Chapter 1.2

The Maryland Coastal Bays ecosystem

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Ecosystem background

The Coastal Bays are estuaries: areas where fresh water mixes with salt water. Due to the flat landscape and sandy soils, rainwater seeps into the ground quickly and groundwater serves as a major pathway of freshwater to the bays. Salinities in the open bays are close to seawater while small portion of the upstream reaches of rivers and creeks remain fresh (Figure 1.2.1). Circulation in the bays is controlled by wind and tides. Tidal exchange with the Atlantic Ocean is limited to two inlets, one dividing Fenwick and Assateague islands and the second in Virginia south of Chincoteague Island. Tidal range near the Ocean City Inlet is more than 3.4 feet, while it drops to 0.4 feet in the middle of Chincoteague and 1.5 feet in Assawoman Bay (UMCES 1993). The Coastal Bays overall are classified as microtidal. Flushing in the bays (the amount of time it takes to replace all of the water by freshwater and ocean exchange) is very slow. That means that contaminants such as nutrients, sediment and chemicals that enter the bays tend to stay in the bays. Because the systems are shallow and have relatively long water residence times, increased nutrients can have a disproportionate effect relative to the nation's larger and deeper bays such as the Chesapeake, Delaware, Raritan, Narragansett, San Francisco and Puget Sound.

<u>Influence of the Ocean: Barrier Islands</u>

Barrier islands are rocky, sandy islands and beaches, dunes, and wetlands located along the Atlantic and Gulf coasts. There are 295 barrier islands along the U.S. coastline (Leatherman 1988). These beaches and the wildlife resources of these islands attract thousands of tourists and millions of dollars to coastal communities every year. Barrier islands serve two main functions in the Coastal Bays ecosystem. First, they protect the coastlines from severe storm damage. Second, they harbor several habitats that are refuges for wildlife.

Natural barrier island processes help create and maintain habitat and benefit circulation. For example, newly formed inlets often amplify tidal flushing. Many inlets have existed along Fenwick and Assateague islands over the past 400 years, including the Ocean City Inlet, which was formed during a major storm in 1933. During storms, ocean water can wash over the barrier islands, carrying sand from the ocean beaches to the bays. This overwash provides a sediment source for the creation of salt marshes and seagrass beds.

Many marine creatures find shelter in extensive marsh lands along the coast. Protected by islands, these salt marsh nurseries add millions of dollars to the economy through commercial and sport fishing opportunities. (Assateague Island National Seashore 2004) Of all the barrier islands between Maine and Mexico; Assateague is one of the last still in a natural state. It's beaches, lagoons and maritime forests offer a rare solitude not far from a rapidly developing coast.

Rising sea-levels and predominant winds from the northeast cause a landward migration of the islands. During storms, overwash of the islands by the sea pushes sand to the mainland side in large quantities. Strong winter winds blowing predominantly from the northeast also pushes sand towards the land. Summer hurricanes and winter storms called "Nor' Easters" account for the most dramatic short-term changes to the islands. A large hurricane can overwash large areas of the islands.

These same wind and weather patterns also move sand generally from north to south. At natural inlets sand tends to erode from the north and accrete (accumulate) on the south side. Where man puts hardened structures like jetties or groins in place, the opposite is true- sand blocked on its normal southerly migration piles up on the north side of a jetty but is eaten away on the south side by the eddy that is created.

For example, a hurricane opened the Ocean City Inlet in 1933 (the inlet separates Fenwick Island from Assateague Island to the south). To keep the channel navigable to the mainland, the U.S. Army Corps of Engineers constructed two rock jetties. Although the jetties stabilized the inlet, they altered the normal north-to-south sand transport by the longshore currents. The result is that sand built up behind the north jetty and the sand below the south jetty was quickly eroded. The accelerated erosion has shifted Assateague Island almost one-half mile (.8 km) inland. In a very short time, human interventions have permanently altered the barrier island profile.
(http://science.howstuffworks.com/barrier-island4.htm)

Influence of the Ocean: hydrodynamics

River input to the Coastal Bays is low and groundwater is an important source of freshwater inflow. Circulation in the bays is mainly controlled by winds and tides. Tidal range near the Ocean City Inlet is more than 3.4 feet, while it drops to 0.4 feet in the middle of Chincoteague and 1.5 feet in Assawoman Bay (Boynton et al. 1993). Flushing rates have been estimated for the northern segments as follows: Isle of Wight Bay 9.45 days, Assawoman Bay 21.2 days, and St. Martin River 12 days (Lung 1994). The flushing rate for Chincoteague Bay may be as long as 63 days (Pritchard 1969). The actual residence time of any constituent would vary from the flushing time because of its water column kinetics. Processes such as algal uptake and settling of phytoplankton would tend to decrease the residence time while nutrient recycling would increase the residence time. Intense benthic – pelagic coupling, which is common in systems such as these, increases the impact of contaminants such as nutrient, sediment and chemicals entering the bays.

