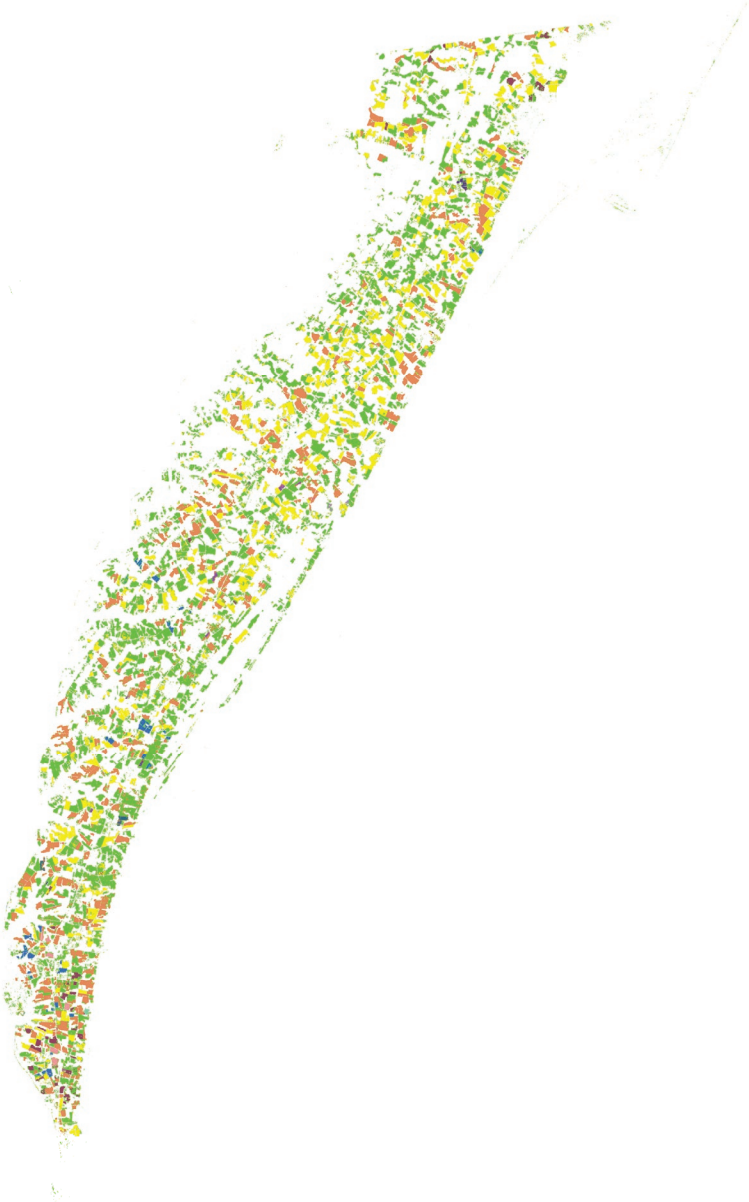
THE IMPACT OF EROSION, SUBSIDENCE, AND SALTWATER INTRUSION ON EASTERN SHORE FARMLAND



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Mentored by Dr. Mark Reiter (Virginia Tech, AREC)
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2024

Sea Grant VIRGINIA

University of Virginia

Virginia Cooperative Extension
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CONTENTS

SUMMARY

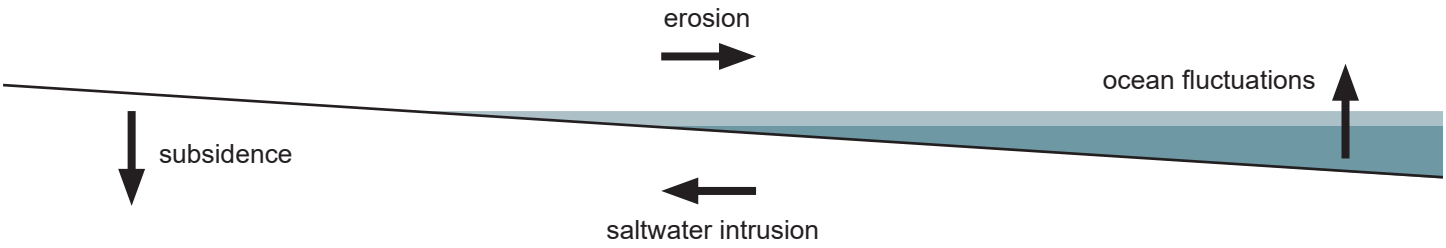
Agriculture plays a valuable role in Virginia's history, culture, economy, and landscape. According to the Virginia Department of Agriculture and Consumer Services (DACS), the state's largest private industry is agriculture at $70 billion annually. The Eastern Shore of Virginia, while comprising only 2% of Virginia's land, holds 3.3% of Virginia's agricultural land, and produces 36% of Virginia's high-value vegetable crops (USDA 2017). The sandy, fertile land that makes this region perfect for crops, however, also makes it vulnerable to erosion, subsidence, saltwater intrusion, and oceanic fluctuations.

With one of the highest rates of subsidence in the United States of America, the Eastern Shore is sinking quickly, with a resulting rise in water level, tides, and storm surge heights. The science behind these changes is robust, but it leaves farmers and landowners without clear strategies on how to adapt. Prepared by a Virginia Sea Grant fellow and graduate student of the University of Virginia's Landscape Architecture Department, this report aims to fill that gap by communicating the threats to farmers directly, while also detailing adaptation strategies that are constructible and affordable.

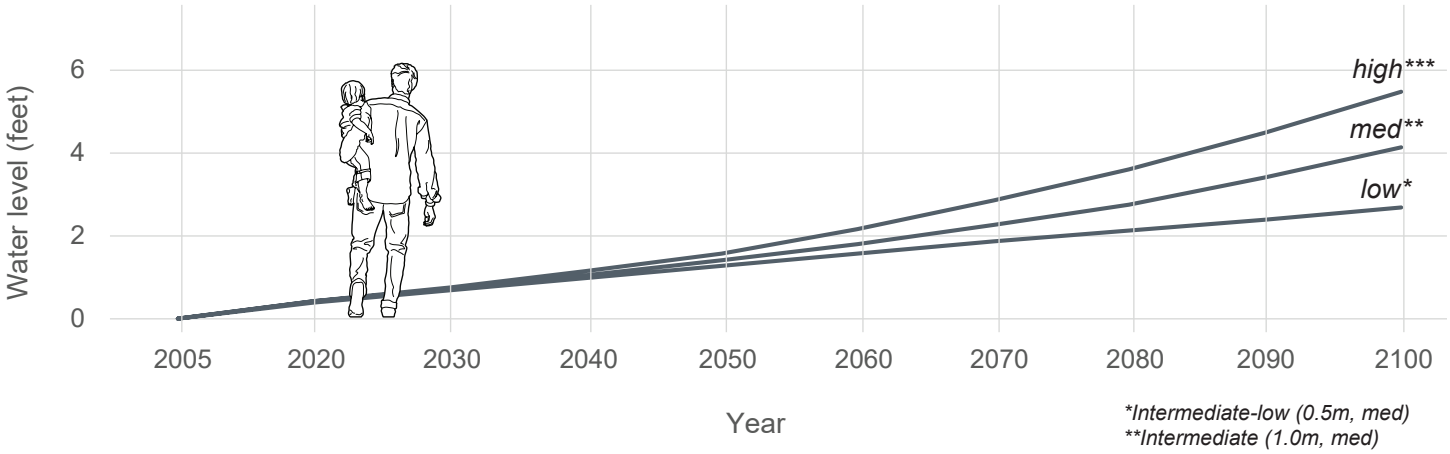
The four adaptation strategies listed in this report (using salt-tolerant crops, implementing aquaculture, filling ditches, and restoring the shoreline) are the result of reviewing existing strategies, talking with local farmers, and understanding the local hydrology and geology in order to synthesize solutions that are specific to this community and location. Other strategies, like constructing dikes or creating wetlands for carbon credits, were considered, but were not ultimately included due to issues with reliability and resilience.

This report is the result of a collaboration between UVA, Virginia Tech, the Virginia Cooperative Extension, and the Eastern Shore Agriculture and Research Extension Center (AREC). I would like to acknowledge and express my appreciation of the support of my professional mentor Dr. Mark Reiter (AREC), my faculty adviser Assistant Professor Michael Luegering (UVA), and Ursula Deitch (DACS), who helped me formulate this project and introduced me to the many generous farmers and landowners of the Eastern Shore.

