Dynamics, Drivers, and Mitigation of Submerged Aquatic Vegetation (SAV) and Shoreline Change: Data Needs Associated with the Mid-Currituck Bridge

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A Multi-Institutional Research Partnership

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RESEARCH & DEVELOPMENT

Dynamics, Drivers, and Mitigation of Submerged Aquatic Vegetation (SAV) and Shoreline Change: Data Needs Associated with the Mid-Currituck Bridge

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16. Abstract

Submerged aquatic vegetation (SAV) in Currituck Sound provides essential ecosystem services, including habitat for fish and birds, shoreline stabilization, and water quality improvements. SAV growth is constrained by light availability, making it highly sensitive to water clarity. The planned Mid-Currituck Bridge raises concerns about potential impacts to water quality, SAV, and shoreline stability in this shallow estuarine system.

This two-year study evaluated spatial and temporal patterns in water quality, SAV distribution, and shoreline change to guide impact reduction and mitigation strategies. In year one, we conducted monthly sampling at 13 sites, continuous sonde monitoring at 1.9 m depth, Sentinel-2 remote sensing of turbidity, hydroacoustic and drop-camera SAV surveys, and shoreline monitoring with drones and wave gauges.

Results show SAV within the bridge footprint increased by ~400% since 2021, now covering nearly 58 acres. SAV depth limits have expanded from 1.8 m (2017–2018) to at least 2.4 m, suggesting improved water clarity. Water is more turbid north of the bridge, but SAV-dominated zones exhibit lower turbidity, indicating positive feedbacks between SAV and water quality. Long-term comparisons reveal declining turbidity and increasing salinity since 2018, though episodic spikes during storms highlight system vulnerability. Shoreline erosion is ongoing, with greater loss on the western shore.

Overall, results suggest that while construction poses risks, mitigation of SAV impacts is achievable if water quality is maintained. Protecting existing SAV beds and targeting mitigation in areas of sufficient light availability will be critical. Continued monitoring will refine thresholds for effective mitigation during year two.

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EXECUTIVE SUMMARY

Submerged aquatic vegetation (SAV) provides critical ecosystem services in Currituck Sound by creating habitat for commercially and ecologically important species, buffering shorelines from wave damage, and improving water quality. Because SAV requires sunlight, its distribution is limited by depth and water clarity. In this shallow, turbid system, water quality—especially parameters influencing light availability—strongly constrains SAV habitat.

The proposed Mid-Currituck Bridge crosses a broad, shallow portion of the Sound where SAV has historically been restricted to <1.8 m water depth. This study is designed to:

1. Quantify temporal and spatial changes in water quality.
2. Document changes in SAV distribution and depth limits.
3. Evaluate shoreline change and erosion rates near the bridge corridor.
4. Integrate field and remote-sensing data to update SAV maps, identify drivers of change, and guide mitigation strategies.

Year One Approach

- ***Water Quality*:** Monthly sampling at 13 sites spanning the bridge footprint and nearby reference areas, continuous sonde monitoring at 1.9 m depth, and Sentinel-2 remote sensing of turbidity.
- ***SAV Distribution*:** Hydroacoustic sonar surveys with drop-camera ground-truthing to quantify areal extent and depth limits.
- ***Shoreline Change*:** Drone and wave gauge monitoring at the eastern and western landings.

Key Findings

- ***SAV Expansion*:** SAV coverage near the bridge has increased by ~400% since 2021, reaching ~58 acres by September 2024. Depth limits expanded from 1.8 m (2017–2018) to at least 2.4 m, with isolated patches deeper, reflecting improved water clarity.
- ***Water Quality Trends*:**
  - Water is generally more turbid north of the bridge, with moderate variability across the west–east transect. SAV-dominated areas exhibit lower turbidity, suggesting positive biophysical feedbacks.
  - Variability is influenced by wind direction, with turbidity, TSS, and CDOM higher on the windward side.
  - Long-term comparisons show increased salinity and reduced turbidity since 2017–2018. Sentinel-2 analysis confirms declining average turbidity since 2018, though seasonal variability and storm-driven spikes remain high.
- ***Shoreline Erosion*:** Both shores are eroding, with greater impacts documented on the western shore.
- ***Disturbance Sensitivity*:** While average clarity is improving, episodic turbidity spikes highlight the vulnerability of SAV to storms and construction-related disturbances.

Implications for Mitigation

- A relatively small but ecologically important portion of extensive SAV will be directly impacted by bridge shading and construction.

- Mitigation success depends on preserving and expanding SAV within zones of sufficient light availability and stable conditions.
- Existing SAV beds create feedbacks that improve clarity and resilience but are also sensitive to disturbance. Protecting them is critical.

Recommendations

1. Target mitigation in areas with demonstrated light availability and expanding SAV range, particularly along ecotones between vegetated and unvegetated zones.
2. Continue integrated monitoring to refine depth limits, track shoreline change, and identify both vulnerable and expansion-ready SAV beds.
3. Recognize that SAV recovery and water quality improvements may be cyclically reversed by storms; long-term monitoring is essential.

Conclusion

Preliminary year-one results indicate widespread SAV coverage, rapid expansion into deeper water, and gradual improvements in water clarity since 2018. While construction poses risks, careful planning and evidence-based mitigation strategies can limit impacts and build on natural recovery trends. Continued monitoring in year two will provide the foundation for long-term conservation and successful mitigation of SAV and shoreline impacts associated with the Mid-Currituck Bridge.

TABLE OF CONTENTS

LIST OF FIGURES

Figure 13: Remote sensing map displays spatial trends in the non-dimensional turbidity index (NDTI). This imagery is a composite of all available cloud-free Sentinel-2 satellite images from our study period (here August 1, 2024- July 1, 2025). The map illustrates spatial trends in NDTI by creating a mosaic of all cloud-free images within our study period. The graph on the right illustrates temporal trends in NDTI from 2014- July 2025. There is no significant temporal trend when all data are included ($P > 0.05$), but there is a significant decrease in annual average NDTI, from 2015 –2024 ($P < 0.05$; $R^2 = 0.29$).

LIST OF TABLES

Chapter 1: Introduction

1.1 Background

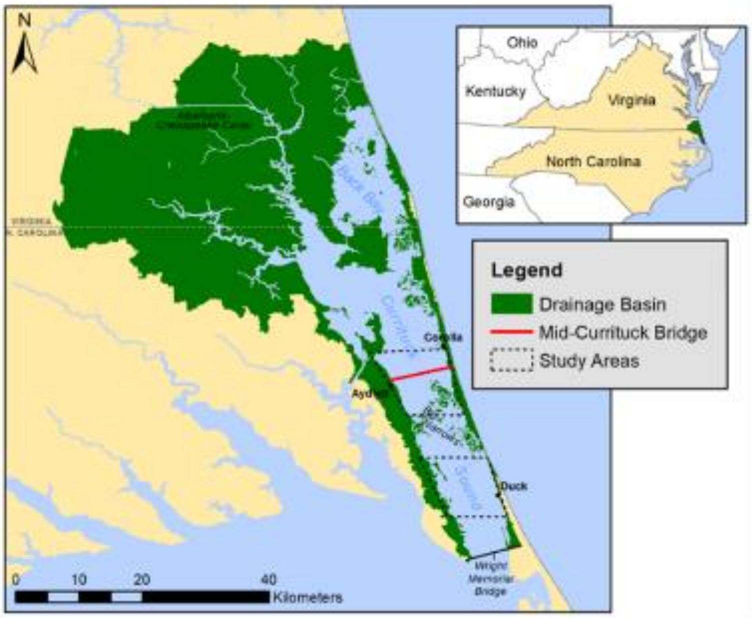
Currituck Sound, the northernmost component of the Albemarle-Pamlico Estuarine System (APES), is a shallow estuary (~400 km², mean depth 1.5 m) that supports ecologically and economically valuable species (Figure 1). The system has long been recognized as a conservation priority, reflected in the establishment of National Wildlife Refuges, state and local parks, and the Cape Hatteras National Seashore. Currituck Sound provides critical habitat for resident and migratory waterfowl, functioning as a key stopover along the Atlantic Flyway. Its global importance arises from the convergence of climatic, geologic, and biological conditions: unfrozen shallow waters during early spring migration, marsh islands and shallow basins that reduce wind stress and predation, and highly productive marsh vegetation, submerged aquatic vegetation (SAV), and invertebrate communities that provide essential foraging resources for waterfowl.

Currituck Sound's proximity to the Atlantic Ocean has made it a unique and valuable ecosystem, but has also driven historically dynamic conditions punctuated by the creation and closure of inlets, the last of which closed around 1832 (Sincock et al. 1985; Moran et al. 2015). Currituck Sound was directly connected to the Atlantic Ocean in 1832, but after closure, became hydrologically isolated from the Atlantic Ocean. Our study region is > 60 km from Oregon Inlet, the closest hydrologic connection to the Atlantic Ocean, and circulation and depth fluctuations are largely driven by wind, with minimal influence from astronomic tides (Wagner et al. 2016; Sincock et al. 1965). Disconnect from the Atlantic created freshwater conditions through the 1980s. Increasing marine influence in the Currituck Sound has since created oligohaline conditions that have remained relatively stable over the last two decades, but continue to gradually increase (Caldwell 2001). Furthermore, rapid increases in salinity may drive short-term mortality to SAV, create species transitions, and alter SAV area (Wagner et al. 2016).

SAV is a crucial food source and habitat for resident and migratory birds, commercially and recreationally valuable fisheries, while enhancing water quality and buffering coastlines from waves and flooding. Submerged Aquatic Vegetation (SAV) is limited by light availability, thus intricately linked to water quality. The turbid waters of Currituck Sound block light and limit the extent of SAV establishment. Naturally turbid due to tannins from the high proportion of swamps in the watershed, water quality issues were exacerbated by draining and canalization of wetlands and nutrient and sediment pollution from development.

SAV in Currituck Sound was widespread to depths of 3 meters (Sincock et al. 1965; Davis and Carey 1981), but drastically reduced in overall area due largely to loss of SAV in water deeper than 2.5 meters by the 1980s (Davis and Brinson 1990) and only occupied depths <1.3 meters in 2017 and <1.8 meters in 2018 (Corbett et al. 2020). However, since 2022, SAV coverage has increased (see Figure 2). In fact, SAV has nearly doubled in area. The change is likely attributable to improving water clarity over time, but may also be indicative of ongoing disturbance recovery.

Figure 1: Currituck Sound (left image) in NE North Carolina (inset), including the drainage basin (green shaded region), the proposed location of the Mid-Currituck Bridge (red line), and the Corbett et al., 2020 study areas (dashed boxes). Currituck Sound was last mapped wholistically by APNEP in 2012 (right image; gray line represents Mid-Currituck Bridge corridor). SAV was only present near the east shoreline (<250 m from shore) within the bridge corridor at this time.



The Mid-Currituck Bridge

Currituck County, the northeastern-most county in North Carolina, includes the northern Outer Banks barrier-island communities, separated from the mainland by Currituck Sound (Figure 1). The Sound is central to the community, supporting valuable fisheries, hosting some of the largest concentrations of migratory waterfowl in North America, and providing recreational opportunities that benefit residents, attract tourists, and drive the local economy.

The need for a bridge connecting the eastern and western portions of Currituck County was first identified in 1975, with planning by the North Carolina Department of Transportation (NCDOT) beginning in 1995. After decades of delay and litigation, NCDOT gained legal approval in 2023 to proceed with the Mid-Currituck Bridge, a ~7-mile span connecting Corolla on the barrier island to Aydlett on the mainland in partnership with the North Carolina Turnpike Authority (NCTA). The bridge is intended to relieve severe congestion on the Wright Memorial Bridge—nearly 20 miles south—and surrounding areas, especially during summer when the Outer Banks population more than doubles. Improved traffic flow is also critical for storm evacuation and access to emergency services.

Construction raises concerns about impacts to shoreline dynamics, water quality, and aquatic habitats. Of particular concern is submerged aquatic vegetation (SAV), which covers large portions of Currituck Sound and provides critical fish habitat, improves water quality, and stabilizes shorelines. Short-term risks include direct damage to SAV beds and increased turbidity from pile driving and clearing; long-term risks include degraded water clarity from runoff and shading. NCDOT estimates 61.4 ha of SAV and 2.1 ha of potential habitat could be permanently lost (NCDOT, 2019).

Population growth and the $2.1 billion tourism economy of the Outer Banks have driven transportation demand since the 1960s, yet construction costs and community opposition—focused on concerns about overdevelopment and environmental impacts—have delayed progress. As a result, road capacity has remained largely unchanged for nearly 50 years, despite growing safety and infrastructure needs.

1.2 Research Objective and Scope

This study examines oligohaline SAV spatial and temporal dynamics in response to water quality and wave exposure. We will study biological, chemical, and physical parameters influencing the presence and abundance of SAV in Currituck Sound to better inform potential mitigation strategies related to SAV impacts associated with coastal bridge projects. The overarching question guiding this project is: *What areas and techniques can most effectively mitigate the impacts to SAV and shorelines associated with bridge construction*? This project has two primary objectives:

1. Water Quality: quantify temporal and spatial changes in water quality in the surface water of northern Currituck Sound.
2. Shorelines & SAV: monitor changes in SAV area and depth limitation with particular focus on interactions among water quality parameters that influence water clarity (turbidity, chlorophyll, CDOM, total suspended sediment) and the expansion and contraction of SAV and to monitor shoreline erosion, sinuosity, and water depth near the bridge landings.

1.3 Relevance of Proposed Research

The Mid-Currituck Bridge is a pending NCDOT project decades in the making. The 11 km long two-lane toll bridge will span across Currituck Sound, connecting US 158 on the Currituck County mainland to NC 12 on the Outer Banks. Submerged aquatic vegetation (SAV) plays an essential role in Currituck Sound by providing essential habitat and improving water quality, but is also vulnerable to changing water clarity, salinity, and land-use. Earlier studies have shown a declining coverage of SAV across the system, with very little SAV present in waters deeper than 1.5m (Corbett et al., 2020; NCDOT Project 2018-05). The most recent SAV distribution (i.e., 2012) of the historic data compiled in that study showed very limited SAV coverage, particularly in the bridge corridor region (Figure 1). SAV in the bridge corridor was limited to just the east side of the sound and only within 250m of the shoreline. Acoustic SAV distribution data collected in that region in 2017 showed patchy SAV limited to <800 m of the eastern shoreline. However, since 2021, there have been indications of extensive SAV expansion. Due to the dynamic nature of valuable SAV habitat in Currituck Sound, a better understanding of the dynamics and drivers of water quality and SAV distribution is needed to reduce and mitigate impacts from bridge construction and to conserve Currituck Sound more generally.

Submerged aquatic vegetation establishment and survival is reliant on light availability in the benthic environment. Light must reach the benthos for SAV establishment and must be synchronized with vegetative reproduction (through sexual reproduction and seed germination or asexually through rhizomatous spread or propagule spread). Like all plants, SAV is particularly sensitive to environmental conditions during establishment. Clear water and calm conditions are required for the establishment and expansion of SAV. Depth limits on SAV are largely a function of various water-quality parameters (e.g., TSS, chlorophyll-a, DIN, DIP, CDOM, etc.) affecting light availability (Fonseca et al., 1998; Short et al., 2002; Batiuk et al., 2000). SAV plays a vital role in improving and maintaining water quality. SAV roots stabilize sediment, stems slow water flow, facilitating sediment deposition and removal from the water column. Finally, SAV establishment supercharges nutrient cycling both directly and by providing a three-dimensional structure for additional organisms to colonize.

Like all macrophytes, SAV requires sunlight for photosynthesis and survival, and like terrestrial macrophytes, they are rooted to the spot and reliant on surviving in the environmental conditions in which they were established. Living in a submerged environment makes SAV particularly dependent on the estuarine environment. In particular, SAV is reliant on clear water and relative stability. Terrestrial plants grow vertically to compete for light to ensure long-term light availability. Submerged aquatic plants similarly grow vertically to compete for light, but in the aquatic environment, reduced light penetration driven by increased water depth or decreased clarity, even if only transient, can cause mortality. Depth limits on SAV are largely a function of various water-quality parameters (e.g., TSS, chlorophyll-a, DIN, DIP, CDOM, etc.) affecting light availability (Fonseca et al., 1998; Short et al., 2002; Batiuk et al., 2000).

In the first year of this two-year project, we planned and implemented a multi-faceted research program to quantify spatial and temporal trends in water quality submerged aquatic vegetation and shorelines in Currituck Sound. Submerged Aquatic Vegetation in Currituck Sound is an incredibly valuable resource that improves water quality and protects property locally, improves fisheries regionally and is globally important for migratory birds. However, SAV in Currituck Sound is also vulnerable to and obscured by turbid water and despite documented fluctuation in SAV extent, there is no integrated plan to predict vulnerability or even monitor extent changes in SAV. Broadly this research will provide fundamental baseline data on the dynamics and drivers of water quality and SAV trends in Currituck Sound. Monitoring SAV and water quality will improve ecological understanding of rare, turbid, oligohaline SAV dynamics, provide baseline data to monitor change and ultimately promote long-term conservation. This research is specifically designed to inform planning and construction of the mid-Currituck Bridge in collaboration with the North Carolina Department of Transportation.

Chapter 2: Summary of Data Collected

2.1 Study Design

In the first year of this two-year project, we began to1) quantify temporal and spatial trends in water quality a) with repeat field measurements along a transect of 13 water-quality sampling sites along a transect that crosses Currituck Sound along the mid-Currituck bridge footprint and reference sites 5-km North and South for spatial context b) continuously with a multiparameter-sonde (YSI- EXO2) established in mid-Currituck Sound to monitor water quality adjacent to previously identified depth limitation (established in depth-driven transition between SAV dominated and unvegetated benthic environments; 1.9 meter water depth) and c) used remote sensing to produce maps of spatial trends in turbidity in Currituck Sound (using Sentinel-2 imagery and the Non Dimensional Turbidity Index [NDTI], analyzed in Google Earth Engine). 2) quantified changes in SAV distribution and depth limitation with boat-based sonar and ground-truthing with drop-camera surveys 3) quantified shoreline change and erosion rates adjacent to proposed bridge footprint and 4) began to synthesize remote sensing and field data to provide information to update SAV distribution and depth limitations, identify drivers of change and prioritize mitigation for maximum benefits.

2.2 Shorelines and SAV within Bridge Footprint

First, we surveyed the region directly within the mid-Currituck Bridge Footprint, where RKK (2024) identified >57 acres of SAV that will be directly impacted by bridge construction. Field data was collected utilizing unmanned aerial system (UAS) technology and side-scan marine imaging sonar from a 20' center console vessel. To ensure the geospatial accuracy of seagrass bed margins, sonar data was acquired in conjunction with an RTK-equipped high-resolution GNSS receiver. Field data was then processed within GIS environment to identify potential areas of SAV for ground-truthing purposes.

From 2015 to May 2021, SAV coverage has remained relatively constant throughout the study area; however, since the September 2021 survey, a steady increase in SAV coverage has been observed with a substantial increase starting in 2022 (Figure 2). Delineated SAV within the project study area was 60.63 acres in May 2024 and 57.66 acres in September 2024 (Figure 2). The western terminus of the project area was previously void of SAV. However, since May of 2022, this area has experienced substantial growth (Figure 3, Western Shoreline). Across the study area, SAV was observed in water depths down to 7.4 feet, not accounting for daily wind or tide variations. Deeper open waters (depth >7.4 feet) were assessed, and no SAV was located (RKK, 2024). Water clarity was measured with a Secchi disk and ranged from 0.7 m to 1 m during these 2024 surveys (Figure 3).

