the value of the island to colonial water birds.

**Better characterization of shoreline data:** Shoreline is important for several sensitive species. The most recent shoreline survey was taken in 1989. Though this survey is useful in identifying some areas, such as sandy shorelines, ground-truthing would benefit this effort. In addition, the types of hardened shoreline can have an influence on the aquatic resources.

**Integration of historical data:** Additional historical data is available for numerous species. At this time, however, the information is either not in a format available to be incorporated in the mapping exercise or the technical task force has not determined how to best use the information. This will be considered later. The Task Force recommends the creation of a document that describes this historical data.

**Updated bathymetry of the coastal bays:** The current bathymetry data for the coastal bays is outdated. Due to the relationship between depth and a variety of identified sensitive resources it is important that this information be updated. A project has been funded for Maryland Geological Survey to do a bathymetric study of the coastal bays. When this information is available it should be added to the sensitive resources map.

**Inclusion of buffer and other landuse information:** The Task Force focused its efforts on aquatic sensitive resources located within and directly adjacent to the water body of the coastal bays. The maps generated during the planning process can be used in association with other coastal
bays planning activities. As such, it may be appropriate to expand the mapping exercise to land-based resources.

*Inclusion of waterfowl:* Although the Task Force recognized the importance of waterfowl, data was not available to facilitate consideration during the mapping and ranking exercises. Research is now taking place that could be added to the maps, including waterfowl flying surveys. The coastal bays serve as an important winter resource to the waterfowl, which use the seagrass beds and benthic communities as a food source. Wetlands also serve as a key breeding ground for some species. At this time, waterfowl are considered as a component of the resources listed above. As additional information becomes available the maps should be updated.

*Values of seagrass densities:* For this mapping exercise the value (ranking) of seagrasses was based on the density of the beds. The values ranged from one to five as density increased. There is interest in further quantifying the relative value of different seagrass bed density. As this information is made available the seagrass rankings can be modified, if necessary, to reflect the new information.
**Threats**

Recreation and Navigation Goal 3 of the Coastal Bays Comprehensive Conservation Management Plan (CCMP) calls for an interagency task force of resource experts to evaluate threats to sensitive aquatic resources. To date, the Task Force has compiled an initial list of potential threats to aquatic resources. The Task Force is currently working to determine the relationship between the different threats and the resources themselves. This ongoing activity will be important in the management stage of the sensitive aquatic resources initiative.

Below is the list of threats to the aquatic resources, as identified by the Task Force, grouped into five main categories: (1) boating threats, (2) fishing threats, (3) landuse threats, (4) runoff threats, and (5) miscellaneous others. Not all of the identified threats will be priorities in the management stage, since the initiative is focused on water-based activities. However, by listing all threats, the Task Force recognizes the wide variety of activities that can influence the aquatic resources. Some of these threats are being considered under other CCMP goals.

**Boating threats:** propeller wash/scarring, boat wakes, exhaust, engine noise, jet skis, oil-chronic

**Fishing threats:** commercial fishing - nets, commercial fishing - dredge, recreational fishing, aquaculture - finfish, aquaculture - shellfish, beach activities

**Landuse threats:** marina locations, constructions (docks, piers), shoreline and bay island stabilization, dead end canals, shoreline development

**Runoff threats:** nutrient runoff, sediment runoff, chemical contaminant runoff, harmful algal blooms, macroalgae, low dissolved oxygen, sediment contamination

**Other threats:** navigational dredging, episodic oil spills, ecotourism (intrusive and nonintrusive)

The effect of these threats on each identified resource may not be known and efforts are ongoing to obtain available information to incorporate. As needs are realized, efforts can be made to increase knowledge in these areas. In addition, not all of the threats fall directly under the water-based activity umbrella as identified in the Comprehensive Conservation Management Plan Goal. It is the role of the management workgroup to determine threats in need of further examination. The role of the Task Force is to provide information to the management workgroup on the effect of the threat on the identified sensitive resources. Following are some of the initial evaluations:

<table>
<thead>
<tr>
<th>Resource</th>
<th>Key Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benthic Invertebrates (non-commercial)</td>
<td>Boat Wakes (erosion), Oil (chronic and episodic), Recreational Fishing (release of non-indigenous bait species), Marina Location, Dead End Canals, Shoreline Development, Sediment Runoff, Chemical Contaminant Runoff, Harmful Algal Blooms, Low Dissolved Oxygen,</td>
</tr>
<tr>
<td>Coastal Bays Sensitive Areas</td>
<td>Technical Task Force Report</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td><strong>Sediment Contamination, Navigational and Commercial Dredging</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Blue Crabs</strong></td>
<td>Dead End Canals (flushing), Harmful Algal Blooms, Low Dissolved Oxygen, Navigational and Commercial Dredging</td>
</tr>
<tr>
<td><strong>Colonial Waterbirds</strong></td>
<td>Jet Skis, Beach Activities, Marina Locations, Construction (docks and piers), Shoreline/Bay Island Stabilization, Shoreline Developments, Oil</td>
</tr>
<tr>
<td><strong>Diamondback Terrapin</strong></td>
<td>Propeller Wash/Scarring, Beach Activities, Construction (docks and piers), Shoreline/Bay Island Stabilization, Dead End Canals, Shoreline Developments, Fishing (Crab Pots)</td>
</tr>
<tr>
<td><strong>Finfish (Adult, Juvenile, and Foragers)</strong></td>
<td>Commercial Fishing (nets), Dead End Canals (flushing), Harmful Algal Blooms, Low Dissolved Oxygen, Nutrient Runoff</td>
</tr>
<tr>
<td><strong>Horseshoe Crabs</strong></td>
<td>Construction (docks and piers), Shoreline/Bay Island Stabilization, Dead End Canals (flushing), Low Dissolved Oxygen</td>
</tr>
<tr>
<td><strong>Rare, Threatened and Endangered Species</strong></td>
<td>Jet Skis, Beach Activities, Marina Locations, Construction (docks and piers), Shoreline/Bay Island Stabilization, Shoreline Developments, Oil</td>
</tr>
<tr>
<td><strong>Seagrasses</strong></td>
<td>Commercial Fishing (dredge), Aquaculture (finfish and shellfish), Shoreline Developments, Nutrient Runoff, Sediment Runoff, Harmful Algal Blooms, Macroalgae, Sediment Contamination, Navigational Dredging, Recreational Boating and Personal Water Craft Scarring</td>
</tr>
<tr>
<td><strong>Shellfish (hard clams, scallops, ribbed mussels, oysters)</strong></td>
<td>Boat Wakes (erosion), Oil (chronic and episodic), Recreational Fishing (release of non-indigenous bait species), Marina Locations, Dead End Canals, Shoreline Development, Sediment Runoff, Chemical Contaminant Runoff, Harmful Algal Blooms, Low Dissolved Oxygen, Sediment Contamination, Navigational Dredging (see also Seagrasses and Tidal Wetlands)</td>
</tr>
<tr>
<td><strong>Shorebirds</strong></td>
<td>Jet Skis, Beach Activities, Marina Locations, Construction (docks and piers), Shoreline/Bay Island Stabilization, Shoreline Developments, Navigational Dredging, Oil</td>
</tr>
<tr>
<td><strong>Tidal Wetlands</strong></td>
<td>Construction (docks and piers), Shoreline/Bay Island Stabilization, Shoreline Developments</td>
</tr>
</tbody>
</table>
**Resource Bibliography**

**Benthic Organisms (non-commercial)**


**Blue Crab**


Williams, A. 1984. Shrimps, Lobsters and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida. Smithsonian Institute Press, Washington, D.C.

**Colonial Waterbirds**


**Diamondback Terrapin**


**Finfish**

Bohlen, C. and W. Boynton. 1997. Maryland Coastal Bays Status and Trends (final draft). University of Maryland, Chesapeake Biological Laboratory, Solomons, MD.