Four Coastal Factors Threatening Farmland



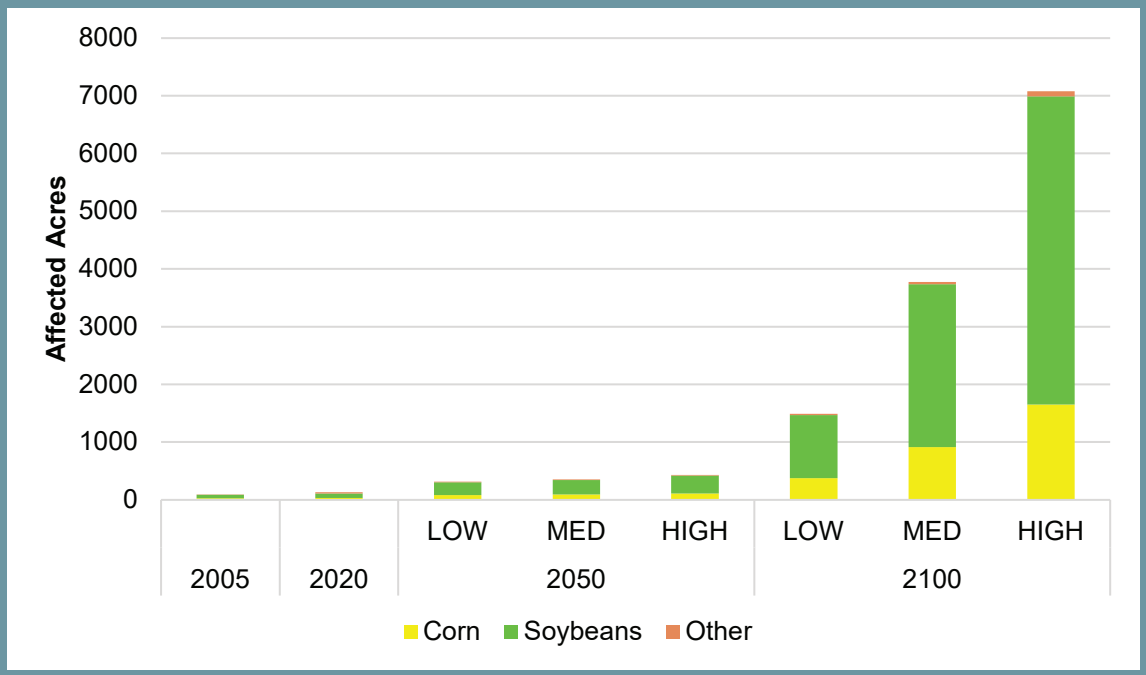
Combined water level change over time



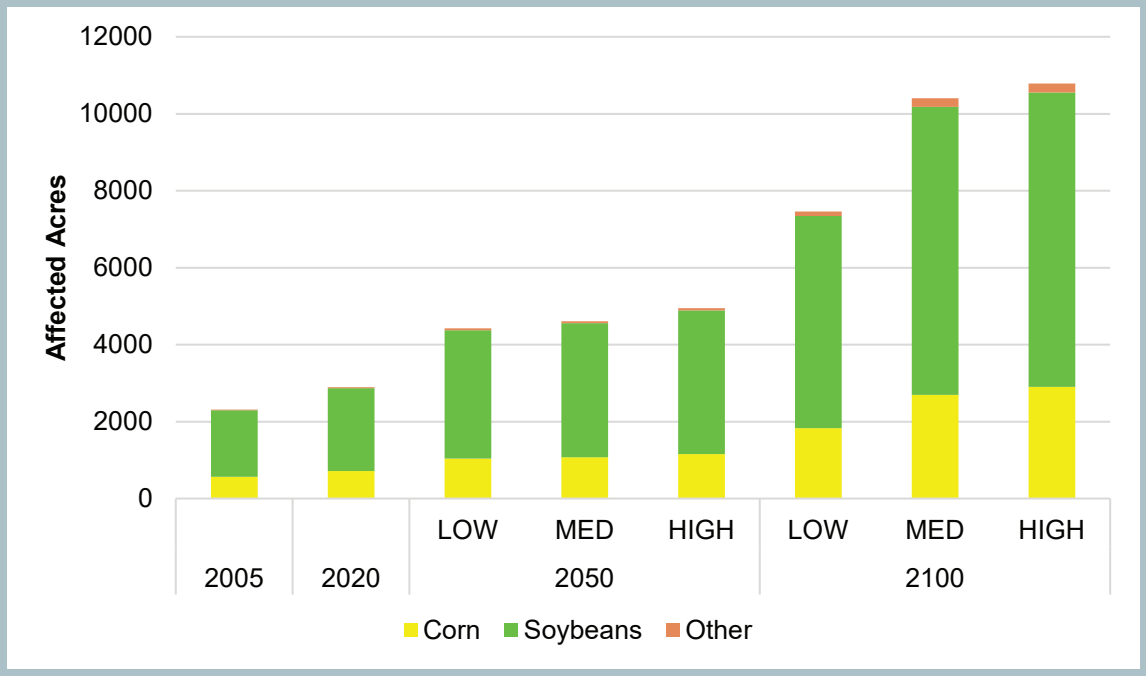
*Intermediate-low (0.5m, med)
**Intermediate (1.0m, med)
***Intermediate-high (1.5m, med)

AGRICULTURAL PROJECTIONS

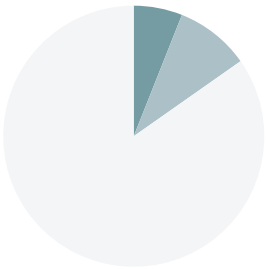
Acres within or below tidal range over time



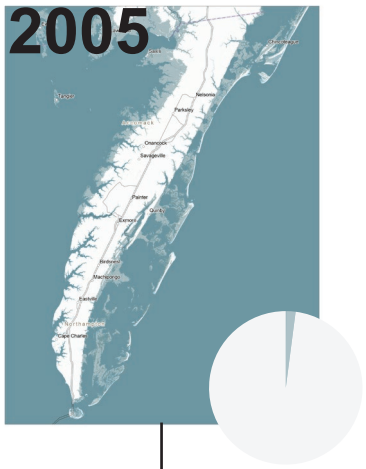
Acres within 4’ storm surge zone over time

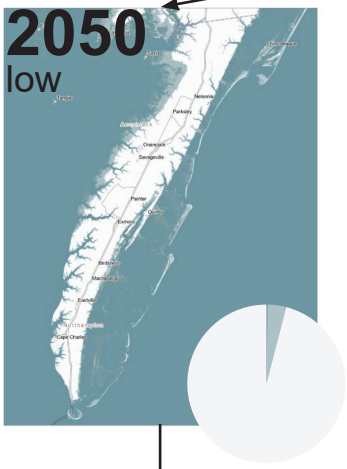


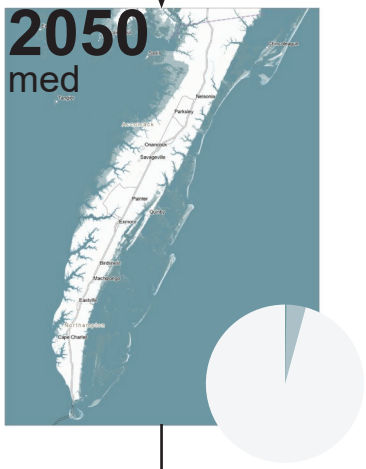
Tidal range (below high tide)
4’ Storm Surge Zone
Above 4’ Storm Surge

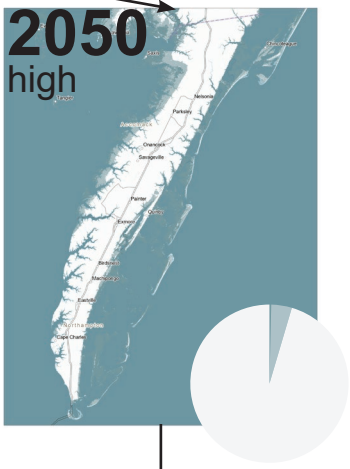


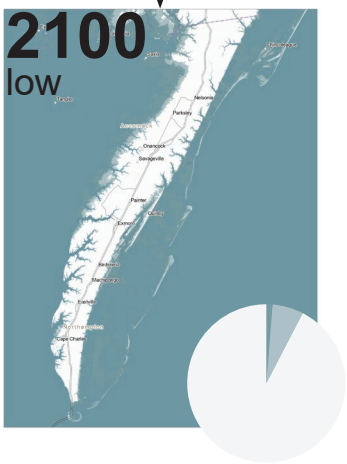
Acres of affected farmland (by percentage)

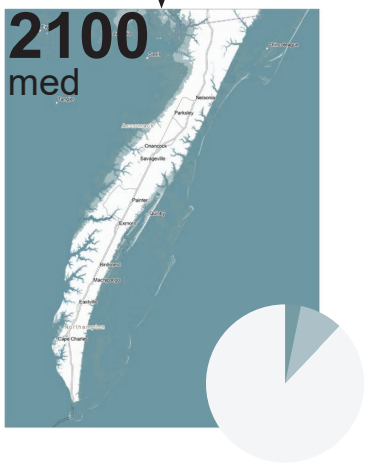












Scenarios are based on NOAA’s 2022 models for the southern tip of the Eastern Shore (Chesapeake Bay Bridge Tunnel).

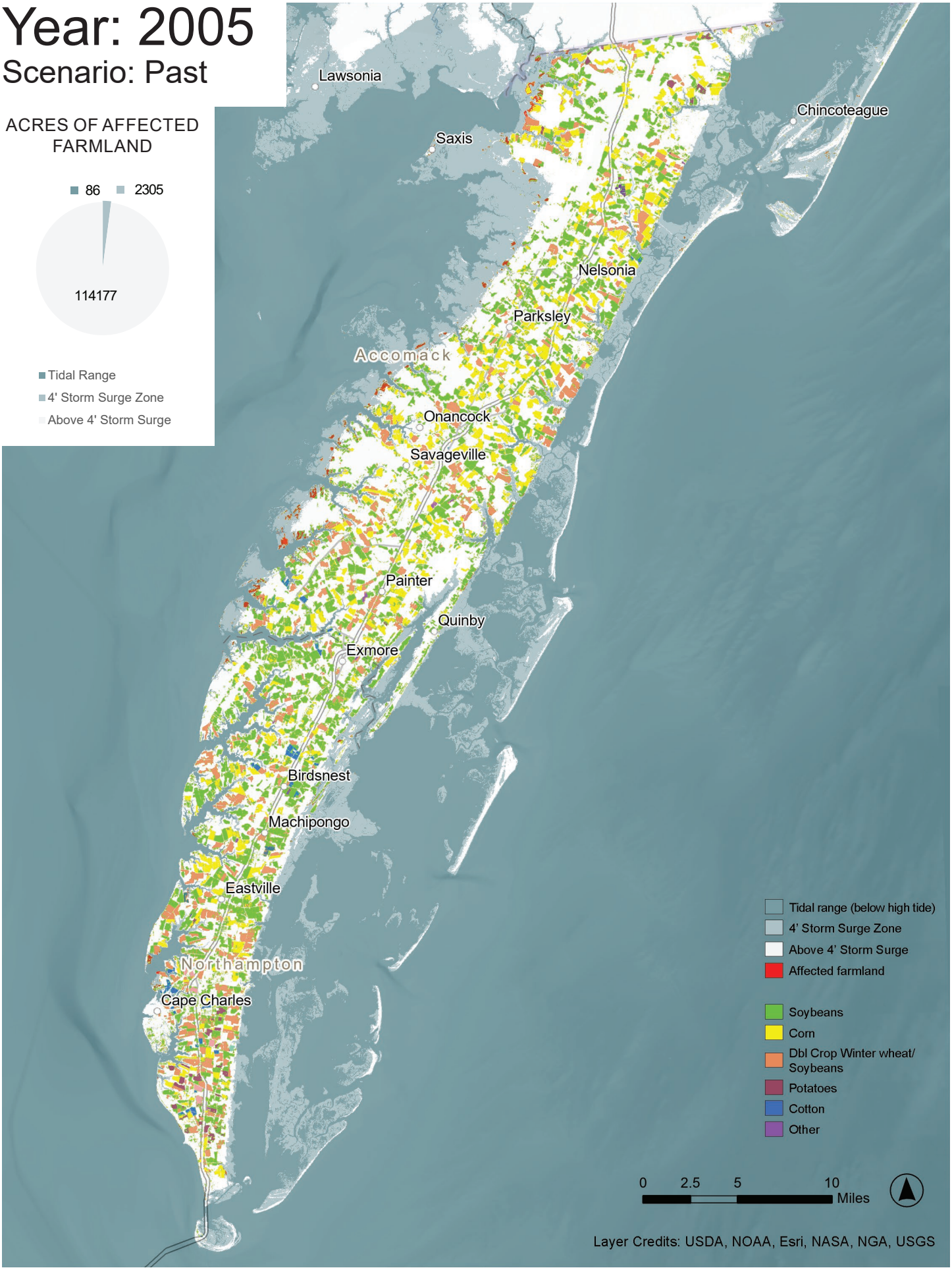
Low*: low levels of erosion, subsidence and saltwater intrusion