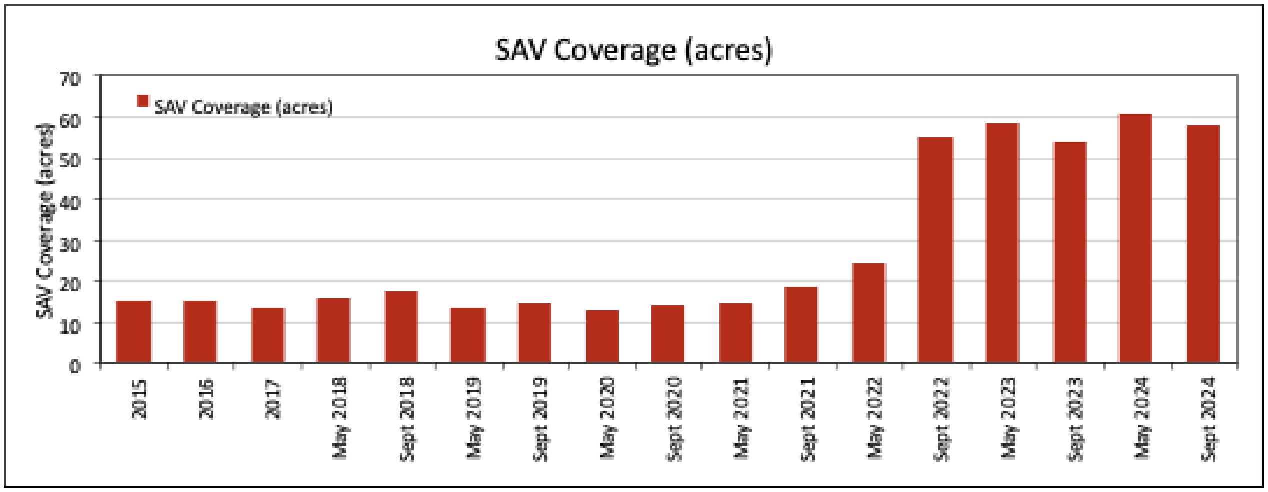


Figure 2: SAV increased dramatically in the mid-Currituck Bridge Footprint, increasing around 400% since 2020.

Shorelines on both sides of the Sound experience erosion (Appendix A). However, the eastern shore has been more erosive. The western shore has experienced drastic erosion as well, leading to large areas of low-lying land loss, including a large extent of low-lying land loss documented alongside the Native American archaeological Baum site (Appendix A). Now, much of the western shoreline adjacent to the mid-Currituck Bridge landing site is armored with bulkheads. However, as is often the case, the bulkhead protected the shoreline temporarily before ultimately failing (Appendix A).

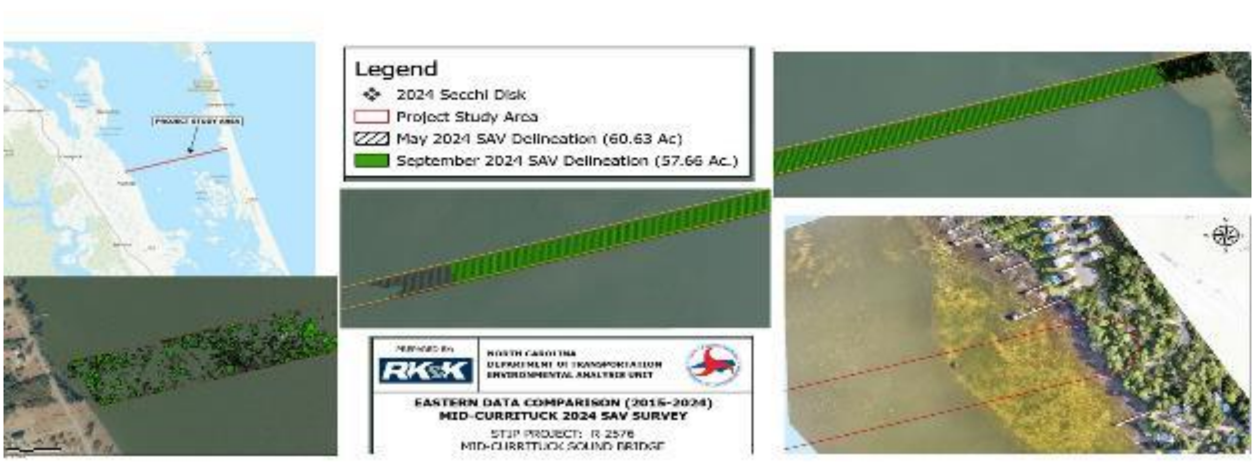


Figure 3: SAV delineation within the mid-Currituck Bridge Footprint. Note the large expanse of SAV extending kilometers from the eastern shore and the patchy SAV adjacent to the Western Bank.

2.3 Water Quality Field Samples and Transect Surveys

To monitor spatial patterns across Currituck Sound, we established a transect that spans the Currituck Sound, adjacent to the mid-Currituck Bridge footprint, with reference sites approximately 5 km north and south (Figure 4). Our transect begins 25 meters from the Western shore (C1; Figure 4). This site sits in <1m water depth and does not have SAV due to high energy and low water. To characterize wave energy, water level fluctuations and water quality characteristics in this near-shore zone, a RBR wave gauge and a Hobo water level logger were installed.

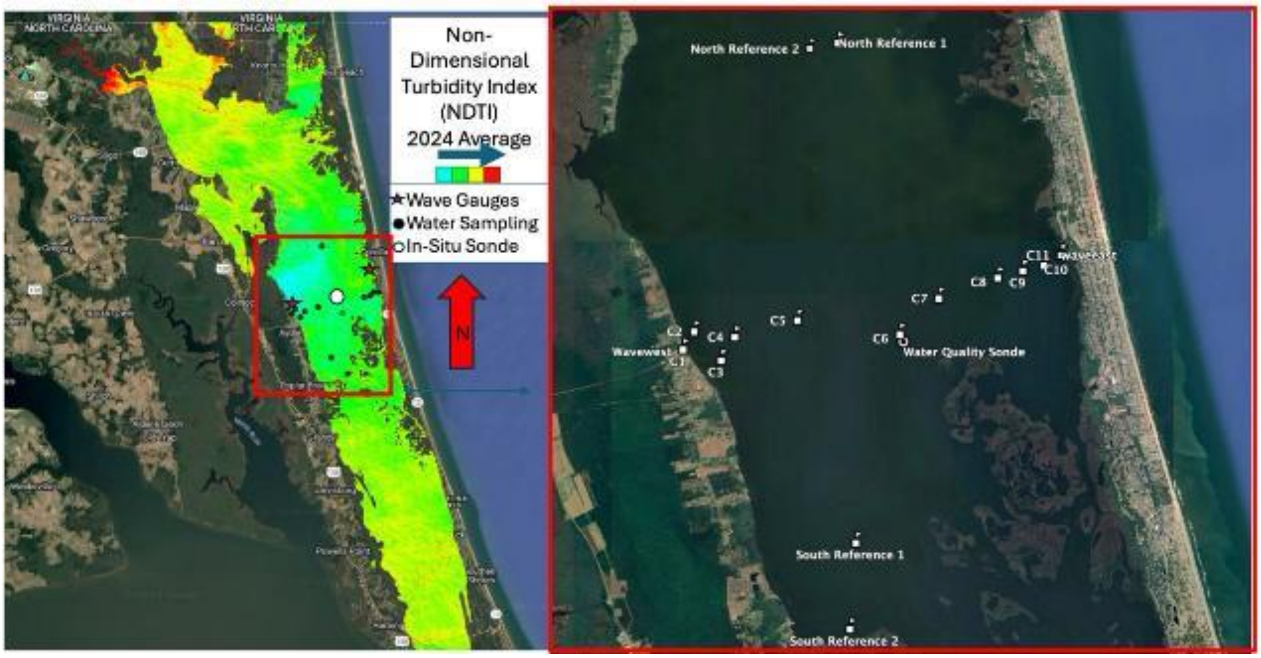


Figure 4: Image of Non-Dimensional Turbidity Index (NDTI) average for 2024, an overview of our research area and an inlay map of field sites.

The mid-Currituck Bridge footprint includes a shallow western zone extending 600–650 m from shore. Site C2 (1.6 m) contains SAV within and adjacent to the site. Site C3 (2.2 m) lies just offshore, outside but near the SAV-dominated zone, while Site C4 (~1 km offshore at similar depth) is further removed from SAV. Site C5 (~2 km offshore, 2.4 m depth) was selected to document SAV presence deeper than previously identified. Site C6 (1.9 m) sits along the transition between dense SAV and unvegetated bottom, dominated by *Myriophyllum spicatum* and *Ruppia maritima*, and houses a multiparameter sonde for continuous water quality monitoring. Site C7 (2.1 m) marks the western edge of an extensive *Ruppia maritima* bed extending eastward toward the shoreline. Sites C8–C10 span the SAV-dominated benthic ecosystem along the eastern shore.

Monthly water quality sampling was conducted along this transect from October–July (with additional surveys in August and September 2025). The transect extends 7.2 km northeast from Aydlett to within 50 m of the eastern shore. Analyses focus on (1) the depth and water quality conditions supporting SAV, (2) ongoing changes in SAV distribution and extent, and (3) contrasts between water quality in bare-sediment areas, SAV-dominated zones, and transitional ecotones.

Initial Hydroacoustic Survey Findings and Transect Characteristics

In Year one of our research, we conducted hydroacoustic surveys to characterize depth and SAV characteristics (presence, percent cover, and height) within the bridge footprint (and therefore along our established field transect sites and along repeat transects both North and South of the footprint. As well as characterizing the bridge footprint, our sites and the adjacent benthic environment, we created hydroacoustic transect surveys to place our study transect in context and to better characterize SAV depth relationships.

Similarly, our first Biosonics sonar survey of SAV presence/absence, density and height established a baseline for SAV seasonally, conducting surveys in winter (12/14/2024), spring (03/04/2025, 4/24/2025) and throughout summer (5/23/2025, 6/24/2025), which will serve as a comparison with previous years and will be compared to upcoming surveys (October 2025, January 2026, April 2026, June 2026). In the first quarter of (RP 2026-20), we will produce a map of SAV density and height during peak SAV biomass. Additionally, we will continue to ground-truth SAV presence/absence, density, height, and community composition with drop-camera surveys. Our upcoming survey (October 2025) will represent a full year of data and will allow us to quantify annual patterns in SAV dynamics and growth. We are also conducting a ground-truthing campaign with drop-camera surveys to better differentiate SAV from false positives created by benthic detritus (uprooted SAV on or near the benthic environment is particularly difficult to differentiate from living SAV). In this upcoming quarter, we plan to complete SAV mapping during peak SAV biomass, with a focus on ground truthing areas of uncertainty (particularly potential SAV in water >1.8 m, which was previously considered the maximum depth of SAV growth).

Furthermore, our initial SAV sonar survey characterizes SAV directly adjacent to the mid-Currituck bridge, but additional SAV surveys will characterize SAV along a wider bridge footprint. The magnitude of indirect impacts on SAV are uncertain, and therefore expanding our mapping efforts will improve ecological management.

Water quality field sampling repeat measurements Currituck Sound

We established 13 repeat water-quality sampling sites that span the proposed mid-Currituck Bridge Footprint from West to East and include Northern and Southern reference sites (Figure 2). A submerged multiparameter sonde was established in the transitional zone from shallow SAV-dominated benthic environment to unvegetated sediment to continuously record water parameters, and finally we established wave gauges along the Eastern and Western bridge landing sites and in a central location chosen to represent the transition from SAV-dominated to bare benthic habitats (Figure 2).

Previous research has shown that spatial heterogeneity within SAV beds requires site-specific measurements to quantify the relationships among physical parameters and SAV survival (ie. Kenworthy et al. 2012). Previous studies have identified a theoretical cutoff of 1.79 – 1.99 meters in Currituck Sound based on light attenuation values, yet the majority (80% of SAV grows in depths less than 1.2 m deep (Corbett et al. 2020). Therefore, in this study, we focus our efforts on multiple scales, including comparing water quality transecting Currituck Sound.

We used a multiparameter sonde (YSI EXO-2 or Eureka Manta Pro) to take water quality measurements (temperature, PH, dissolved oxygen, salinity, chlorophyl-A, turbidity, CDOM, specific conductivity, total suspended solids), measured depth of Secci Disk visibility and collected water samples for lab analysis on ten research excursions in 2024-2025 period (10/24/24, 11/26/24, 1/10/2025, 2/25/2025, 3/4/2025, 4/2/2025, 4/24/2025, 5/23/2025, 6/24/2025 and 7/22/2025) and collected 500 ml water samples for lab analysis. Samples were filtered to quantify total suspended solids (TSS) in mg/L.

Along our field transect, we measured water quality parameters in the Currituck Sound, at 13 sampling sites along the proposed mid Currituck Bridge and North and South of the bridge. Water quality analysis from sample sites is compared along the bridge footprint from West to East across Currituck Sound with reference sites upstream and downstream (~4 km North and South of the proposed bridge corridor) to identify spatial patterns in water quality parameters (temperature, dissolved oxygen, salinity, chlorophyl-A, turbidity, CDOM; Figure 5-8).

We quantified a full suite of water quality parameters in Northern Currituck Sound with a focus on those impacting water clarity (Turbidity, CDOM, Chlorophyll-a, total suspended solids) by comparing data across high temporal (satellite-based imaging and 1-2 *in situ* sondes; low spatial resolution) and high spatial resolutions (12 field sites; but low temporal resolution). In-situ field samples were taken with a handheld multiparameter sensor (YSI-EXO-2), and water samples were collected and kept on ice and further analyzed in the lab. Water samples were filtered using pre-cleaned and weighed glass fiber filters. Samples were then weighed to calculate total suspended solids and combusted to calculate the proportion of organic matter versus sediment. Further identification of constituents was determined by quantifying constituents.

Our transect results indicate greater turbidity in the northern reference site than our bridge footprint overall ($P < 0.05$), while the southern reference sites had statistically similar turbidity concentrations, indicating a northern source of turbidity and generally lower concentrations along the proposed bridge footprint (Figure 5). Turbidity varies moderately across the transect, with significantly lower turbidity in SAV-dominated sites than in the northern reference west of site C6 (the ecotone between deeper bare-sediment and SAV-dominated benthic environments), but a distinct pattern emerges from site C6 to site C11 (Figure 6). Site C6 is located in 1.9 m of water along the ecotone between bare and SAV-dominated benthic ecosystems. Turbidity significantly decreases from site C6 → C11, indicating that turbidity decreases within SAV beds and that the biophysical feedback increases with distance from the edge of SAV bed.

Our northern reference site again displayed the highest average CDOM values. Although unlike turbidity, CDOM values in the SAV-dominated eastern benthic ecosystem (sites 6, 8, and 10) increase compared to adjacent unvegetated ecosystems (Figure 7). Chlorophyll-a (Figure 8) lacks a consistent pattern across the transect.

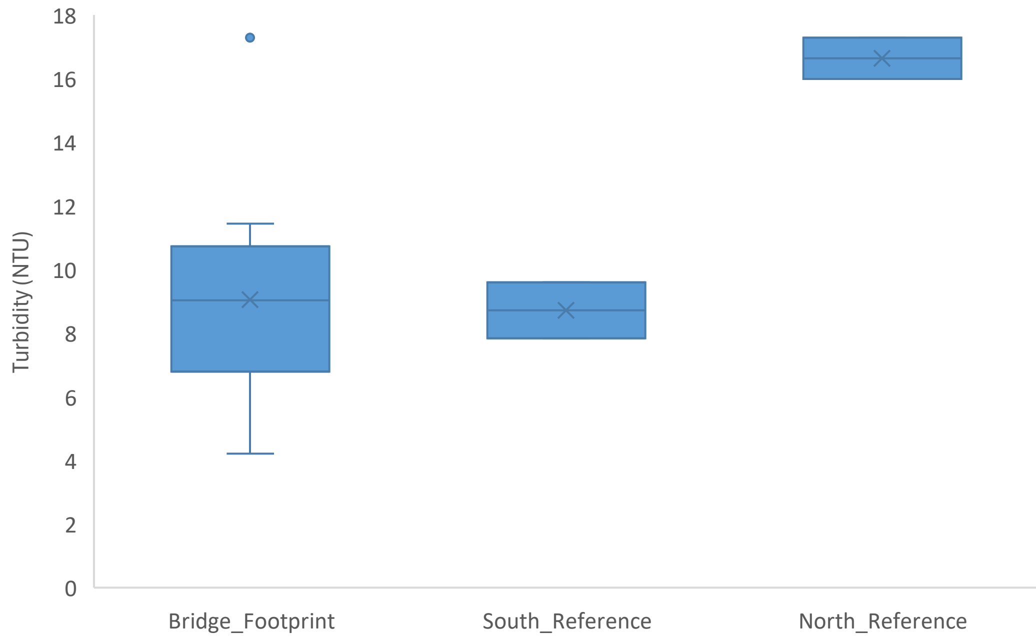


Figure 5: Turbidity was significantly higher at the Northern Reference site (P < 0.05), with similar turbidity between the bridge footprint transect and the Southern Reference site.

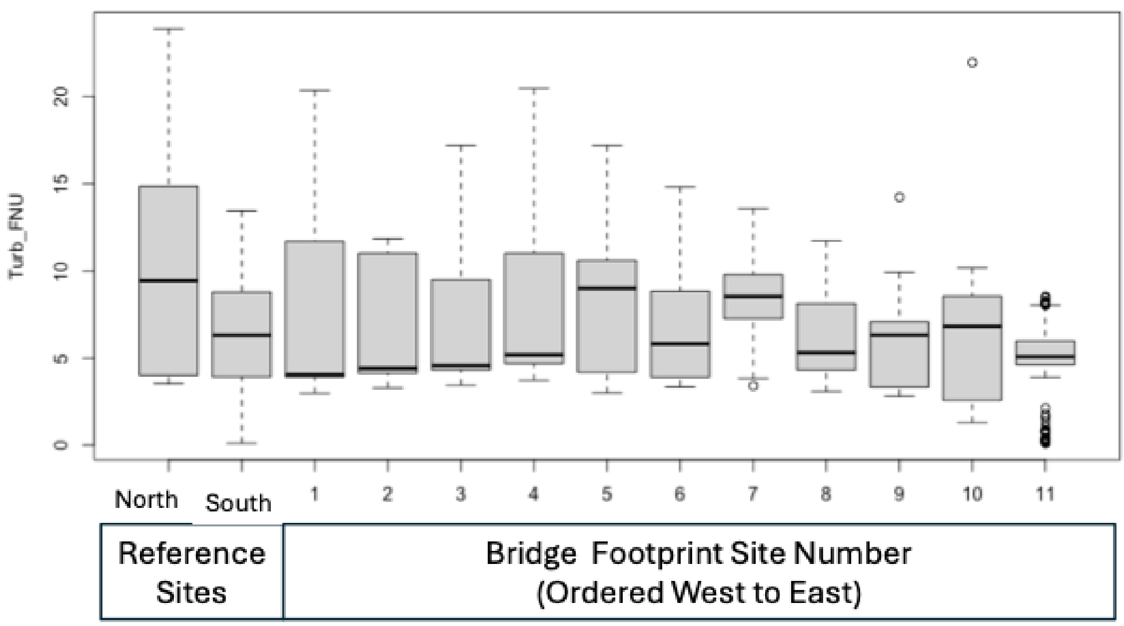


Figure 6: Turbidity measurements from repeat field transect sites. Grouped by reference sites and from West to East (C1-C11) across the proposed mid-Currituck Bridge Footprint.

