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# FARM RESILIENCY EDUCATION FOR AT-RISK COASTAL AREAS IN THE CHESAPEAKE BAY

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*The authors would like to acknowledge significant contributions to this report by Katherine Tully and Dani Weissman (University of Maryland); Amy Jacobs and Brian Boutin (The Nature Conservancy); Bridgett Costanzo, Steve Strano, Jeffray Jones, and Diane Dunaway (USDA Natural Resources Conservation Service); and Alan Franzluebbers and Chris Miller (USDA Natural Resources Conservation Service, Cape May Plant Materials Center).*

## Introduction

The Virginia Institute of Marine Science (VIMS) in collaboration with its partners, the Land Trust Alliance, Sustainable Chesapeake, and The Nature Conservancy, explored and refined questions critical for advising and guiding landowners who farm within coastal areas that are vulnerable to sea level rise and saltwater intrusion, and ultimately, loss of arable cropland in the Chesapeake Bay watershed. While the questions posed are those that agricultural experts across the coastal zones are struggling with, this effort focused on identifying the current state of the science and informational gaps; building current, best professional guidance for landowner conservation program choices; and developing a research framework for improving our understanding and building capacity to maximize, incentivize, and secure ecosystem services beyond food provision at the farm-scape scale.

## Strategies for assessing the scale of impact of sea level rise and saltwater intrusion on agricultural lands

Critical to an understanding of the scope and scale of the challenge of sea level rise to agriculture is the need for a method to readily identify and assess those lands most at risk from both rising seas and salt water intrusion. On-the-ground stakeholders and partners including landowners and farmers have worked diligently to prioritize conservation delivery intended to offset these impacts including growing alternative

**Acknowledgements.** This report is significantly informed by stakeholders, advisors, and boots-on-the-ground including representatives of Virginia Institute of Marine Science, University of Maryland, Sustainable Chesapeake, Land Trust Alliance, The Nature Conservancy, Ducks Unlimited, Virginia Eastern Shore Land Trust, Lower Shore Land Trust, Virginia Department of Game and Inland Fisheries, USDA-Natural Resources Conservation Service, and USDA-Agricultural Research Service.

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agricultural crops that are better adapted to saltwater intrusion and implementing riparian buffers, ditch management, and to some extent, wetland restoration. The approach undertaken in this effort evaluated lands most vulnerable to sea level rise and saltwater intrusion at the county level, to provide information on the scale of potential impact as well as dominant soil types that will be affected. This information will provide landowners and their advisors with a pathway for improved decision making to enhance the economic and ecological outcomes on vulnerable lands.

The Center for Coastal Resources Management (CCRM) at VIMS analyzed data and produced maps of farm land (crops and pasture) below 10 feet in elevation and the associated soils and depths of water table for these areas in the localities of Accomack and Chesapeake, Virginia (see Appendix A). In order to provide information on the potential impact on farmland relative to sea level rise scenarios, data were depicted in 0.5-foot increments.

Farmland with an elevation of 10 feet or less equaled 21.6% (14,874 acres) and 24% (9,722 acres) in Accomack County and Chesapeake City, respectively. In Accomack County, where all farmland makes up 24% of the land area, 1% of farmland (681 acres) had an elevation of 3 feet or less. In Chesapeake City, where farmland comprises 16% of the total land area, 0.2% of farmland (113 acres), was at an elevation of 3 feet or less. CCRM used available Natural Resources Conservation Service (NRCS) data (which have different categories for depth to water table for each county) to identify farmland with a water table down to approximately 18 inches. In Accomack County, 37% of farmland less than 10 feet in elevation has a water table within 1.7 feet of the surface, while in Chesapeake City 98% of the farmland less than 10 feet in elevation has a water table within 1.5 feet of the surface. The top three soil mapping units associated with farmland under 10 feet in elevation are Bojac sandy loam (0 to 2 percent slopes), Mundy sandy loam (0 to 2 percent slopes), and Nimmo sandy loam (0 to 2 percent slopes) in Accomack County, and Acredale silt loam (0 to 1 percent slopes), Tomotley-Nimmo complex (0 to 1 percent slopes), and Tomotley-Deloss complex (0 to 2 percent slopes) in Chesapeake City. Some of the soil mapping units are composed of soil types that are hydric. Table 1 shows the percentage of hydric soils within each map unit.