Med**: moderate levels of erosion, subsidence and saltwater intrusion

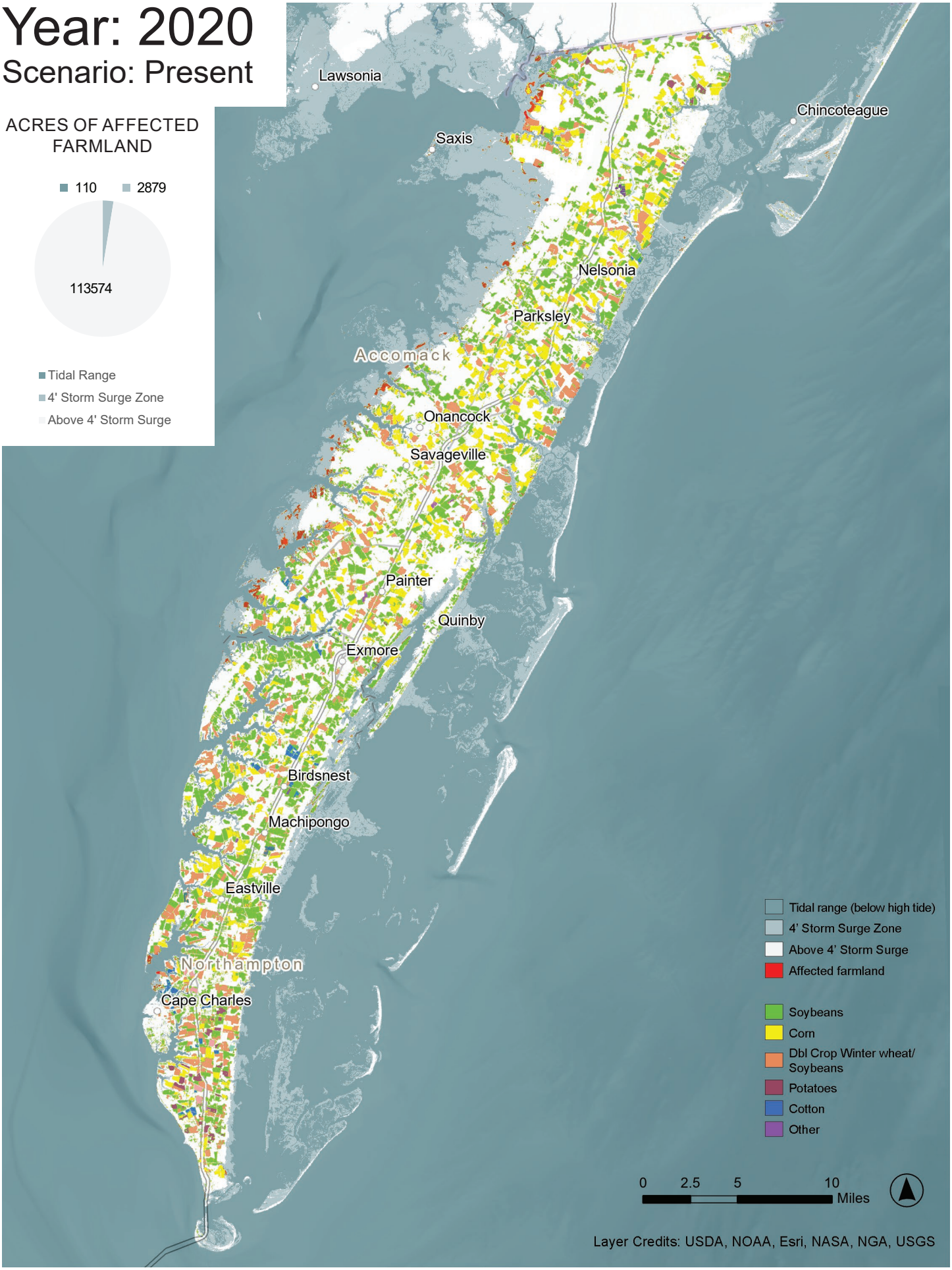
High***: high levels of erosion, subsidence and saltwater intrusion