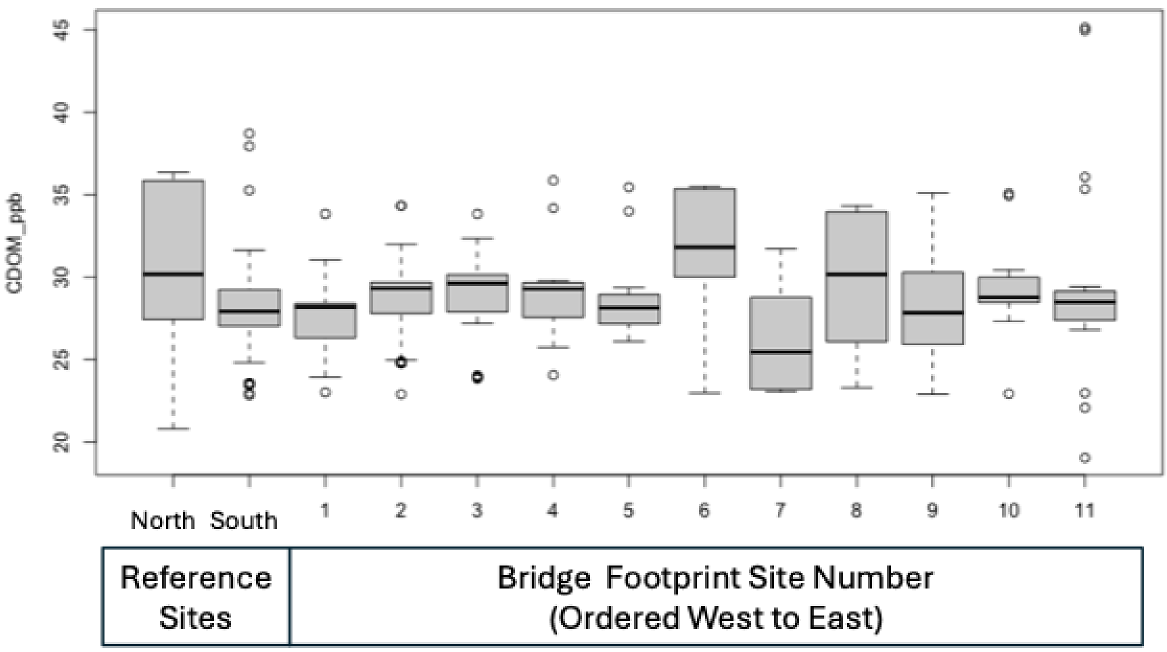


Figure 7: Colored Dissolved Organic Matter (CDOM) measured across our reference and transect sites. The Northern Reference Site had statistically similar average CDOM values with sites 6, 8 and 9, but was significantly greater than all other sites along the bridge footprint.

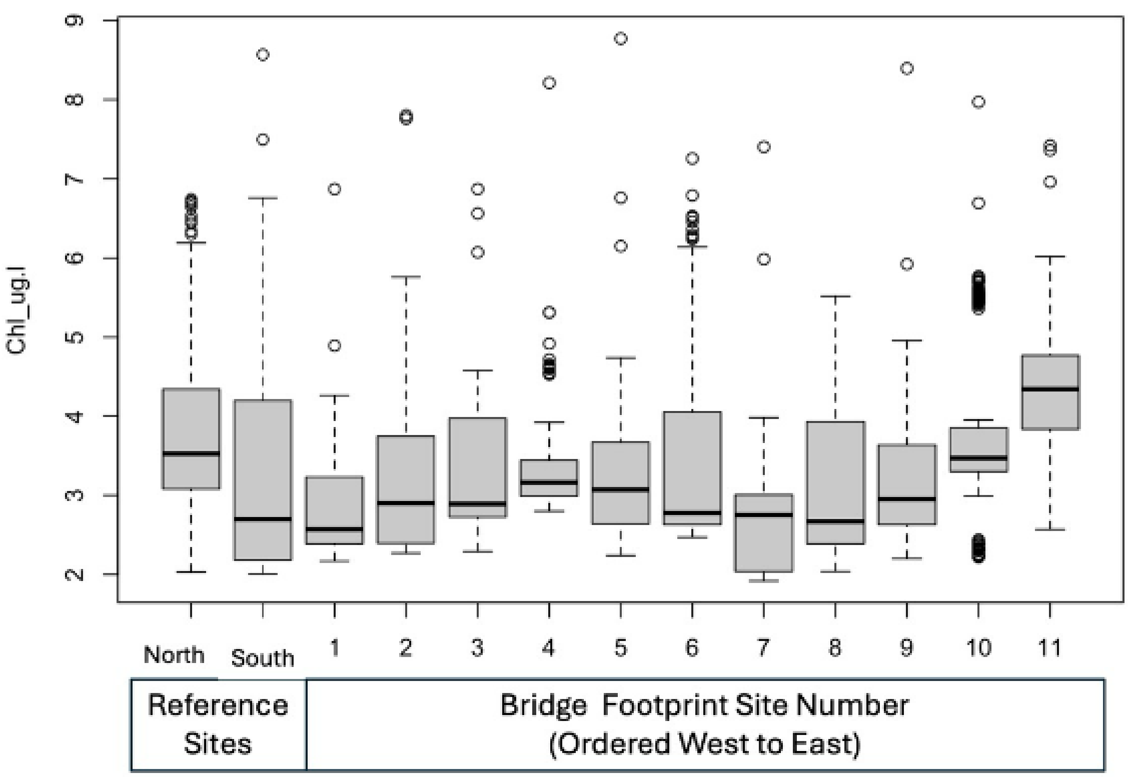


Figure 8: Chlorophyl concentration varies across field transect sites. However, there is no clear trend in chlorophyll concentration across our field sites.

2.4 Continuous in-situ water quality

We deployed a multi-parameter sonde to record water quality parameters, including temperature, pH, dissolved oxygen, salinity, chlorophyll, turbidity (FNU, NTU), and CDOM. Measurements were initially taken at 1-hour intervals, later increased to 30-minute intervals, and finally to 5-minute intervals as instrument capacity improved. To reduce biofouling and ensure adequate storage and battery life, sondes were deployed for approximately one month at a time before retrieval, calibration, and redeployment.

The study began with an Eureka Manta Pro and an In-Situ sensor, but the In-Situ unit failed repeatedly and was ultimately replaced with a YSI EXO-2, which provided reliable high-frequency data collection.

The sonde was strategically located at the ecotone between SAV-dominated shallow benthic habitat and adjacent bare sediment in deeper water. Because SAV distribution is constrained by light availability, monitoring at this depth—representing the maximum range of dense SAV—allowed us to capture conditions most likely to influence shifts in SAV extent across Currituck Sound.

Temperature and dissolved oxygen displayed a generally inverse relationship, where dissolved oxygen dropped as summer temperatures increased (Figure 9). However, as the spring and summer progressed, dissolved oxygen displayed increasing daily variability, with dissolved oxygen peaking during the day, indicating that as SAV biomass increased, photosynthesis had a larger impact on dissolved oxygen. In January 2025, water temperature dropped below freezing as Currituck Sound froze. The lowest temperature corresponds with a distinct dip in dissolved oxygen, indicating that the Currituck Sound froze not just along the edges, but ice extended all the way to our sensor location, as evidenced by the destruction of some adjacent Duck Blinds.

Table 1: Average and standard deviation for water quality parameters at Transect Site 6.

Annual Average Water Quality Parameters, Site 6 (ecotone) 10/22/24 to 7/22/2025										
Water Quality Parameter	Temperature C	pH	SpCond uS/cm	HDO mg/l	HDO % Saturation	Salinity PSU	Depth m	Chl ug/l	Turbidity FNU	CDOM ppb
Average	22.7	8.6	6817.5	9.2	110.9	4.2	1.8	6.8	7.9	19.5
Standard Deviation	9.0	0.4	2786.1	1.6	15.9	0.5	0.1	4.2	6.4	7.9

Salinity averaged 4.2 from 10/22/2024 to 7/22/2025, falling toward the upper end of oligohaline conditions (0.5-5). Salinity gradually increased as 2025 progressed, from an average of 3.6 from 10/22/2024 to 4/01/2025 to an average of 4.6 in July 2025, while precipitation events drove short-term dips in salinity (Table 1; Figure 9). Currituck Sound's salinity is the product of its distant hydrologic connection to Oregon Inlet (approximately 50 km South). Due to weak hydrologic connectivity, Currituck Sound is a wind-tidal system with no demonstrable lunar tidal signature. Increased salinity in the summer is a common phenomenon in Currituck Sound as southerly wind patterns push ocean water into the system and drive increasing marine influence (Wagner 2016).

Water quality parameters associated with light attenuation all displayed high values in January and February 2025, following freezing conditions and winter storms. An increase also occurred in July, when high temperatures and increased salinity likely increased decomposition, driving reduced water clarity (Figures 9-10).

2.5 Hydroacoustic Surveys

Our hydroacoustic surveys were focused on the mid-Currituck Bridge footprint, creating a linear transect beginning along the western shore in Aydlett and extending just under 7.4 km to the eastern shore of Currituck. In 2024 and 2025, we continued to strategically expand upon our hydroacoustic surveys to 1) develop a better understanding of the relationship between SAV and water depth and 2) compare SAV cover, height, and composition seasonally and interannually.

The echosounder is equipped with an integrated DGPS (horizontal accuracy <3 m) to position the survey-obtained information, including water depth, plant height, and plant cover data. The data were analyzed and edited with the BioSonics Visual Habitat post-processing software (BioSonics, Inc., 2016). Water depth was calculated as the distance from the transducer face to the seabed plus the transducer depth measured before data collection. All data collected at distances <0.4 m from the transducer is in the transmit pulse range and, therefore, excluded by the Visual Habitat algorithm (BioSonics, Inc., 2013). Thus, for this study, only water depths >0.65 m were considered. These data were then used to correct the hydroacoustic depth.

The plant detection settings were constrained to plant heights ≥15 cm above the bottom. Plant percent cover was calculated as the number of pings with a positive plant signal divided by the total number of pings in a survey point (10 pings) and was extracted at 10% cover intervals. Although percent cover was considered, most of the analyses using the hydroacoustic data focused on a simple presence/absence protocol (i.e., presence = ≥10% cover, absence = <10% cover).

Our bathymetric surveys demonstrate the shallow bathymetry of Currituck Sound that enables abundant SAV, particularly north of The Narrows on the shallow eastern shore (Figure 10, 11). Throughout our study area, the deepest locations in our study region are under 3 meters. The deepest channel is located <1 km from the western shore (represented by darker blue; Figure 10). The previously identified depth threshold for SAV in Currituck Sound sits at 1.8 meters, and the vast majority of the eastern side of our study area (east of our Site C5) is within the depth range in which SAV thrives, as is the western shore and a significant portion of our tracks to the south of our transect sites. A channel with deeper bathymetry (located 0.6 to 3 km from the western shore) is likely too deep for significant SAV establishment and survival, but a significant portion of the region outside of this channel has potential for SAV establishment and survival.

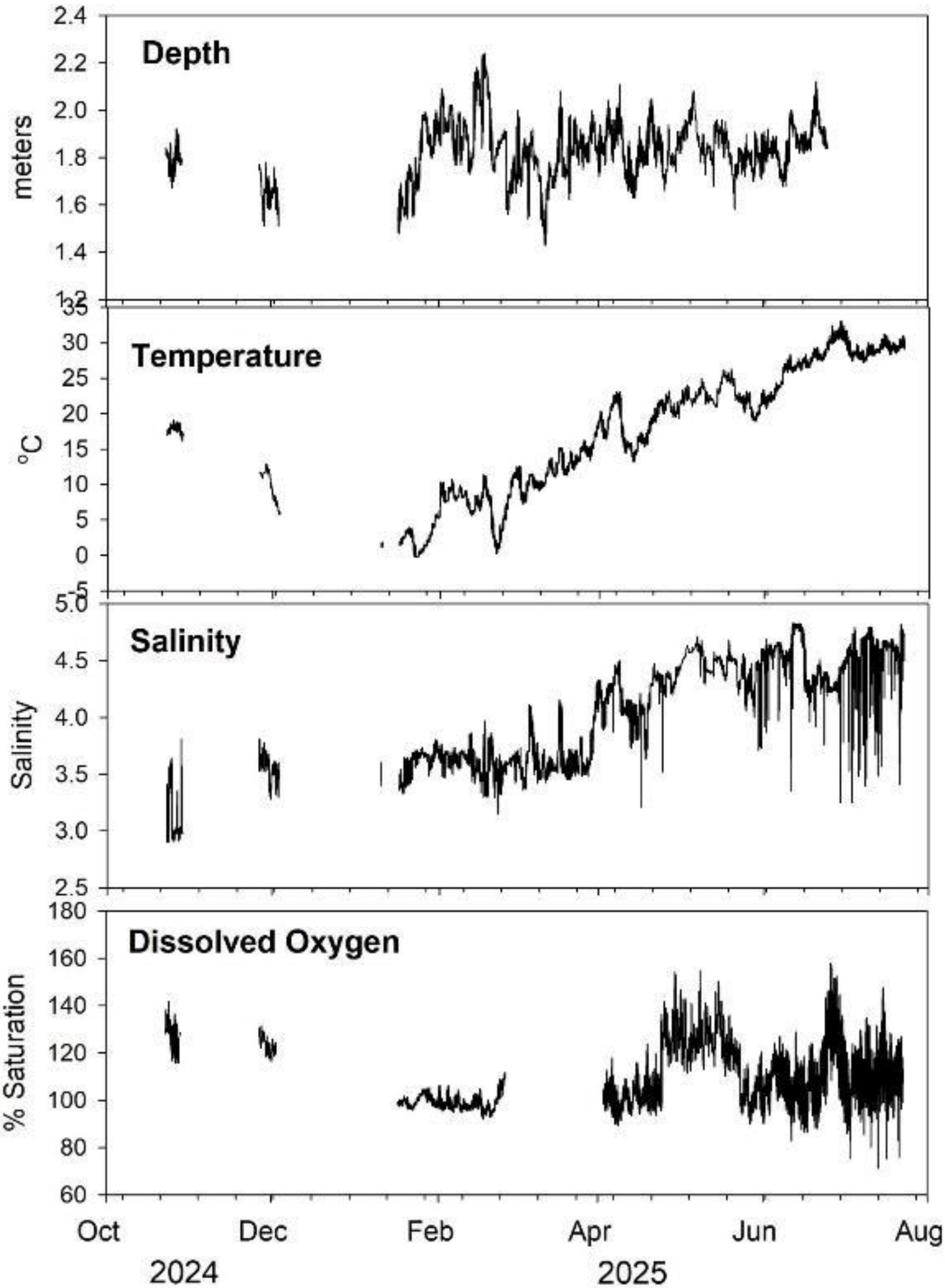


Figure 9: Water quality parameters over the course of Y1 of our study. Temperature, salinity and depth are intricately linked to SAV dynamics and habitat provision in Currituck Sound.

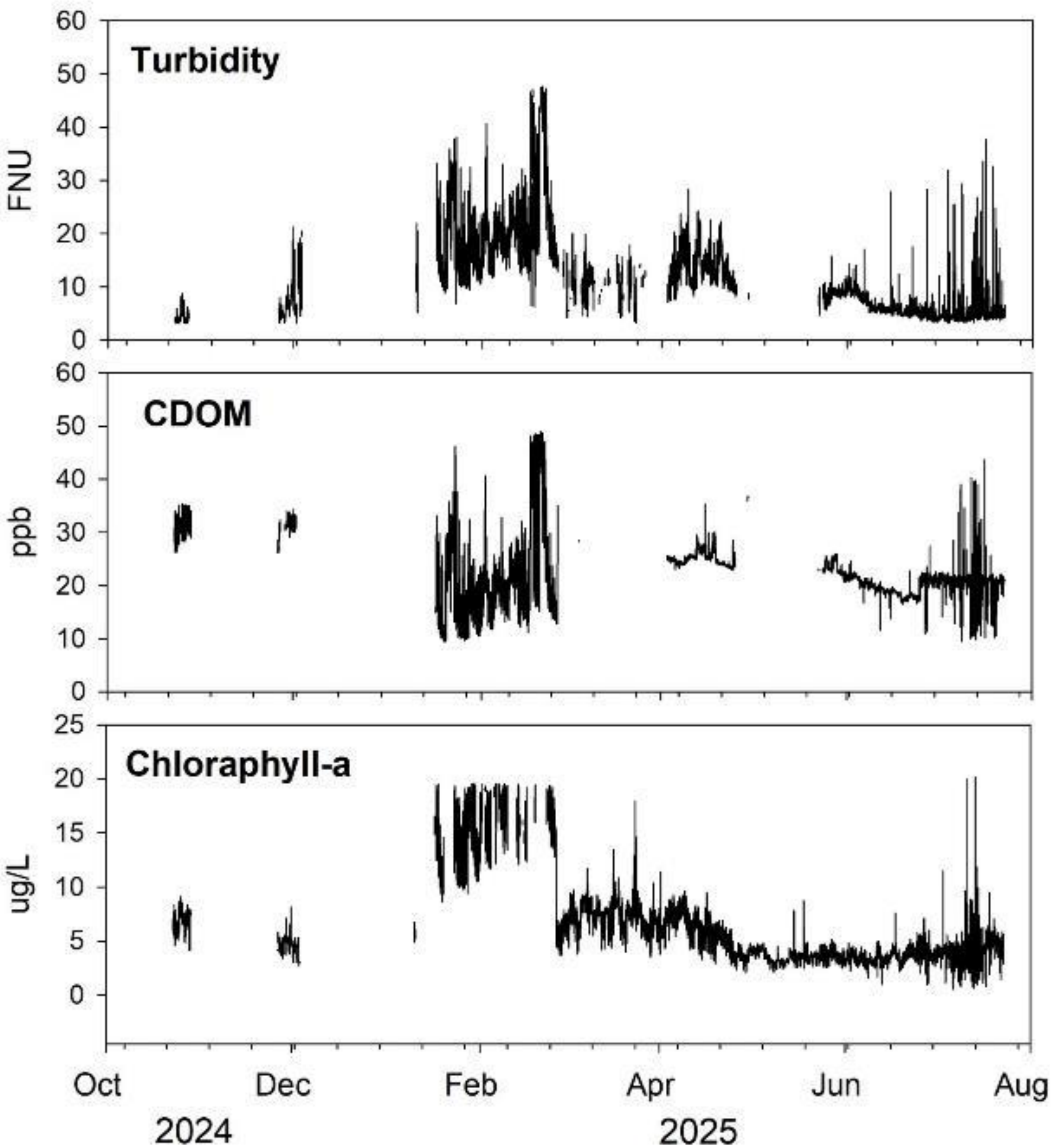


Figure 10: Continuous measurements of water quality parameters associated with water clarity. Turbidity, CDOM, and Chlorophyll are major drivers of light attenuation. Water clarity determines the maximum depth of SAV establishment and survival.

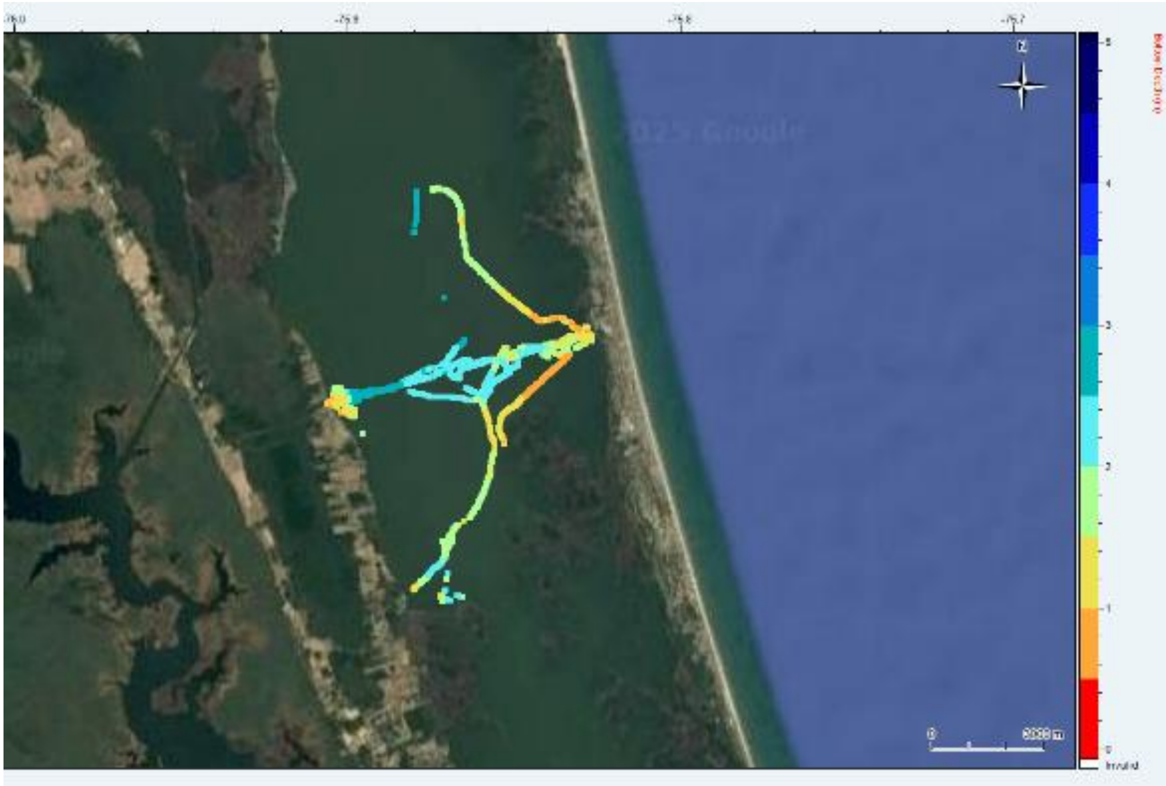


Figure 11: Bathymetry monitoring transects established with Biosonics acoustic surveys. Our transects identify a narrow shallow area with patchy SAV along the western edge, which leads to deep largely unvegetated channel (darker blue) before gradually decreasing depth and a relatively broad shallow area on the eastern edge.