Casey, J. F. and A.E. Wesche. 1982. Benthos and Finfish; a study f the effects of tidal fluctuation over a coastal bay shoal. Maryland Department of Natural Resources.


**Horseshoe Crabs**


**Intertidal Invertebrates (Oysters and Mussels)**


Rare, Threatened and Endangered Species


Seagrasses

Orth et al., “Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay and Tributaries and the Coastal Bays”, Annual reports 1986 - 1999. Virginia Institute of Marine Science, Gloucester Point, VA.


Shellfish (Hard Clams and Scallops)


**Shorebirds**


NPS Assateague National Seashore Beach Bird Surveys, 1980s-1996, Contact: Carl Zimmerman.


**Tidal Wetlands**

Army Corps of Engineers. 1994. ACOE Tidal Wetlands Loss Estimates. Data from 1930’s to present.

APPENDIX A

Aquatic Sensitive Resource Maps
Sensitive Resource Map 1 – Map includes: shorebirds (blue), terrapin (red), and foragers/grazers (grey).
Sensitive Resource Map 2 - Map includes: shorebirds (blue), terrapin (red), and foragers/grazers (grey).
**Sensitive Resource Map 3** – Map includes: oysters (green), ribbed mussels (purple), adult blue crab (blue), perch spawning areas (black stripe), and striped bass spawning areas (red stripe).
Sensitive Resource Map 4 - Map includes: oysters (green), ribbed mussels (purple), adult blue crab (blue), perch spawning areas (black stripe), and striped bass spawning areas (red stripe).
Sensitive Resource Map 5 – Map includes: tidal wetlands (red), adult finfish (brown), seagrasses (green) and horseshoe crabs (blue).
Sensitive Resource Map 6 - Map includes: tidal wetlands (red), adult finfish (brown), seagrasses (green) and horseshoe crabs (blue).
Sensitive Resource Maps 7 – Map includes: colonial waterbirds (pink), juvenile blue crab (green) and juvenile finfish (tan).
Sensitive Resource Maps 8 - Map includes: colonial waterbirds (pink), juvenile blue crab (green) and juvenile finfish (tan).
Sensitive Resource Map 9 – Map includes: rare, threatened and endangered species (green), elver runs (red) and hard shell clams (grey).
Sensitive Resource Map 10 - Map includes: rare, threatened and endangered species (green), elver runs (red) and hard shell clams (grey).
APPENDIX B

Aquatic Sensitive Resource Maps Metadata
Title: MD Coastal Bays Finfish Sensitive Areas  
Originator: MD Department of Natural Resources and Worcester Regional GIS Program  
Description:  
  Abstract: The Sensitive Areas Finfish dataset shows areas within Maryland's Coastal Bays that are significant for Finfish populations. The areas less than 3 feet deep are especially important to juvenile Finfish, while areas greater than 3 feet deep are more utilized by adult Finfish populations. This dataset show cumulative seasonal use. It does not break out the seasonality of use of certain areas of the bays by Finfish.  
  Purpose: The Sensitive Areas Finfish dataset was developed to show the geographic location of areas specifically sensitive for Finfish populations in the Coastal Bays.  
  Process_Description: The MGS Shoreline dataset was combined with the vectors from the USGS 3 foot contour to create an open water area that was divided up into 3 sections: islands (land), greater than 3 feet deep (gt3ft), and less than 3 feet deep (lt3ft). These vectors were all combined with the state line to form polygons labeled with the attributes listed above.