**Intermediate-low (0.5m, med)*
***Intermediate (1.0m, med)*
****Intermediate-high (1.5m, med)*

Year: 2005
Scenario: Past

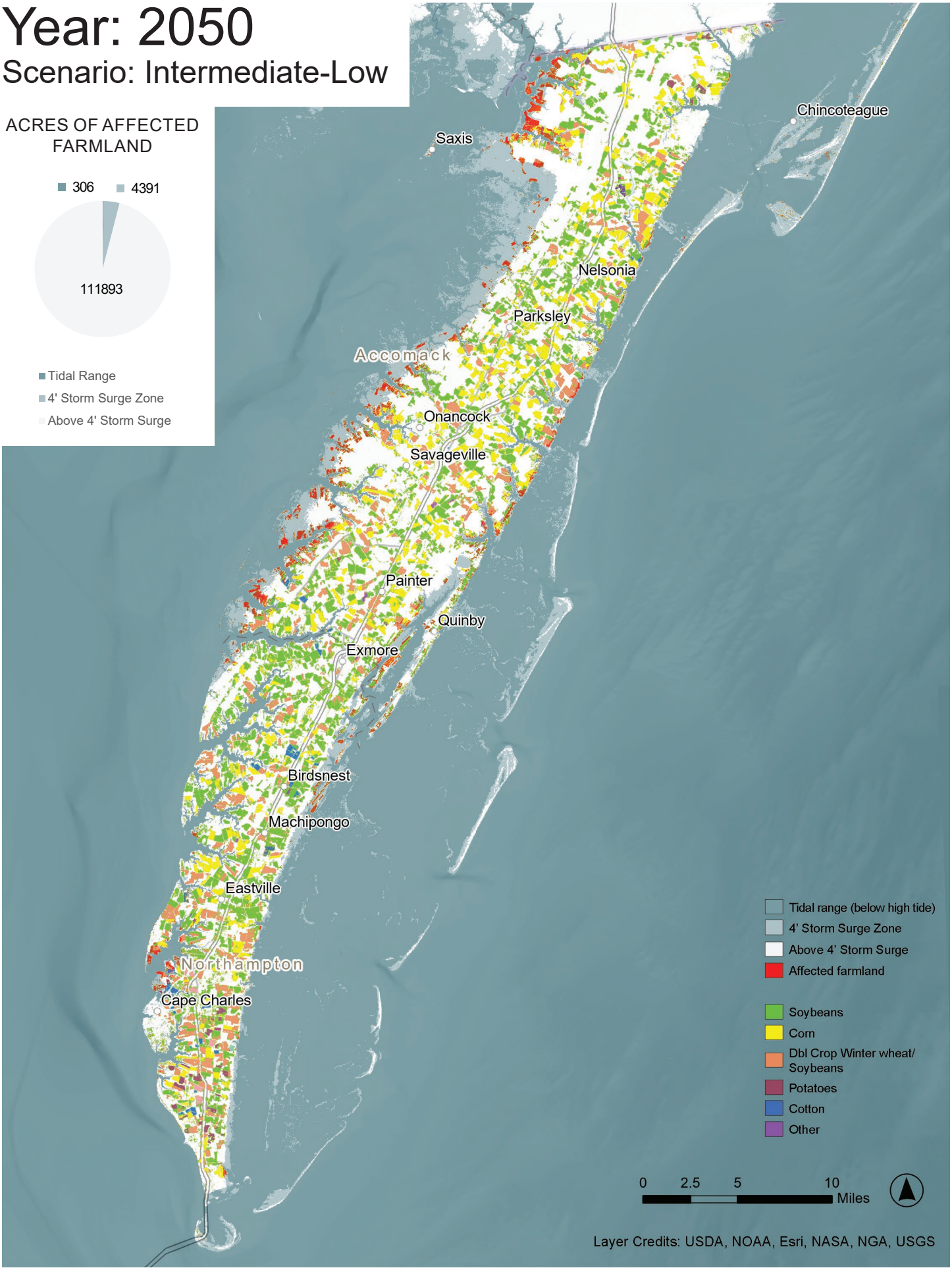


Year: 2020
Scenario: Present



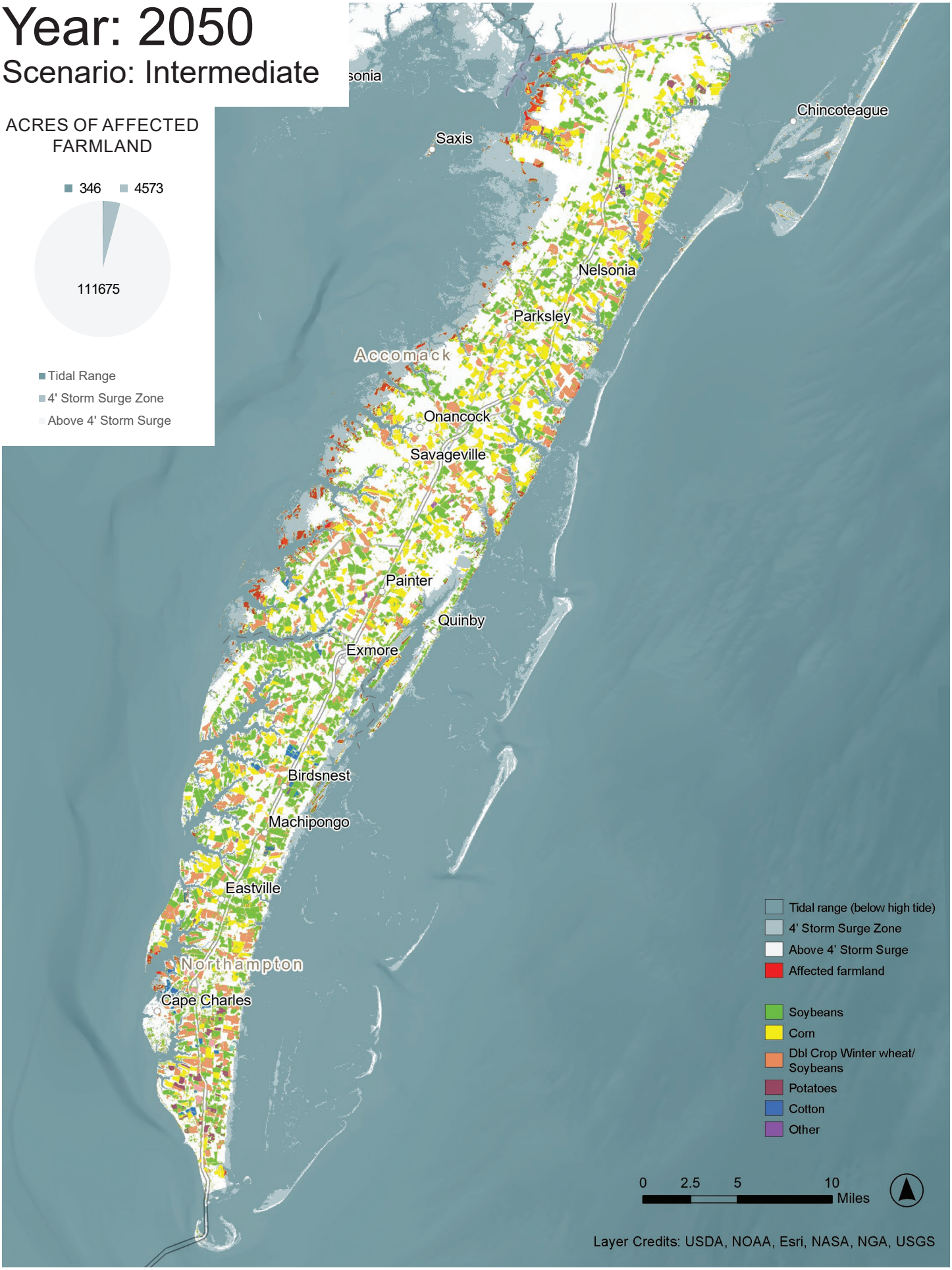
Year: 2050

Scenario: Intermediate-Low



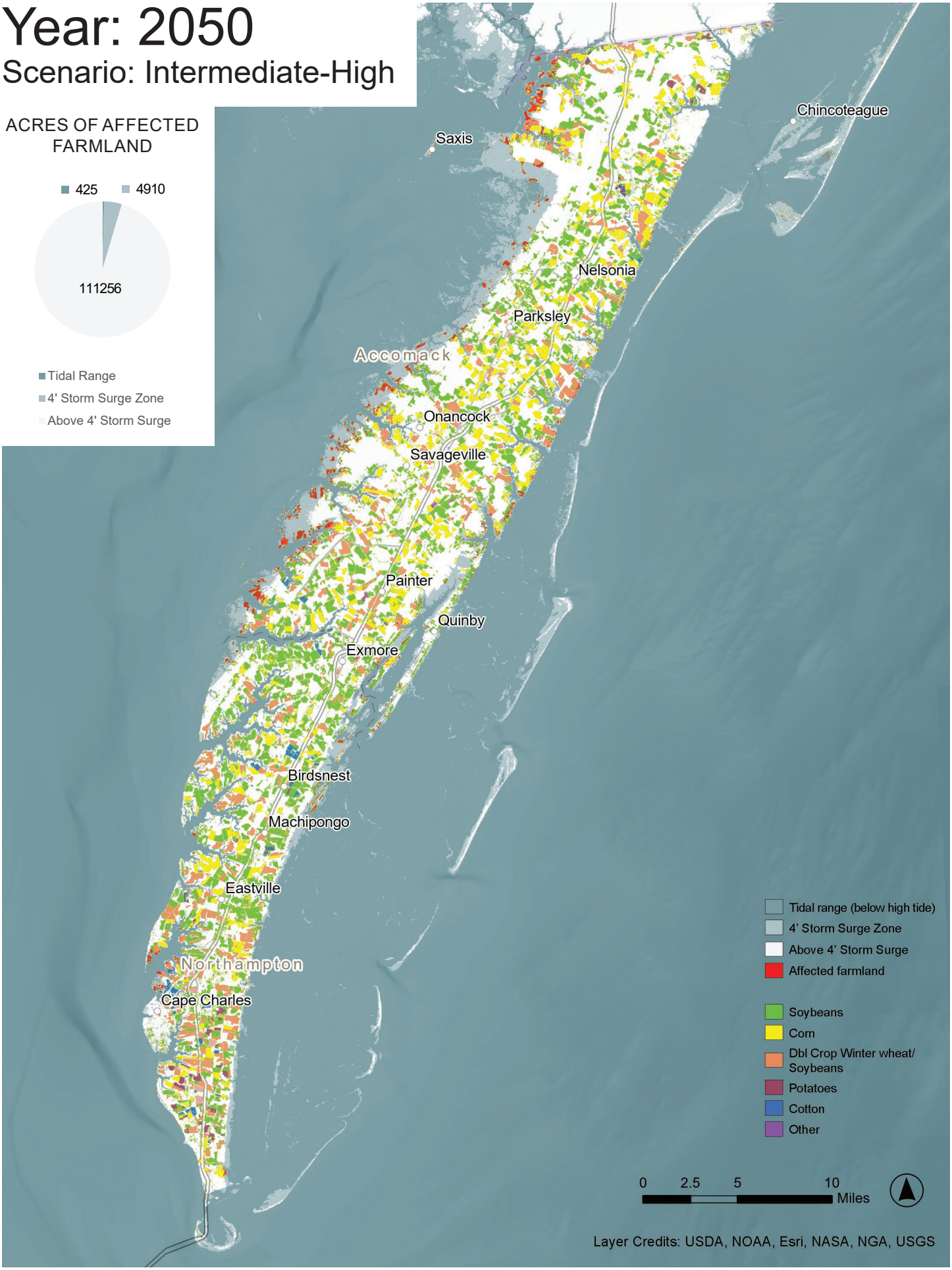
Year: 2050

Scenario: Intermediate



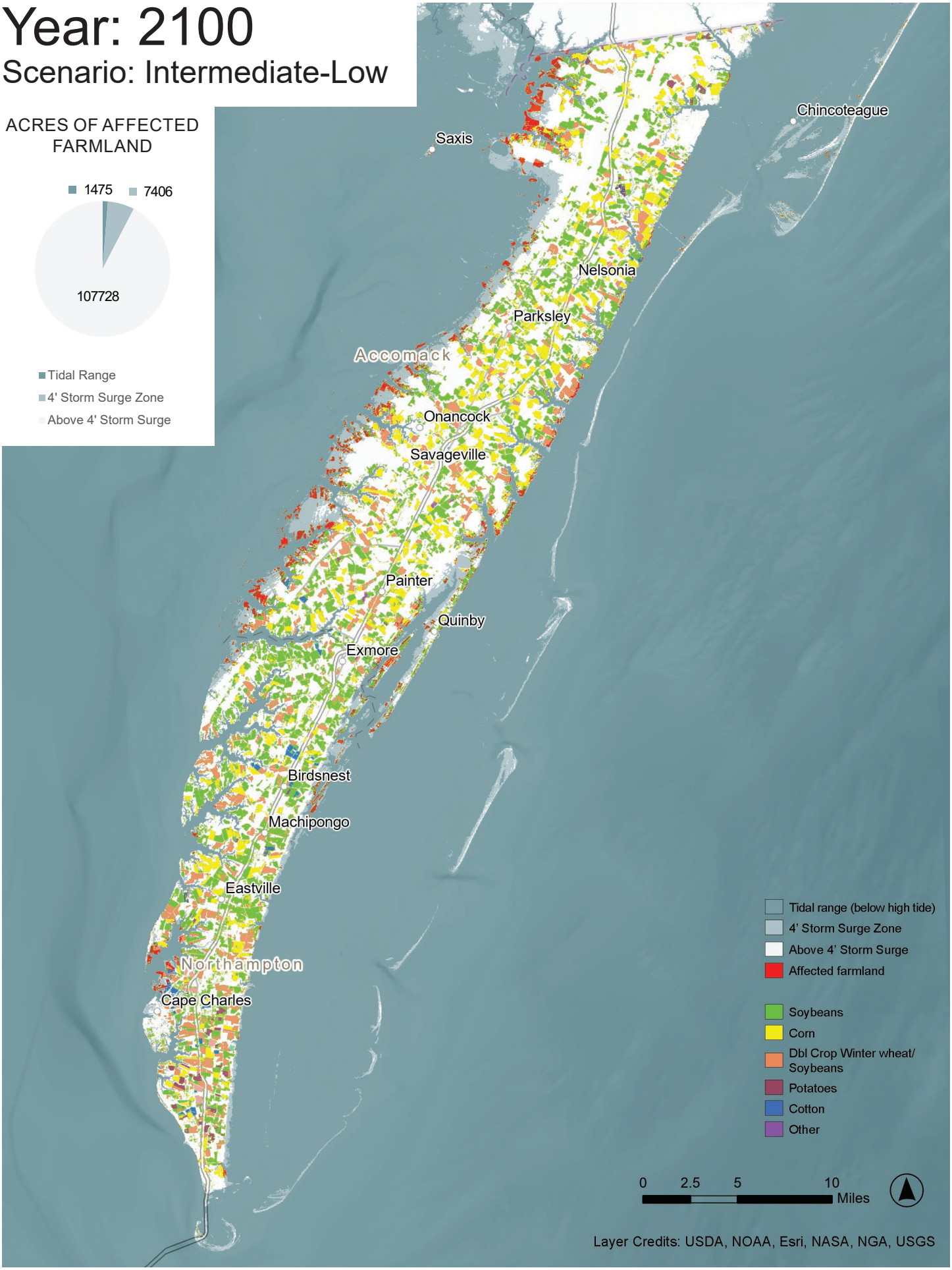
Year: 2050

Scenario: Intermediate-High



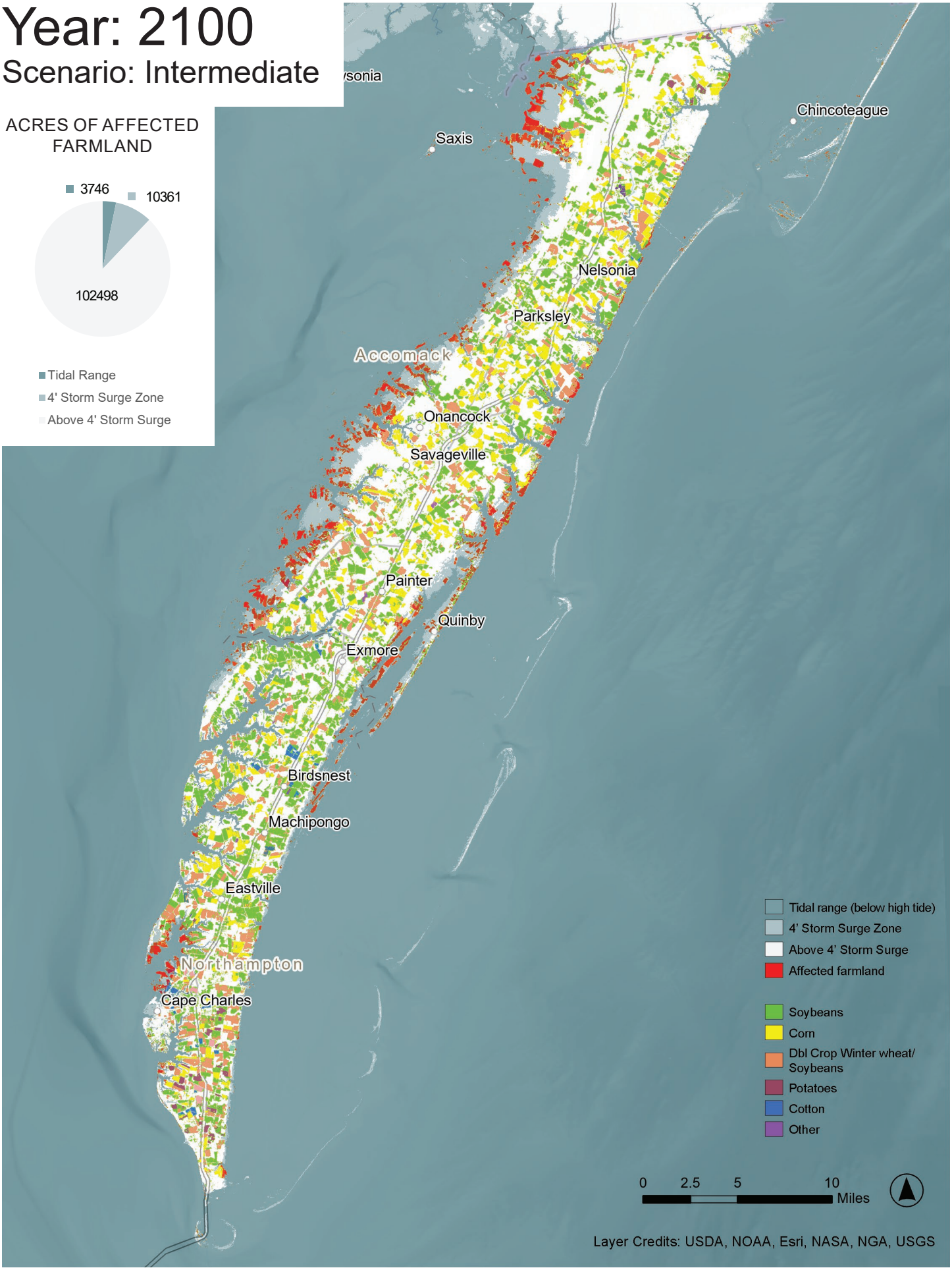
Year: 2100