Hydroacoustic monitoring provides essential information about water depth, bottom type, and SAV presence and structure. However, some uncertainty is inherent in interpreting hydroacoustic data. Our resulting surveys clearly identify widespread SAV dominance in depths of 0.5 to 1.2 meters and clearly identify patches of SAV in deeper water, with identification confirmed and widespread as deep as 2.4 meters (Figure 11). However, isolated SAV patches appear in depths up to 2.7 meters. These deep, isolated SAV patches will be another area of focus in year 2 of this study. Due to the previous depth limitation identified at 1.8 m, indication of potential range expansion providing an extensive area for potential mitigation.

Overall, dense SAV beds dominated the eastern edge of our transects, while a lower percent cover of SAV existed in depths ranging from 1.5-2.2 meters, with isolated patches in the deeper water and bare sediment in the deepest parts of the channel.

Bathymetry and SAV depth relationship

Our preliminary results suggest that SAV has expanded its range into deeper water in the mid-Currituck Sound. While we continue to ground-truth our hydrographic survey data to determine the absolute deepest SAV within our study area, this study indicates a substantial expansion of SAV into deeper water. Previous research identified an upper depth limit of 1.8 m in 2017-2018. We have definitively identified SAV presence within our field sites with drop-camera surveys, transects, and benthic grab-samples at depths greater than 2.4 meters. This represents at least a 60 cm increase in possible depth range, corresponding to a large potential increase in overall area of SAV. Overall, the 5.5 eastern kilometers of the bridge footprint is <2.5 meters deep.

All studies of SAV in Currituck Sound have highlighted the importance of light to SAV establishment and survival and turbidity as a primary factor influencing SAV abundance and distribution (e.g., Bourn, 1932; Dickson, 1958; Sincock et al., 1965; Davis and Carey, 1981; Davis and Brinson,1983, 1990; Ferguson and Wood, 1994; Carter and Rybicki, 1994). Furthermore, numerous studies have identified the maximum water depth (z-max) as between 1.2 and 2 meters deep (Corbett et al. 2020). However, historic studies indicate a small percentage of SAV at depths of 2 to 2.4 meters (Corbett et al. 2020). A study commissioned by APNEP in 2012 indicated a maximum depth up to 2.9 m; thus understanding potential SAV depth ranges requires ground-truthing (Corbett et al. 2020).

We continue to ground-truth our hydrographic survey results to determine the absolute upper limits of SAV depth. Preliminary results suggest SAV presence in >2.4 meters. Furthermore, in year two of this research, we plan to continue to verify and map SAV with combined hydroacoustic surveys and drop-camera ground-truthing with a particular focus on mapping SAV boundaries. Finally, we plan to continue to map SAV species to better characterize habitat and predict expansion. Existing SAV beds should be used as indicators of the thresholds of wave exposure and water depth for SAV in the system (Fonseca et al., 1998; Short et al., 2002), thus continued monitoring is essential.

2.6 Remote Sensing Turbidity Analysis

We used Sentinel-2 satellite imagery (10 m resolution) to map spatial and temporal patterns in turbidity across Currituck Sound. In Year 1, we generated five mosaics: one annual average for 2024 and four seasonal composites. An additional annual mosaic was created using 22 cloud-free images from 2023–2024 to provide baseline conditions prior to the study (Figure 13). All Landsat and Sentinel imagery was sorted, filtered, and cloud-masked, then processed in Google Earth Engine (Gorelick et al., 2017).

These Year 1 products broadly characterized water quality trends and guided field sampling. Field measurements of CDOM, TSS, and chlorophyll will be integrated with satellite reflectance data to train site-specific water quality models. Using machine learning and multi-linear regression, we will generate change maps that differentiate and quantify CDOM, TSS, algal chlorophyll, and SAV. Daily models will be aggregated monthly following a harmonized Landsat-8/Sentinel-2 workflow (Page et al., 2019), producing comprehensive monthly estimates of multiple water quality variables across the Sound. Low water clarity “hotspots” will also be identified by tracking the frequency of pixels exceeding threshold concentrations. Together, these remote sensing products provide system-wide context for site-specific transect data, improving our ability to identify spatial drivers of water quality and SAV dynamics across Currituck Sound.

Figure 12: SAV cover in Currituck Sound. Green colors indicate SAV, while the intensity indicates % cover. Generally, our surveys show patchy SAV along the Western Coast, before a rapid depth increase 600 meters from the western shore a zone of deep unvegetated benthic habitat, ultimately giving way to patchy SAV and ultimately a broad shallow SAV-dominated eastern shore.

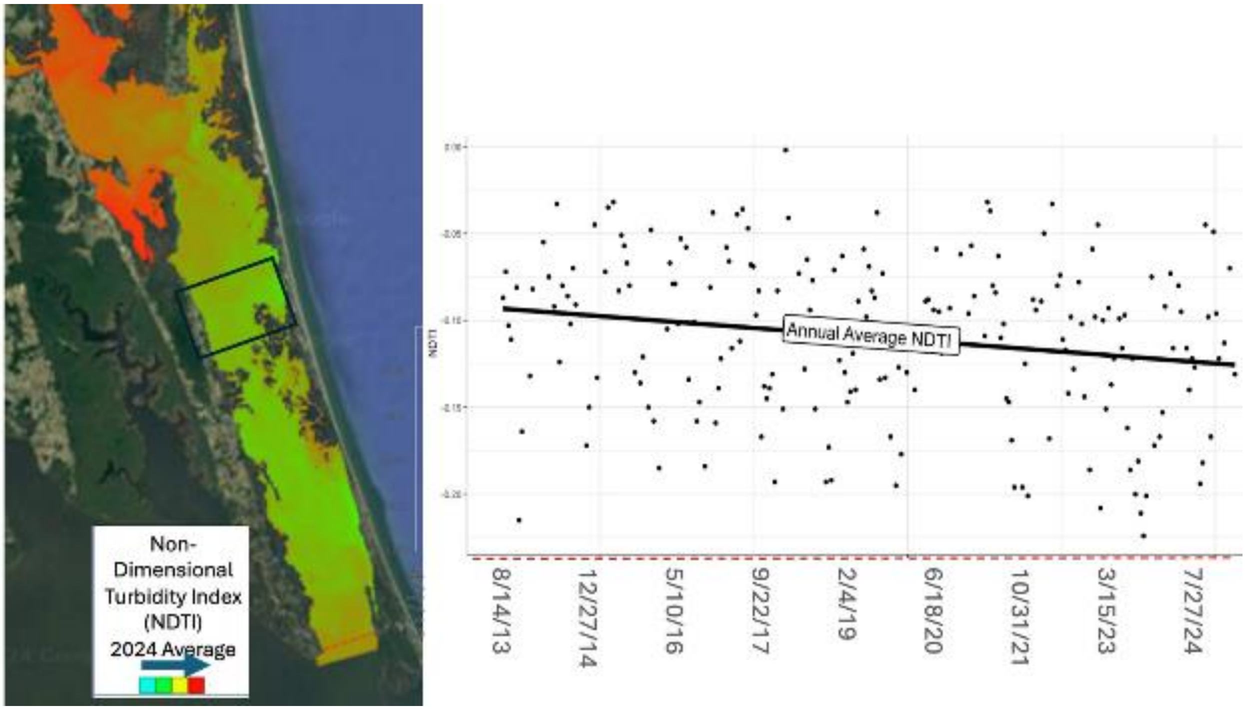


Figure: 13: We used Sentinel-2 imagery to create an annual mosaic of the non-dimensional turbidity index (NDTI), demonstrating spatial patterns in turbidity largely driven by turbidity north of the mid-Currituck Bridge. Temporal trends demonstrate a significant decrease in annual average NDTI since 2016 (P <0.05: R^2 = 0.44). Note that only annual averages create a significant negative relationship.

Chapter 3: Findings and Conclusions

3.1 Water Quality

Our results indicate gradual improvements in water quality in northern Currituck Sound, though historical data remain patchy and provide only snapshots of past conditions. Turbidity appears to have declined over the long term, based on analysis of the Non-Dimensional Turbidity Index (NDTI), yet large episodic spikes and gaps in the record create some uncertainty. Dissolved organic matter continues to play an outsized role in light attenuation. While fDOM concentrations decreased by approximately 15% between 2016 and 2017, disturbance-driven resuspension events may have periodically reduced clarity (Corbett et al., 2020; USGS unpublished). Light availability remains the primary factor governing SAV extent, with a threshold of approximately 13% of surface light required for survival in oligohaline systems (Batiuk et al., 2000). Overall, turbidity has historically been highest in the northern Sound (Dickson, 1958), a trend confirmed by both our field transect data and recent NDTI analysis.

Remote sensing results further demonstrate that turbidity has generally declined over the past eight years. At the same time, our field transect shows that SAV itself exerts a measurable influence on water quality. Turbidity decreases significantly within SAV beds, particularly from the ecotone at Site 6 (1.9 m) eastward toward Site 11, suggesting that vegetation creates positive feedbacks that enhance clarity with distance from bed edges. Other water quality indicators were more variable: CDOM values were highest in SAV-dominated eastern sites and along the western shore, while chlorophyll-a displayed no consistent spatial pattern.

Despite these encouraging trends, both remote sensing and field data illustrate the Sound's sensitivity to disturbance. Sharp increases in turbidity were observed during storms, underscoring the vulnerability of this shallow, wind-driven system. Hurricanes in particular exert a strong control over long-term trajectories. SAV coverage increased following recovery from storm events in 2016–2018, while the absence of a direct hurricane impact since Hurricane Dorian in 2019 has likely supported recent stability and expansion. These results emphasize that water quality in Currituck Sound is improving but remains fragile, with progress that could be reversed by storm events or construction-driven turbidity.

3.2 Shorelines & SAV

Within the footprint of the proposed Mid-Currituck Bridge, we identified approximately 57.6 acres of SAV at risk of direct shading or disturbance during construction. This represents a nearly 400% increase since 2021, when SAV coverage remained relatively stable at around 15 acres from 2015 to 2021. Since the rapid expansion in 2021–2022, SAV coverage has remained stable, with the majority of beds located along the eastern shoreline.

Our surveys also reveal that SAV is now occupying greater depths than in the past. In 2017–2018, most SAV was restricted to less than 1.2 m (Corbett et al., 2020), whereas our current surveys document healthy beds down to 2.4 m and isolated patches extending to 2.7 m. This expansion reflects improved water clarity and may also be aided by favorable recent climate conditions, including the absence of major storm events and warmer winter water temperatures that reduce turbidity. Historically, SAV grew to depths greater than 3 m (Sincock et al., 1965; Davis and Carey, 1981), suggesting that water clarity declined with development pressures during the mid-to-late twentieth century. Regulatory measures—including the 1987 statewide ban on phosphate detergents, upgrades in wastewater treatment infrastructure, and North

Carolina's 2014 Nutrient Criteria Development Plan—may now be contributing to gradual recovery, providing a policy-driven explanation for improving clarity.

The stabilizing role of SAV in estuarine systems is well-documented. Established beds reduce sediment resuspension, improve water quality, and buffer against eutrophication (Moore, 2004). Conversely, loss of SAV can drive reinforcing cycles of turbidity and nutrient enrichment, a global trend documented across seagrass ecosystems (Orth et al., 2006; Orth et al., 2015). Evidence from Chesapeake Bay demonstrates that large-scale SAV restoration can reverse these negative feedback loops, with water quality improvements and vegetation recovery reinforcing one another in a positive cycle (Orth & Heck, 2023). Currituck Sound may now be experiencing a similar feedback, in which SAV expansion and water clarity improvements are mutually reinforcing.

Shoreline change further complicates SAV distribution near the bridge landings. Both the eastern and western shores exhibit erosion, though the western shore has experienced particularly severe land loss, even in armored areas where bulkheads have failed over time. Drone surveys and wave gauge data confirm that shoreline erosion remains active on both sides of the Sound. These dynamics have implications not only for infrastructure but also for adjacent SAV beds, which are vulnerable to increased turbidity and physical disturbance from eroding shorelines.

3.3 Overall Conclusions

Together, these findings indicate that SAV within the bridge footprint has expanded substantially since 2021 and is now colonizing deeper areas than previously documented. Improvements in water clarity have likely facilitated this expansion, though high variability and storm-driven turbidity spikes emphasize the system's ongoing vulnerability. SAV both benefits from and contributes to improved clarity, creating a delicate but potentially resilient feedback cycle. At the same time, shoreline erosion continues to reshape nearshore conditions and poses risks to SAV and infrastructure.

Long-term monitoring will be essential to capture both the positive trends of recent years and the potential reversals associated with storm events or development pressures to guide the NCDOT in developing the most efficient mitigation strategies.

3.4 Ongoing research

In Year 1, we produced maps to identify spatial and temporal trends in water quality and to guide field data collection. Field samples of CDOM, TSS, and chlorophyll will be used to train site-specific water quality models, enabling change detection maps that quantify these parameters and SAV. Seasonally collected water samples will be paired with coincident satellite reflectance data and band ratios, applying machine learning and multi-linear regression. Daily models from Landsat-8 and Sentinel-2 will be aggregated monthly following a harmonized workflow (Page et al., 2019), providing comprehensive monthly estimates of water quality variables across Currituck Sound. Low water clarity "hotspots" will be identified based on the frequency of pixels exceeding threshold concentrations.

In Year 2, work will focus on repeat transect sampling to track water quality and SAV dynamics, continued ground-truthing to refine SAV mapping, and improved delineation of ecotones between vegetated and unvegetated areas. Efforts will also prioritize identifying SAV beds most vulnerable to disturbance based on depth and water clarity, as well as areas with potential for natural or mitigation-driven expansion. Because construction will likely cause short-term declines in clarity, particular caution should be taken to avoid impacts to vulnerable SAV beds. Effective mitigation will depend on targeting areas with adequate light availability; areas lacking sufficient clarity are unlikely to succeed. Monitoring ecotones can improve site selection, and supporting existing SAV beds is preferable, as they stabilize sediments, enhance water clarity, and promote positive feedbacks that facilitate further SAV expansion.

3.5 Recommendations

Our findings suggest that while only a small portion of Currituck Sound's extensive SAV will be directly affected by bridge construction, careful management is required to limit indirect impacts. Recent water quality improvements have supported SAV expansion, and SAV itself enhances clarity through positive feedback. Protecting this dynamic system will require targeted mitigation and consistent monitoring.

- **Target mitigation strategically:** Mitigation should prioritize areas with sufficient light availability, as SAV cannot persist where clarity is inadequate. Monitoring ecotones between vegetated and unvegetated zones can improve site selection and long-term success.
- **Leverage feedback:** SAV establishment can initiate positive feedback loops that further improve water quality and expand habitat. Supporting existing SAV beds is more reliable than relying solely on expansion into new areas, which carries greater risk.
- **Maintain long-term monitoring:** Effective management requires ongoing assessment of SAV area, extent, and water quality. Seasonal variability must be considered, as clarity and light penetration fluctuate across the year.
- **Recognize spatial variability:** Our transect study shows moderate improvements in water quality within SAV beds, and remote sensing indicates higher turbidity in the northern Sound compared to the south. This spatial variability should inform mitigation and monitoring priorities.

In summary, mitigation will be most effective if it focuses on protecting existing SAV, and aligning site selection with depth and light availability. With careful planning, construction impacts can be reduced, and long-term SAV resilience supported.

Chapter 4: Implementation and Technology Transfer Plan

The final deliverables for this project include: Comprehensive geospatial and temporal datasets on submerged aquatic vegetation (SAV) distribution within the Mid-Currituck Bridge footprint. These data include mapped coverage, change analyses, and associated environmental factors (e.g., water clarity, disturbance history). All datasets have been quality controlled and are available for continued use in decision-making, mitigation planning, and long-term monitoring. Final Report – A detailed written report summarizing methods, results, and interpretations. The report provides a scientific foundation for understanding SAV dynamics in the project area, highlights potential impacts from bridge construction, and offers recommendations for mitigation and monitoring. References to peer-reviewed literature and supporting appendices (maps, figures, and tables) are included to ensure transparency and usability. Presentation – A concise, presentation-ready product delivered to NCDOT and project stakeholders. The presentation distills the report's findings into accessible visuals and summary points, allowing for effective communication of key outcomes and recommendations to technical and non-technical audiences. Collectively, these deliverables provide the scientific basis for evaluating SAV impacts related to the Mid-Currituck Bridge, inform regulatory review, and support planning for mitigation and long-term ecosystem management.

Implementation of this research is dependent on the progression of the Mid-Currituck Bridge project and associated permitting processes. While there is no fixed timeline at this stage, the data, report, and recommendations are intended for use by NCDOT and regulatory partners during environmental review, project design, and mitigation planning. If and when the bridge project advances, this research can be immediately applied to support compliance, impact assessments, and long-term monitoring strategies.

Continued research and long-term tracking of SAV conditions will be important to fully implement the findings of this project. While this study provides a robust baseline, ongoing monitoring is needed to detect future changes in SAV distribution and to evaluate the effectiveness of any mitigation measures. Assistance from NCDOT in supporting continued data collection, integrating monitoring into project operations, and facilitating coordination with regulatory partners will ensure that the research is applied effectively and remains relevant throughout the lifecycle of the Mid-Currituck Bridge project.

