Shorter's Wharf Tidal Marsh Restoration Project

Draft Environmental Assessment

U. S. Fish and Wildlife Service

12/2/2015

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Chapter 1 Purpose and Need

1.1 Introduction and Background

Blackwater National Wildlife Refuge, located 12 miles south of Cambridge, Maryland, protects over 28,000 acres of tidal marsh, mixed hardwoods and loblolly pine forests, freshwater wetlands, and croplands (Figure 1). The Blackwater River meanders through the central part of the refuge and is a tidal tributary of Chesapeake Bay. The Blackwater River spans the single largest area of brackish marsh within the Chesapeake Bay watershed, and is of regional ecological significance for its wetlands and for the wildlife populations it supports. However, approximately 5,028 acres of tidal marsh have converted to open water since 1938 as a consequence of impacts associated with rising sea level, hydrologic changes, and wildlife damage (Scott et al 2009). This represents one of the most significant areas of marsh conversion to open water within the Chesapeake Bay.

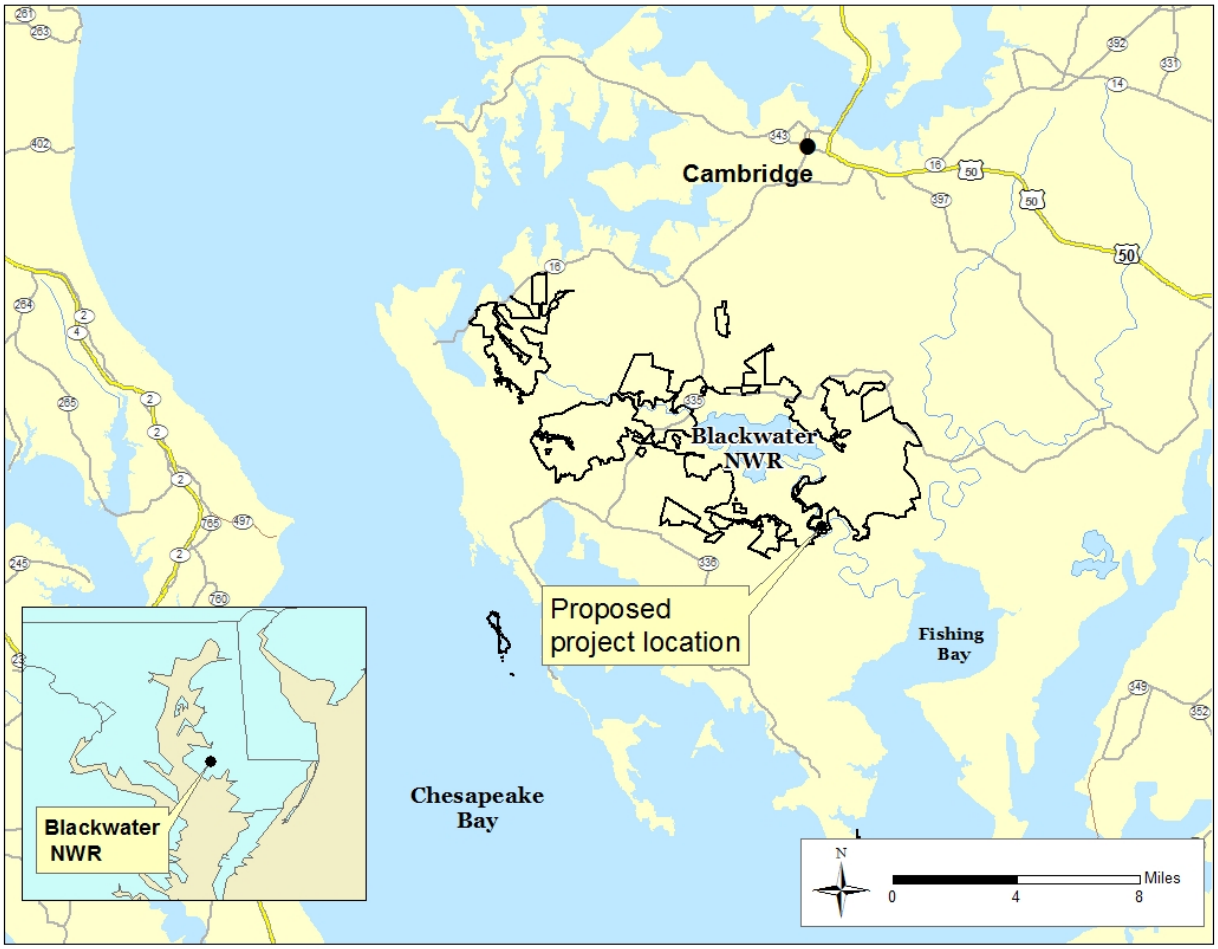
Normally tidal marshes are self-maintaining ecosystems that build vertically (accrete) from the accumulation of tidal mineral sediment and plant remains, as long as the relative rate of sea level rise is not too excessive. However, in marshes of the Blackwater River system the vertical development of the marsh surface, either through accretion or the development of belowground biomass, does not appear to be keeping pace with rates of relative sea level rise (Cahoon and Guntnerspergen 2010). The principal process of marsh loss in the Blackwater-Nanticoke system has been the interior breakup and fragmentation of formerly contiguous marsh, leading to the formation of ponds in the marsh interior, which expand via wave erosion and coalesce into larger ponds. The mechanisms contributing to Blackwater's tidal marsh loss are generally attributed to a combination of sea level rise, subsidence, and herbivory by nutria.