Scenario: Intermediate-Low



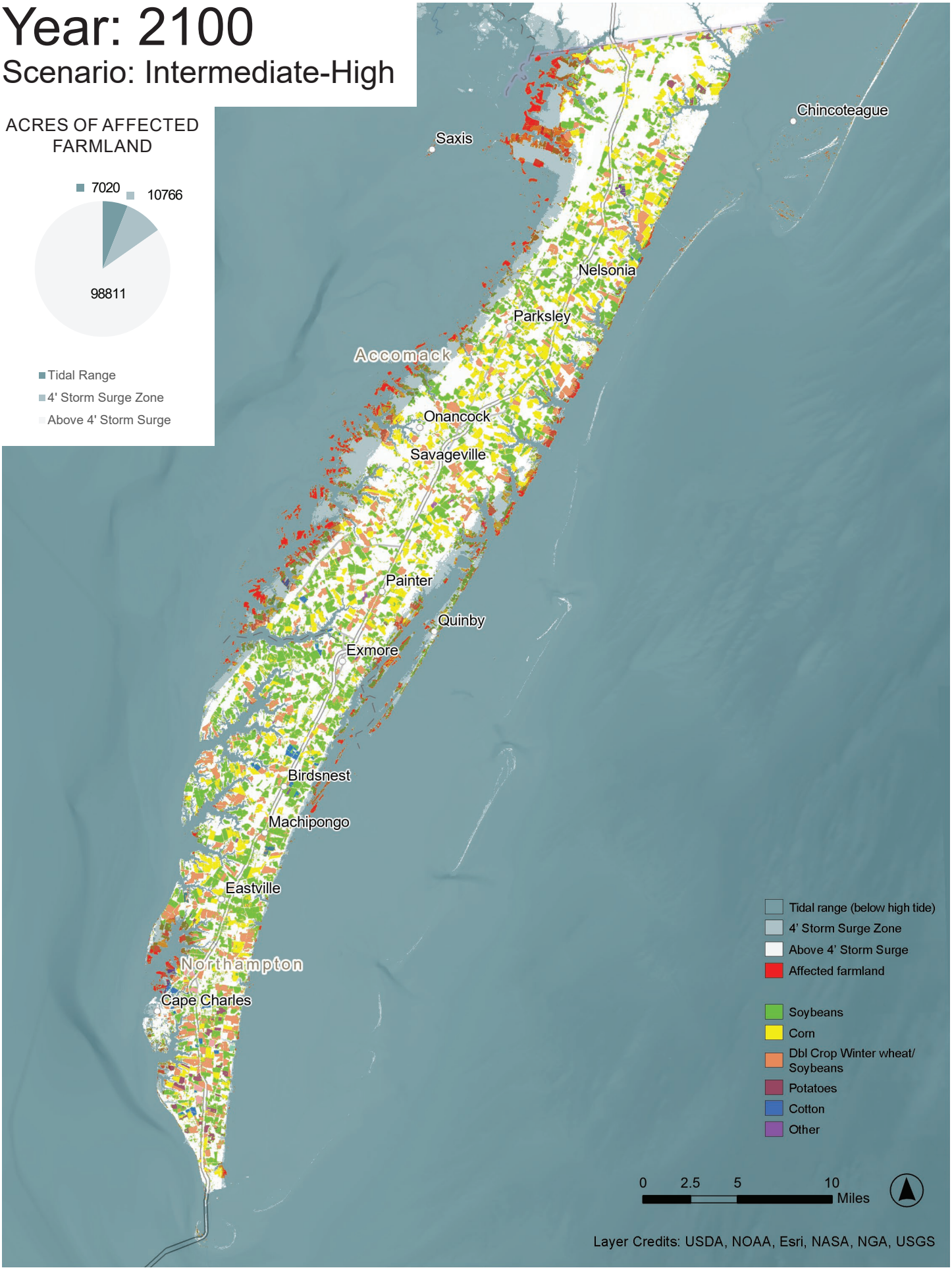
Year: 2100

Scenario: Intermediate



Year: 2100

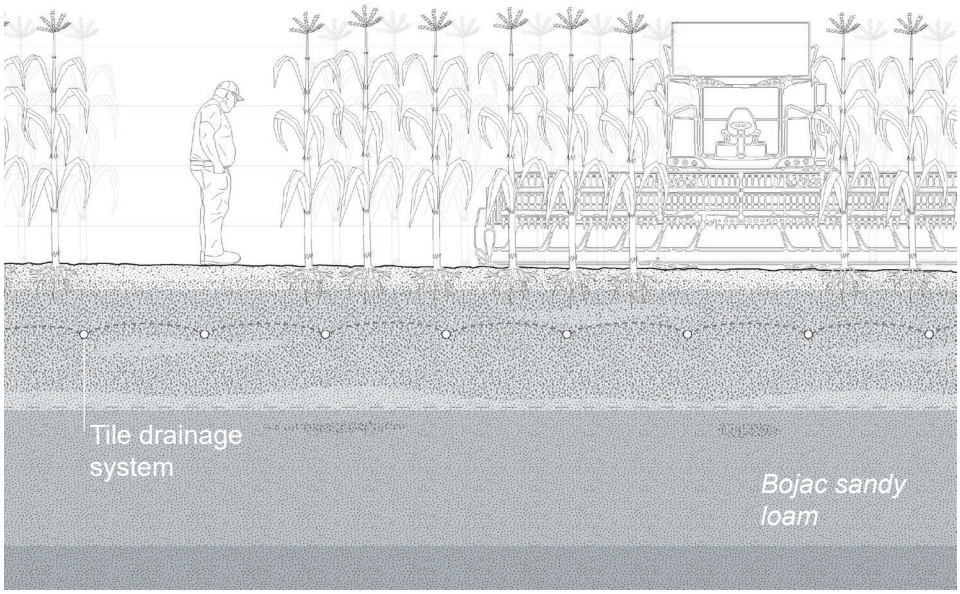
Scenario: Intermediate-High



ADAPTATION STRATEGIES

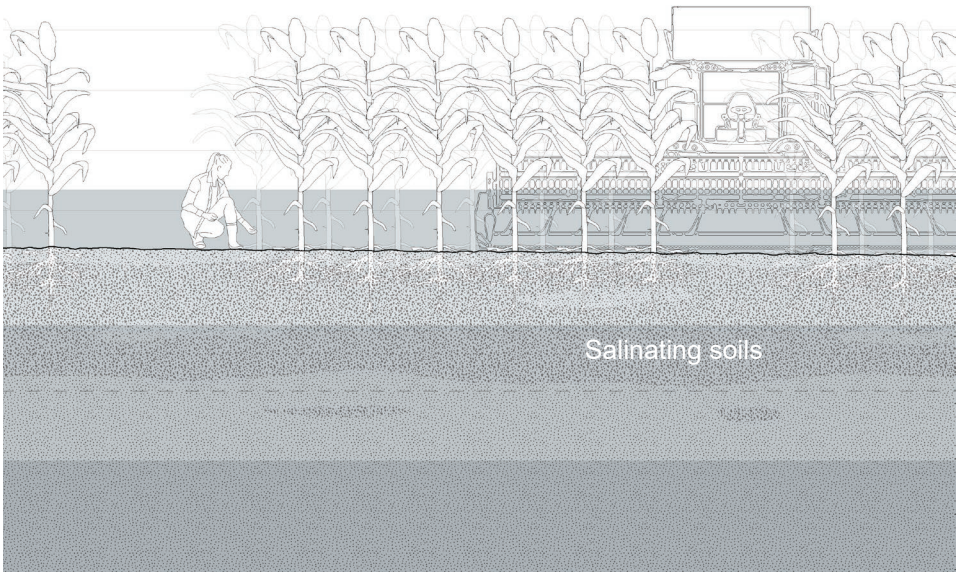
#1 Salt-tolerant crops

Corn farming



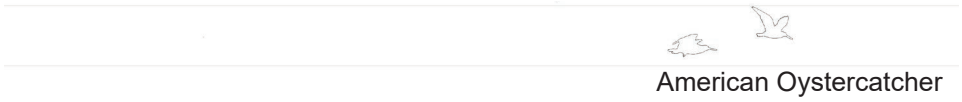
Corn and soy require good drainage and low soil salinity. When crops start failing due to saltwater intrusion, switching to salt-tolerant crops will offer bigger crop yields.