Title: MD Coastal Bays Blue Crab Sensitive Areas  
Originator: MD Department of Natural Resources and Worcester Regional GIS Program  
Description:  
  Abstract: The Sensitive Areas Blue Crab dataset shows areas within Maryland's Coastal Bays that are significant for Blue Crab populations. The areas less than 3 feet deep are especially important to juvenile blue crabs, while areas greater than 3 feet deep are more utilized by adult blue crab populations. This dataset show cumulative seasonal use. It does not break out the seasonality of use of certain areas of the Bays by Blue Crabs.  
  Purpose: The Sensitive Areas Blue Crab dataset was developed to show the geographic location of areas specifically sensitive for Blue Crab populations in the Coastal Bays.  
  Process_Description: The 1989 MGS Shoreline dataset was combined with the vectors from the USGS 3 foot contour to create an open water area that was divided up into 3 sections: islands (land), areas greater than 3 feet deep (gt3ft), and areas less than 3 feet deep (lt3ft). These vectors were all combined with the state line to form polygons labeled with the attributes listed above.

Title: MD Coastal Bays Hard Clam Sensitive Areas  
Originator: MD Department of Natural Resources and Worcester Regional GIS Program  
Description:  
  Abstract: The Sensitive Areas Hard Clam dataset shows areas within Maryland's Coastal Bays that are significant for Hard Clam populations. This dataset shows cumulative use. The only area of the MD Coastal Bays that Hard Clams do not utilize in a significant manner is the St. Martin River area.  
  Purpose: The Sensitive Areas Hard Clam dataset was developed to show the geographic location of areas specifically sensitive for Hard Clam populations in the MD Coastal Bays.  
  Process_Description: The MGS Shoreline dataset was combined with the vectors from the USGS 3 foot contour to create an open water area that was divided up into 3 sections: islands (land), areas greater than 3 feet deep (gt3ft), and areas less than 3 feet deep (lt3ft). These vectors were all combined with the state line to form polygons labeled with the attributes, land, gt3ft, and lt3ft.

Title: MD Coastal Bays Colonial Waterbirds Sensitive Areas  
Originator: MD Department of Natural Resources and Worcester Regional GIS Program  
Description:  
  Abstract: The MD Coastal Bays Colonial Waterbirds dataset shows areas within Maryland's Coastal Bays that are significant for Colonial Waterbird populations. This dataset shows cumulative use from 1985 to 1999.  
  Purpose: The MD Coastal Bays Colonial Waterbirds dataset was developed to show the geographic location of areas specifically sensitive for Colonial Waterbirds populations in the MD Coastal Bays.
**Process_Description:** The MGS Shoreline database was used to extract the islands and certain other portions of the shoreline that are used by colonial waterbirds. The only exception is the Assateague Island shoreline that was extracted from the 1998 shoreline file created by Assateague Island National Seashore that represented the most up-to-date shoreline dataset at the time.

*******************************************************************************

**Title:** MD Coastal Bays Horseshoe Crab Sensitive Areas  
**Originator:** MD Department of Natural Resources and Worcester Regional GIS Program  
**Description:**

**Abstract:** The Sensitive Areas Horseshoe Crab dataset shows areas within Maryland's Coastal Bays that are significant for Horseshoe Crab breeding populations. Horseshoe Crabs use sandy beach areas for breeding.  
**Purpose:** The Sensitive Areas Horseshoe Crab dataset was developed to show the geographic location of areas specifically sensitive for Horseshoe Crab breeding populations in the MD Coastal Bays.  
**Process_Description:** Data on the location of sandy beach areas in the MD Coastal Bays was extracted from the MGS Shoreline dataset and recombined into a new dataset. Data was buffered by 20 feet on all sides to create polygons representing areas sensitive to Horseshoe Crab breeding populations.

*******************************************************************************

**Title:** Maryland Coastal Bays Rare, Threatened and Endangered Species Sensitive Areas  
**Originator:** Department of Natural Resources - Wildlife and Heritage Division  
**Description:**

**Abstract:** The MD Coastal Bays Sensitive Areas - Rare, Threatened and Endangered Species dataset represents the general location of all State Listed RTE species within a 1/2 mile of the Coastline. Staff at DNR, Heritage Division, processed some of this data from their extensive database of RTE locations and some were indicated by field personnel.  
**Purpose:** The purpose of creating this dataset was to complete a portion of the official list of sensitive areas within the Maryland Coastal Bays.  
**Process_Description:** The staff at the Department of Natural Resources, Heritage Division took locations of known Rare, Threatened and Endangered species locations and buffered those points by 500 feet. Additional areas were then added to this dataset to fill in missing information from reliable sources within the Department of Natural Resources, Heritage Division.

