Appendix E. The Atlantic Coast of Virginia, Maryland, and Delaware (including coastal bays)

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Along the Atlantic Ocean between the mouths of the Chesapeake and Delaware bays lie approximately 200 kilometers of ocean beaches—mostly barrier islands--and only 30 kilometers have been developed. But the oceanfront development includes major resorts such as Ocean City (MD), Rehoboth (DE) and Dewey Beach (DE). The mainland behind those barrier islands is starting to become developed, especially in Delaware and Maryland.

This appendix examines some of the implications of rising sea level on the Atlantic Coast of the DelMarVa Peninsula. We present maps and summary statistics on the low land vulnerable to rising sea level (section E.1). We then discuss the species that rely on vulnerable habitat, with a focus on the coastal bays that lie behind the barrier islands (E.2). We then briefly discuss existing coastal policies (E.3), and development and shore protection (E.4). We do not evaluate whether the implications of accelerated sea-level rise might cause those policies to change. Finally, we present new estimates of the population that inhabits the land that could be potentially inundated as sea level rises (E.5).

E.1 COASTAL ELEVATIONS AND INUNDATION

Figures E.1 and E.2 show the elevations of lands close to sea level along the Atlantic Coast of the DelMarVa peninsula. Most noticeable is the 764 square kilometers of tidal wetlands behind Virginia's undeveloped barrier islands, of which 375 square kilometers are mudflats, giving this area the largest concentration of mudflats in the Mid-Atlantic. The peninsula also has about 90–180 square kilometers of dry land and non-tidal wetlands within 1 meter above spring high water (see Table E.1).

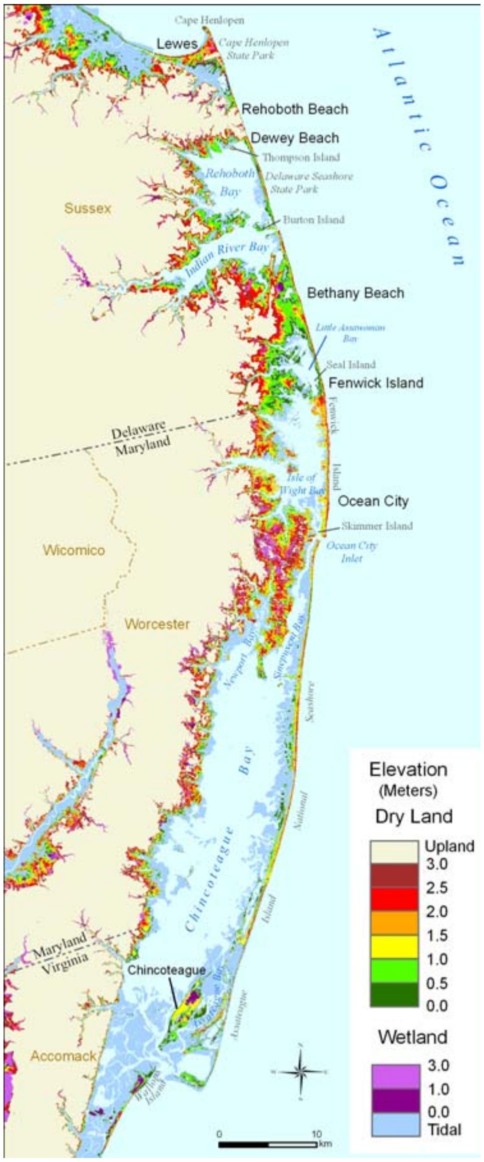

Figure E.1 Lands close to sea level, DelMarVa Atlantic Coast from Chincoteague to Cape Henlopen.