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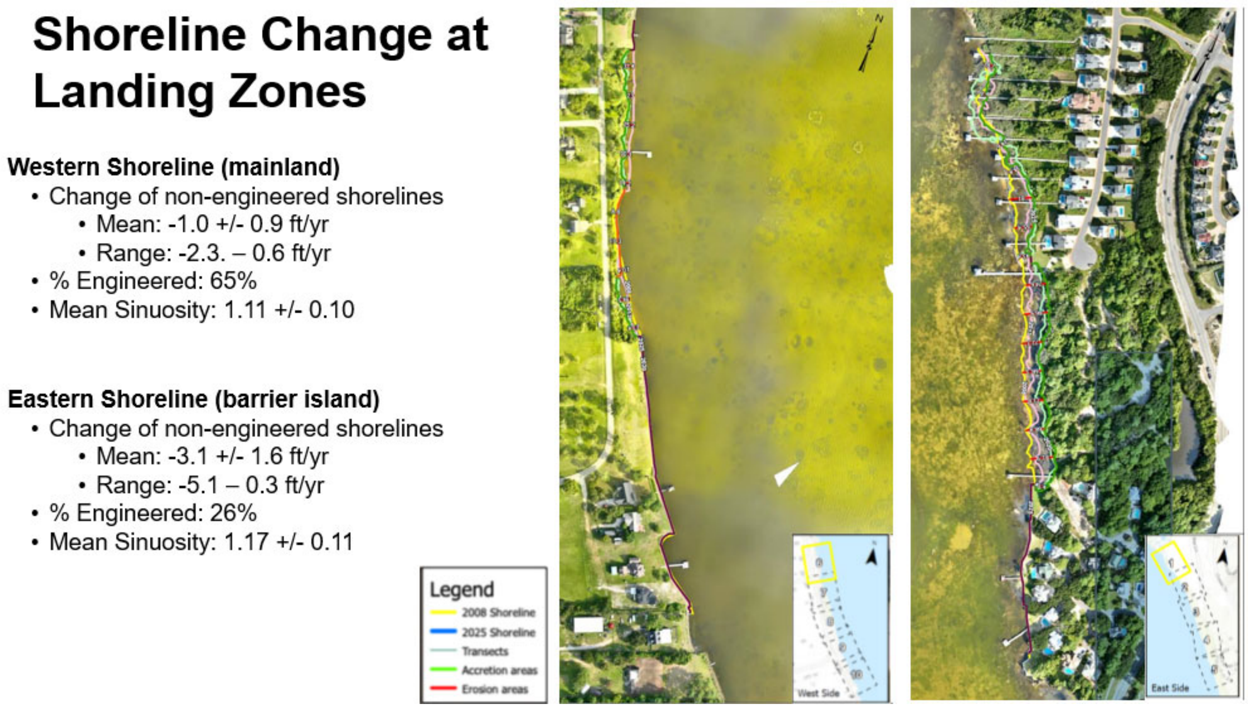
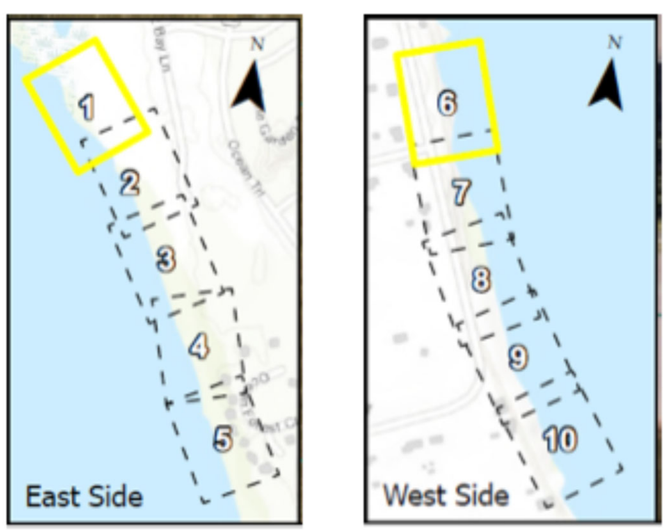
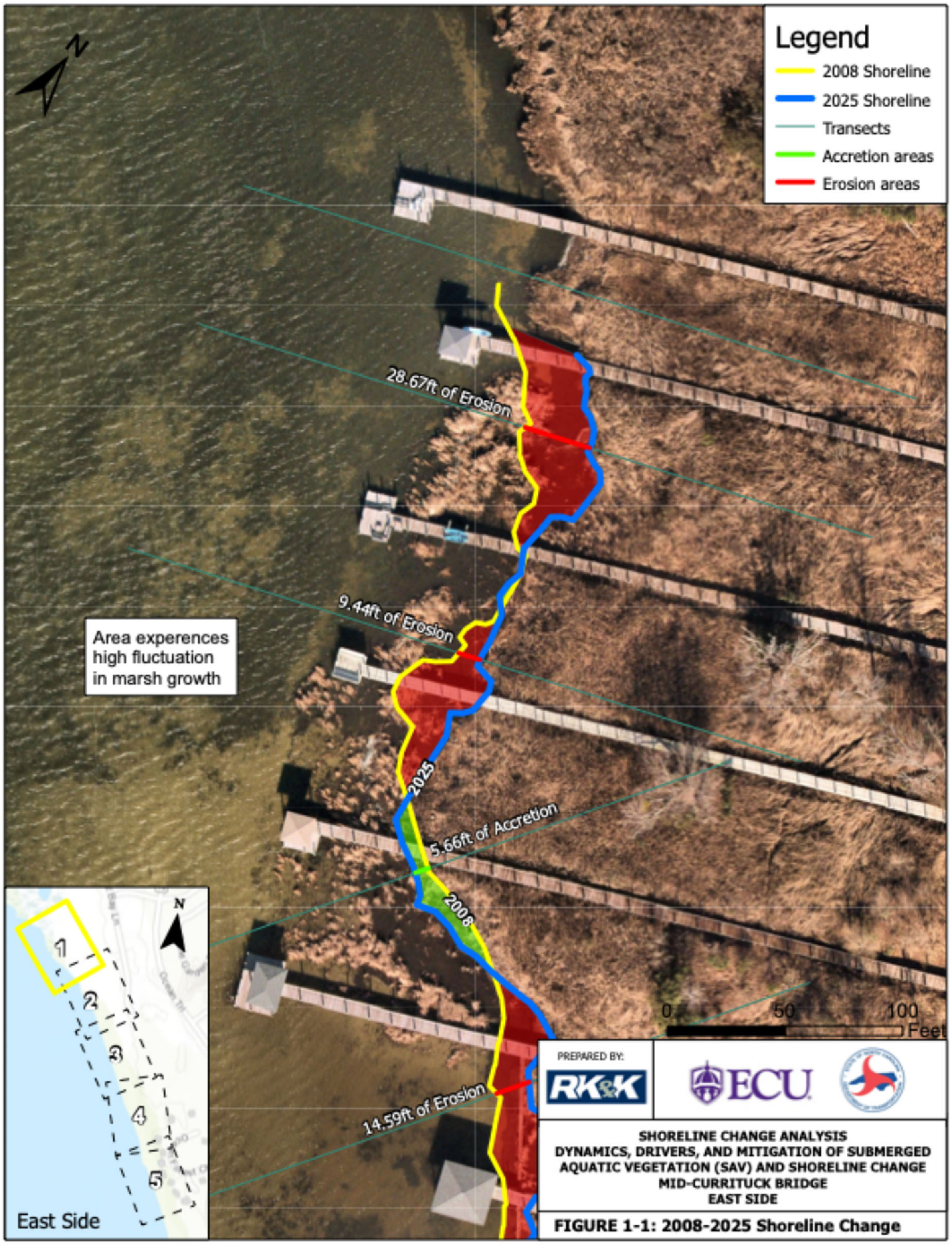
Appendix A: Erosion Rates