One measure that has been taken to slow tidal marsh loss is an effort to eradicate nutria (*Myocastor coypus*), a destructive non-native rodent species, from the Delmarva Peninsula. The multi-agency Chesapeake nutria eradication program has successfully slowed the rate of marsh loss in the project area in recent years. Anecdotal observations suggest that a marsh will recover if nutria are removed from an area before the root mat is destroyed and marsh surface elevation is lost. Eradication of nutria is a critical step toward the long-term survival of marshes in the project area. Now that nutria have been effectively eliminated from Blackwater NWR and efforts continue to eradicate them from surrounding watersheds, the primary remaining threat to the survival of the tidal marsh is accelerating relative sea level rise.

Globally, sea levels have risen over the past century at an average rate of about 1.8 mm per year due to the thermal expansion of the world's oceans from a warming climate (Miller and Douglas, 2004). The local rate of sea level rise at Blackwater is currently 3.44 mm per year, greatly exceeding the global rate, as a consequence of regional land subsidence adding to the effects of global sea level rise (Boon et al 2010). Regional subsidence in the Blackwater area is a natural

consequence of the glacial isostatic adjustment that has occurred since the last ice age. In addition, however, regional groundwater withdrawals to support agriculture and other human consumptive uses are suspected to be increasing the rate of land subsidence, and consequently increasing the rate of local relative sea level rise. The rate of sea level rise is forecast to increase during the 21st century as a consequence of ongoing global warming. An analysis by the Scientific and Technical Workgroup of the Maryland Commission on Climate Change indicates that sea level could rise from 0.6 to 1.3 feet (0.18 to 0.39 meters) by the middle of the current century, and by more than 3 ft (1.03 meters) by the year 2100 (MCCC 2008). In a 2013 update to the Commission's 2008 report, a panel of Maryland and national experts revised projections upward to 1.1 meters, or 3.7 feet, as its 'best estimate' of relative sea level rise that would affect the region by 2100 (MCCC 2013).