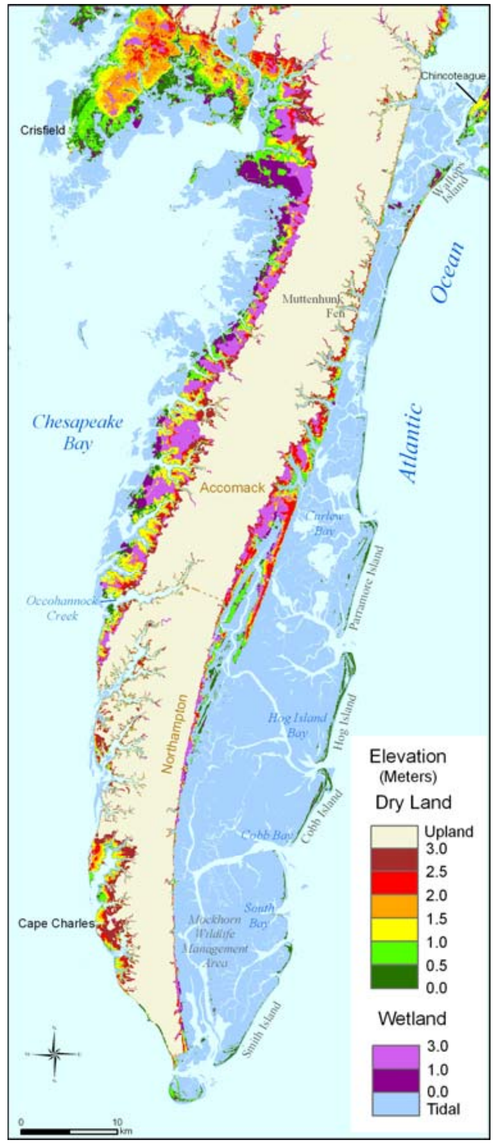

Figure E.2 Lands close to sea level, the Virginia Eastern Shore from Cape Charles to Saxis and Wallops Island.

Table E.1 Low and high estimates for the area of dry and wet land close to sea level DelMarVa Atlantic Coast (square kilometers).

Elevations above spring high water:		Tidal	50 cm		1 meter		2 meters		3 meters		5 meters	
			Low	High	Low	High	Low	High	Low	High	Low	High
Locality	State	Cumulative (total) amount of Dry Land below a given elevation										
Northampton	VA		5.1	14.5	13.0	16.8	17.9	20.6	21.4	24.6	30.5	35.0
Accomack	VA		7.5	22.6	20.1	37.7	44.5	61.7	65.8	81.2	103.7	118.9
Worcester	MD		3.7	18.6	21.7	42.4	77.5	102.8	134.0	154.6	219.1	234.6
Sussex	DE		11.1	32.4	27.6	53.5	64.5	94.9	104.2	139.5	196.5	234.2
Total			**27.4**	**88.1**	**82.5**	**150.3**	**204.4**	**280.0**	**325.4**	**399.9**	**549.9**	**622.7**
		Cumulative (total) amount of wetlands below a given elevation										
Northampton	VA	436.4	0.3	0.8	0.7	2.1	2.8	4.4	4.6	5.2	5.8	6.1
Accomack	VA	327.3	1.3	4.1	3.5	10.4	13.5	20.7	21.9	26.2	31.2	33.7
Worcester	MD	118.5	0.4	4.3	5.0	8.8	14.1	18.1	23.4	27.0	36.0	37.6
Sussex	DE	41.0	1.7	4.9	4.2	7.5	8.8	12.2	12.9	15.7	18.9	20.7
Total		**923.3**[1]	**3.7**	**14.1**	**13.4**	**28.7**	**39.2**	**55.4**	**62.7**	**74.1**	**91.9**	**98.1**
Dry and Non-tidal wetland			31	102	96	179	244	335	388	474	642	721
All Land		923	954	1025	1019	1102	1167	1259	1311	1397	1565	1644

Source: Titus and Cacela, 2008. Uncertainty Ranges Associated with EPA's Estimates of the Area of Land Close to Sea Level. Section 1.3 in: Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1: Coastal Elevations and Sensitivity to Sea-level Rise, J.G. Titus and E. Strange (eds.). EPA 430R07004. U.S. EPA, Washington, DC. The low and high estimates are based on the on the contour interval and/or stated root mean square error (RMSE) of the data used to calculate elevations. See Chapter 1 for more details.

[1] Includes 375 square kilometers of tidal mudflats in Northampton and Accomack counties.