Erosion Rates Summary & Site Areas





Shoreline Erosion inlay



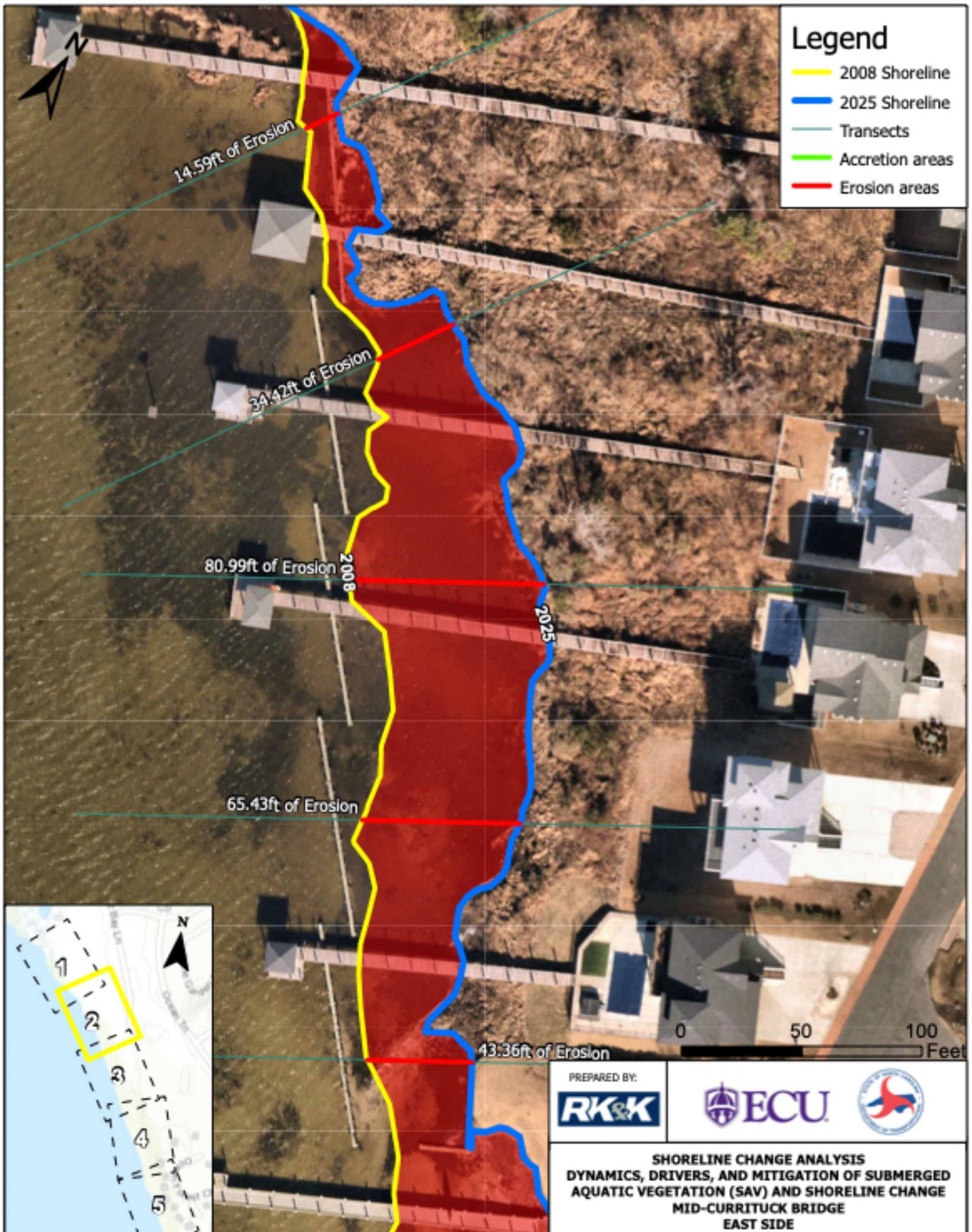


FIGURE 1-2: 2008-2025 Shoreline Change

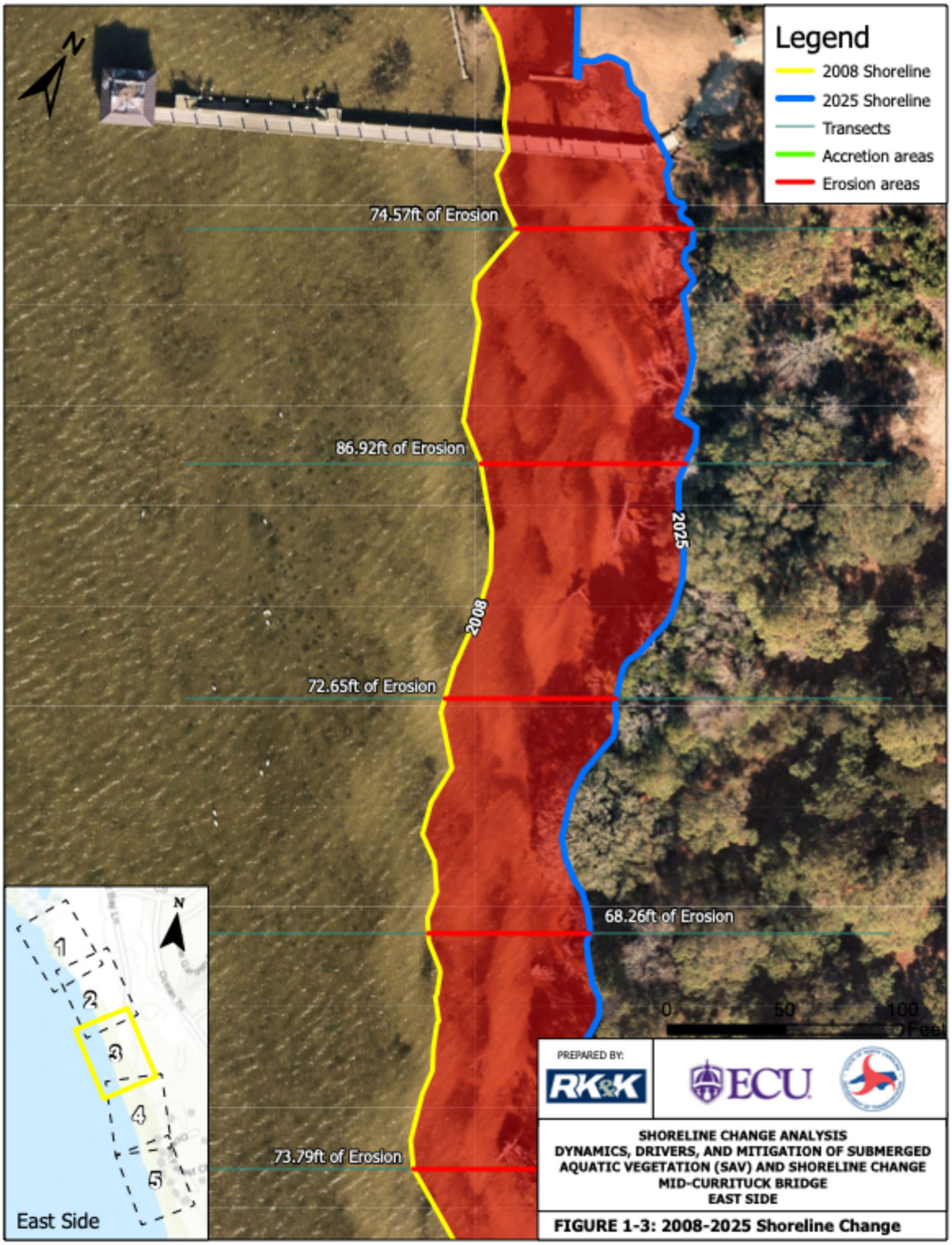


FIGURE 1-3: 2008-2025 Shoreline Change

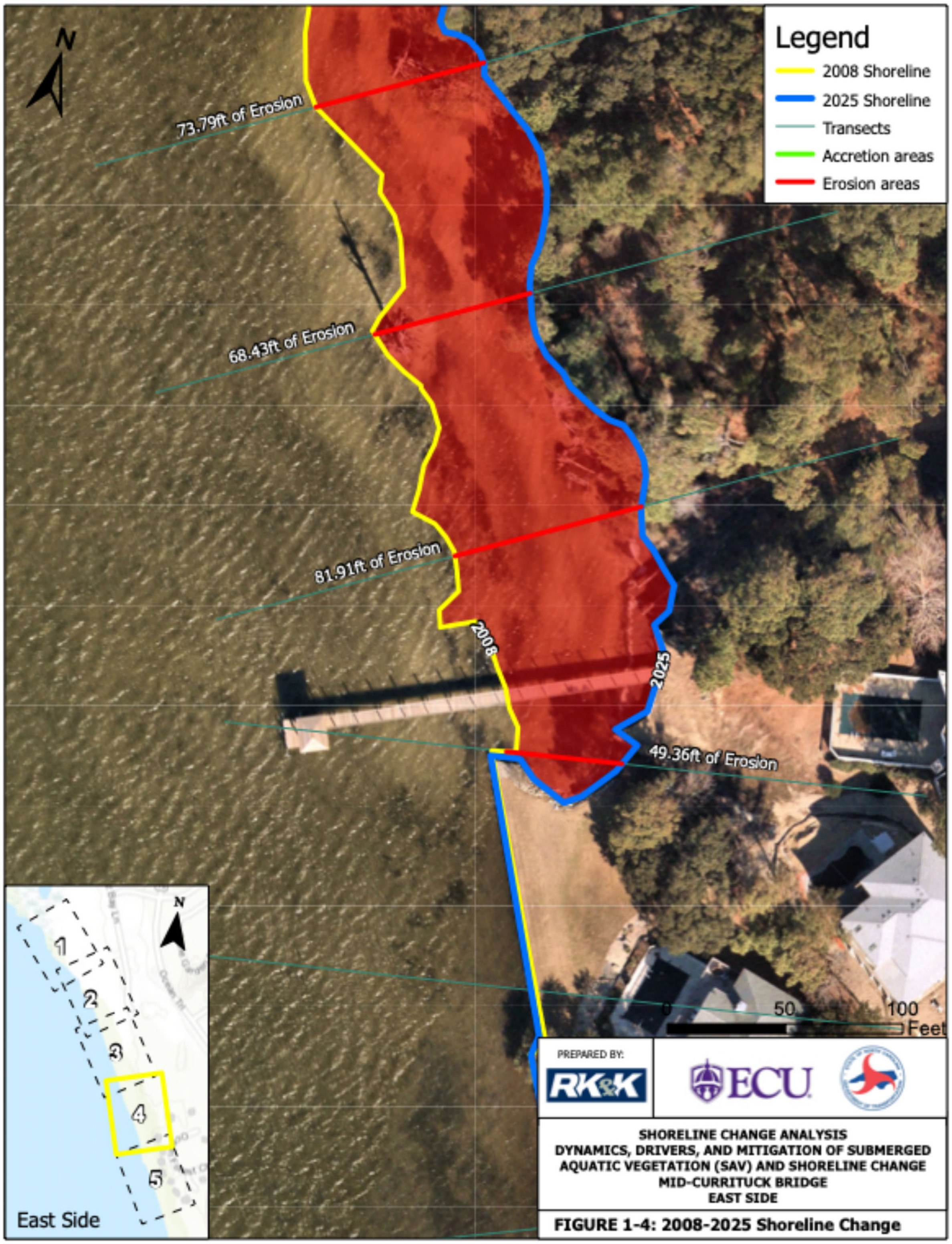
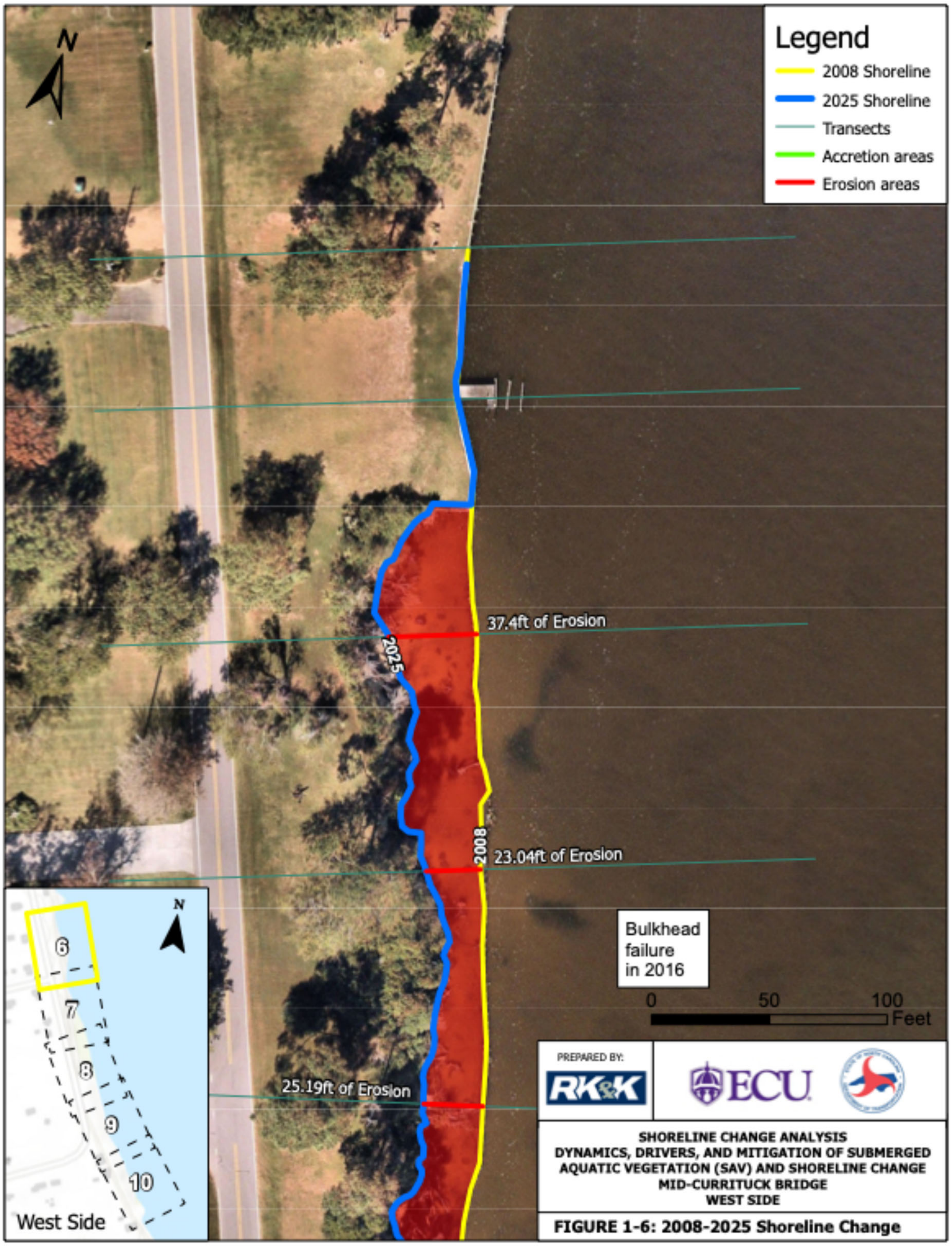
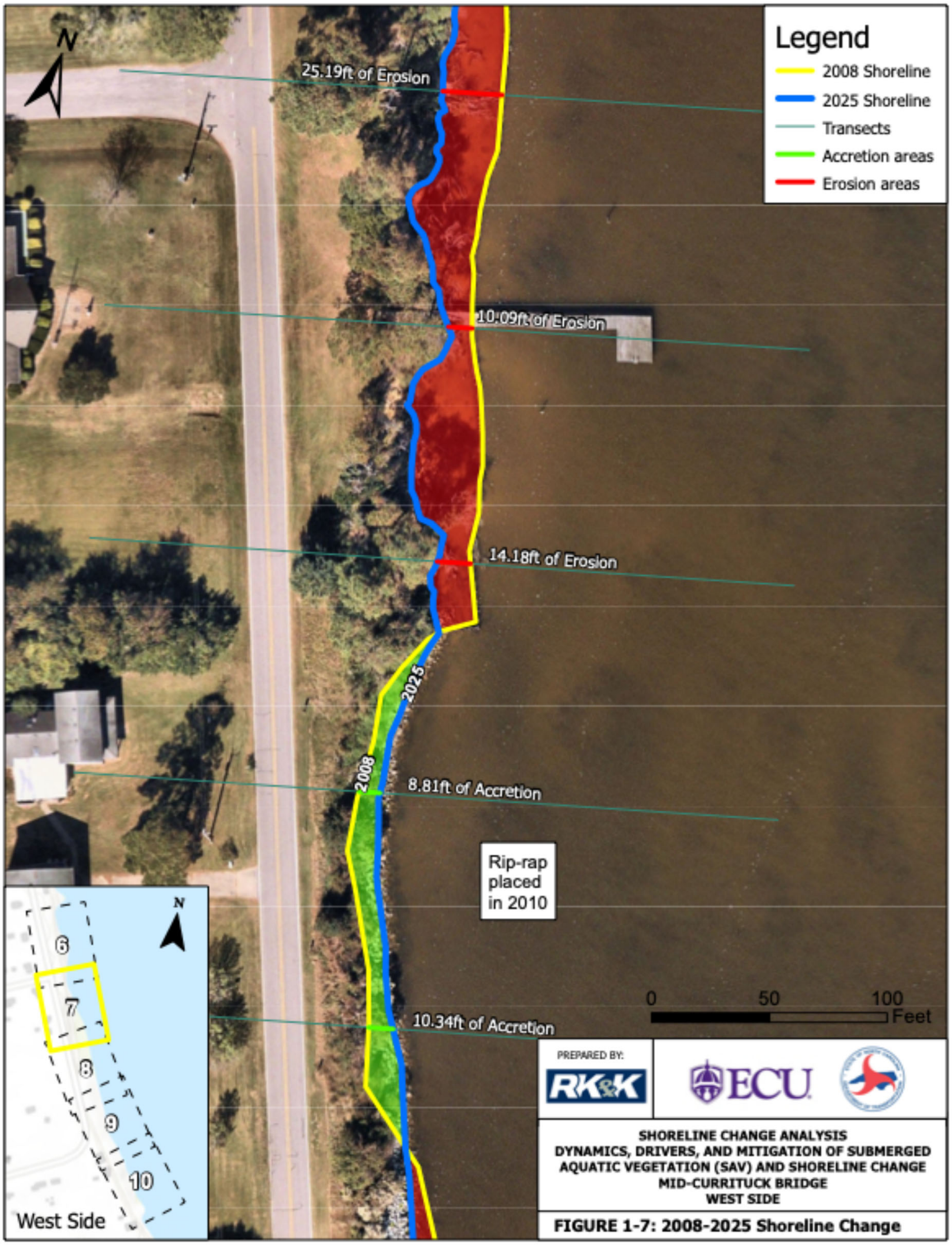


FIGURE 1-4: 2008-2025 Shoreline Change

FIGURE 1-5: 2008-2025 Shoreline Change


Legend
2008 Shoreline
2025 Shoreline
Transects
Accretion areas
Erosion areas
N
37.4ft of Erosion
2025
2008
23.04ft of Erosion
25.19ft of Erosion
Bulkhead failure in 2016
0
50
100
Feet
6
7
8
9
10
West Side
PREPARED BY:
SHORELINE CHANGE ANALYSIS
DYNAMICS, DRIVERS, AND MITIGATION OF SUBMERGED AQUATIC VEGETATION (SAV) AND SHORELINE CHANGE
MID-CURRITUCK BRIDGE
WEST SIDE
FIGURE 1-6: 2008-2025 Shoreline Change


Legend
2008 Shoreline
2025 Shoreline
Transects
Accretion areas
Erosion areas
N
25.19ft of Erosion
10.09ft of Erosion
14.18ft of Erosion
2025
2008
8.81ft of Accretion
Rip-rap placed in 2010
10.34ft of Accretion
0 50 100 Feet
6
7
8
9
10
West Side
PREPARED BY:
RK&K
ECU
SHORELINE CHANGE ANALYSIS
DYNAMICS, DRIVERS, AND MITIGATION OF SUBMERGED AQUATIC VEGETATION (SAV) AND SHORELINE CHANGE
MID-CURRITUCK BRIDGE
WEST SIDE
FIGURE 1-7: 2008-2025 Shoreline Change

