3.16 Western Shore Chesapeake Bay Shoreline

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Overview

The western shore region of Chesapeake Bay includes St. Mary's, Calvert, and Anne Arundel counties and Baltimore City and County.[621] Land types in these counties vary from major urban areas such as Baltimore and Annapolis to largely rural areas in Calvert County. The region, particularly Calvert County, is characterized by smoothed shorelines, indicating sufficient sediment supply and longshore transport as compared to the more jagged eastern shore's coves, inlets, and islands.[622]

This brief literature review discusses species that could be at risk because of further habitat loss resulting from sea level rise and shoreline protection. Existing literature and knowledge of coastal scientists in the area appears to be sufficient in many cases to make qualitative statements about the possible impact if sea level rise causes a total loss of habitat, which might be expected if shores are protected with hard structures and the wetlands are unable to keep pace with sea level rise. Our ability is more limited, however, to say what the impact might be if only a portion of the habitat is lost. The major tributaries to Chesapeake Bay on the western shore are the Patuxent River, a major Bay tributary bordering Calvert, St. Mary's, Charles, and Prince George's counties; the South River and the Severn River in Anne Arundel County; the Patapsco River on the southern side of Baltimore; and the Gunpowder River, straddling the border of Baltimore and Harford counties. Western shore tidal wetlands are primarily located in these tributaries, in particular, at the mouth of the Gunpowder, at Jug Bay in the Patuxent, and in Sullivan's Cove Marsh and Round Bay Bog on the Severn. Some of these tributaries have been dramatically modified with shoreline protections, yet others have remained largely unchanged. For example, the Patapsco formerly supported populations of anadromous fish, but urbanization along its banks and installation of dams along its course have since prevented their migration.[623] In contrast, the Severn's steep cliffs and deep ravines earned it a designation of Scenic River by the Maryland General Assembly.

The western shore will see a range of impacts from sea level rise in the future. Despite large areas of conservation or parkland and restricted development (e.g. upper Patuxent River, Calvert Cliffs), loss of key habitats may occur. The large degree of shoreline armoring from northern Calvert County through Baltimore will also affect shoreline retreat. The overall environmental impact of sea level rise in this multicounty region are likely to include the following:

- Partial or complete marsh loss is expected in many areas. In the upper Patuxent River, marsh areas have experienced minimal migration despite inundation. Saltwater intrusions may shift the fauna dependent on nontidal wetlands in Shady Side, particularly freshwater fish. The potential loss of the wide mudflats at Hart-Miller Island would eliminate foraging and nesting for the large bird population, including many sensitive species.
- *Beach* loss, particularly in St. Mary's, Calvert, and Anne Arundel counties along

[621]This review looks at ecological implications of sea level rise from Baltimore County through the northern half of St. Mary's County, including its Patuxent River shoreline.

[622]Stevenson and Kearney, 1996, p. 234 (see note 38).

[623]Alliance for the Chesapeake Bay, n.d., River Summaries, accessed on May 3, 2006, at http://www.acb-online.org/about.cfm.

Chesapeake Bay, may occur in areas without nourishment. The widespread presence of shoreline protection can interfere with longshore transport. Beach loss or reduction may occur even in areas where shoreline retreat is possible. Many invertebrates will lose their habitat, including the northeastern beach tiger beetle (federally listed as threatened).

- The *cliffs* of Calvert County will not be lost, but effects from increased rates of sea level rise and impediments to longshore sediment transport may increase erosion rates above sustainable levels for the resident populations. The Puritan tiger beetle (federally listed as threatened) may lose essential habitat.
- Effects on *nearshore* communities may be observed. In the upper Patuxent River, the spread of SAV more tolerant of deeper depths and higher turbidity (*Hydrilla*) may be accompanied by a decrease in larger fish, though its spread may be tempered by changes in salinity.[624]

Sediment deposition is fairly high along the western shore of Chesapeake Bay, both from land runoff and erosion. Along the bay shorelines, marsh areas are expected to be marginal with a 2 mm per year rate increase in sea level rise and to be lost with a 7 mm per year increase. The ability to migrate will most likely determine their survival. In upper reaches of tributaries, marsh accretion should be sufficient to meet a 7 mm per year increase in the rate of sea level rise (Section 2.1). However, localized areas may have differing rates of accretion, subsidence, and erosion, and some wetlands on the western shore are being inundated (e.g., in Jug Bay on the upper Patuxent). Planners indicate that shoreline protections are almost certain throughout much of Anne Arundel and Baltimore City/County, which will most likely lead to the loss of both intertidal areas and wetlands with sea level rise rate increases of 2 mm per year.