Figure 1. Vicinity map and proposed project location, Blackwater NWR, Dorchester County, MD



Rising sea levels lead to marsh loss via erosion because salt marsh plants, though well adapted to life in the intertidal zone, can only tolerate a certain frequency, depth, and duration of flooding before plant vigor declines and drowning occurs. Elevation capital in a marsh system refers to

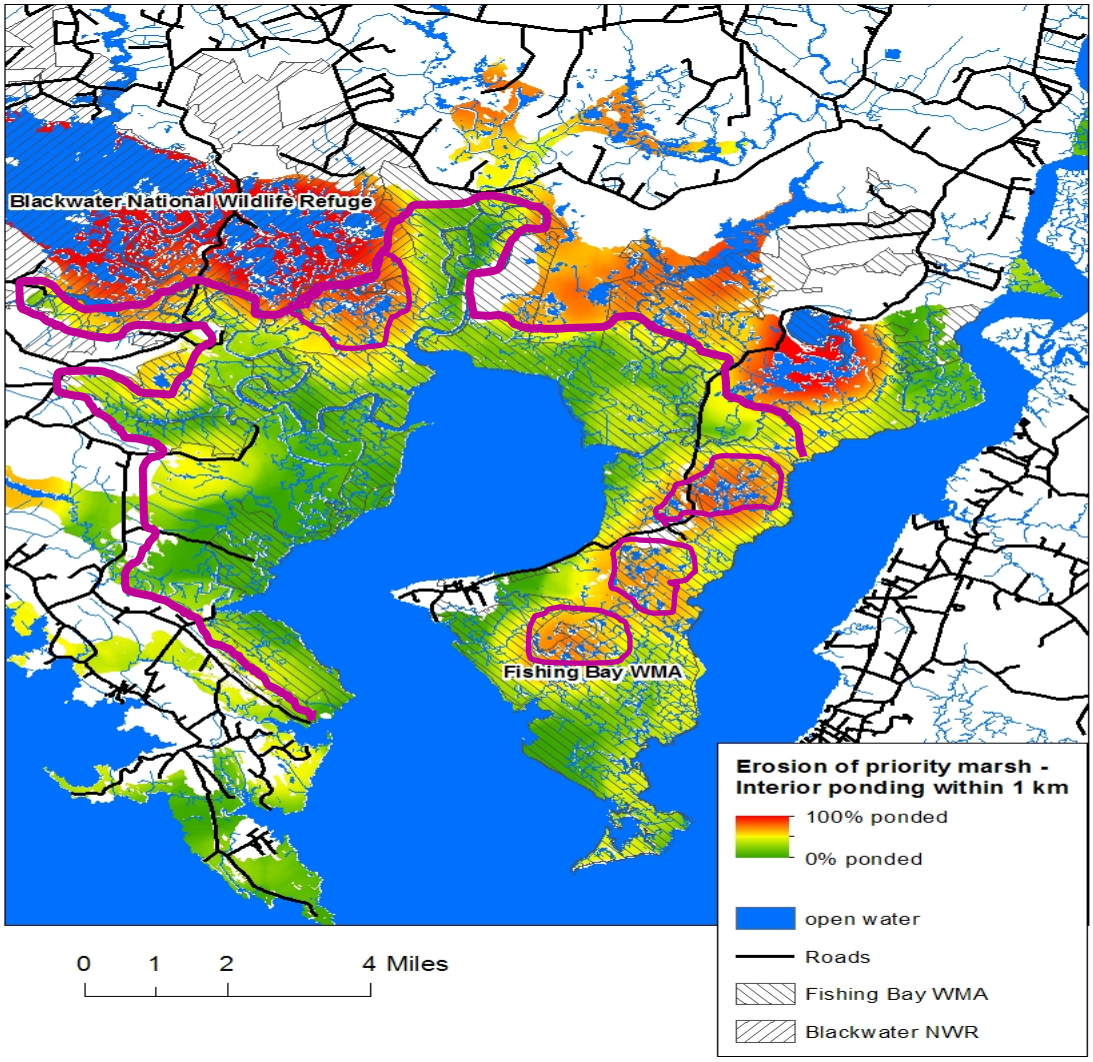
the elevation of the marsh surface relative to the lowest elevation the native marsh plants can survive within the local tidal range (Cahoon and Guntenspergen 2010). The higher the marsh surface elevation relative to the growth range for these intertidal plants, the more elevation capital and longer a marsh can exist with an elevation deficit. However, much of the marsh along the Blackwater River appears to currently have a surface elevation below ideal growing conditions within this tidal range (Kirwan and Guntenspergen 2012).