*******************************************************************************

**Title:** MD Coastal Bays Shorebird Sensitive Areas  
**Originator:** Worcester Regional GIS Program in conjunction with the MD Department of Natural Resources, Heritage Division  
**Description:**

**Abstract:** The Sensitive Shorebird Areas dataset was developed to show all locations in the Maryland Coastal Bays that are sensitive for shorebirds. The dataset is a subset of the National Wetlands Inventory (NWI) dataset. The polygons that were extracted from the NWI dataset were of the NWI_TYPE = E1UB4L and E2FLN. These wetland types represent specific types of subtidal and intertidal mud flats that are desirable to shorebirds.  
**Purpose:** The Sensitive Shorebird Areas dataset was developed to show all locations in the Maryland Coastal Bays that are sensitive for shorebirds.  
**Process_Description:** The polygons with the NWI_TYPE of E1UB4L and E2FLN were copied directly from the NWI dataset for Maryland and placed into the SASHOREBIRDS dataset, attributes and all. The only field added to this "new" dataset was the sbird_rank field. This ranking of sensitivity was determined by a workgroup of scientists convened by the Maryland Dept. of Natural Resources in a series of meetings from October of 1999 to October of 2000.

*******************************************************************************
Title: MD Coastal Bays Sensitive Terrapin Turtle Nesting Sites  
Originator: Worcester Regional GIS Program in conjunction with MD Geologic Survey and MD Dept. of Natural Resources  
Description:  
Abstract: The Sensitive Terrapin Turtle Nesting Sites dataset represents all areas in the Coastal Bays Watershed that have been observed as nesting sites for terrapins as well as those areas that are excellent potential areas for nesting, i.e. sandy beaches. The Sensitive Areas Taskforce, convened by the MD Dept. of Natural Resources, Water Use Committee, ranked all areas for sensitivity. The dataset was created by combining the sandy beach areas compiled by MD Geologic Survey from the MD Wetland Guidance Map shoreline data and information of the observed nesting sites given to staff by Mr. Jim Casey of the MD DNR Fisheries Division.  
Purpose: The Sensitive Terrapin Nesting Sites dataset was developed as a layer to represent the areas needed by Terrapin Turtles as a threatened species in the MD Coastal Bays Area.  
Process_Description: All terrapin nesting sites identified by DNR Fisheries Division were digitized to an ArcInfo coverage and buffered by 50 feet. The resulting coverage revealed areas known to be utilized by Terrapin turtles. After this, data from the 1989 MGS Shoreline dataset showing the locations of beaches were buffered by 25 feet and added to the nesting site coverage. All of the sites were assigned a sensitivity rank that was determined by the Sensitive Areas Taskforce, convened by the MD Dept. of Natural Resources Water Use Committee.

Title: Maryland Coastal Bays Sensitive Tidal Wetlands  
Originator: Worcester Regional GIS Program  
Description:  
Abstract: The Sensitive Tidal Wetland coverage is a dataset extracted from the MD Dept. of Natural Resources Wetland Guidance Maps. This dataset represents only a portion of the data available from the Wetland Guidance Maps - mainly just the TIDAL wetland types. The tidal wetlands were identified by reviewing the extensive classification system developed for the National Wetland Inventory and identifying codes that represent Wetland types in the tidal areas. The <wetlnd_ran> field was added to this dataset and represents a sensitivity value assigned by the Sensitive Areas Taskforce which was convened by the MD Department of Natural Resources Water Uses Committee.  
Purpose: The Sensitive Tidal Wetland dataset was formed to provide a layer of information on tidal wetlands for the Maryland Coastal Bays Area.  
Process_Description: The polygons, with attributes which describe them as tidally influenced wetlands, were extracted from the DNR Wetland Guidance dataset and placed into a separate layer. This new dataset was called the SATIDALWET3M.