Nutrient Loading / comparison to other estuaries

Since point sources (e.g. 3 industry and 4 wastewater treatment plants) are heavily regulated in the Coastal Bays, the estimated contribution of nutrients is small (<5% of total nutrients) (UMCES 1993). Nutrient inputs to the Coastal Bays are dominated by non-point sources (e.g. surface runoff, groundwater, atmospheric and shoreline erosion). The amount of nutrients coming from an area is largely dependent on the predominant landuse with agriculture and developed lands generally contributing more nutrient than wetlands and forests. The large variety of non-point sources and pathways makes estimates of relative contribution from different land uses difficult. Current estimates suggest that one-third of nutrients entering the bays come from agriculture sources (Bohlen et al 1997). Efforts are presently underway to refine these estimates using data collected in the Coastal Bays watershed.

Table 1.2.1 Key physical characteristics of each bay segment.

Bay Segment	Drainage area (km^2)	Average depth (m)	Surface area of bay (km^2)	Watershed: Surface area ratio	water volume (m^3*10^6)	Watershed: water volume	Flushing rate (days)
Assawoman	24.7	1.20	20.9	1.18	27.0	0.91	21.2
Isle of Wight	51.8	1.22	21.1	2.45	22.85	2.27	9.45
St. Martin River	95.5	.67	8.40	11.4	5.63	16.96	12
Sinepuxent	26.7	0.67	24.1	1.1	16.5	1.62	U
Newport	113	1.22	15.9	7.1	19.4	5.82	U
Chincoteague (MD)	141	1.22	189	0.75	231	0.61	63
Chincoteague (VA)	174.5	U	188	0.93	143.5	1.22	U
Coastal Bays System	452	1.0	282	1.6	322	1.40	U
Chesapeake Bay	165,759	6.4	18,130	9.1	68,137	2.4	U

Bathymetry/ Surficial Sediment type

Chincoteague Bay, the southernmost of the Coastal Bays, has a drainage area of approximately 141 km^2 and an average depth of 1.22 m. Most of this bay is shallower than one meter, with deeper water in the central channel (7.6 m maximum) pulling the average up. The surface area of the Maryland portion of Chincoteague Bay is 189 km^2. Sediments range from mostly sandy in the eastern part of the bay to silty within the channel to a silt/sand mix along the western shoreline (UMCES 1993, Figure 1.2.2 and Figure 1.2.3). Average grain size as percent of fines is 8.5%, with average percent organic carbon by dry weight at 0.39% (extremely low for an estuarine system). The major source of sedimentation to Chincoteague Bay is storm overwash events and wind erosion from Assateague Island, with stream sedimentation providing relatively little contribution.

Moving north, **Newport Bay** drains approximately 113 km^2 of land area. The average depth of the bay proper is 1.22 m with a maximum of 1.9 m in a central channel. Newport

Bay has a surface area of 15.9 km^2. Sediments are fine-grained, containing mostly silt with little clay (Wells et al. 1996,, Figure 1.2.22 and Figure 1.2.3). Total carbon averaged 1.86% for Newport and Sinepuxent bays combined, with a majority of this contribution from organic sources (Wells et al. 1996). Newport generally has higher carbon contents than Sinepuxent due to more marsh and tributary drainage. Due to the low gradient of Trappe Creek and the other tributaries that constitute the major sediment sources for this bay, sedimentation rates are relatively low.

Sinepuxent Bay, to the immediate east of Newport Bay, has a drainage of 26.7 km^2 and a surface water area of 24.1 km^2 (UMCES 1993). This Bay has the shallowest average depth (0.7 m), despite depths around the Ocean City Inlet reaching 7.8 m. Bottom sediments are fairly course, consisting mostly of sand and, to a lesser degree, silt (Wells et al. 1996, Figure 1.2.22 and Figure 1.2.3). Sedimentation mainly comes from storm overwash and wind erosion on Assateague Island and occurs at a higher rate here than in any other Bay (Wells et al. 1996).