The greatest concentrations of dry land within a few meters above spring high water appear to be along a few necks between the southern border of Accomack County and Wachapreague (opposite Cedar and Parramore islands), Chincoteague Island, and the mainland between Chincoteague Bay and Indian River Bay (opposite Bethany and Ocean City). The barrier islands are a small portion of the low land.

E.2 VULNERABLE HABITAT

Numerous species and habitats in the back-barrier bays of Maryland, Delaware, and Virginia's Eastern Shore are potentially at risk because of sea-level rise[100]. This region contains the largest stretch of natural coastline along the Atlantic Coast of the United States. The region includes extensive tidal flats, back-barrier lagoonal marshes, and areas of estuarine beach behind the region's barrier islands. Fringing salt marshes occur on the mainland side of the lagoons. Habitats of particular significance include salt marsh, beach, marsh and bay islands, tidal flats, submerged aquatic vegetation, sea-level fens, and coastal plain ponds.

*Tidal Marshes***.** The region's tidal marshes provide roosting, nesting and foraging areas for a variety of bird species, including black-bellied plover, dunlin, and horned grebe, wading birds such as herons and egrets, migratory shorebirds, and many species of waterfowl[101]. Ducks and geese, including mallards, pintails, blue and green winged teals, gadwalls, canvasbacks, loons, buffleheads, mergansers, and goldeneyes, overwinter in the bays' marshes[102]. The marshes also provide nesting habitat for many species of concern to federal and state agencies, including American black duck, Nelson's sparrow, salt marsh sharp-tailed sparrow, seaside sparrow, coastal plain swamp sparrow, black rail, Forster's tern, gull-billed tern, black skimmers, and American oystercatchers.

100 The Maryland Coastal Bays include Chincoteague, Sinepuxent, Newport, Isle of Wight, and Assawoman bays. The Delaware Inland Bays are three interconnected bays (Little Assawoman Bay, Indian River Bay, and Rehoboth Bay).

101 Wilson, Dave, Maryland Coastal Bays Program. In 13 June 2006 email to E. Strange, Stratus Consulting, entitled "Follow up to my visit," providing review of draft text and recounting personal observations reported in a meeting on 16 May 2006. (Dave Wilson is the outreach coordinator for the Maryland Coastal Bays Program.)

102 DNREC, Date unkown and personal observations of Chris Bason, Center for the Delaware Inland Bays, written communication to EPA, 5/14/07.

Sea-level rise is considered a major threat to bird species in the Virginia Barrier Island/Lagoon Important Bird Area (IBA) (Watts, 2006). Biologists at the Patuxent Wildlife Research Center suggest that submergence of lagoonal marshes in Virginia would have a major negative effect on marsh-nesting birds such as black rails, seaside sparrows, saltmarsh sharp-tailed sparrows, clapper rails, and Forster's terns (Erwin, 2004). The U.S. Fish and Wildlife Service considers black rail and both sparrow species "birds of conservation concern" because populations are already declining in much of their range (USFWS, 2002). The number of bird species in Virginia marshes was found to be directly related to marsh size; the minimum marsh size found to support significant marsh bird communities was 4.1–6.7 ha (10–15 acres) (Watts, 1993).

The region's tidal marshes also support a diversity of resident and transient estuarine and marine fish and shellfish species that move in and out of marshes with the tides to take advantage of the abundance of decomposing plants in the marsh, the availability of invertebrate prey, and refuge from predators (Boesch and Turner, 1984; Kneib, 1997). Marine transients include recreationally and commercially important species that depend on the marshes for spawning and nursery habitat, including black drum, striped bass, bluefish, Atlantic croaker, sea trout, and summer flounder. Important forage fish that spawn in marsh areas include spot, menhaden, silver perch, and bay anchovy. Shellfish species found in the marshes include clams, oysters, shrimps, ribbed mussels, and blue crabs (Casey and Doctor, date unknown).