[624]See Section 3.1 for general background on species and habitats vulnerable to sea level rise for the mid-Atlantic. It includes overview information on salinity and other factors not discussed in detail here.

St. Mary's County, Chesapeake shoreline

Beginning at the southern tip of St. Mary's County, the bay-front shoreline between the Potomac and the Patuxent rivers is primarily narrow sandy beaches with low bank heights (less than 5 feet). Erosion is a significant problem: more than half the beach is eroding, although a large portion of the remaining shoreline is already stabilized with bulkheads or riprap.[625] Erosion is likely to be a problem on the beaches fronting shoreline protections and may be so in other areas as well. In general, beach loss will lead to habitat loss for resident insects and other invertebrates and forage loss for larger predators such as shorebirds.[626] Estuarine marshes line the many small coves. Given existing erosion, these marshes are unlikely to accrete or migrate sufficiently to retain their current size, even in unprotected areas. Wetlands loss harms the crustaceans, mollusks, and other invertebrates that live in close association with the wetland vegetation and the turtles (e.g. diamondback terrapins) and birds (e.g. ducks, rails) that forage on them.[627] At Point Lookout State Park (CBIM location 38), a loblolly pine tidal woodland is already being lost to relative sea level rise. Saltwater intrusion across the fronting estuarine marsh is killing trees as a result of salt stress and increased inundation.[628,629] Tidal hardwoods such as loblolly pines provide nesting sites for piscivorous species such as ospreys, bald eagles, and double-crested cormorants.[630]

Patuxent River

Erosion is also an issue in the lower Patuxent River. The St. Mary's County shoreline is a mix of low to high banks, mostly with trees and shrubs or residential development, with

[625]Berman et al., 2003, St. Mary's County (see note 580).
[626]Lippson and Lippson, 2006, pp. 26–42 (see note 2).
[627]Lippson and Lippson, 2006, pp. 201–239 (see note 2).
[628]Tiner and Burke, 1995, Plate 7 (see note 32).
[629]Harrison, J.W., P. Stango III, and M.C. Aguirre, 2004, Forested tidal wetland communities of Maryland's Eastern Shore: Identification, assessment, and monitoring, Maryland Department of Natural Resources, Natural Heritage Program, Annapolis, MD, unpublished report submitted to U.S. EPA.
[630]Robbins and Blom, 1996, pp. 44 and 92–94 (see note 552).

significant erosion rates in the higher banks.[631] The immediate shores are primarily vegetated bank with a minimal intertidal area; roughly 15 percent are fronted by sandy beaches and 25 percent by marshes.[632] Erosion is prevalent through all shoreline types. The Calvert County shoreline is assumed to be similar in this region. Planners indicate that shoreline protections are almost certain for the first few miles of the river, but further up are unlikely. Given current erosion rates and low rates of accretion near Chesapeake Bay, marsh areas are likely to be inundated in the protected areas. Some marsh migration may occur at the northern end of St. Mary's County, but the high banks in many locations will inhibit migration, resulting in net loss of marsh areas.