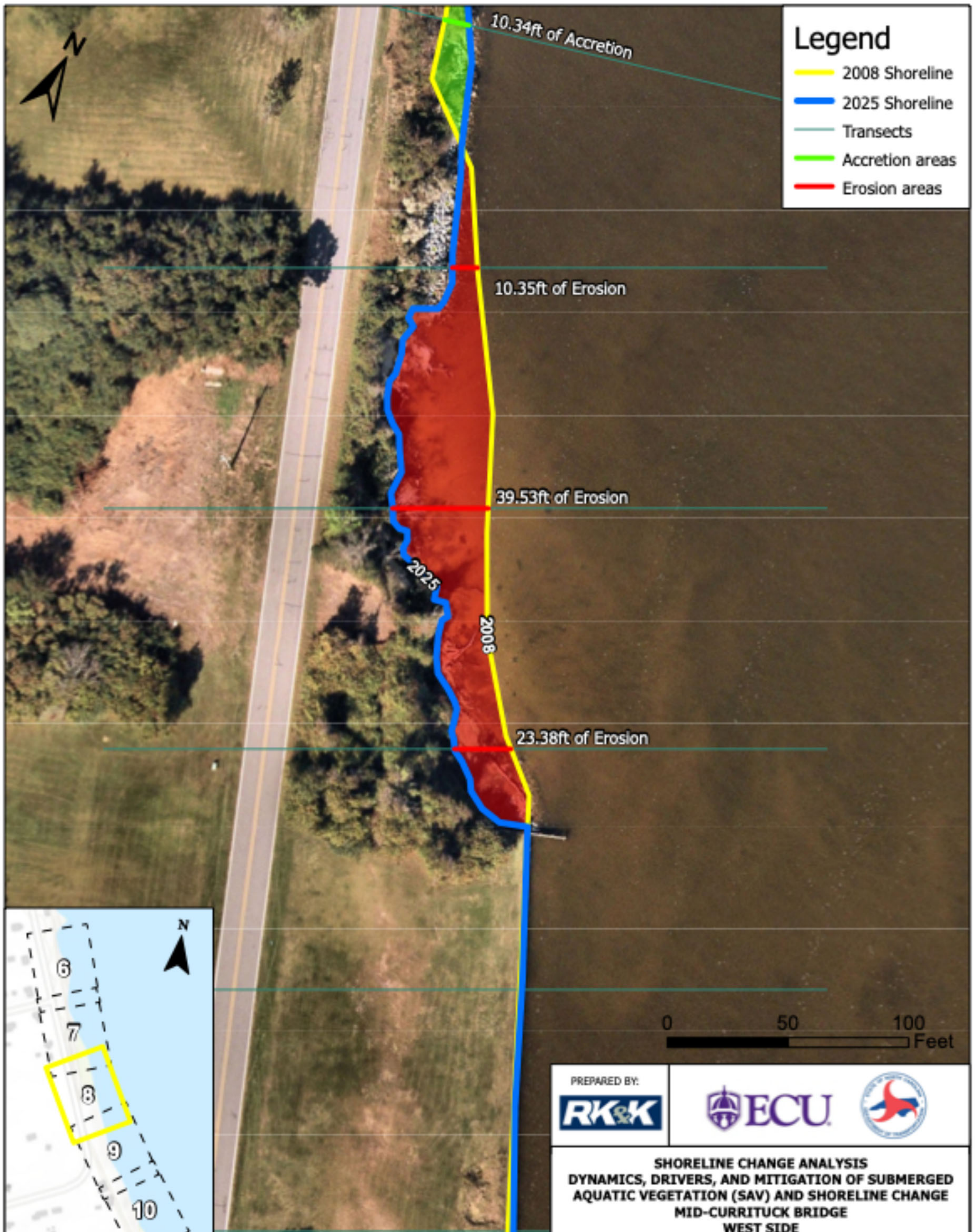


FIGURE 1-8: 2008-2025 Shoreline Change

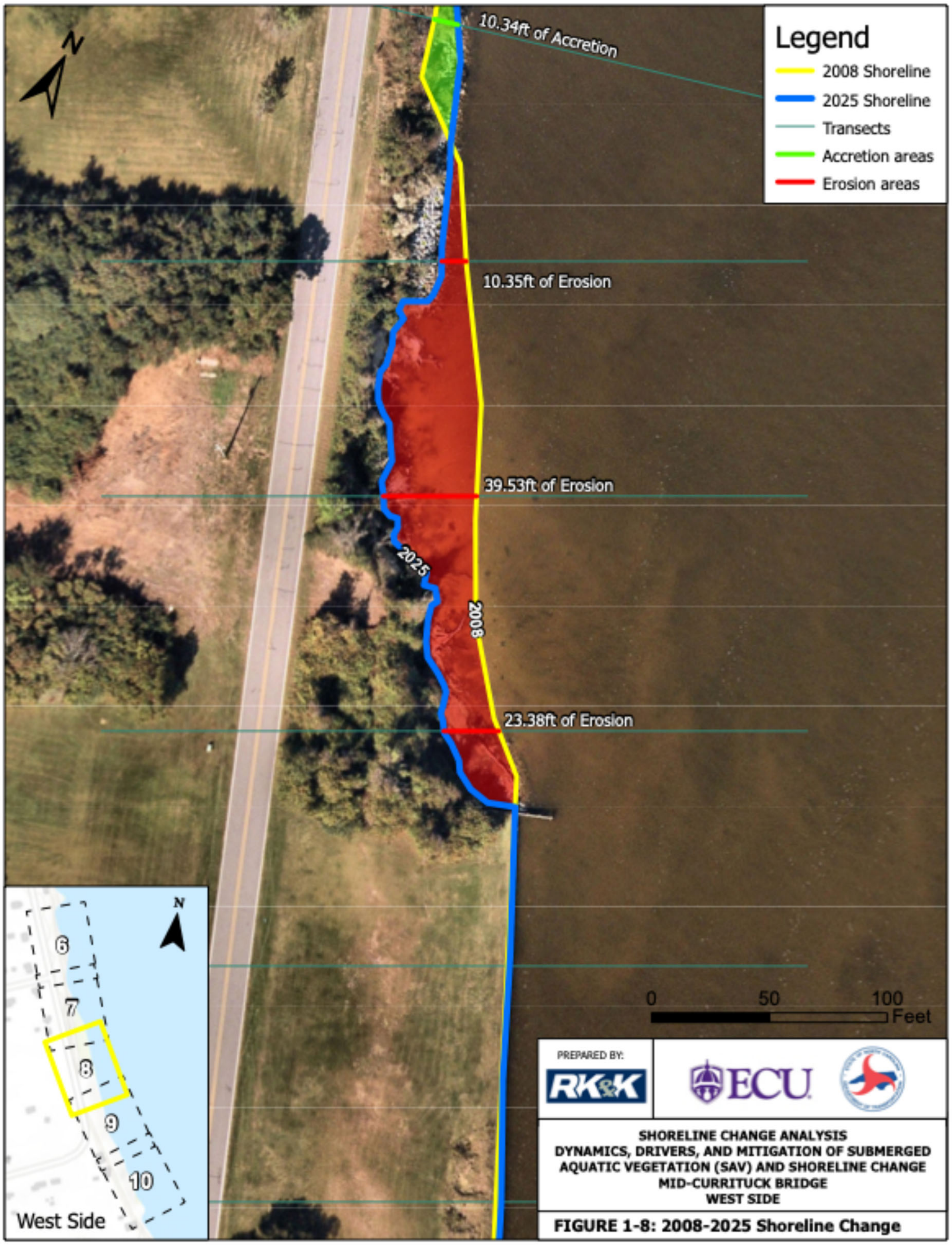


FIGURE 1-8: 2008-2025 Shoreline Change

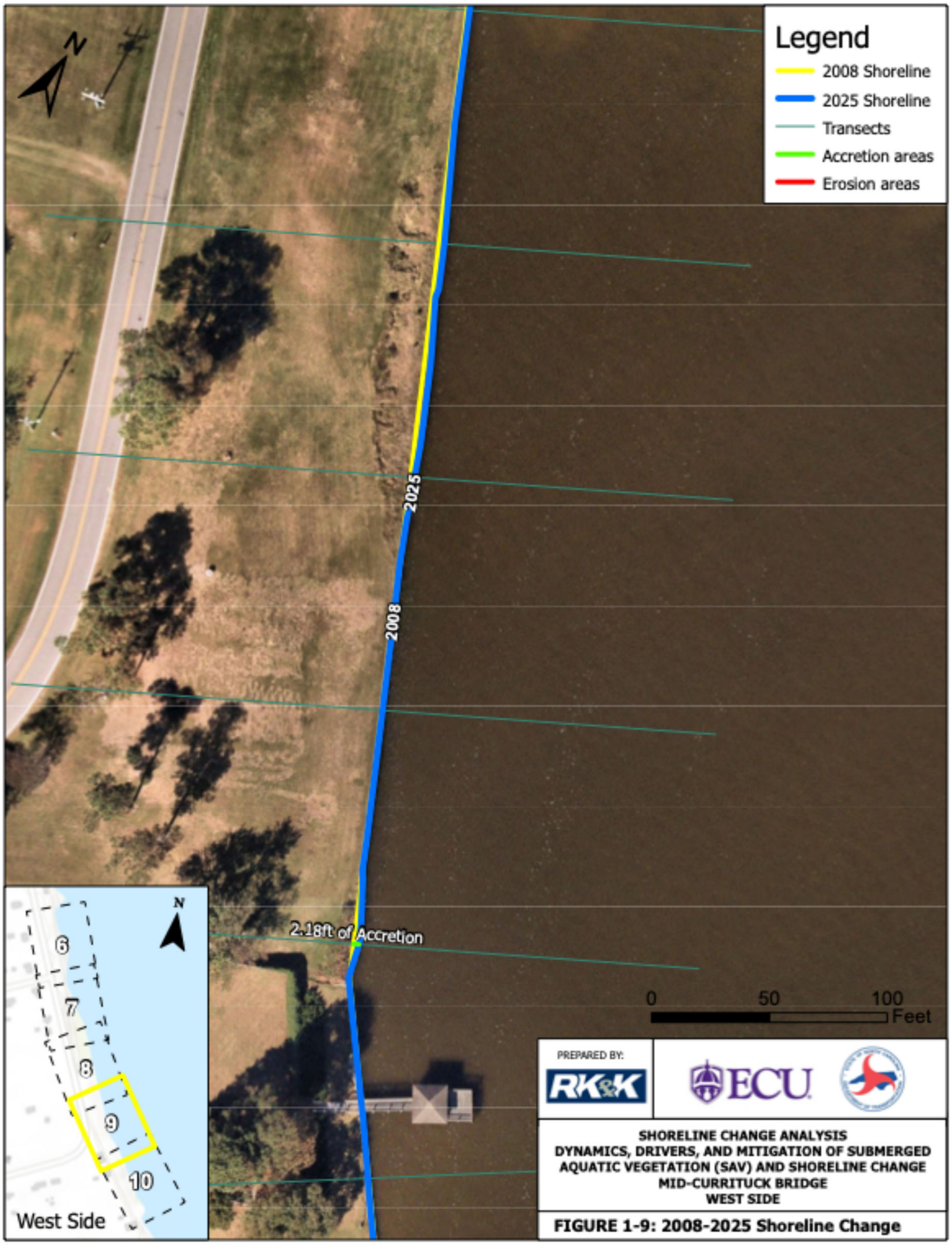


FIGURE 1-9: 2008-2025 Shoreline Change

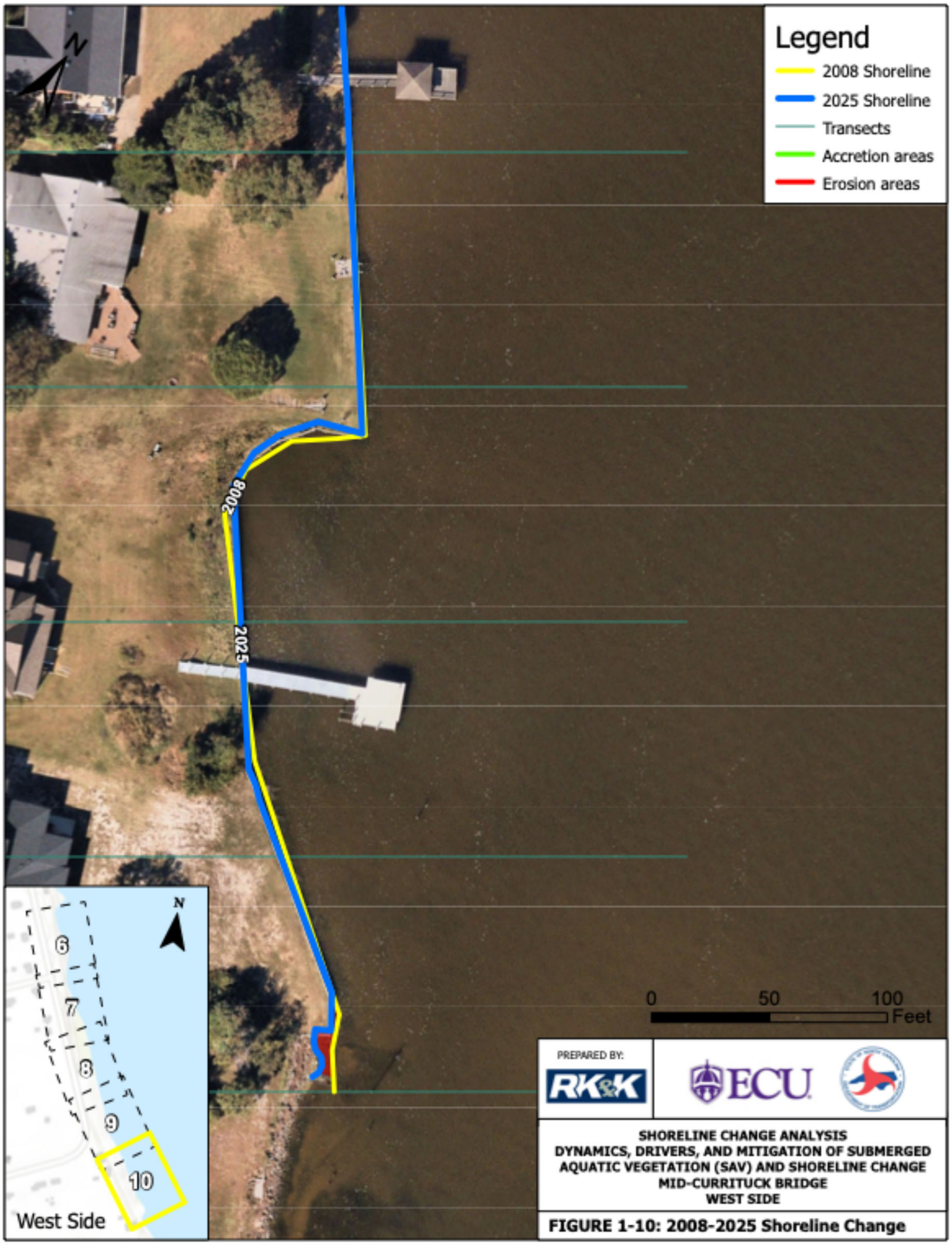


FIGURE 1-10: 2008-2025 Shoreline Change

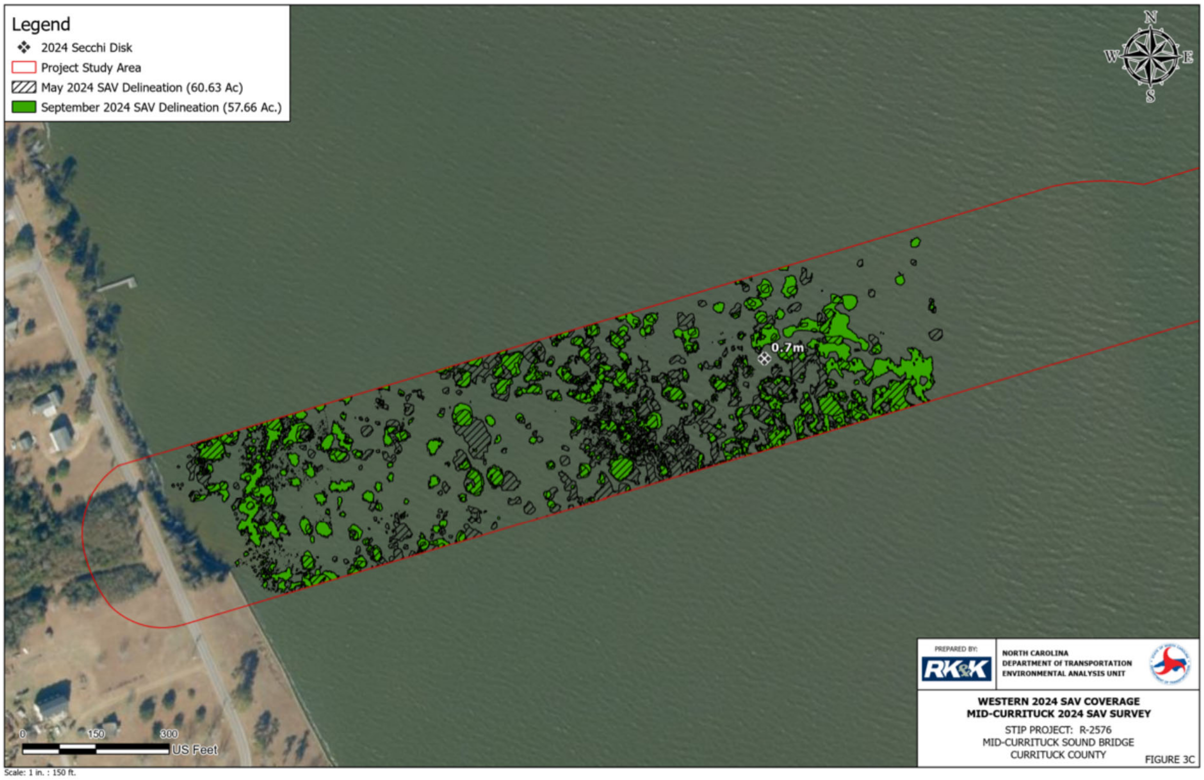
Appendix B: Submerged Aquatic Vegetation Delineation

Bridge Footprint Submerged Aquatic Vegetation Delineation overview map

B.2. Submerged Aquatic Vegetation Delineation 2024

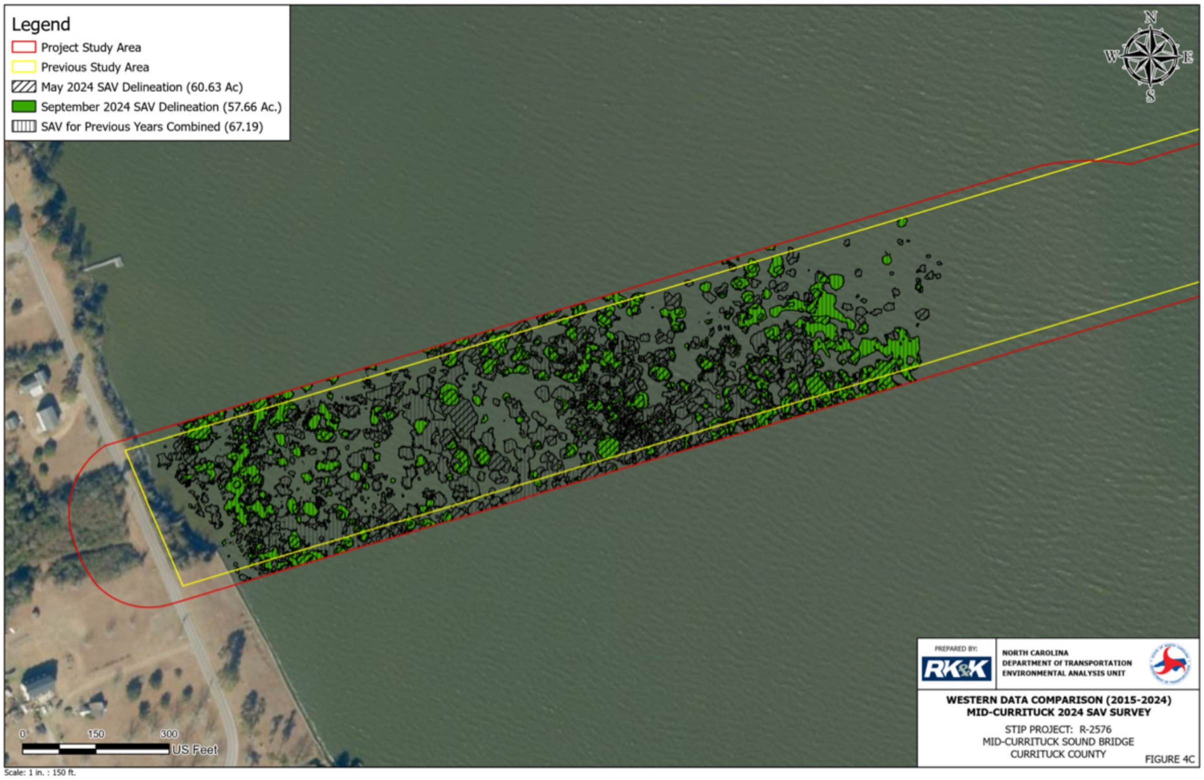

Legend
2024 Secchi Disk
Project Study Area
May 2024 SAV Delineation (60.63 Ac)
September 2024 SAV Delineation (57.66 Ac.)
0.7m
EASTERN 2024 SAV COVERAGE
MID-CURRITUCK 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 38


Legend
2024 Secchi Disk
Project Study Area
May 2024 SAV Delineation (60.63 Ac)
September 2024 SAV Delineation (57.66 Ac.)
0.7m
PREPARED BY:
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
EASTERN 2024 SAV COVERAGE
MID-CURRITUCK 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 3B
0
300
600
US Feet
Scale: 1 in. : 300 ft.

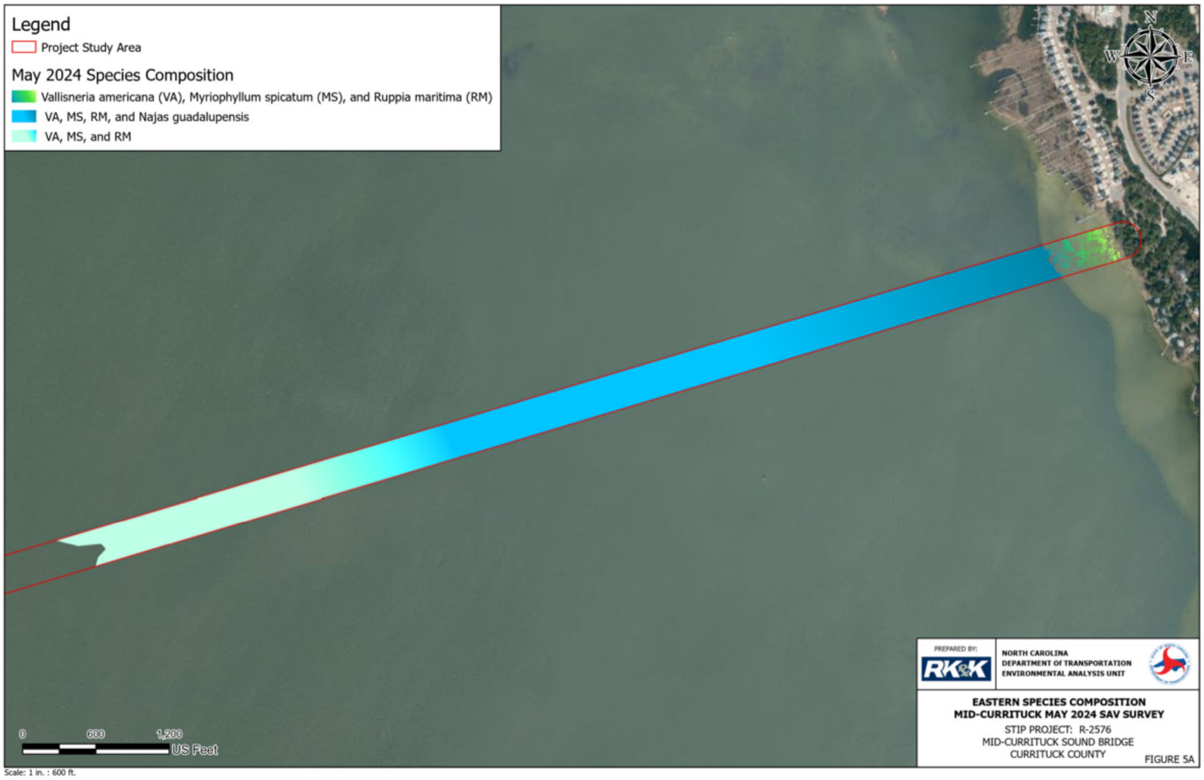

Legend
2024 Secchi Disk
Project Study Area
May 2024 SAV Delineation (60.63 Ac)
September 2024 SAV Delineation (57.66 Ac.)
0.7m
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
WESTERN 2024 SAV COVERAGE
MID-CURRITUCK 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 3C
0
150
300
US Feet
Scale: 1 in. : 150 ft.

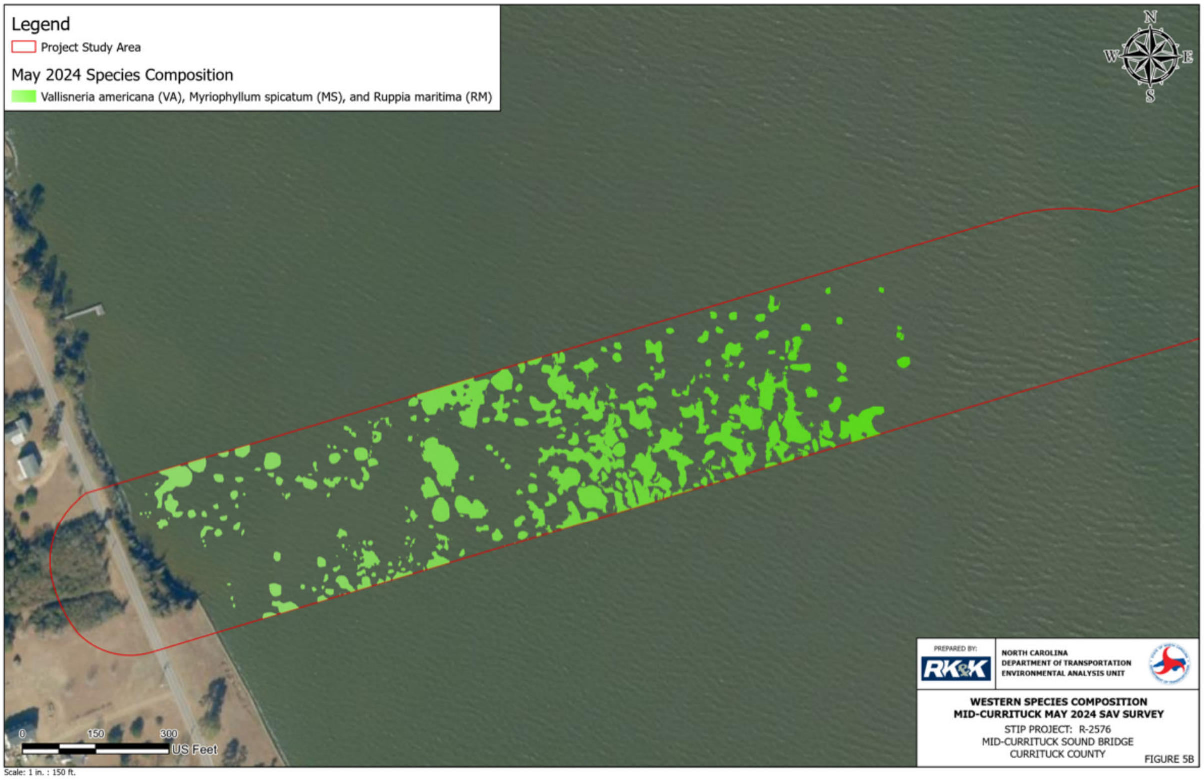

Legend
Project Study Area
Previous Study Area
May 2024 SAV Delineation (60.63 Ac)
September 2024 SAV Delineation (57.66 Ac.)
SAV for Previous Years Combined (67.19)
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
EASTERN DATA COMPARISON (2015-2024)
MID-CURRITUCK 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 4A
0
300
600
US Feet
Scale: 1 in. : 300 ft.

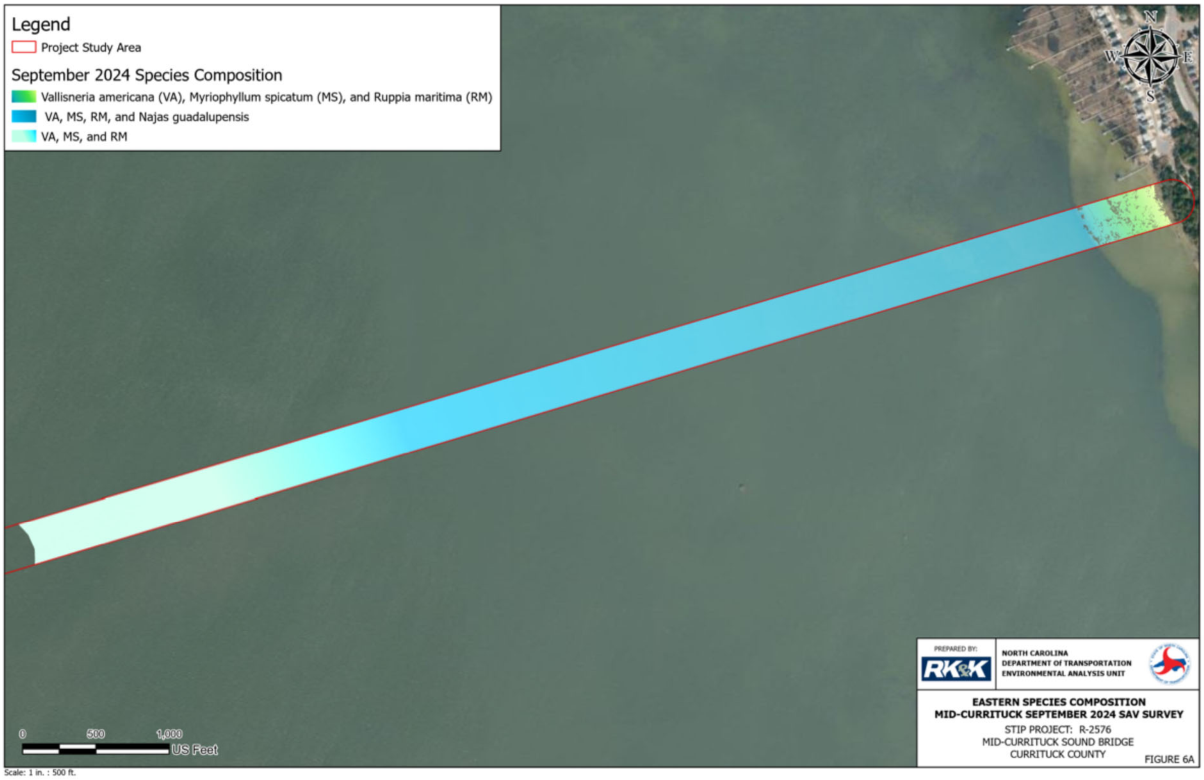
Legend
Project Study Area
Previous Study Area
May 2024 SAV Delineation (60.63 Ac)
September 2024 SAV Delineation (57.66 Ac.)
SAV for Previous Years Combined (67.19)
N
W
E
S
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
EASTERN DATA COMPARISON (2015-2024)
MID-CURRITUCK 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 4B
0
300
600
US Feet
Scale: 1 in. : 300 ft.