Isle of Wight Bay, directly north of Sinepuxent, has a drainage area of 146 km^2 and a surface water area of 19 km^2 including the St. Martin River. The average depth of this Bay is 1.22 m, with a maximum depth of 9.3 m in the Ocean City inlet (maintained by dredging) (UMCES 1993). Sediment is mostly silt, averaging 44% in cores taken from Isle of Wight, St. Martin River, and Assawoman Bay combined (Wells et al. 1994). A higher percentage of sand is found along the eastern portions of Isle of Wight Bay, due to overwash and erosion from Fenwick Island (Figure 1.2.22 and Figure 1.2.3). Total organic carbon averages 1.83% in Isle of Wight, St. Martin, and Assawoman Bay combined, with carbon content reflecting a combination of both terrigenous and planktonic sources (Wells et al. 1994). St. Martin River and Turville Creek sediments contain the least sand and the most clay and have been classified as tidal stream deposits. Major contributors to Isle of Wight Bay sedimentation are Turville Creek and St. Martin River in the west along with sand from Fenwick Island.

The furthest north embayment, **Assawoman Bay**, drains 24.7 km^2 and has a surface water area of 20.9 km^2 (UMCES 1993). This bay averages 1 m in depth, with a maximum of 2.5 m in a central channel. The canal (also called the 'ditch') connecting Isle of Wight Bay with Assawoman averages 4.7 m in depth. Assawoman Bay sediments contain mostly silt with east-west gradient and total carbon properties identical to Isle of Wight Bay (Figure 1.2.22 and Figure 1.2.3). Major sediment contributors to this bay island on the eastern side.

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Figure 1.2.1 Salinity classification for water quality sampling stations within the Coastal Bays. Several sampling stations are non-tidal and are thus freshwater.

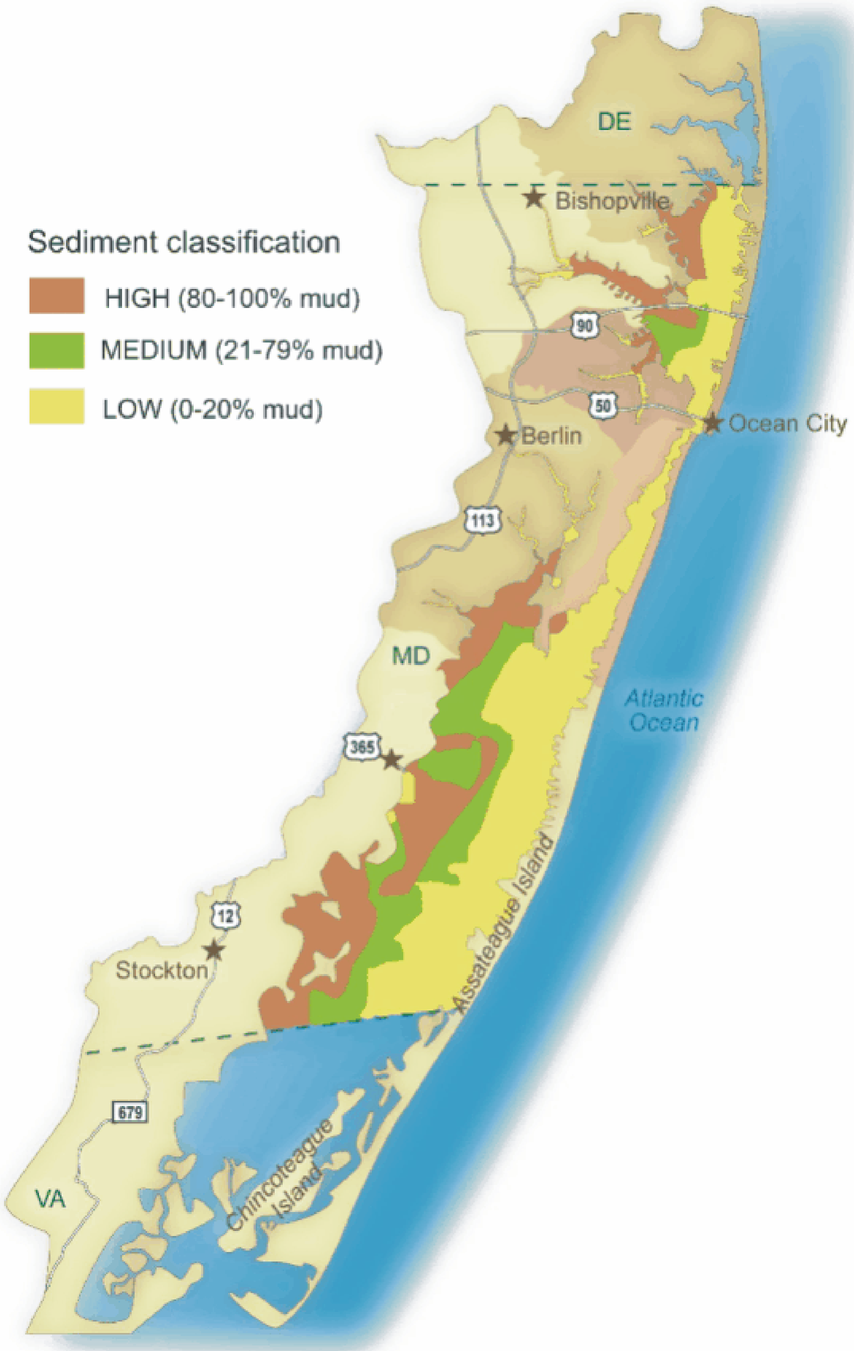

Figure 1.2.2 Percent mud in Coastal Bays shallow bottom sediments.