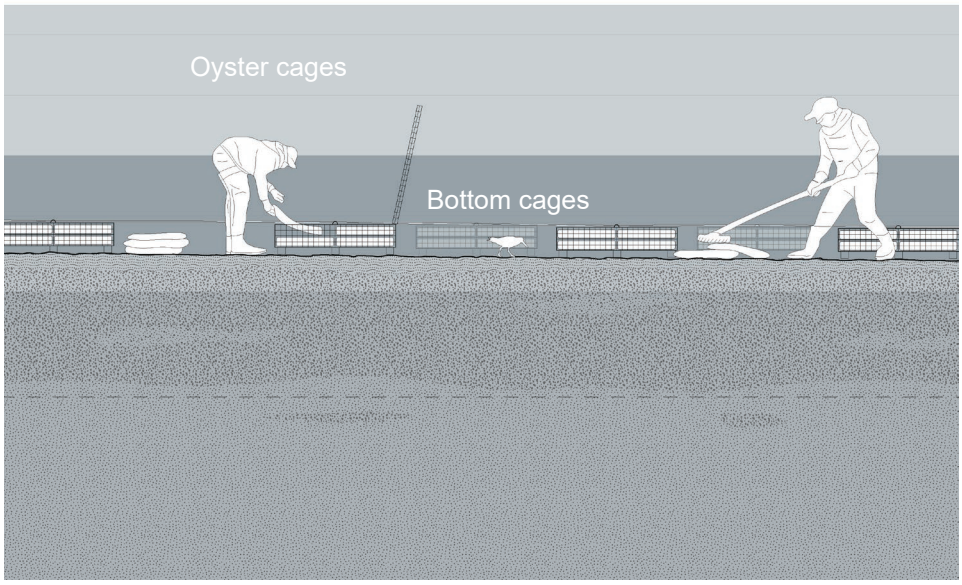
Sorghum farming



Sorghum is one crop that can withstand wetter and saltier soils, and it has been grown successfully on the Eastern Shore. Other options are rice, quinoa, marsh mallow, and more.

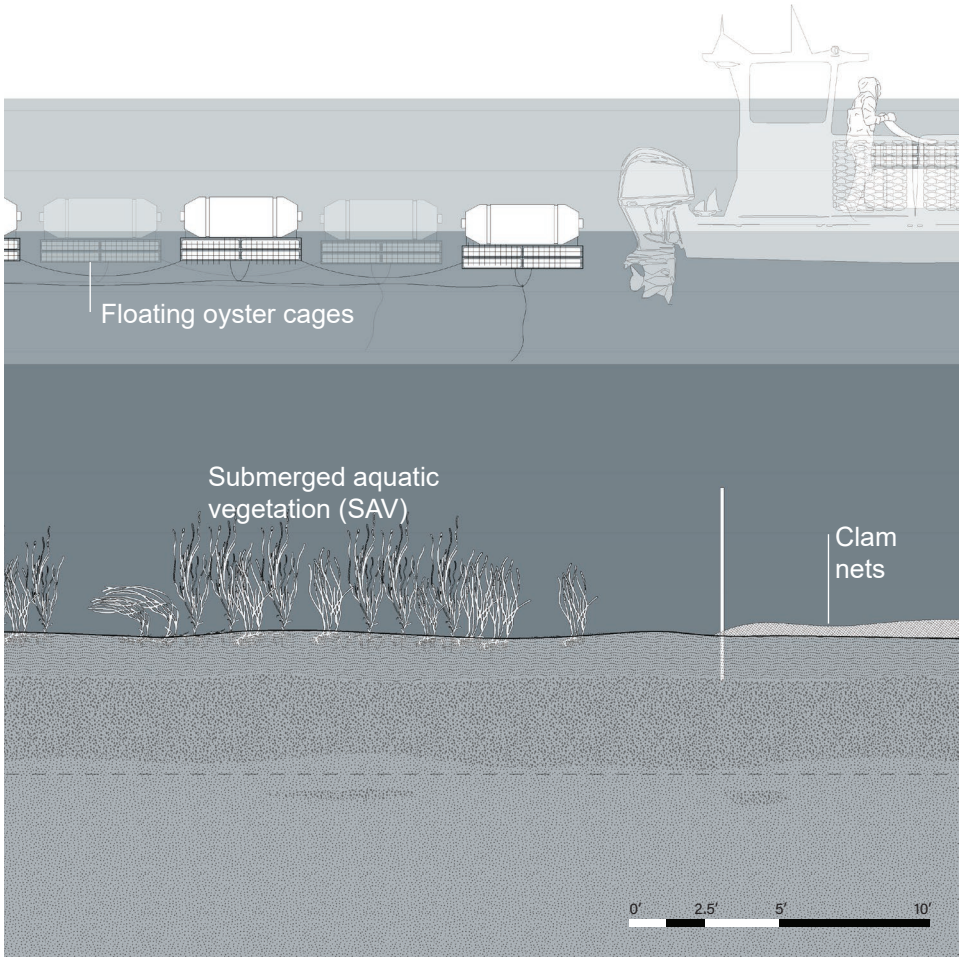
#2 Aquaculture





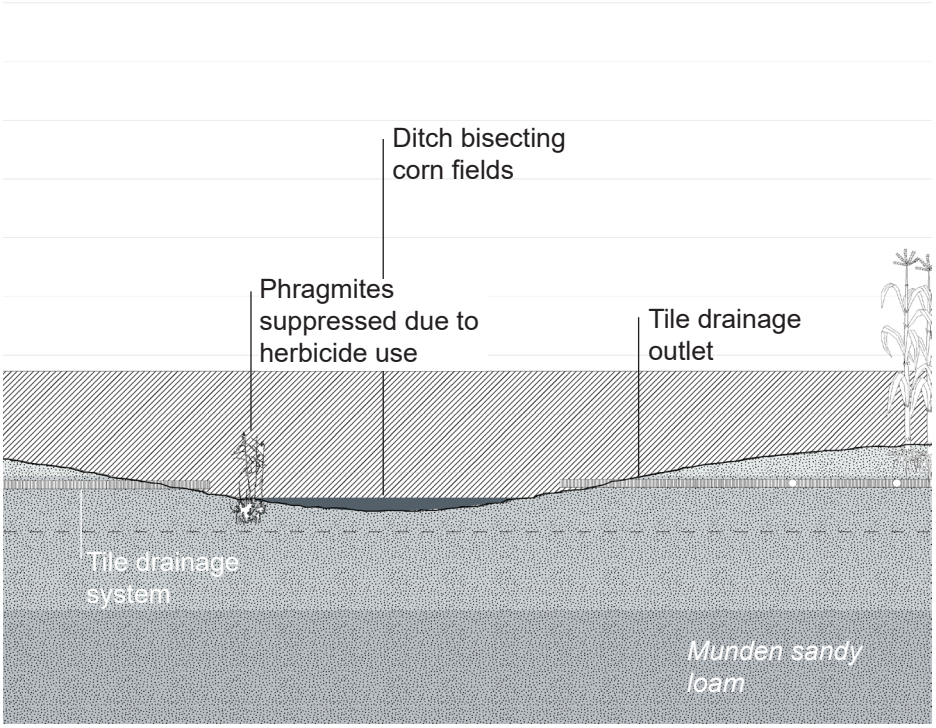
Supplementing dry-land farming with aquaculture, either on one's own land or leasing on public grounds, can help mitigate losses caused by saltwater intrusion.