**TABLE 1. HYDRIC SOIL RATING.**

	<b>% Hydric Rating</b>
<b>Accomack County</b>	
Bojac sandy loam	0
Mundy sandy loam	6
Nimmo sandy loam	87
<b>City of Chesapeake</b>	
Acredale silt loam	96
Tomotley-Nimmo complex	98
Tomotley-Deloss complex	100

The GIS modeling and analysis in the two pilot counties provide an approach for identifying and assessing farm lands at risk in other locations and at a broader scale in the Chesapeake watershed.

## Need to assess and mitigate nutrient and sediment loading rates associated with increased flooding and/or groundwater inundation

The dynamics of sea level rise and saltwater intrusion create rapidly changing landscapes. In Somerset County, Maryland, 420 acres of marsh were lost and 1507 acres of uplands were converted to marsh from 2009 to 2017 (Gedan et al. 2020). In Accomack County, VA, between 1977 and 2016, 13,025 acres of marsh were lost due to erosion and sea level rise and 9,187 acres of new marsh were created through migration (CCRM 2019). Alongside these changes to land types, there can be significant implications for nutrient loads in rivers and streams adjacent to flooded farmlands. Researchers at the University of Maryland have been assessing the impacts of saltwater intrusion on nutrient runoff from agricultural fields, and this research indicates that saltwater intrusion is linked to increased nitrogen and phosphorus transport from farm fields to adjacent marshes (Weissman and Tully 2020).

When saltwater is introduced to farmland, nutrients can be released into soil pore water and subsequently lost to surface waters. Salts in seawater can displace nitrogen bound to the soil, and inundation can cause nitrate to leach out of upper soil layers. Anaerobic conditions spurred by soil inundation can reduce the ability of iron in soils to bind phosphorus. Additionally, sulfates found in seawater and agricultural soils can bind to iron, and prevent the iron from rebinding to phosphorus if oxygen levels change during drying and wetting cycles in the soil. Consequently, bioavailable forms of nitrogen and phosphorus in soil pore water can migrate out of the soil and into nearby surface waters through surface runoff and drainage ditch systems (Tully et al. 2019).

## Potential cropping or land-use practices that would sustain economic use

Managing for production. In the short term, there are several management strategies that can reduce the impact of saltwater intrusion and keep fields productive. Guidance is readily available through the USDA's Climate Hubs (<https://www.climatehubs.usda.gov/>) and includes examples like utilizing freshwater from rain, or irrigation systems to flush salt out of soils, or adding gypsum to reduce salt in soil. Gypsum disperses sodium ions (which tend to form an impermeable crust on upper soil layers) and replaces them with calcium ions. The sodium can then be flushed out with irrigation and precipitation events. Low-salt manure or compost are also known to mitigate negative impacts. Soil health practices such as cover crops that reduce runoff, increase infiltration, or improve the availability of soil water can also help to



reduce salt concentrations in the root zone. However, it is important to note that these practices have a threshold to their effectiveness. They work for areas that are beginning to show the effects of saltwater intrusion but may be less effective in areas with high water tables.

Research to identify salt-tolerant crop varieties that can be managed with equipment many farmers already own is underway. Promising species include salt-tolerant soy, barley, sorghum, salt marsh hay, and switchgrass. Likewise, sugar beets, safflower, sunflower, rye, and asparagus all are very salt-tolerant and readily available. Perennial grasses and livestock grazing operations may also be suited for these areas.

However, many salt-tolerant varieties of crops currently on the market were developed for irrigated systems in dry climates. In the Chesapeake Bay region, fields at risk for saltwater intrusion are both salty and wet, which will pose challenges to planting and harvesting even if suitable crops are identified to grow in these areas.

Another issue that some producers/landowners are concerned about is erosion and subsidence of soils. Planting deep-rooted crops, like switchgrass, would bind soils, reducing erosion losses.

Farmers considering switching to a new crop will need to consider whether there is an existing market for the new crop, as well as the return on investment for crops that require new on-farm or processing equipment. A key question is whether the upfront costs and time associated with switching to a new crop will result in a reasonable return on investment given the vulnerability of the land to future inundation and/or salinization. Research currently underway to identify salt tolerant varieties suitable for the Chesapeake Bay region, as well as market analysis and business planning, will provide information that farmers need to make sound economic decisions.