North from the Prince George's and Charles County border, large areas of tidal estuarine marsh line the Patuxent River, changing to tidal freshwater above the Anne Arundel County line.[633] Shoreline protection is unlikely in this area. Sediment inputs are predicted to be high enough to retain marsh area, but naturalists at Jug Bay in the upper Patuxent River (CBIM location 41) have observed inundation and minimal migration of low marsh, with direct conversion of wooded or high marsh areas to open water.[634] The marsh has decreased visibly in size over the last 25 years, with the appearance of more emergent vegetation (e.g., spatterdock, *Nuphar luteum*) as water depth increases. In the Jug Bay Sanctuary, as erosion continues and water levels rise, spatterdock is becoming submerged and is being displaced by the highly invasive *Hydrilla verticillata*, which can tolerate deeper waters and reduced light, and higher suspended sediment loads is filling in open water and unvegetated mudflat areas. Spatterdock, a perennial, grows before *Hydrilla* in the spring, and has not been affected by the increase in *Hydrilla*.[635] Although *Hydrilla* may displace other native vegetation or become sufficiently dense to prohibit movement of larger fish, the species does improve water quality (as compared to the absence of vegetation) by trapping sediments, contributing oxygen, and increasing carbon dioxide uptake, and may provide sheltering habitat for smaller fish.[636] The increasing water depth has also compounded stress on local vegetation and on the birds that feed on the plants. Migrating populations of Sora rails (*Porzana carolina*), a marsh-dependent species that feed primarily on seed and green plant matter, declined in Jug Bay throughout the 1990s because of overgrazing of one of their primary food sources (wild rice, *Z. aquatica*) by resident Canada geese (*Branta canadensis*).[637,638] Wild rice restoration efforts have been affected by the increasing water depths. The rice survives regular tidal inundation of up to 2 feet, and usually stands in roughly 6 to 12 inches of water, but under additional stresses such as the foraging of resident Canada geese is less resilient. Unusually cold and wet weather in the spring of 2005 and 2006, with associated higher water levels in the marsh, hindered wild rice growth in the lower marsh. Wild rice in the upper marsh areas was not adversely affected, and even

[631]The St. Mary's County Patuxent River shoreline is more than 40 percent low bank (0–5 feet), 10 percent medium (5–10 feet), more than 25 percent high (10–30 feet), and more than 10 percent above 30 feet. Berman et al., 2003 (see note 580).

[632]Berman et al., 2003 (see note 580).

[633]Tiner and Burke, 1995 (see note 32).

[634]Phone conversations on April 27 and December 1, 2006, and email confirmation "Re: Final review of Patuxent section of report," of discussions about Jug Bay, and 25 years of observations there, between IEc and Greg Kearns, naturalist, Jug Bay Natural Area.

[635]Phone conversation, including description of *Hydrilla* and its current presence, characteristics, and relation to spatterdock in the Patuxent marshes. Greg Kearns, naturalist, Jug Bay Natural Area, December 1, 2006.

[636]Nonindigenous aquatic species: *Hydrilla verticillata*, accessed on May 30, 2006, at http://nas.er.usgs.gov/taxgroup/plants/docs/hy_verti.html; Plant Invaders of Mid-Atlantic Natural Areas, accessed on May 30, 2006, at http://www.nps.gov/plants/alien/pubs/midatlantic/hyve.htm; and phone conversation with Greg Kearns (see note 636).

[637]Gough, G.A., J.R. Sauer, and M. Iliff, 1998, *Patuxent Bird Identification Infocenter*, version 97.1, Patuxent Wildlife Research Center, Laurel, MD, available at: http://www.mbr-pwrc.usgs.gov/id/framlst/infocenter.html.

[638]Phone conversation, including discussion of sora rail populations, dependence on wild rice, and efforts to monitor and restore wild rice. Greg Kearns, April 27, 2006. Confirmed by email "Re: Final review of Patuxent section of report," on December 1, 2006. Note: smartweeds (*Polygonum* spp.) are also important in diets of sora rails.

increased its coverage dramatically in some areas.[639,640]