Bottom cages for oyster aquaculture are easy to install and work well in the inter-tidal zone.

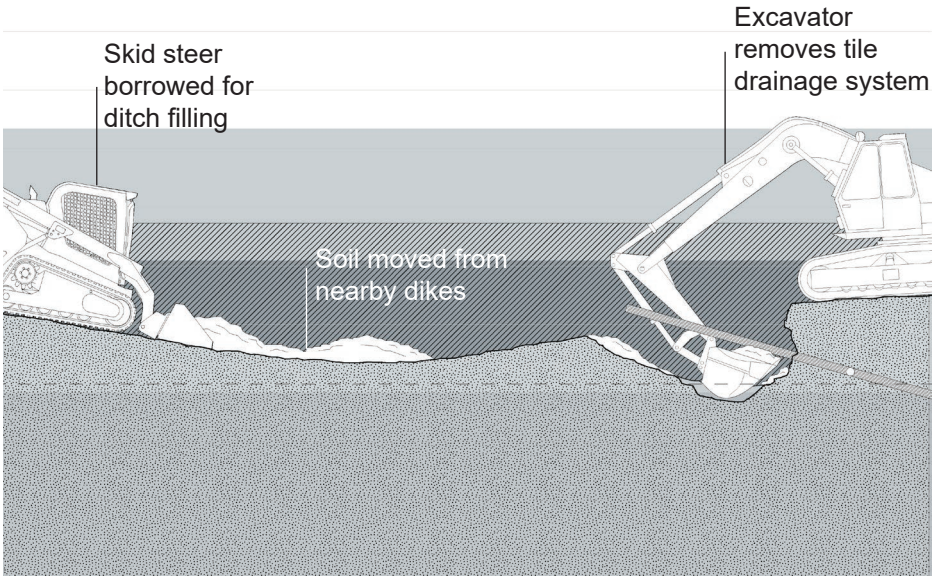


In deeper waters, floating oyster cages are preferable, and allow for clam nets and SAV to grow on the sea bottom. The deeper the water gets, the more opportunity for diverse production and restoration.

#3 Ditch Filling

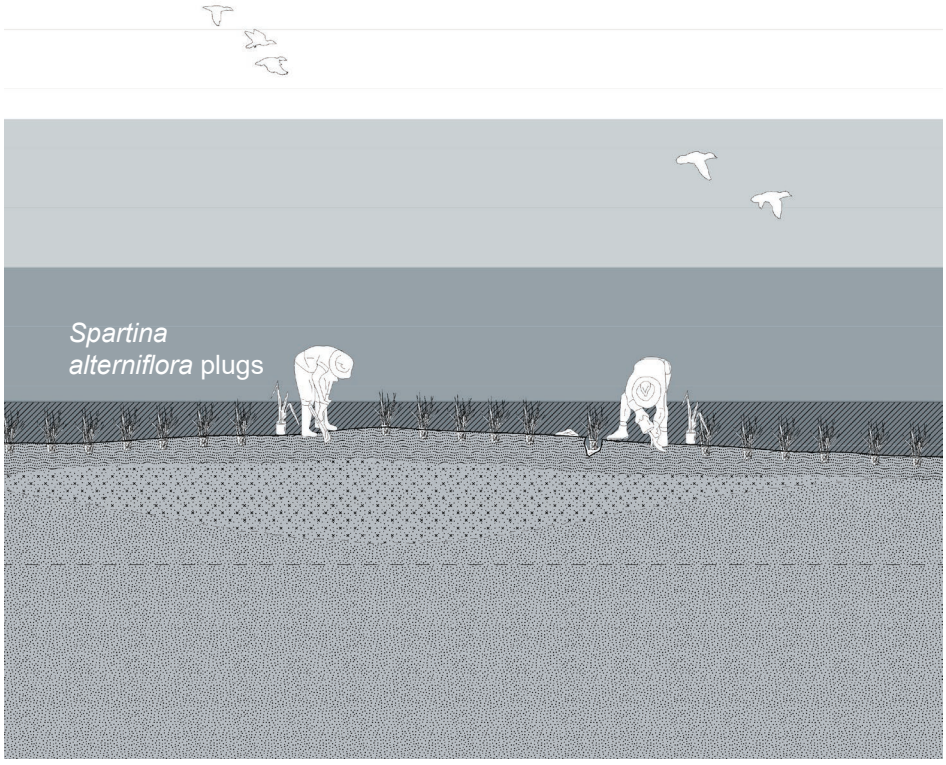


Ditches drain farmland to keep crops healthy, but they also act as a conduit for saltwater intrusion. Farmland with ditches will typically see the effects of intrusion near ditches first, before it spreads into the rest of the farm.

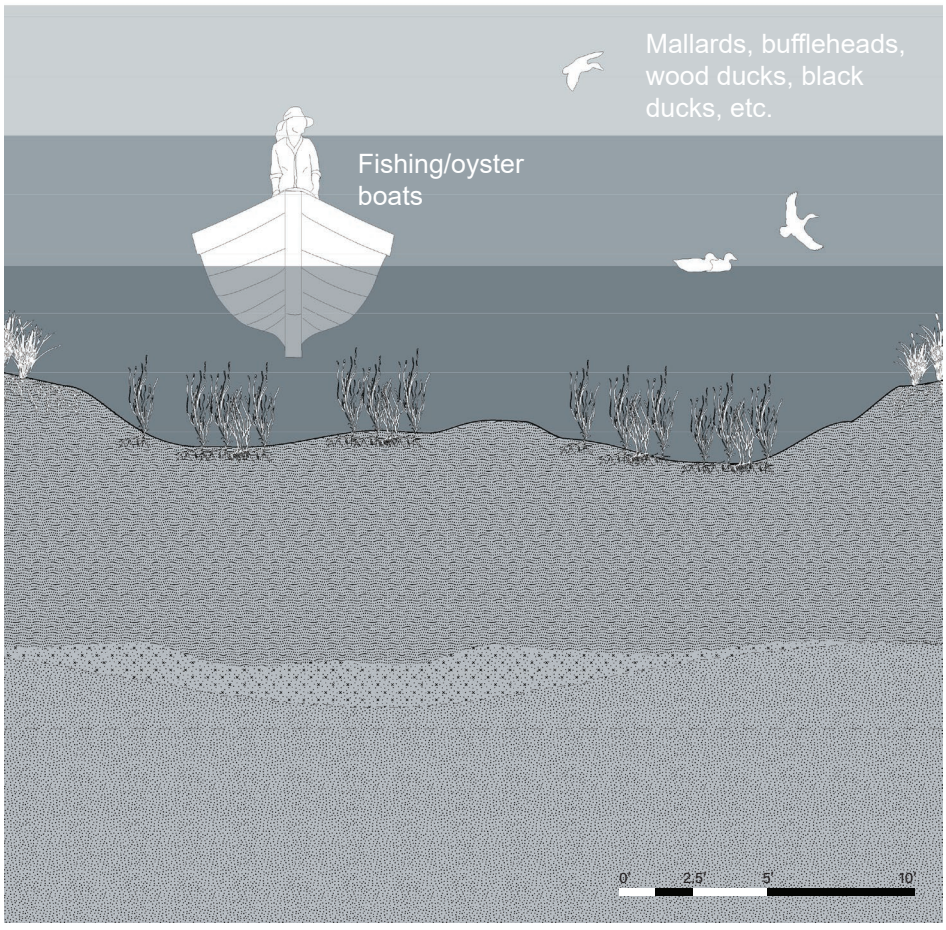


Filling ditches prevents saltwater intrusion and failing downstream infrastructure. Although labor intensive, this in combination to switching to salt-tolerant crops can provide long-term resilience to a farm.

#4 Shoreline Restoration



Marsh grasses stabilize soils, mitigate wave damage, trap sediment, and support migration. Converting the edge of a farm into a living shoreline can help the rest of the farm survive storms, erosion, and other threats.



In addition to keeping farmland productive, restored marshland areas offer opportunities for hunting and fishing, both of which are part of the cultural history of the Eastern Shore.

APPENDIX

Table 1: 2005

	Tidal range	Storm surge	Unexposed
Corn	24.6	565.4	31500.5
Cotton	0.6	3.7	1172.2
Sorghum		1.1	59.1
Soybeans	48.0	1562.8	57374.5
Peanuts			15.4
Tobacco			0.4
Sweet Corn		0.4	398.0
Barley			2.1
Winter Wheat		1.8	193.8
Dbl Crop WinWht/Soybeans	13.3	171.4	22555.7
Rye	0.2		4.8
Millet			0.2
Alfalfa		0.7	133.0
Other Hay/Non Alfalfa	1.0	5.9	171.7
Dry Beans			45.1
Potatoes		1.6	1573.7
Other Crops			0.3
Sod/Grass Seed		0.3	3.3
Fallow/Idle Cropland			2.0
Aquaculture	6.5	0.6	1.3
Cantaloupes			2.2
Strawberries			0.4
Dbl Crop WinWht/Corn			0.4
Dbl Crop WinWht/Sorghum			0.4
Dbl Crop Soybeans/Oats		0.2	13.5
Dbl Crop Corn/Soybeans			0.6
Dbl Crop Barley/Soybeans		0.2	155.8
TOTAL	94.2	2316.1	115380.2

The acres of farmland in Northampton and Accomack Counties affected by saltwater intrusion (columns refer to: within/below tidal range, within 4' storm surge zone, and above 4' storm surge zone)