The need for thoughtful economic analysis is also true of engineered solutions such as levies and drainage systems (tile drains and ditches) that are widely utilized to drain high water tables and make land arable. Factors to consider when making decisions about investments in water control infrastructure include return on investment (how much does it cost and how long will it last). Also, design and management will need to consider how to avoid making a bad flooding situation worse. For example, tile drains and ditches have the potential to act as conduits for salt water during flooding events. When overtopped, tide gates and levies can “lock in” salts and prevent flood waters from naturally receding if not properly designed and managed. However, tide gates are effective in preventing less catastrophic saltwater inundation (e.g. from normal tide cycles and smaller storm events) and can be an effective mitigative tool in man-made ditches.

A key consideration for low-lying farmland in the Chesapeake Bay region is that original drainage ditches



constructed in these areas relied on gravity drainage. With already high water tables and sea level rise, many of these ditch networks no longer function as intended. More deliberate water management approaches will be needed to maintain productivity and reduce environmental impacts associated with drainage water.

**Managing for water quality.** Where farmland is at risk for saltwater intrusion or inundation, management practices that draw down phosphorus and reduce the concentration of nitrogen and phosphorus in the soil prior to inundation can mitigate nutrient pollution. Researchers are currently evaluating crops like switchgrass, a native perennial that requires little to no fertilizer for nutrient uptake in this environment. If producers are interested in maximizing switch grass yields with fertilizer, application can be timed to reduce risk of nutrient transport to surface and ground waters. In both cases, regular harvesting can remove nutrients from the field system over time. Additionally, well-managed, perennial grass grazing systems that minimize nutrient loss from pastures are also an option to improve water quality outcomes.

**Managing for habitat.** Transitioning crop and pasture lands to alternative ecosystems in vulnerable agricultural areas has captured much attention in the Chesapeake Bay region. Thousands of acres of wetlands that provide important habitat and water quality functions in the landscape are threatened by sea level rise. Low-lying cropland could provide critical and timely opportunities for wetland migration and management needed to support habitat for biodiversity and plants and animals that are both iconic to the region and critical to the recreational and commercial fishing industries.

Many species of resident and migratory shorebirds, wading birds, and the American black duck, (a priority species in the Chesapeake Bay) would directly benefit from restoration in vulnerable agricultural lands identified through this project. Several NGOs and government agencies have been advancing this work with landowners to improve waterfowl habitat, by restoring wetlands that results in both habitat and water quality benefits. Many

of these wetland landscapes are recognized to have international significance through UNESCO Biosphere Reserve and Ramsar designations. To support these efforts, there are key federal and some state programs, as well as NGO incentives that help to compensate farmers and cover the costs of wetland restoration and establishment. Additionally, the sale of hunting leases is a potential source of revenue for landscapes that provide waterfowl habitat.

## Proposal for implementation of the priority activities identified by stakeholders

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Scoping and prioritizing the next steps necessary to develop the breadth of data, decision-support, financial incentive programs, technical assistance, and informational gaps requiring research is critical. This team's work has identified a series of needs and opportunities:

**Identify all at-risk lands along the Bay shoreline to fully define scope of problem and highlight agronomic, restoration, conservation, pollution reduction and habitat opportunities.** At-risk lands should be identified using established sea level rise scenarios using defined timelines (e.g. 2040, 2080) allowing for not only identification of farmland threatened by erosion and/or inundation, but also prioritization based on the threat timeline. To promote transparency and avoid possible perceptions that urgency is over-stated, it is critically important to articulate which model was used to project sea level rise, and to provide ranges of projected impacts along with timeline estimates.

**Develop conservation planning guidance and decision support tools.** Support and guidance are needed for landowners to increase their understanding of their choices and decision points, for either continuation of cropping systems in changing agronomic conditions, or transition to alternative ecosystem services. Technical experts will need to be well-trained and skilled in working in extreme and difficult-to-manage landscapes. Along with those managing financial incentive programs, they are the first points of contact and must be able to consider risk, vulnerability, and maximum benefits possible to provide the best available conservation planning, financial assistance and other support to landowners. A decision-support tool, included in the Appendix, is a draft, example resource.