Title: MD Coastal Bays Foragers and Grazers Sensitive Areas  
Originator: MD Department of Natural Resources and Worcester Regional GIS Program  
Description:  
Abstract: The Sensitive Areas Foragers and Grazers dataset shows areas within Maryland's Coastal Bays that are significant for aquatic forager and grazer populations. The Sensitive Areas Taskforce listed areas less than 3 feet deep as most important to Foragers and Grazers. This dataset shows cumulative seasonal use. It does not break out the seasonality of use of certain areas of the Bays by aquatic foragers and grazers.  
Purpose: The Sensitive Areas Foragers and Grazers dataset was developed to show the geographic location of areas specifically sensitive for aquatic forager and grazer populations in the Coastal Bays.

Title: 1998 Chesapeake Bay SAV Coverage  
Originator: Virginia Institute of Marine Science
Coastal Bays Sensitive Areas  
Technical Task Force Report  

Description:  
Abstract: The 1998 Chesapeake Bay SAV Coverage was mapped from 1:24,000 black and white aerial photography to access water quality in the Bay. Each area of SAV was traced onto 1:24,000 USGS quadrangles and classified into one of four density classes by the percentage of cover. The SAV beds were then digitized into an ArcInfo GIS coverage using the quality control procedures documented below.  
Purpose: The annual SAV aerial photographic monitoring program provides a comprehensive and accurate measure of change in SAV relative abundance that has been used to link improving water quality to increases in bay living resources.  
Process_Description: Identification and delineation of SAV beds by photointerpretation utilized all available information including: knowledge of aquatic grass signatures on film, distribution of SAV in 1998 from aerial photography, 1998 ground survey information, and aerial site surveys. USGS 7.5 minute quadrangle maps (1:24,00 scale) printed by the Mid-Continent Mapping Center of the National Cartographic Information Center on stable transparent mylar were used as base maps. Distortion-free, identical copies of these base maps were made at the same scale on stable transparent mylar using a contact diazo process. SAV beds from the 1998 aerial photographs were then mapped onto these diazo mylar copies of USGS 7.5 minute quadrangles. Delineation of each SAV bed was facilitated by superimposing the photographic print with the appropriate diazo mylar quadrangle on a light table. SAV bed boundaries were then traced directly onto the mylar quadrangle with a pencil. Where minor scale differences were evident between a photograph and a quadrangle, or where significant shoreline erosion or accretion had occurred since USGS publication of the map, either a best fit was obtained or shoreline changes were noted on the quadrangle. In addition to delineating SAV bed boundaries, an estimate of SAV density within each bed was made by visually comparing each bed to an enlarged Crown Density Scale similar to those developed for estimating forest tree crown cover from aerial photography. Bed density was categorized into one of four classes based on a subjective comparison with the density scale. These were 1, very sparse 10% coverage; 2, sparse (10-40%); 3, moderate (40-70%); or 4, dense (70-100%). Either the entire bed or subsections within the bed were assigned a bed density number (1 to 4) corresponding to the above density classes. Some beds were subsectioned to delineate where variation in SAV density occurred. Additionally, each distinct SAV unit (bed or bed subsection) was assigned an identifying two letter designation unique to its map. Subsections were further identified as contiguous beds by the addition of two letters unique to that sequence. These contiguous bed identifications aid the tracking and analysis of single natural bed units that were subsectioned due to variation in SAV density. Coupled with the appropriate SAV map number and year of photography, these two letter designations uniquely identify each SAV bed in the database.  