Table 2: 2020

	Tidal range	Storm surge	Unexposed
Corn	31.5	713.3	31370.2
Cotton	1.7	4.4	1174.8
Sorghum		1.1	59.1
Soybeans	60.5	1924.0	56956.1
Peanuts			18.4
Tobacco			0.3
Sweet Corn	0.2	0.9	399.2
Barley	0.2	0.2	1.9
Winter Wheat		3.2	196.9
Dbl Crop WinWht/Soybeans	16.2	235.2	22503.4
Rye			4.1
Millet			0.2
Alfalfa		2.2	134.5
Other Hay/Non Alfalfa	1.5	8.4	171.0
Dry Beans		0.2	46.9
Potatoes	0.4	2.2	1569.0
Other Crops			0.4
Sod/Grass Seed		0.6	2.1
Fallow/Idle Cropland		0.2	1.9
Aquaculture	6.9	0.6	1.0
Cantaloupes			2.0
Strawberries			0.4
Dbl Crop WinWht/Corn			0.4
Dbl Crop WinWht/Sorghum			0.9
Dbl Crop Soybeans/Oats			12.5
Dbl Crop Corn/Soybeans			0.5
Dbl Crop Barley/Soybeans			154.3
TOTAL	119.0	2896.7	114782.6

The acres of farmland in Northampton and Accomack Counties affected by saltwater intrusion (columns refer to: within/below tidal range, within 4' storm surge zone, and above 4' storm surge zone)

Table 3: 2050; Intermediate-Low

	Tidal range	Storm surge	Unexposed
Corn	81.9	1040.2	30998.0
Cotton	2.5	9.5	1169.3
Sorghum		5.4	54.5
Soybeans	183.4	2906.3	55867.1
Peanuts		0.2	18.3
Tobacco			0.3
Sweet Corn	0.4	0.9	399.0
Barley	0.2	0.2	1.8
Winter Wheat	0.2	3.8	196.2
Dbl Crop WinWht/Soybeans	37.7	432.2	22290.7
Rye			4.1
Millet			0.2
Alfalfa		6.6	130.3
Other Hay/Non Alfalfa	1.6	14.9	164.0
Dry Beans		0.2	46.9
Potatoes	0.8	3.1	1568.0
Other Crops			0.4
Sod/Grass Seed		0.7	1.9
Fallow/Idle Cropland		0.4	1.8
Aquaculture	7.0	0.8	0.7
Cantaloupes			2.0
Strawberries			0.4
Dbl Crop WinWht/Corn			0.4
Dbl Crop WinWht/Sorghum			0.9
Dbl Crop Soybeans/Oats			12.5
Dbl Crop Corn/Soybeans			0.5
Dbl Crop Barley/Soybeans			154.3
TOTAL	315.7	4425.5	113084.3

The acres of farmland in Northampton and Accomack Counties affected by saltwater intrusion (columns refer to: within/below tidal range, within 4' storm surge zone, and above 4' storm surge zone)

Table 4: 2050; Intermediate

	Tidal range	Storm surge	Unexposed
Corn	92.1	1072.7	30954.8
Cotton	2.7	10.3	1168.0
Sorghum		6.8	52.9
Soybeans	210.8	3019.2	55729.6
Peanuts		0.2	18.3
Tobacco			0.3
Sweet Corn	0.4	0.9	399.0
Barley	0.2	0.2	1.8
Winter Wheat	0.2	3.9	196.1
Dbl Crop WinWht/Soybeans	39.3	467.6	22254.5
Rye			4.1
Millet			0.2
Alfalfa		6.9	130.0
Other Hay/Non Alfalfa	1.6	15.4	163.7
Dry Beans		0.2	46.9
Potatoes	0.8	3.1	1568.0
Other Crops			0.4
Sod/Grass Seed		0.7	1.9
Fallow/Idle Cropland		0.4	1.8
Aquaculture	7.0	0.8	0.7
Cantaloupes			2.0
Strawberries			0.4
Dbl Crop WinWht/Corn			0.4
Dbl Crop WinWht/Sorghum			0.9
Dbl Crop Soybeans/Oats			12.5
Dbl Crop Corn/Soybeans			0.5
Dbl Crop Barley/Soybeans			154.3
TOTAL	355.0	4609.2	112863.8

The acres of farmland in Northampton and Accomack Counties affected by saltwater intrusion (columns refer to: within/below tidal range, within 4' storm surge zone, and above 4' storm surge zone)

Table 5: 2050; Intermediate-High

	Tidal range	Storm surge	Unexposed
Corn	111.5	1154.0	30854.8
Cotton	2.7	12.3	1166.0
Sorghum		8.7	51.0
Soybeans	266.0	3213.7	55478.3
Peanuts		0.2	18.3
Tobacco			0.3
Sweet Corn	0.4	0.9	399.0
Barley	0.2	0.4	1.6
Winter Wheat	0.3	3.8	196.1
Dbl Crop WinWht/Soybeans	43.8	526.9	22189.2
Rye			4.1
Millet			0.2
Alfalfa		7.2	129.6
Other Hay/Non Alfalfa	1.6	16.7	162.4
Dry Beans	0.2		46.9
Potatoes	0.9	3.3	1567.6
Other Crops			0.4
Sod/Grass Seed		0.7	1.9
Fallow/Idle Cropland		0.4	1.8
Aquaculture	7.0	0.8	0.7
Cantaloupes			2.0
Strawberries			0.4
Dbl Crop WinWht/Corn			0.4
Dbl Crop WinWht/Sorghum			0.9
Dbl Crop Soybeans/Oats			12.5
Dbl Crop Corn/Soybeans			0.5
Dbl Crop Barley/Soybeans			154.3
TOTAL	434.5	4950.1	112441.0

The acres of farmland in Northampton and Accomack Counties affected by saltwater intrusion (columns refer to: within/below tidal range, within 4' storm surge zone, and above 4' storm surge zone)

Table 6: 2100; Intermediate-Low

	Tidal range	Storm surge	Unexposed
Corn	375.8	1833.8	29918.1
Cotton	4.0	51.2	1126.1
Sorghum	0.2	23.5	36.3
Soybeans	980.4	4436.0	53549.3
Peanuts		0.4	18.1
Tobacco			0.3
Sweet Corn	0.7	0.8	398.9
Barley	0.2	0.4	1.6
Winter Wheat	1.6	3.8	195.1
Dbl Crop WinWht/Soybeans	112.6	1075.6	21573.6
Rye			4.1
Millet			0.2
Alfalfa	0.2	11.4	125.3
Other Hay/Non Alfalfa	4.4	17.3	159.6
Dry Beans	0.1		46.9
Potatoes	1.6	9.6	1560.8
Other Crops			0.4
Sod/Grass Seed	0.2	0.6	1.9
Fallow/Idle Cropland	0.2	0.2	1.8
Aquaculture	7.4	0.6	0.5
Cantaloupes			2.0
Strawberries			0.4
Dbl Crop WinWht/Corn		0.4	
Dbl Crop WinWht/Sorghum			0.9
Dbl Crop Soybeans/Oats		0.2	12.4
Dbl Crop Corn/Soybeans		0.1	0.4
Dbl Crop Barley/Soybeans		0.1	154.2
TOTAL	1489.7	7465.8	108889.1

The acres of farmland in Northampton and Accomack Counties affected by saltwater intrusion (columns refer to: within/below tidal range, within 4' storm surge zone, and above 4' storm surge zone)

Table 7: 2100; Intermediate

	Tidal range	Storm surge	Unexposed
Corn	910.5	2694.8	28524.9
Cotton	7.2	150.3	1022.7
Sorghum	3.0	41.7	15.8
Soybeans	2480.1	5802.3	50683.3
Peanuts	0.2	0.8	17.5
Tobacco			0.3
Sweet Corn	1.1	1.3	398.0
Barley	0.4	0.3	1.4
Winter Wheat	3.5	3.8	193.2
Dbl Crop WinWht/Soybeans	344.3	1681.4	20730.7
Rye			4.1
Millet			0.2
Alfalfa	4.3	9.0	123.9
Other Hay/Non Alfalfa	12.2	17.5	151.2
Dry Beans	0.1		46.8
Potatoes	3.5	32.6	1536.0
Other Crops			0.5
Sod/Grass Seed	0.7		2.0
Fallow/Idle Cropland	0.2	0.4	1.6
Aquaculture	7.8	0.2	0.5
Cantaloupes			2.0
Strawberries			0.4
Dbl Crop WinWht/Corn		0.4	
Dbl Crop WinWht/Sorghum			0.9
Dbl Crop Soybeans/Oats		0.4	12.2
Dbl Crop Corn/Soybeans		0.2	0.4
Dbl Crop Barley/Soybeans		1.2	153.1
TOTAL	3779.1	10438.6	103623.4

The acres of farmland in Northampton and Accomack Counties affected by saltwater intrusion (columns refer to: within/below tidal range, within 4' storm surge zone, and above 4' storm surge zone)

Table 8: 2100; Intermediate-High

	Tidal range	Storm surge	Unexposed
Corn	1649.9	2906.0	27568.1
Cotton	25.6	162.9	991.4
Sorghum	16.9	30.5	12.1
Soybeans	4445.9	5642.8	48872.1
Peanuts	0.2	0.8	17.6
Tobacco			0.3
Sweet Corn	1.5	1.3	397.7
Barley	0.5	0.2	1.4
Winter Wheat	4.8	3.9	191.5
Dbl Crop WinWht/Soybeans	892.1	2004.3	19863.9
Rye			4.1
Millet			0.2
Alfalfa	9.0	5.6	122.4
Other Hay/Non Alfalfa	18.7	21.5	140.1
Dry Beans	0.1	0.2	46.6
Potatoes	7.0	50.2	1515.9
Other Crops			0.5
Sod/Grass Seed	0.6	0.3	1.7
Fallow/Idle Cropland	0.4	0.6	1.2
Aquaculture	8.0		0.5
Cantaloupes			2.0
Strawberries			0.4
Dbl Crop WinWht/Corn		0.4	
Dbl Crop WinWht/Sorghum			0.9
Dbl Crop Soybeans/Oats		1.4	11.3
Dbl Crop Corn/Soybeans		0.1	0.4
Dbl Crop Barley/Soybeans	0.1	1.1	153.1
TOTAL	7081.3	10834.0	99917.2

The acres of farmland in Northampton and Accomack Counties affected by saltwater intrusion (columns refer to: within/below tidal range, within 4' storm surge zone, and above 4' storm surge zone)

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