**Identify funding resources and barriers to participation.** Balancing marsh migration and restoration to meet landowners' goals is an important aspect of considering which program best suits their needs. From a restoration standpoint, conservationists want to allow as much marsh migration as possible, but waterfowl biologists and often prefer to allow for some water impoundment in order to produce ponding, generally shallow emergent areas

with vegetation. In addition to habitat for resident and migratory birds, marshes (and associated species) also contribute to Bay ecosystem services and goals, such as water filtration, fisheries, and flood risk reduction. In Maryland, the NRCS state wetland restoration design criteria were modified to address multiple restoration objectives in a balanced approach. Several federal and state programs are designed to support ecosystem services at the farm scale, including the restoration, protection, and management of wetlands to maximize their water quality and habitat function.

One suggestion was made for a Chesapeake-wide Regional Conservation Partnership Program (RCPP) initiative that would address salt-impacted farmlands and expand and refine the use of NRCS technical and financial resources to pilot innovative planning and implementation solutions in these landscapes. Benefits of the RCPP approach are that both the easement and financial assistance programs described below can be integrated and geographic areas that are at highest risk can be targeted. An RCPP grant would set aside a specific amount of money to address this resource concern and provide both financial and technical assistance for landowners

- **USDA NRCS AGRICULTURAL CONSERVATION EASEMENT PROGRAM (ACEP)**

**Wetland Reserve Easement (WRE)** is a critical tool for habitat restoration and wetlands protection. WRE can provide permanent easement protection and financial assistance for wetland restoration. The WRE program ranks permanent protection more highly than 30-year easements and pays 100% of restoration costs if the easement is permanent. Nonprofit partners generally prefer permanent easements as well: The Nature Conservancy, for example, prioritizes working only on permanent WRE protection and restoration projects. From an environmental perspective, WRE likely provides the greatest benefits as currently implemented, but all programs are needed to address all the needs and circumstances on the ground. WRE may be paired with state agricultural easement programs, such as Maryland's Rural Legacy Program, to protect portions of a farm that are not priorities for agricultural protection. Of interest, WRE is often fully subscribed in Maryland and generally under-subscribed in Virginia, effectively reducing the Commonwealth's portion of national funding. Since funding levels are related to demand, there may be opportunity through landowner outreach to increase the demand for WRE resources and thus gradually increase funding available to Virginia farmers over time.

**Agricultural Land Easement (ALE).** The purpose of ALE is to keep land in agricultural use, so it is often not a good fit for farmland impacted by sea level rise. For example, in Maryland, the ALE Advisory Committee has recommended not accepting easements on land

under 2 feet of elevation, eliminating this option for many of the lands impacted by sea level rise in the near term. In Virginia, lands similarly at risk may not score highly in ALE reviews due to the uncertainty about the long-term agricultural viability of such lands. However, ALE could potentially be targeted to protect agricultural lands for future marsh migration and provide buffers for water quality and wildlife.

- **USDA FSA CONSERVATION RESERVE PROGRAM IN PARTNERSHIP WITH STATES**

**Conservation Reserve Enhancement Program (CREP).** Some landowners among those impacted by saltwater intrusion are interested in CREP resources for restoration—usually on smaller parcels that are less conducive to an easement, or where a landowner is not interested in permanent protection. Another benefit of CREP is landowners can choose to install conservation buffers instead of wetlands if they prefer a simpler approach or just want minimize the amount of land taken out of production. However, financial incentives may be more limited and 15-year contracts (and annual rental payments) may not be able to be renewed indefinitely if the land becomes inundated due to sea level rise.

- **USDA NRCS FINANCIAL ASSISTANCE PROGRAMS**

**Environmental Quality Incentives Program (EQIP).** For smaller areas where more waterfowl habitat is desirable, EQIP is often preferred by landowners, largely due to the length of agreements (comparable to CREP in time frame/duration) and the type of wetlands that are funded. EQIP provides approximately 75% of the cost of the project but with no additional rental or easement payment. EQIP supports a wide variety of wetland restoration and creation, including some types of impoundments which are not funded by other programs. Another benefit of EQIP is that it can fund habitat restoration and management on existing wetlands and other areas that don't qualify for WRE or CREP. As with CREP, other types of conservation projects such as buffers and grass plantings on smaller areas can be implemented.