Title: MD Coastal Bays Sensitive White Perch Spawning Areas  
Originator: MD Department of Natural Resources and Worcester Regional GIS Program  
Description:  
Abstract: The Sensitive Areas Perch Spawning dataset shows areas within Maryland's Coastal Bays that are significant for White Perch spawning activities. The Perch Spawning activity is seasonal, occurring from approximately March 1 to May 15th of each year.  
Purpose: The Sensitive Areas Perch Spawning dataset was developed to show the geographic location of areas sensitive for the spawning of White Perch populations in the Coastal Bays every spring.  
Process_Description: The MGS Shoreline dataset was combined with the vectors from the USGS 3 foot contour to create an open water area that was divided up into 3 sections: islands(land), areas greater than 3 feet deep(gt3ft), and areas less than 3 feet deep(lt3ft). These vectors were all combined with the state line to form polygons labeled with the attributes listed above. The Perch Spawning areas were cut from this original dataset to form its own spawning area dataset in the upper portions of major tributaries to the Coastal River and Bays.  

Title: MD Coastal Bays Sensitive Elver Run Areas  
Originator: MD Department of Natural Resources and Worcester Regional GIS Program  
Description:  
Abstract: The Sensitive Areas Elver Run dataset shows areas within Maryland's Coastal Bays that are significant
Coastal Bays Sensitive Areas
Technical Task Force Report

for Eel populations. These areas are less than 3 feet deep and are especially important to juvenile eels, called elvers. This dataset is seasonal. Elver Runs occur from March 1 to June 10 each year.

**Purpose:** The Sensitive Areas Elver Run dataset was developed to show the geographic location of areas sensitive for Elver populations in the Coastal Bays during the time of year when they are spawning.

**Process_Description:** The MGS Shoreline dataset was combined with the vectors from the USGS 3 foot contour to create an open water area that was divided up into 3 sections: islands (land), greater than 3 feet deep (gt3ft), and less than 3 feet deep (lt3ft). These vectors were all combined with the state line to form polygons labelled with the attributes listed above. The elver run areas were subsequently extracted from this larger dataset to show only specified areas in upper tributaries to the Coastal Bays.

********************************************************************************

**Title:** MD Coastal Bays Sensitive Areas for Striped Bass
**Originator:** MD Department of Natural Resources and Worcester Regional GIS Program
**Description:**

**Abstract:** The Sensitive Areas Striped Bass dataset shows areas within Maryland's Coastal Bays that are significant for Striped Bass populations. This dataset shows seasonal use of certain areas of the bays by Striped Bass during spawning season.

**Purpose:** The Sensitive Areas Striped Bass dataset was developed to show the geographic location of areas seasonally sensitive for spawning Striped Bass populations in the Coastal Bays.

**Process_Description:** The MGS Shoreline dataset was combined with the vectors from the USGS 3 foot contour to create an open water area that was divided up into 3 sections: islands (land), areas greater than 3 feet deep (gt3ft), and areas less than 3 feet deep (lt3ft). These vectors were all combined with the VA and DE state lines to form polygons labelled with the attributes listed above. From this original dataset, the areas used by Striped Bass during spawning season (March 1 to June 10) were extracted and placed into a separate dataset.

********************************************************************************

**Title:** Sensitive Areas
**Originator:** MD Department of Natural Resources and Worcester Regional GIS Program
**Description:**

**Abstract:** This dataset is an integration of data from 19 other datasets which were created specifically for the Sensitive Areas Project. This project, led by the Sensitive Areas Task Force (through MD DNR), represents some of the aquatic or aquatic-related important areas for sensitive resources. The integrated data-sets include the following: adult and juvenile blue crabs, colonial waterbirds, diamondback terrapin nest sites, state-listed rare, threatened and endangered species, juvenile and adult finfish, white perch and striped bass spawning areas, elver runs, foragers and grazers, horseshoe crab spawning sites, ribbed mussels, oysters, SAV beds, hard clams, shorebirds, tidal wetlands and scallops. In general, areas were ranked 0 (no worth) to 5 (highly important) for all aforementioned data sets. This composite coverage includes the cumulative ranking score. Since natural resources are dynamic over time and the state of knowledge is increasing, this data-set is expected to change over time to represent most current ground conditions.

**Purpose:** This dataset is in draft. It was developed to condense data from 17 separate coverages into one coverage for extended analysis by the sensitive areas workgroup.

********************************************************************************

- 74 -