Salt Marsh Adaptation to Sea-level Rise. Salt marshes occupy thousands of acres in eastern Accomack and Northampton counties (Fleming *et al.*, 2006). Marsh accretion experts believe that most of these marshes are keeping pace with current rates of sea-level rise, but may be unable to continue to do so if the rate of sea-level rise increases by another 2 mm/yr (Reed *et al.*, 2008). Some local field measurements indicate that accretion rates may be insufficient to keep pace even with current rates of sea-level rise. Accretion rates as low as 0.9 mm/yr (Phillips Creek Marsh) and as high as 2.1 mm/yr (Chimney Pole Marsh) have been reported (Kastler and Wiberg, 1996), and the average relative sea-level rise along the Eastern Shore is estimated as 2.8–4.2 mm/yr (May, 2002). Although some wide marshes may survive under an increase of 2 mm/year in the rate of sea-level rise, the fringing marshes along the mainland are likely to be lost (Reed *et al.*, 2008).

In some areas, marshes may be able to migrate onto adjoining dry lands. For instance, lands in Worcester County that are held for the preservation of the coastal environment might allow for wetland migration. . Portions of eastern Accomack County that are opposite the barrier islands and lagoonal marshes owned by TNC are lightly developed today, and in some cases already converting to marsh. In unprotected areas, marshes may be able to migrate inland in low-lying areas. Kastler and Wiberg (1996) found that from 1938 to 1990 mainland salt marshes on the Eastern Shore increased in area by 8.2%, largely as a result of encroachment of salt marsh into upland areas (Kastler and Wiberg, 1996).

Where sea-level rise leads to increased flooding of the marsh, some fishes may benefit, at least in the short term, from an increase in tidal creeks and channels, providing greater access to the marsh. However, where marshes drown, the loss of marsh primary production will impair the value of the habitat for fish and shellfish. The area's highly valued commercial and recreational fishing industry may be harmed if fish and shellfish production declines as marshes are lost.

Marsh and Bay Islands. Another key habitat vulnerable to sea-level rise is the *islands* within the coastal bays. These islands are undergoing rapid erosion. For example, Big Piney Island in Rehoboth Bay experienced erosion rates of 30 ft/yr between 1968 and 1981, and is now gone (Swisher, 1982). Seal Island in Little Assawoman Bay is eroding rapidly after being nearly totally devegetated by greater snow geese (Strange *et al.*, 2008). Island shrinking is also apparent along the Accomack County, Virginia shore; from 1949 to 1990, Chimney Pole marsh showed a 10% loss to open water (Kastler and Wiberg, 1996). The U.S. Army Corps of Engineers has created many small dredge spoil islands in the region, many of which are also disappearing as a result of erosion (Federal Register, 2006).

Sea-level rise can have both a direct and an indirect effect on these islands. The direct effect is the inundation and shore erosion discussed throughout this report. The indirect effect is that shoreline stabilization activities can prevent the formation of new islands, by limiting overwash and formation of new inlets and flood tidal deltas (US Army Corps of Engineers, 1998). The interruption of these processes may have a more important impact than the loss of dredge spoil islands, which were never designed to be permanent features.

The loss of these bay islands is a concern both because they protect other natural and developed shorelines and marshes from increased erosion, and because they directly support numerous bird species. For example, hundreds of horned grebes prepare for migration at the north end of Rehoboth Bay near Thompson's Island (Ednie, undated). Several bird species of concern in this region nest on shell piles (shellrake) on marsh islands, including gull-billed terns, common terns, black skimmers, royal tern, and American oystercatchers, (Erwin, 1996; Rounds *et al.*, 2004). Shell piles are generally free of mammalian predators. However, marsh islands are also subject to tidal flooding which reduces the reproductive success of island-nesting birds (Eyler *et al.*, 1999). Therefore, as islands experience more erosion and flooding as a result of sea-level rise, local populations of island-nesting birds may decline.

Sea-Level Fens. A rare sea-level fen vegetation community grows in the Angola Neck Natural Area along Rehoboth Bay. Because of its location, the Angola Neck sea-level fen could be lost as rising seas move inland, bringing nutrient-rich waters that are not tolerated by sea-level fen vegetation. On the other hand, sea-level rise could cause groundwater discharge to increase in volume at some locations, which would benefit fens (Strange, 2008).