- **USDA CONSERVATION INNOVATION GRANT PROGRAM (CIG)**

Offered at both the national and state levels, CIG is a competitive grant program that drives public and private sector innovation in resource conservation. The CIG program is a potential source of funding for the development and demonstration of conservation planning, management, and restoration tools for farmlands at risk for sea level rise.

- **OTHER PROGRAMS**

In addition to the Farm Bill programs described above, there are other federal and state level programs that could be leveraged to support farm lands in transition.

**North American Wetlands Conservation Act (NAWCA)** can be a useful program in this context, especially for larger projects at a broader landscape scale.

**State Program Example.** Maryland's Rural Legacy Program focuses on protection of large, contiguous tracts of land rich in natural and cultural resources to reduce sprawl development. The extent to which this program and other state programs can support at-risk agricultural lands in transition requires further exploration. However, state funding is often critical to securing federal funding as many federal easement and conservation programs require a significant (e.g. 1:1), non-federal cost share match.

**Build technical assistance capacity that supports landowner and farmer decision-making.** Technical assistance for landowners and farmers, and more specifically, face-to-face interaction with producers managing at-risk lands is key to improving economic and ecosystem outcomes. The ideal technical expert will be trustworthy, technically savvy, have good interpersonal skills and be attentive and responsive to the landowners' needs. Both the landowner and the farmer (if they are not the same person) should be part of the discussion and working together to make the best decision for the property. Ideally, farmers and landowners will be presented with options before inundation or salt damage reduces or eliminates management options for water quality and habitat. For example, phosphorus drawdown management strategies in cropping systems need to be in place for multiple years prior to inundation to be effective. Conservation easement programs typically base payments on the assessed value of the land. Once land becomes inundated or impacted by salt, the value of the land, and thus the payment for easements to farmers, is reduced. Financial incentives for agricultural practices may be available to the farmer but assistance for restoration and easements are typically made to the landowner.

Building mechanisms (training, tools, predictive measures) for ensuring that the technical assistance providers can help farmers and landowners consider the full extent of choices and potential outcomes is critical in the near-term and long-term for optimizing the landowners' options and outcomes.

**Consider social, cultural, and economic needs in landowner decision-making.** In addition to the natural science-based questions (e.g., hydrology, biology, chemistry) embedded in the challenge of sea level rise and saltwater inundation in these landscapes, there are a number of social, cultural, and economic considerations raised by stakeholders in discussions that should inform potential solutions and program and policy development.

- **UNDERSTANDING THE LANDOWNERS' NEEDS.** In many cases, the landowner and farmer are different people who may not have the same priorities for managing the land. Technical experts should consider



business considerations and needs of the landowners in decision-making including: the landowner's values and priorities for their land; motivation towards and perceptions of particular management options over others; and legacy and traditional cultural identities. Additionally, some landowners may be reluctant to work with government agencies and NGO's.

- **PERCEPTIONS OF CURRENT CIRCUMSTANCES, CHALLENGES, AND SOLUTIONS.** Considerations include: public and neighbor expectations about what land "should" look like; willingness and/or receptivity to consider transition to new methods/ approaches and overall capacity for adaptation to change; building collective understanding of the role of individual parcels in overall landscape health and resilience; historically informed perceptions of flood risk and active landscape management; potential for conflict with neighbors over management goals and outcomes; effectiveness and need for local examples that demonstrate success.
- **CHALLENGES WITH EXISTING PROGRAM FUNDING.** These include: lack of consistent or adequate funding; misalignment of funding timelines and/or the uncertainty of the availability of funds versus more urgent needs of landowners; and potential disconnect between landowner needs and incentives available.

**Identified research needs.** Stakeholders identified broad research needs related to the extent of impacts of saltwater intrusion including the broader mapping of

vulnerable areas (e.g. VIMS' modeling), understanding the survival and performance of salt-tolerant agronomic crops or conservation plantings on marginal farm land, and quantifying economic tradeoffs of farmer decision-making related to saltwater intrusion. With respect to nutrient transport, additional research is needed to better understand the impacts of nutrient loading from the field to the watershed level on a regional scale as well as the timing and duration of increasing loads. Much of this research is already underway. Results will inform future guidance for farmers and landowners on cropping and land management options, and expand knowledge of the potential nutrient pollution impacts from released nitrogen and phosphorus in local streams, rivers and the Chesapeake Bay.