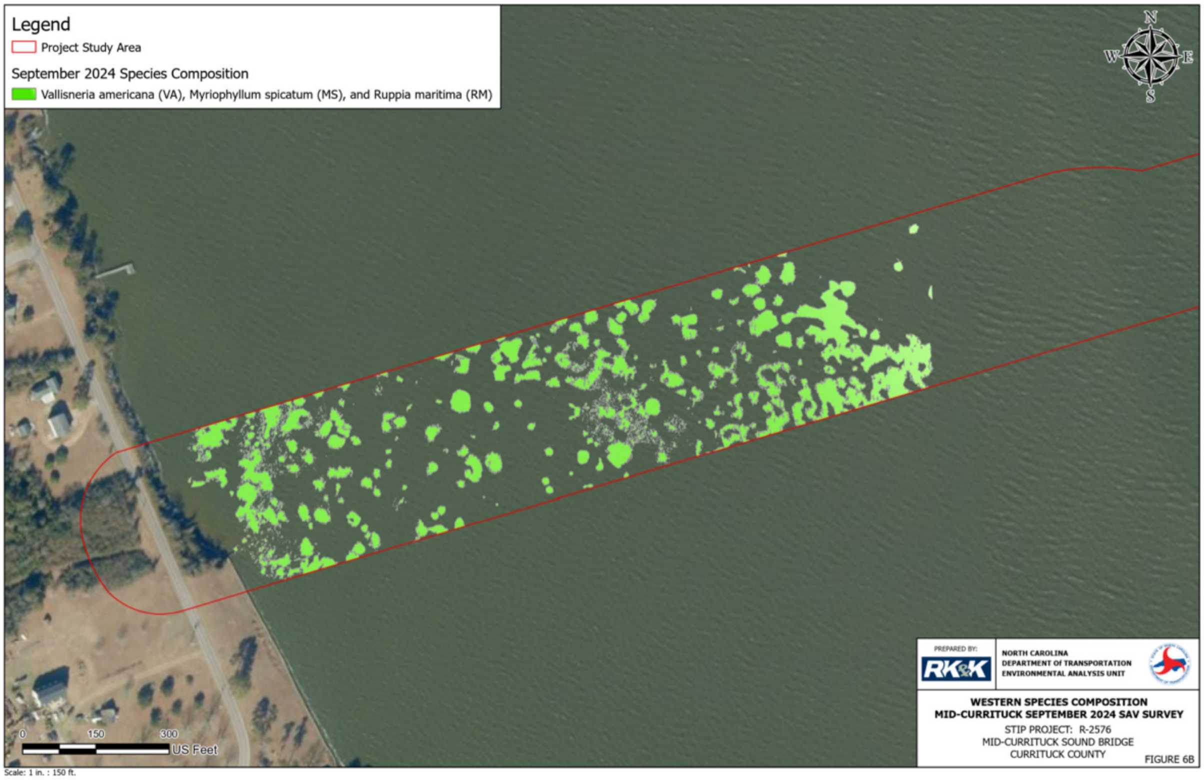


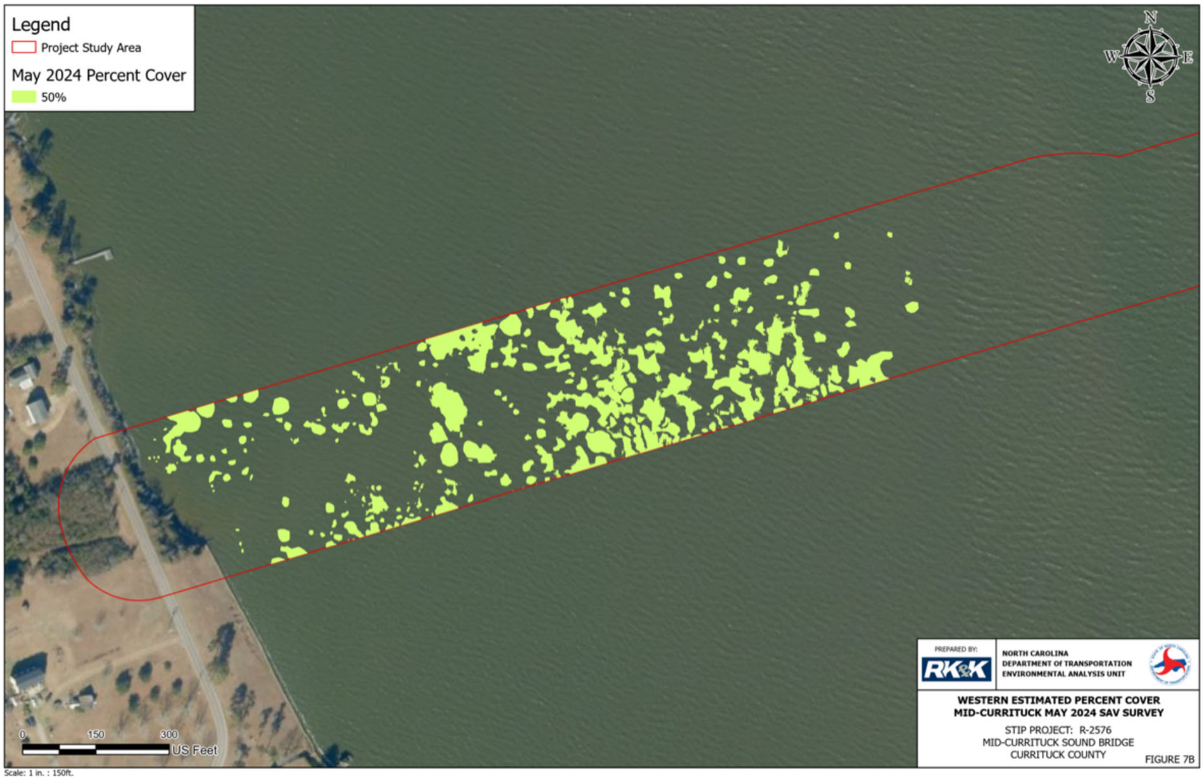
Scale: 1 in. : 150 ft.


Legend
Project Study Area
May 2024 Species Composition
Vallisneria americana (VA), Myriophyllum spicatum (MS), and Ruppia maritima (RM)
VA, MS, RM, and Najas guadalupensis
VA, MS, and RM
N
W
E
S
0
600
1,200
US Feet
Scale: 1 in. : 600 ft.
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT Of TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
EASTERN SPECIES COMPOSITION
MID-CURRITUCK MAY 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 5A


Legend
Project Study Area
May 2024 Species Composition
Vallisneria americana (VA), Myriophyllum spicatum (MS), and Ruppia maritima (RM)
N
W
E
S
0
150
300
US Feet
Scale: 1 in. : 150 ft.
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
WESTERN SPECIES COMPOSITION
MID-CURRITUCK MAY 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 5B

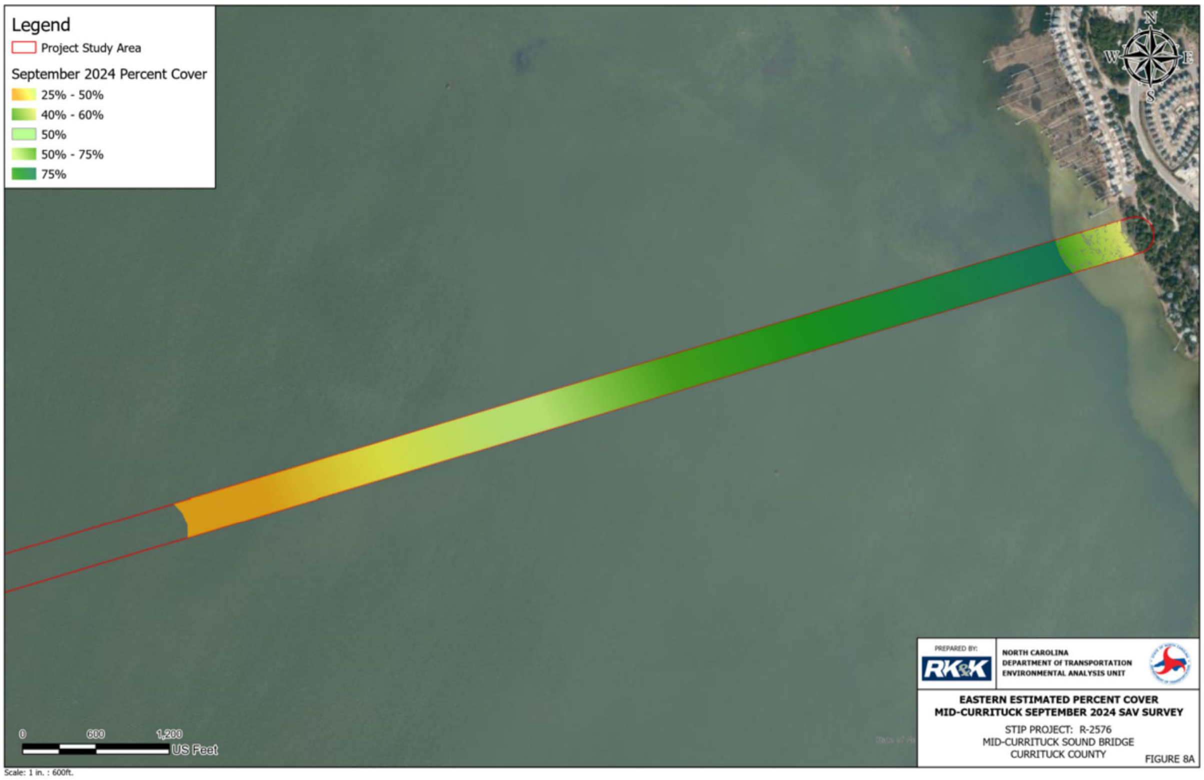

Legend
Project Study Area
September 2024 Species Composition
Vallisneria americana (VA), Myriophyllum spicatum (MS), and Ruppia maritima (RM)
VA, MS, RM, and Najas guadalupensis
VA, MS, and RM
N
W
E
S
0
500
1,000
US Feet
Scale: 1 in. : 500 ft.
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT Of TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
EASTERN SPECIES COMPOSITION
MID-CURRITUCK SEPTEMBER 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 6A

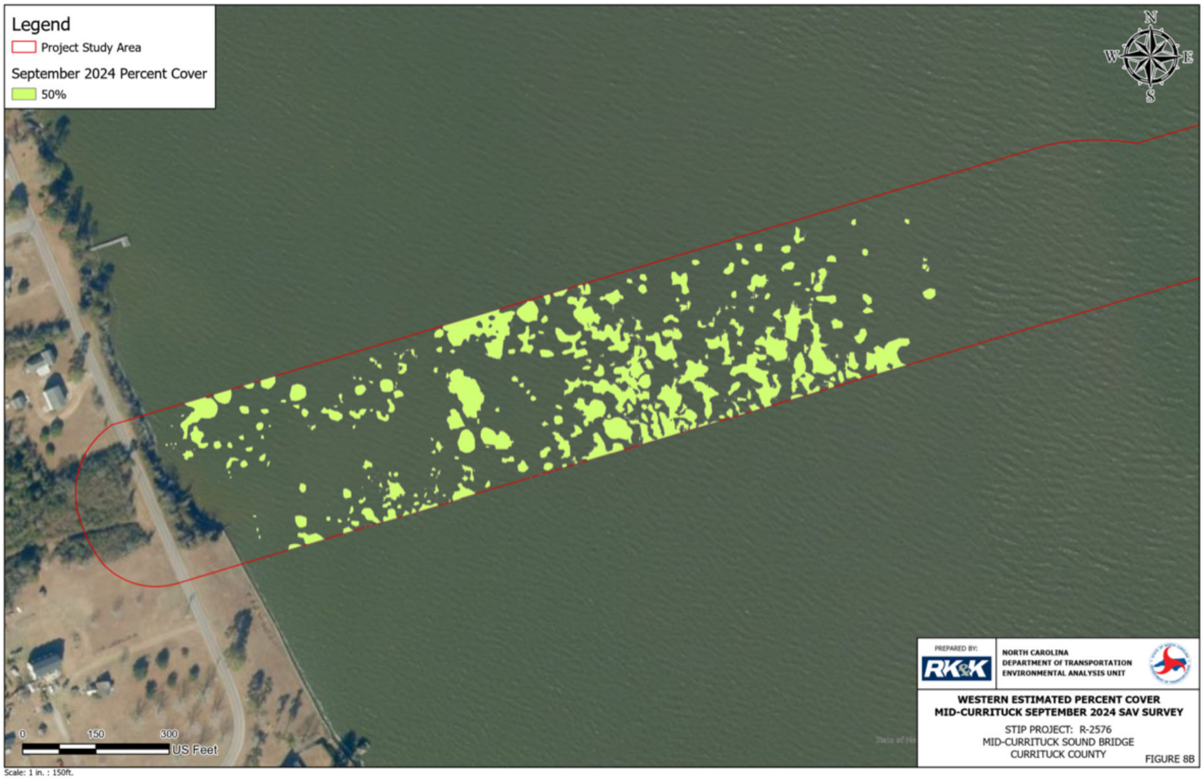

Legend
Project Study Area
September 2024 Species Composition
Vallisneria americana (VA), Myriophyllum spicatum (MS), and Ruppia maritima (RM)
N
W
E
S
0
150
300
US Feet
Scale: 1 in. : 150 ft.
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
WESTERN SPECIES COMPOSITION
MID-CURRITUCK SEPTEMBER 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 6B

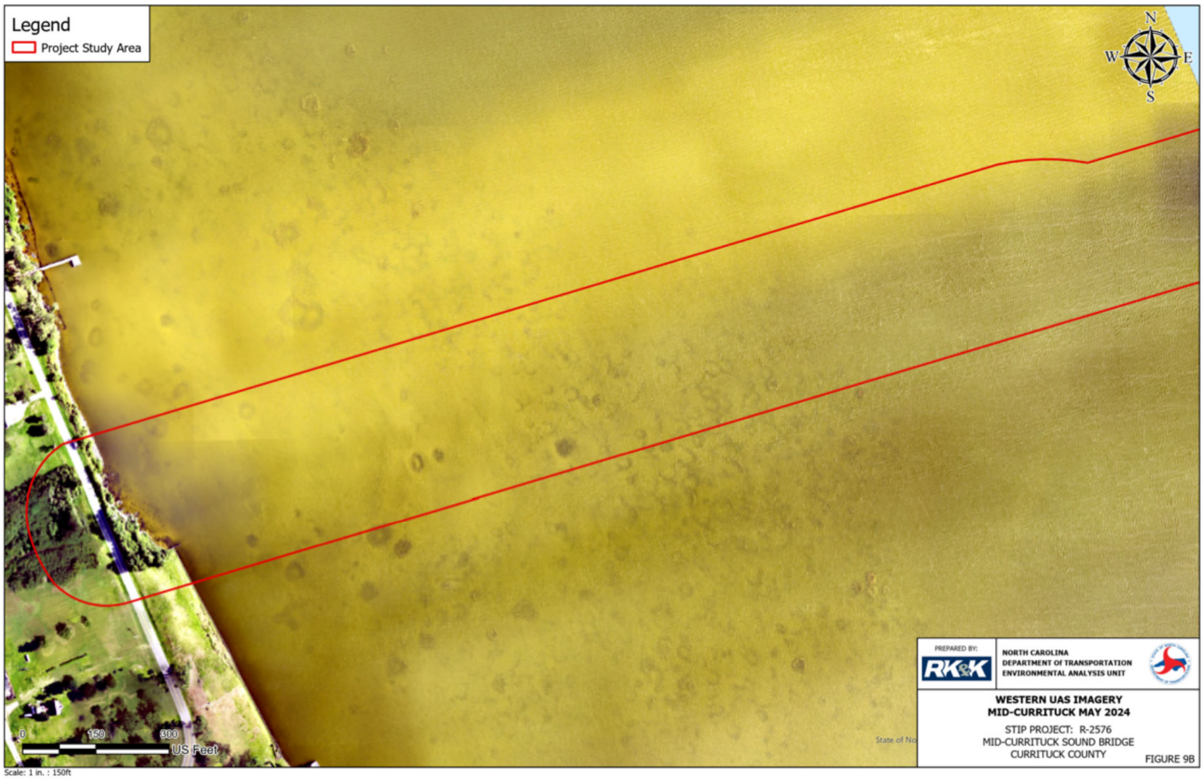


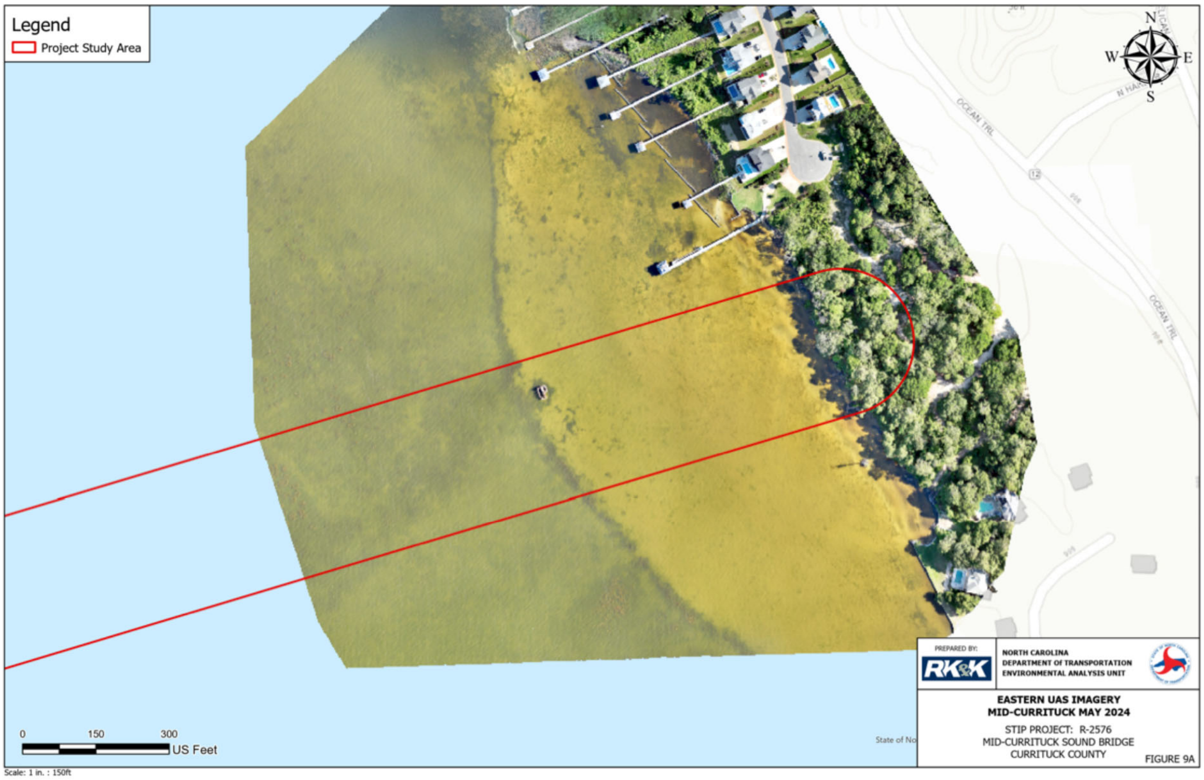
Scale: 1 in. : 150ft.


Legend
Project Study Area
May 2024 Percent Cover
25% - 50%
50%
50% - 75%
<50%
0
600
1,200
US Feet
Scale: 1 in. : 600ft.
PREPARED BY:
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
EASTERN ESTIMATED PERCENT COVER
MID-CURRITUCK MAY 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 7A


Legend
Project Study Area
September 2024 Percent Cover
25% - 50%
40% - 60%
50%
50% - 75%
75%
0
600
1,200
US Feet
Scale: 1 in. : 600ft.
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
EASTERN ESTIMATED PERCENT COVER
MID-CURRITUCK SEPTEMBER 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 8A


Legend
Project Study Area
September 2024 Percent Cover
50%
N
W
E
S
0
150
300
US Feet
Scale: 1 in. : 150ft.
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
WESTERN ESTIMATED PERCENT COVER
MID-CURRITUCK SEPTEMBER 2024 SAV SURVEY
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 8B


Legend
Project Study Area
N
W
E
S
0
150
300
US Feet
Scale: 1 in. : 150ft
State of No
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
WESTERN UAS IMAGERY
MID-CURRITUCK MAY 2024
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 9B


Legend
Project Study Area
N
W
E
S
OCEAN TRL
0
150
300
US Feet
Scale: 1 in. : 150ft
State of No
PREPARED BY:
RK&K
NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL ANALYSIS UNIT
EASTERN UAS IMAGERY
MID-CURRITUCK MAY 2024
STIP PROJECT: R-2576
MID-CURRITUCK SOUND BRIDGE
CURRITUCK COUNTY
FIGURE 9A