Calvert County/Chesapeake shoreline

Returning to Chesapeake Bay at the mouth of the Patuxent River, Cove Point (CBIM location 39) has a unique shoreline formation, the cuspate foreland. The foreland results when sand is moved along a shoreline predominantly in one direction, and then hits a geologic formation that traps the sand. A point forms with sands accreting on the downshore side of the cusp. Cove Point Marsh is a 150-acre freshwater, barrier-beach marsh on the upshore side of the cusp. Numerous state-defined rare plant species, including American frog's-bit (*Limnobium spongia*), silver plumegrass (*Erianthus alopecuroides*), various ferns, and unique wetland communities,[641] as well as populations of the northeastern beach tiger beetle, and the Puritan tiger beetle (both federally listed as threatened), and the rare leaf beetle *Glyptina maritima*, are present there. The marsh side is threatened by storm-driven overwash, sea level rise, and residential development on the south side, which has disrupted the migration of the foreland in recent decades. The marsh is continuing to migrate, but will soon hit the northern edge of the development. Shoreline protections to the north may limit sediment inputs to the marsh that would otherwise allow accretion to keep up with sea level rise.[642] The marsh area will slowly be lost as the outer edge is eroded and inundated, endangering the many rare plants in the marsh. The upstream protections may be leading to significant erosion and coincidental loss of northeastern beach tiger beetle larval habitat areas north and south of the Cove Point pier, the likely causes of decline in the local population.[643]

North of Cove Point are the Calvert Cliffs (CBIM location 40), which formed during the Miocene epoch when Chesapeake Bay was a shallow sea. The cliffs are the remnants of the sea floor, now standing up to 115 feet above the water. Fossilized remains are exposed as wind and water erode the cliffs at a rate up to 2.75 feet per year.[644] The area inland of the cliffs in southern Calvert County is largely undeveloped (primarily because of the presence of the Calvert Cliffs Nuclear Power Station), but more development is present along the northern shoreline. The northeastern beach tiger beetle and the Puritan tiger beetle both depend on the naturally eroding cliffs and the sandy fronting beaches of the Calvert Cliffs for habitat, both as larvae and as adults. Puritan tiger beetle populations at Calvert Cliffs have been declining in recent years, in part owing to habitat loss.[645] The larvae require a moderate amount of cliff face erosion, although exact rates are unknown. Continuous erosion prevents vegetation from establishing on the beaches or cliffs, maintaining the necessary bare substrate for the beetles. In areas where cliff erosion is slowed by increased toe elevation or armoring, the cliff face subsides into a more modest slope, and vegetation then stabilizes it. At Calvert Beach, larvae and adults were absent from the areas stabilized by vegetation, but were present on sandy bluff faces.[646] According to a beetle expert, in areas where beach is entirely submerged at high to mid-tides, few to no Puritan tiger beetles are present.[647] In contrast to areas stabilized by

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[639]Phone conversation, including description of observations of vegetation dynamics by Greg Kearns, April, 27, 2006, and confirmed by email "Re: Final review of Patuxent section of report," on December 1, 2006. Aerial photographs described by Kearns have captured these changes in wild rice coverage.

[640]Wild rice also occurs in the freshwater portions of the York, Potomac, and Choptank rivers (Lippson and Lippson, 2006, p. 208, see note 2).

[641]Steury, B., 2002, "The vascular flora of Cove Point, Calvert County, Maryland," *The Maryland Naturalist* 45(2):1–28, pp. 16, 21.

[642]Email communication from Katharine McCarthy, Southern Regional Ecologist, Natural Heritage Program, Wildlife and Heritage Service, Maryland DNR, to Ann Shellenbarger Jones and Christina Bosch, Industrial Economics. "RE: Calvert Cliffs State Park" including confirmation of prior emails, and text in draft report. Sent September 11, 2006.

[643]Knisley, C.B., 2000, Population decline of the northeastern beach tiger beetle in Calvert County, MD. Final Report, submitted to Cove Point Natural Heritage Trust, January 18.

[644]Calvert Cliffs State Park, accessed on May 9, 2006, at http://www.dnr.state.md.us/baylinks/15.html.

[645]Knisley, 2000 (see note 643).

[646]USFWS, 1993 (see note 166).