## Appendices

- A. **Pilot county maps identifying at-risk farm lands.** Accomack County and Chesapeake City, Virginia.
- B. **Example decision support tree.** Landowner agronomic and conservation choices in at-risk landscapes.
- C. **References.** Stakeholders have provided several examples of research and educational resources for additional information. These are not intended to comprise an exhaustive list, rather to represent current undertakings.

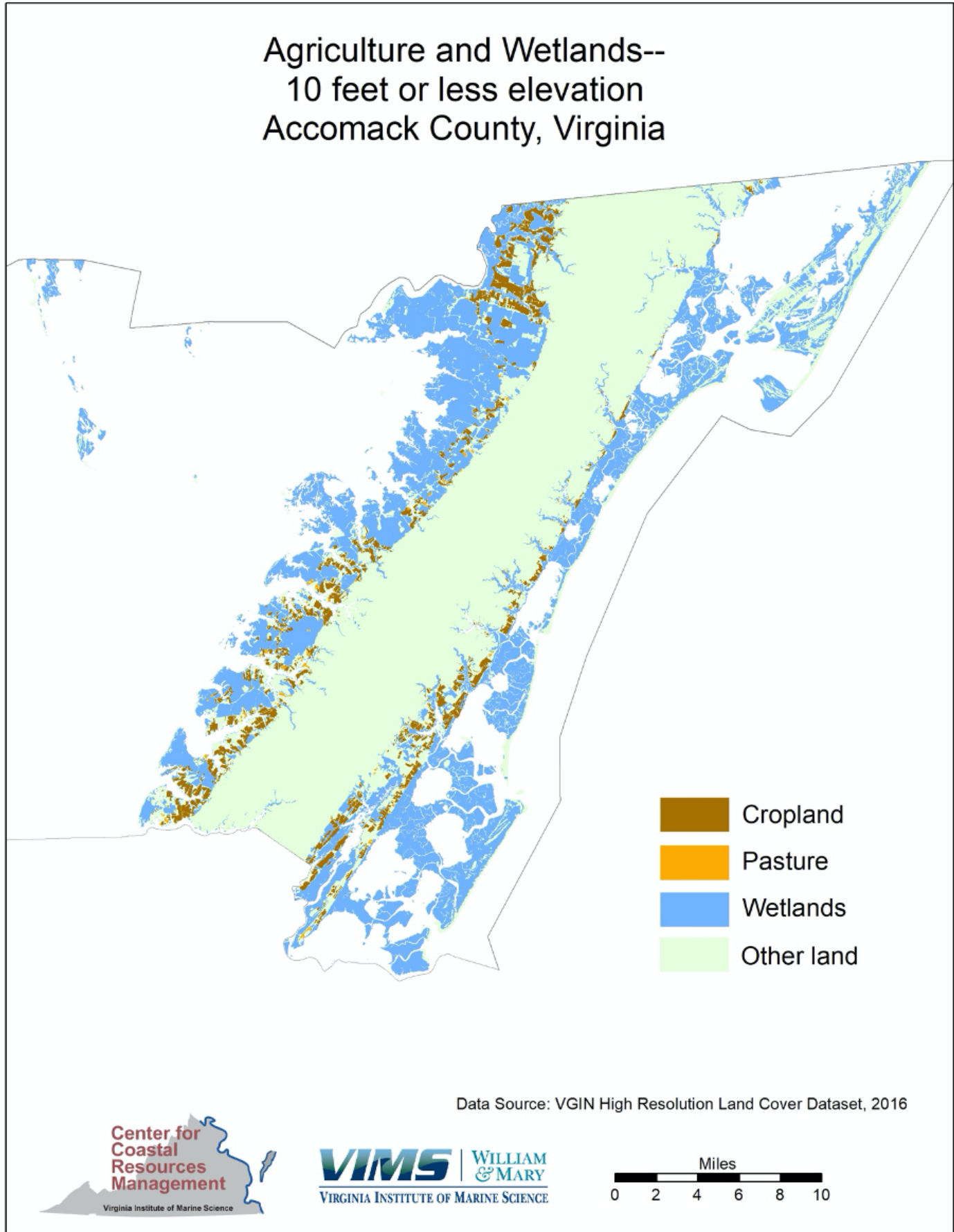


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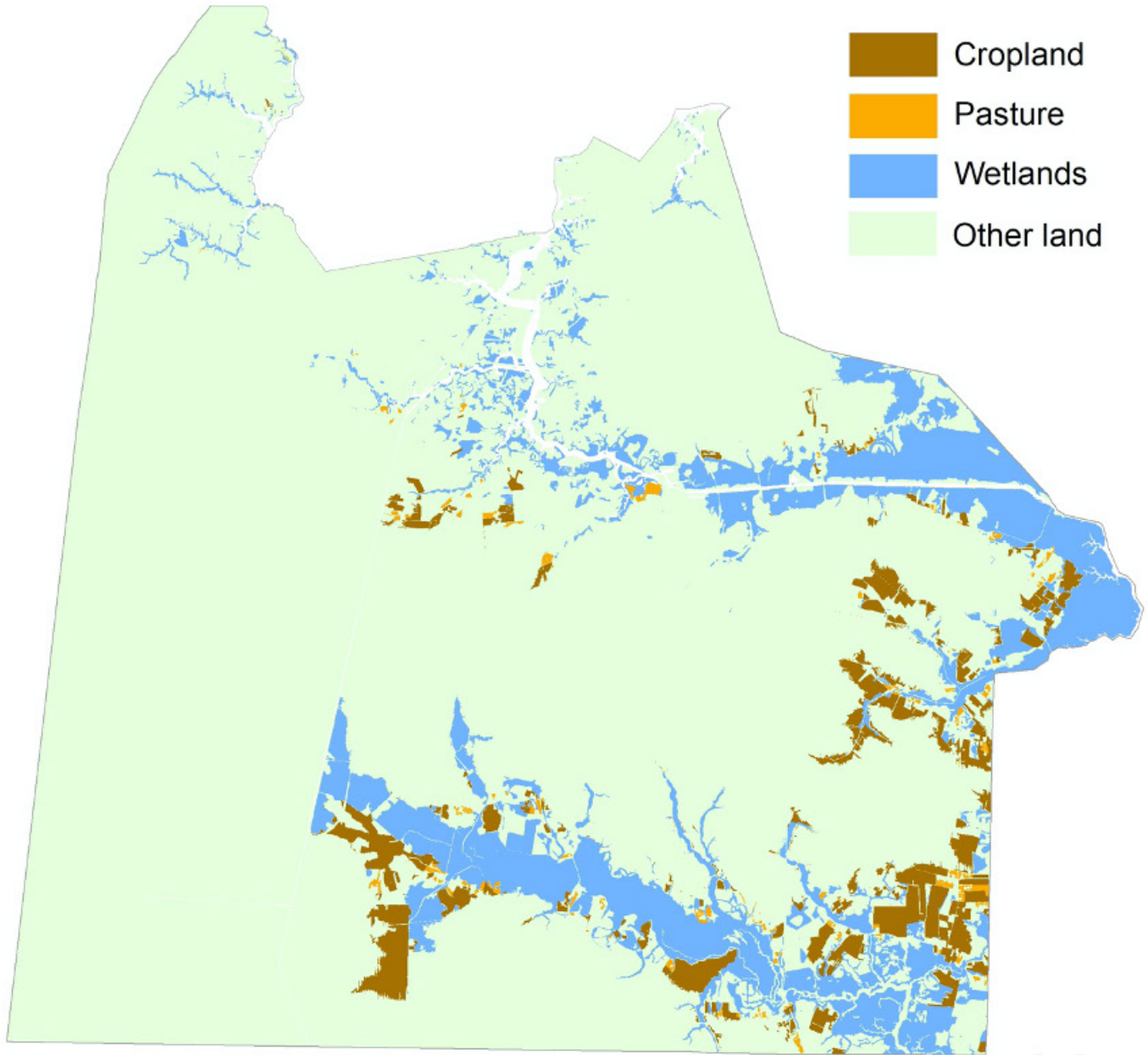


## Appendix A. Pilot county maps identifying at-risk farm lands

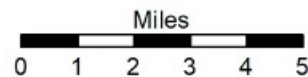
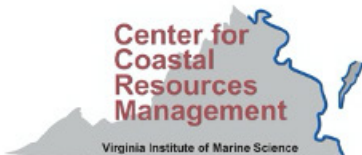
High resolution maps are available through VIMS. Contact [CCRMinfo@vims.edu](mailto:CCRMinfo@vims.edu) for more information