In 2013 a suite of climate adaptation strategies, focused on sea level rise, was completed for Blackwater NWR and surrounding areas of Dorchester County by the Blackwater Climate Adaptation Project (BCAP), a collaboration of The Conservation Fund, Audubon Maryland-DC and USFWS, actively assisted by Maryland Department of Natural Resources (MD DNR). The goal of the BCAP was to develop strategies that, despite accelerating sea level rise, would ensure the long term persistence of Dorchester County's extensive tidal marsh ecosystem together with its full assemblage of associated bird species and other wildlife. The BCAP mapped projections of wetland change according to Sea Level Affecting Marshes Model (SLAMM), a computer-based model used by Maryland's agencies and elsewhere to project sea level rise from climate change. Application of SLAMM forecasts a near total loss of high tidal marsh at Blackwater NWR with 1.03 m of sea level rise in the absence of adaptation measures.

A key strategy identified in the BCAP is to enhance the resiliency of tidal marsh habitats to the impacts of sea level rise in priority areas. The area identified as one of the highest priorities for this type of work is the Blackwater-Fishing Bay Marsh Conservation Zone (MCZ) [See Figure 2.] The MCZ comprises approximately 25,000-acres of tidal marsh surrounding Fishing Bay where management actions are likely to yield the greatest long-term conservation benefits for high tidal marsh and its suite of obligate salt marsh birds. The MCZ was delineated based on analysis of factors such as intact high quality salt marsh and presence of relatively high breeding populations of high priority salt marsh obligate species, such as black rail (*Laterallus jamaicensis*) and saltmarsh sparrow (*Ammodramus caudacutus*). The BCAP recommended that sediment enhancement techniques be used to maintain the integrity of the MCZ in targeted areas despite loss of surrounding marsh areas that had lesser ecological and strategic value to slowing sea level rise impacts (Lerner *et al.* 2013).

In August 2006, the Chesapeake Marshlands NWR Complex completed its Comprehensive Conservation Plan (CCP) for the refuges it administers, including Blackwater NWR. The CCP provides long term guidance for management decisions and sets forth goals, objectives, and strategies needed to accomplish refuge purposes. The process to develop the CCP included development of an EA in May 2005. The large-scale use of thin-layer deposition of dredged material for the purpose marsh restoration is specifically discussed on pages 4-15 and 4-16 of the Draft CCP and EA (USFWS 2005), and became Objective 1.1.2 for the refuge in the final CCP (USFWS 2006).

Figure 2. Outline of the Marsh Conservation Zone for the Blackwater-Fishing Bay area, Dorchester County, Maryland.



1.2 Purpose and Need for the Proposed Action

The purpose of this project is to prevent the loss of approximately 40 acres of high tidal marsh within Blackwater NWR at Shorter's Wharf to erosion. Furthermore, the project is designed to increase resiliency to relative sea level rise and storm impacts through sustainable and cost-effective habitat restoration measures. The project is needed to restore tidal marsh elevation and thereby increase plant productivity. Increased plant productivity, by adding more organic material in future years, will help this key tidal marsh area keep pace with rising relative sea. Without this action, the marsh at the project site will likely convert to open water in the near future.

The proposed restoration work will prevent the erosional loss of approximately 40 acres of high tidal marsh within Blackwater NWR at Shorter's Wharf by the use of sedimentary materials from the adjacent Blackwater River to elevate the marsh surface. Due to its low elevation in the growth curve of native tidal marsh plants and thus the decline of naturally generated organic material from those plants, the marsh at the project site is deteriorating. The root mat is disintegrating and interior ponds are expanding (figures 3-5), the same process by which much of the marsh at Blackwater NWR has been lost to open water in recent decades.