[647]Peer review comment by Barry Knisely on this section on the Western Shore Chesapeake Bay Shoreline, received July 20, 2007.

vegetation, as cliff erosion increases because of loss of toe elevation, winter storm waves shear off large portions of cliff and may kill larvae in localized areas.[648] If erosion occurred at rates high enough to shear of areas to a depth below larvae burrows, Puritan tiger beetles could be eliminated. Impacts to adult Puritan tiger beetles may also occur if sea level rise or increased erosion diminishes the beach habitats used for foraging.[649]

Although natural erosion processes are allowed to continue in the protected cliff areas in the southern portion of the county, shoreline protections in the more northern developed areas are affecting the Calvert Cliffs shoreline. Effects on longshore sediment transport from upstream shoreline protections are an identified cause of increased erosion rates.[650] In addition, there is increasing pressure for shoreline stabilization along the more southern shoreline (in particular near Little Cove Point), and revetments and other shoreline stabilization projects have been recently constructed or are proposed.[651] Unfortunately, overly rapid erosion is also a threat to the Puritan tiger beetle, owing to shearing of cliff habitat. Shoreline protections are almost certain along much of the developed northern coast of Calvert County, which may increase erosion rates in the unprotected southern cliff areas beyond the range required by the tiger beetles. In the more northern areas where the cliffs are stabilized, the rocky and sandy toes to the cliffs will be lost to inundation with sea level rise, along with the invertebrate community (e.g., burrowing amphipods and hermit crabs) that resides there.

Anne Arundel County

Anne Arundel County has dense residential development near its primarily sandy bay shoreline. Shady Side (CBIM location 42), at the southern end, is located on a peninsula surrounded on two sides by the West River, and on a third by Chesapeake Bay. The area is generally at low elevation above the water level and highly developed.[652] Given the already severely limited state of tidal wetlands, the primary effect of sea level rise in Shady Side will most likely be more frequent upland flood events. Large portions of the shoreline are already protected, with future protection almost certain along most of the shoreline.[653] The interior areas of the Shady Side peninsula are marked by nontidal wetlands. The myriad creeks and streams that cross the Shady Side wetlands provide spawning and nursery areas for freshwater, estuarine, and anadromous fish such as striped bass, white perch, spot, croaker, and a variety of forage fish.[654] Increased inundation events in the nontidal freshwater areas with higher salinity water could cause significant habitat decline in freshwater species.[655] Farther north in the county, higher elevations limit the wetlands close to the coastline. However, Anne Arundel County does have a policy of encouraging and supporting nonstructural or hybrid shoreline protection projects. The County provides free technical support, site evaluation, and plant plugs (*S. alterniflora* and *S. patens*) for residents.[656] With the likelihood of almost certain shoreline protections throughout, the current

[648]U.S. FWS, 1993 (see note 166).
[649]Barry Knisely (see note 647).
[650]Wilcock et al., 1998 (see note 161).
[651]Barry Knisely (see note 647); and USFWS, 2006, Pre-decisional draft biological opinion on "Chesapeake Ranch Estates/Phase V/Breakwater," Accessed on July 26, 2007, at: http://www.fws.gov/northeast/Endangered/tebo/PDFs/CHES.RANCH.BO.revised%20project6.pdf.

[652]The elevation ranges from 3 to 10 feet, with an average of 7. Anne Arundel County Small Planning Area Plan for Deale/Shady Side, Section X. Land Use and Zoning, p. 71, accessed on May 5, 2006, at http://www.aacounty.org/PlanZone/SAP/DealeSS.cfm.
[653]More than 75 percent (1,609 out of 2,120) of parcels studied had shoreline improvements in place. Michael, J.A., D.A. Sides, and T.E. Sullivan, 2003, The economic cost of sea level rise to three Chesapeake Bay communities. NOAA, Maryland DNR, and Center for Geographic Information Sciences at Towson University.
[654]Anne Arundel County Small Planning Area Plan (see note 652).
[655]Bay waters at Shady Side average between 5–10 ppt salinity in spring and summer and 10–15 ppt in fall. Average Surface Salinities Map, accessed on May 30, 2006, at: http://mddnr.chesapeakebay.net/eyesonthebay/images/bay_salinity.jpg.
[656]Anne Arundel County, Maryland, Office of Environmental and Cultural Resources, 2006, Emergent Marsh Grass Re-Vegetation Program, available at: http://www.aacounty.org/LandUse/OECR/EmergentGrasses.cfm. Program discussed in phone conversation with Jim Johnson, May 30, 2006.