Another rare sea-level fen community — one of only four in Virginia — is found in the Mutton Hunk Fen Natural Area Preserve fronting Gargathy Bay in eastern Accomack County (VA DCR, date unknown). The Division of Natural Heritage within the Virginia Department of Conservation and Recreation believes that chronic sea-level rise with intrusions of tidal flooding and salinity poses “a serious threat to the long-term viability” of sea-level fens (VA DCR, 2001). If rising seas reach the Mutton Hunk Fen Natural Area, the influx of nutrient-rich waters may destroy the populations of the rare plant species at this site, including the carnivorous sundew, and bladderwort (VA DCR, date unknown).

Shallow Waters and Submerged Aquatic Vegetation (SAV). The potential effects of sea-level rise on eelgrass beds have not been studied directly. However, Short and Neckles (1999) estimate that, in general, a 50 cm increase in water depth as a result of sea-level rise could reduce the available light in coastal areas by 50%, resulting in a 30–40% reduction in SAV growth (Short and Neckles, 1999).Where this occurs would depend on current local conditions such as water depth, the maximum depth of eelgrass growth, and water clarity.

Eelgrass beds are essential habitat for summer flounder, bay scallop, and blue crab, all of which support substantial recreational and commercial fisheries in the coastal bays (MCBP, 1999). Various waterbirds feed on eelgrass beds, including brant, canvasback duck, and American black duck (Perry and Deller, 1996).

Tidal Flats. Tidal flats are abundant in this region. In areas where sediments accumulate in shallow waters and shoreline protection prevents landward migration of salt marshes, flats may become vegetated as low marsh encroaches seaward, further increasing sediment deposition and leading to an increase in low marsh and a reduction in tidal flats (Redfield, 1972). Where sediment deposition is comparatively low, marsh may revert to unvegetated flat, at least in the short term, before the area becomes fully inundated (Brinson *et al.*, 1995).

Loss of tidal flats would eliminate a rich invertebrate food source for a number of bird species, including whimbrels, dowitchers, dunlins, black-bellied plovers, and semi-palmated sandpipers (Watts and Truitt, 2002). Eighty-percent of the Northern Hemisphere's whimbrel population feeds on area flats (TNC, 2006). The whimbrel is considered a species "of conservation concern" by the U.S. Fish and Wildlife Service, Division of Migratory Bird Management (USFWS, 2002).

Coastal Plain Ponds. Coastal plain ponds are small, groundwater-fed ponds that contain many rare plant species. Because they are near sea level, these unique plant communities are particularly vulnerable to sea-level rise. Such areas occur along the Eastern Shore and in the Delaware Inland Bays, especially within Assawoman Wildlife Management Area on Little Assawoman Bay[103].

103 Kevin Kalasz, Wildlife Biologist, Natural Heritage & Endangered Species Program, Delaware Division of Fish and Wildlife in written communication to EPA, 5/14/07 and Chris Bason, Center for the Delaware Inland Bays, written communication to EPA, 5/14/07.

Beaches. The beaches on the mainland behind the barrier island complex of the Eastern Shore occur as small strips that are relatively stable because they are protected from high energy wave action. Where beaches erode in front of shoreline protection structures and are not replenished, there will be a reduction in beach habitat. Loss of beach habitat due to sea-level rise and erosion below protective structures could have a number of negative consequences for species that use these beaches:

- Horseshoe crabs rarely spawn unless sand is at least deep enough to nearly cover their bodies, about 10 cm (4 inches) (Weber, 2001). Shoreline protection structures designed to slow beach loss can also block horseshoe crab access to beaches and can entrap or strand spawning crabs when wave energy is high (Doctor and Wazniak, 2005).
- The rare northeastern tiger beetle depends on beach habitat (USFWS, 2004).
- *Photuris bethaniensis* is a globally rare firefly located only in interdunal swales on Delaware barrier beaches. The firefly's habitat is at risk because of beach stabilization and shoreline hardening, which limit dune migration and the formation of interdunal swales[104].
- Erosion and inundation may reduce or eliminate beach wrack communities of the upper beach, especially in developed areas where shores are protected. Beach wrack contains insects and crustaceans that provide food for many species, including migrating shorebirds (Dugan *et al.*, 2003).