# Agriculture and Wetlands-- 10 feet or less elevation City of Chesapeake, Virginia

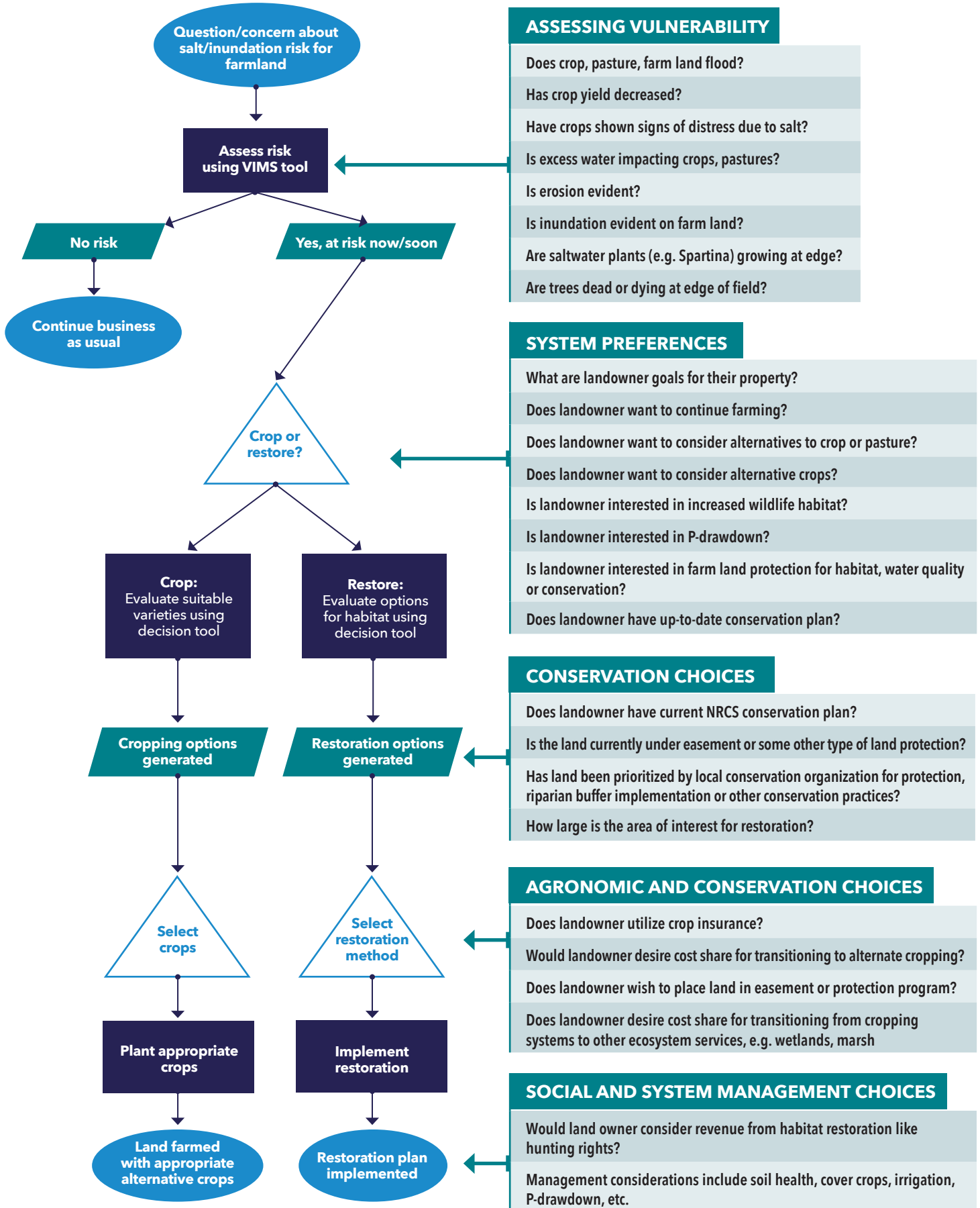


Data Source: VGIN High Resolution Land Cover Dataset, 2016



# Appendix B. Example decision support tree

## Conservation Planning Considerations for Vulnerable Farm Land





## Appendix C. References

Stakeholders have provided several examples of research and educational resources for additional information. It is not intended to be an exhaustive list, rather a representation of current undertakings.

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