intertidal areas will be inundated by sea level rise. The fringing marshes created through Anne Arundel County's shoreline projects may provide key habitat for marsh invertebrates in addition to protecting upland areas. Several rare birds, including the black rail (*Laterallus jamaicensis*), which is listed by the DNR as in need of conservation, breed in the Anne Arundel County marshes.[657]

Baltimore City and County

Planners in both Baltimore City and County anticipate that shore protection is almost certain throughout the area. Almost half of the shoreline already has bulkheads or riprap, particularly along the Patapsco River.[658] The remaining narrow muddy shores and mudflats, particularly in the currently less developed sections of the Patapsco, may be lost because of sea level rise if shorelines are protected. In the upper portion of the Back River north of Baltimore, small areas of wetlands may be able to accrete sufficient sediment to retain function, but migration will be prevented by shoreline protection. Directly on Chesapeake Bay, the large marshes at Edgemere (North Point State Park, CBIM location 43) and Hart-Miller Island may be lost to inundation if the sea level rise rate increases by 2 mm per year, and most will likely be lost with a 7 mm per year increase. Hart-Miller Island, created from dredge material and a haven for migrating shorebirds, has extensive mudflats that will are likely to be lost to sea level rise. During spring and fall migrations, daily numbers of shorebirds range from 1,000 to 10,000. The most numerous shorebird species are sandpipers and plovers. The mudflats are also used as a roost site for significant numbers of migrating Caspian terns (*Sterna caspia*). In 2004, small numbers of three high conservation priority species nested and bred on Hart-Miller Island: the coastal plain subspecies of swamp sparrow (*Melospiza georgiana*), listed by the Maryland Department of Natural Resources as "In Need of Conservation in Maryland," the spotted sandpiper (*Actitis macularia*), a rare species in the state, and the willow flycatcher (*Empidonax traillii*), an Audubon WatchList species.[659] These mudflat areas are all susceptible to inundation from sea level rise. Low-elevation islands such as Hart-Miller have limited habitat migration options and will be dependent on accretion rates (or additional dredged sediment inputs) for maintenance of habitats. Loss of these islands and mudflat areas would eliminate the nesting and foraging opportunities currently provided for the shorebirds.

Wrapup

The Western Shore will see a range of ecological impacts from sea level rise in the future. Most marsh areas near Chesapeake Bay are expected to be marginal with midrange increase in the rate of sea level rise (2 mm per year) and to be lost with a high-range increase (7 mm per year). In upper tributaries, sediment accretion is likely to be sufficient to retain current area under a high-range increase scenario. The extensive shoreline armoring from northern Calvert County through Baltimore City and County will limit shoreline retreat, and eliminate sand and mudflats in front of the protections. Loss of mudflats will eliminate a key stopover for migratory birds (i.e., Hart-Miller Island). With tree death in high marsh and higher water levels already visible in the Patuxent River marshes, sea level rise may induce changes in vegetation types even at current rates and therefore impact the species that rely on them, causing changes similar to those expected in other Bay tributaries such as the Pamunkey in Virginia. In contrast to these potential losses, the protected portions of the Calvert Cliffs will be allowed to continue eroding inland, providing the habitat needed by tiger beetles. Nevertheless, both larval and adult forms of the beetles may suffer impacts of reduced habitat caused by increased erosion and subsequent loss of beach or cliff-face shearing.

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[657]Robbins and Blom, 1996, p. 122 (see note 552).

[658]Maryland Coastal Zone Management Program, Department of Natural Resources, 2004, Development of the Maryland Shoreline Inventory Methods and Guidelines for Baltimore County and the City of Baltimore, prepared by the Comprehensive Coastal Inventory Program, Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA. NOAA Award No. 14-03-889 CZM049.

[659]Audubon Important Bird Areas, Hart-Miller site profile, accessed on May 5, 2006, at http://iba.audubon.org/iba/viewSiteProfile.do?siteId=371&navSite=state.