104 Kevin Kalasz, Wildlife Biologist, Natural Heritage & Endangered Species Program, Delaware Division of Fish and Wildlife in written communication to EPA, 5/14/07.

Coastal Habitat for Migrating Neotropical Songbirds. Southern Northampton County is one of the most important bird areas along the Atlantic Coast of North America for migrating neotropical songbirds such as indigo buntings and ruby-throated hummingbirds (Watts, 2006). Not only are these birds valued for their beauty but they also serve important functions in dispersing seeds and controlling insect pests. It is estimated that a pair of warblers can consume thousands of insects as they raise a brood (Mabey *et al.*, not dated).

Migrating birds concentrate within the tree canopy and thick understory vegetation found within the lower 10 km (6 mi) of the peninsula within 200 m (200 yd) of the shoreline. Loss of this understory vegetation as a result of rising seas would eliminate this critical stopover area for neotropical migrants, many of which have shown consistent population declines since the early 1970s (Mabey, not dated).

E.3 COASTAL POLICY CONTEXT

Less than one fifth of the Delmarva's ocean coast is developed. Unless conservation policies are reversed or conservation organizations change their priorities, the portion that is now developed is probably all that will be developed during the next century. All of Virginia Eastern Shore's 124-km ocean coast is owned by the U.S. Fish and Wildlife Service, NASA, the State, or The Nature Conservancy. Of Maryland's 51 kilometers of ocean coast, 36 kilometers are along Assateague Island National Seashore. The densely populated Ocean City occupies only approximately 15 kilometers. More than three-quarters of the barrier islands and spits in Delaware are part of Delaware Seashore State

Park, while the mainland coast is about evenly divided between Cape Henlopen State Park and resort towns such as Rehoboth, Dewey Beach, and Bethany Beach. With approximately 15 kilometers of developed ocean coast each, Maryland and Delaware have pursued beach nourishment to protect valuable coastal property and preserve the beaches that make the property so valuable (Hedrick *et al.*, 2000).

The mainland along the back barrier bays has been developed to a greater extent than the respective ocean coast in all three states. Development pressures are greatest at the northern end of the DelMarVa due to the relatively close proximity to Washington, Baltimore, and Philadelphia. Although connected to the densely populated Hampton Roads area by the Chesapeake Bay Bridge-Tunnel, southern portions of the DelMarVa are not as developed as the shoreline to the north.

Maryland has the most stringent policies governing development along coastal bays. Recently, the preservation policies of the Chesapeake Bay Critical Areas Act[105] have been extended to the coastal bays of Worcester County, requiring new development to be set back 100 feet from the wetlands or open water[106], and limiting future development density to 1 home per 20 acres along most undeveloped areas[107]. The Virginia counties of the DelMarVa have shores along both the Atlantic Ocean and Chesapeake Bay, and the 100-foot setback that applies along Chesapeake Bay[108] applies to the coastal bays as well.

105 See Appendix D for a discussion of these policies.
106 Code of Maryland Regulations §27.01.00.01 (C)
107 Maryland Natural Resources Code §8-1807(b).
108 See Appendix F for a discussion of these policies.

The Delaware Department of Natural Resources has proposed a 100-foot setback along the coastal bays (DNREC, 2007); Sussex County currently requires a 50-foot setback[109].

E.4 DEVELOPMENT AND SHORE PROTECTION

As Chapter 5 discussed, ongoing studies are analyzing land use plans, land use data, and coastal policies to create maps depicting the areas where shores may be protected and where wetlands may migrate inland.   Because the maps from those studies have not yet been finalized, this section describes some of the existing and evolving conditions that may influence decisions related to future shore protection and wetland migration

With development accounting for only 15-20% of the ocean coast, the natural shoreline processes are likely to dominate along most of these shores. Within developed areas, counteracting shoreline erosion in developed areas with beach nourishment may continue as the primary activity in the near term. The Corps of Engineers has begun to actively plan for beach nourishment of the northern part of Assateague Island, to prevent the increased risks of flooding to nearby developed areas that might otherwise accompany a disintegration of this barrier island (US Army Corps of Engineers, 2001).