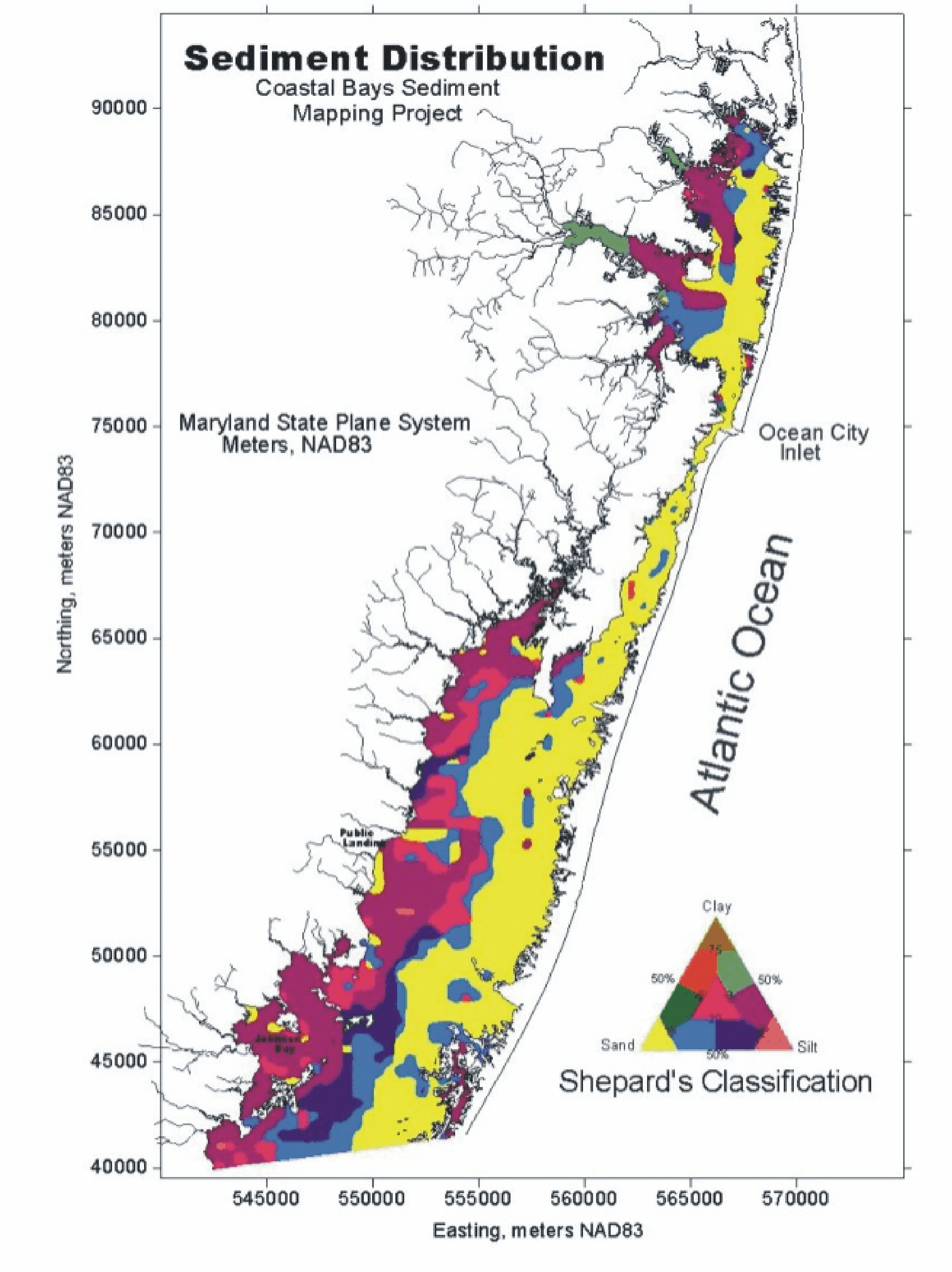

Figure 1.2.3 Sediment distribution in Coastal Bays shallow sediments. The Shepard's classification legend, based on Shepard (1954), shows the relative percentages of sand, silt, and clay in the sediments.