EXECUTIVE SUMMARY

The Commonwealth of Virginia has extensive areas of shallow tidal water supporting essential habitats for estuarine flora and fauna along its thousands of miles of shoreline. Shallow water environments are vital to the coastal community, providing an enormous mix of ecological services. Managing coastal habitats for sustained ecosystem functioning, while accommodating increasing developmental pressures, has never been simple. The challenge is multiplied by the fact that the entire system is changing, driven by both human uses and climate change.

Chesapeake Bay is extremely vulnerable to climate change as rates of relative sea level rise (SLR) are currently more than double the global mean and rising (~4.2mm/yr in Chesapeake vs. 1.7 mm/yr globally). As climate change continues, sea level rise rates are expected to increase and additional negative effects likely will include intensified coastal flood and storm events, increased shore erosion, inundation of wetlands and low-lying lands, and salt-water intrusion into groundwater.

Climate change effects on coastal habitats and species will not occur in isolation, but within a socio-economic context. Land and shoreline development will likely affect the character and magnitude of climate impact, potentially exacerbating ecosystem integrity loss. Areas with shoreline and riparian development effectively prevent the migration of coastal habitats landward in response to climate changes.

In Virginia tidal waters

- *Approximately 11.1% of shoreline has been hardened* (793 km hardened/7134 km shoreline surveyed), and on average, 29 km of shoreline continue to be hardened each year.
- *Over one-quarter of riparian lands are currently developed* (including commercial, residential, industrial and paved land use).

The principal objective of this study was to develop a characterization of current shallow-water habitat components in Virginia tidal waters and predict climate driven changes to these habitats. To project broad-scale climate change effects on the abundance and distribution of coastal habitats, an inundation model based on anticipated relative sea-level rise, temperature and salinity projections, and coastal development were integrated into a GIS modeling framework. Using this framework, simple models were constructed that forecast the distribution of key coastal habitat parameters within the next 50 to 100 years including: shallow-water areas, tidal wetlands, submerged aquatic vegetation and estuarine beaches.

Projected shifts in coastal habitats

- Shallow-waters, highly productive nursery and spawning zones, were estimated to decrease dramatically with SLR ranging from 10-51% loss of habitat.

- More than 65% of existing eelgrass habitat zones will become inhospitable, if temperature and sea level continue to rise at or higher than historic rates. Unless eelgrass beds are able to migrate to shallower reaches with suitable summertime temperatures and water clarity, these critical nursery habitats may be substantially diminished.

- More than 85% of estuarine beaches in Virginia (701/812 km) are at high to moderate risk from sea level rise unless they are subsidized with sand.

- Up to 52% of tidal wetlands may be lost as sea level rises, including tidal sand and mud flats, which has implications for shorebird populations which rely on these habitats as a food source.

- Tidal marshes in the meso-polyhaline reaches of Virginia waters are at the highest relative risk due to land development and sea level rise pressures.

- Although 38% of existing marshes are moderately-highly vulnerable to SLR due to adjacent development, 62% of marshes may have opportunities for landward transgression. Preserving landscapes that allow for the transgression of the Bay's essential shallow-water habitats should be a high conservation priority.

Loss or reduction in function of these habitats could significantly alter the character of Chesapeake Bay from a highly productive shallow-water estuary that provides crucial spawning and nursery habitat for numerous species to a deep open-water system.

To enhance possible model applications, in addition to this report and maps illustrating potential model outputs (e.g. *Marsh Preservation Opportunities*), a companion webpage with an interactive web-based map interface was created using ESRI ArcIMS®. The interactive tool allows the user to view current habitat distribution, modeled climate change output, as well as all base layers used in the analyses (URL: http://ccrm.vims.edu/research/climate_change/index.html). Model output and interactive tools are not to be used for site-specific planning. They are intended to illustrate general regional trends in coastal habitat distribution and vulnerability to climate change. Once additional high resolution data become available, refinement of estimates and increased precision will become possible for future model iterations.

These and similar spatial analyses can be used to inform forward-looking management efforts to identify and protect areas where habitat complexes are most likely to be sustainable, as well as preserve opportunities for migration of habitat elements in an evolving system.