Preventing the inundation of low-lying lands may eventually be necessary as well. Elevating these low areas appears to be more practical than erecting a dike around a narrow barrier island (Titus, 1990). Most land surfaces on the bayside of Ocean City were elevated during the initial construction of residences (McGean, 2003). In an appendix for

109 Sussex County, DE. 2007. Buffer zones for wetlands and tidal and perennial nontidal waters. Section 115-193, Sussex County Code. Enacted July 19, 1988 by Ord. No. 521.

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EPA's 1989 Report to Congress, Leatherman concluded that the only portion of Fenwick Island where bayside property would have to be elevated with a 50 cm rise in sea level would be the portion in Delaware (*i.e.*, outside of Ocean City) (Leatherman, 1989). He also concluded that Wallops Island, South Bethany, Bethany, and Rehoboth Beach are high enough to avoid tidal inundation for the first 50–100 cm of sea-level rise.

Along the coastal bays, market forces have led to extensive development in Delaware but relatively sparse development in Virginia, largely due to their relative proximity to major population centers. Worcester County, Maryland, reflects a balance between development and environmental protection resulting from both recognition of existing market forces and a conscious decision to preserve Chincoteague Bay. Development is extensive along most shores opposite Ocean City. Development is along the bay shores near Ocean City inlet. In the southern portion of the county, conservation easements or the Critical Areas Act preclude development along most of the shore. Although the Critical Areas Act encourages shore protection, and conservation easements in Maryland preserve the right to armor the shore, these low-lying lands are more vulnerable to inundation than erosion and are therefore possible candidates for wetland migration. Since 2004, the Maryland Department of Natural Resources has been working with the U.S. Geological Survey (USGS) to model the risk of flooding and inundation as sea level rises for Worcester County (MDNR and USGS, 2006). Maryland's Coastal Bays National Estuary Program has long included sea-level rise as a factor to be addressed in plans to protect the bays.

The Maryland Coastal Bays Program considers erosion (due to sea-level rise) and shoreline hardening major factors contributing to a decline in natural shoreline habitat available for estuarine species in the northern bays (MCBP, 1999). Much of the shoreline of Maryland's northern coastal bays is protected using bulkheads or stone riprap, resulting in unstable sediments and loss of wetlands and shallow water habitat (MCBP, 1999). Armoring these shorelines will prevent inland migration of marshes, and any remaining fringing marshes will ultimately be lost. The Maryland Coastal Bays Program estimated that more than 607 hectares (1,500 acres) of salt marshes have already been lost in the coastal bays as a result of shoreline development and stabilization techniques (MCBP, 1999). If shores in the southern part of Maryland's coastal bays remain unprotected, marshes in low-lying areas will be allowed to potentially expand inland as seas rise.

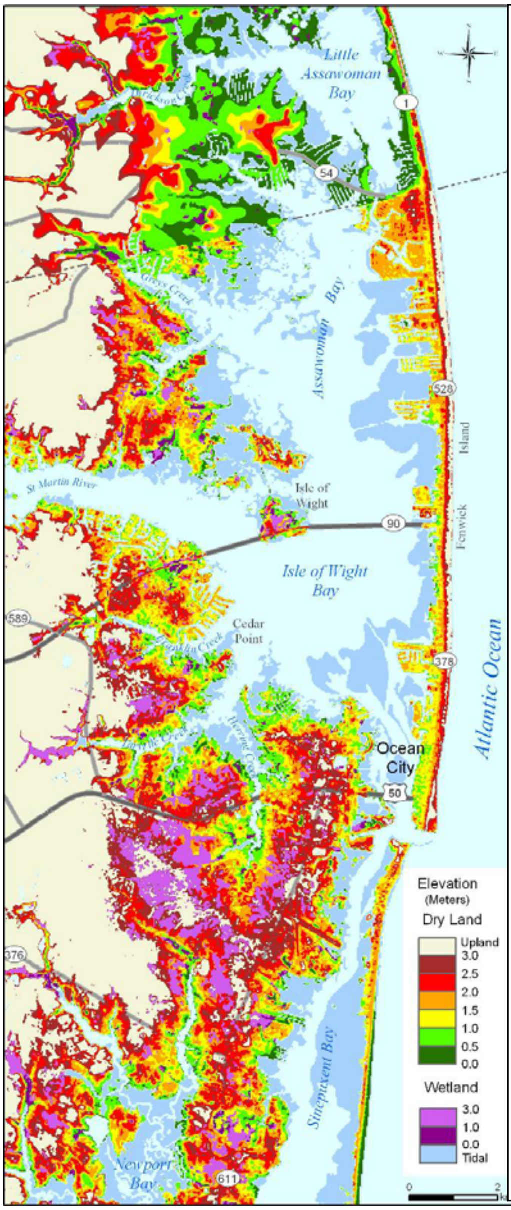
E.5 POPULATION OF LANDS CLOSE TO SEA LEVEL

Table E.2 shows the populations of lands close to sea level for the four counties along the Atlantic Coast of the DelMarVa peninsula. Because Maryland provided LIDAR elevation data, the estimates for Worcester county are most reliable. In spite of the higher population densities, Worcester County has fewer people vulnerable to a 50 cm rise than Sussex County, presumably in part because Ocean City's bay side is mostly 1-2 meters above spring high water. (See elevation map of Ocean City.) The two counties have similar populations within two meters above spring high water. With the undeveloped barrier islands and generally steep slopes along the mainland, the Virginia counties have very few people living close to sea level along the Atlantic side.

Table E.2 Population of Lands Close to Sea Level: The Atlantic Coast of Virginia, Maryland, and Delaware.

	Low and high estimates of population below a given elevation (thousands)					
	50cm		1m		2m	
County	**Low**	**High**	**Low**	**High**	**Low**	**High**
Delaware						
Sussex[1]	1.1	7.2	1.1	9.5	7.1	17.0
Maryland						
Worcester[2]	0.0	1.1	0.6	3.2	6.4	12.6
Virginia						
Accomack[2]	0.8	7.0	0.8	7.6	6.9	9.3
Northampton[2]	0.0	0.3	0.0	0.6	0.2	1.1
Total	**1.9**	**15.5**	**2.5**	**20.8**	**20.6**	**40.0**

[1] Figures are for the entire county. County is split between Chesapeake, Atlantic Coast, and Delaware Bay Watersheds.
[2] Figures are for the entire county. County is split between Chesapeake and Atlantic Coast Watersheds.



BOX E.1: Elevating Ocean City as Sea Level Rises

Logistically, the easiest time to elevate low land is when it is still vacant, or during a coordinated rebuilding. Low parts of Ocean City's bay side were elevated during the initial construction. As sea level rises, the town of Ocean City has started thinking about how it might ultimately elevate.

Ocean City's relatively high bay sides make it much less vulnerable to inundation by spring tides than other barrier islands. Still, some streets are below the 10-year flood plain, and as sea level rises, flooding will become increasingly frequent.

However, the town cannot elevate the lowest streets without considering the implications for adjacent properties. A town ordinance requires property owners to maintain a 2% grade so that yards drain into the street. The town construes this rule as imposing a reciprocal responsibility on the town itself to not elevate roadways above the level where yards can drain, even if the road is low enough to flood during minor tidal surges. Thus, the lowest lot in a given area dictates how high the street can be.

As sea level rises, failure by a single property owner to elevate could prevent the town from elevating its streets, unless it changes this rule. Yet public health reasons require drainage, to prevent standing water in which mosquitoes breed. Therefore, the town has an interest in ensuring that all property owners gradually elevate their yards so that the streets can be elevated as the sea rises without causing public health problems.

Ocean City has developed draft rules that would require that, during any significant construction, yards be elevated enough to drain during a 10-year storm surge for the life of the project, considering projections of future sea-level rise. The draft rules also state that Ocean City's policy is for all lands to gradually be elevated as the sea rises.[1]

Note: 1. This discussion is based on the presentation by Terry McGean, city engineer, Town of Ocean City, to *Coastal Zone 2003.*

Figure E.3

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