The projected loss of the tidal marsh at the project site location is supported by both the prevailing model for sea level rise and by direct observation. SLAMM predicts that, without intervention, the project site will convert from irregularly flooded high marsh to daily flooded low marsh under 42 cm of sea level rise (expected by 2050) and will fully convert to open water under 72 cm of sea level rise (expected by 2075; Lerner *et al*. 2012). Observations of the process of marsh loss at Blackwater and measurements of the recent expansion of interior ponds at the project site suggest that the high marsh currently dominant at the project site will likely convert directly to open water.

Recent advances in the understanding of the mechanisms of tidal marsh loss provide insights into how marsh loss to sea level rise might be slowed by appropriate management. While the wetland obligate plant species that characterize the tidal marshes of Dorchester County are well adapted to life in this environment, there are limits to the amount of flooding they can tolerate. Excessive inundation reduces substrate aeration and increases the phytotoxin hydrogen sulfide (Crain et al 2009). These stressors reduce the vigor of wetland plants and can eventually lead to plant mortality. The results of this process can be seen on the landscape as the internal fragmentation and breakup of formerly intact marsh.

Figure 3 – Aerial imagery of project area, May 1938

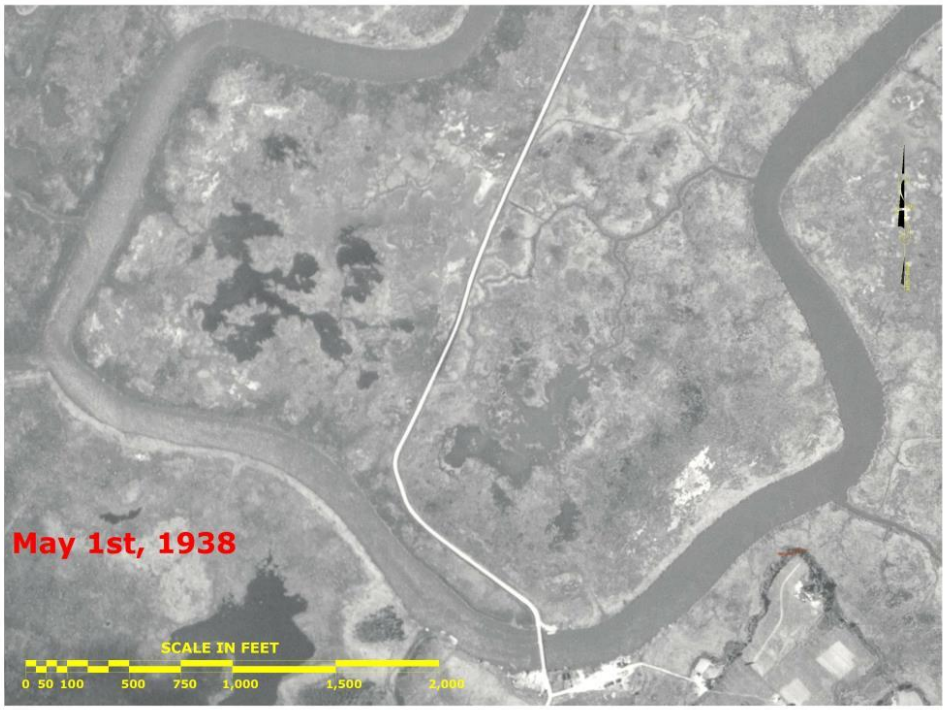


Figure 4 – Aerial imagery of project area, May 1964

Figure 5 – Aerial imagery of project area, May 2013

At Blackwater, excessive inundation is caused by low elevation of the tidal marsh surface. More than 80% of elevation points recently surveyed on Blackwater NWR were found to be well below the elevations needed for optimum plant growth for our tide range (Kirwan and Guntenspergen 2012). When tidal marsh vegetation is at an elevation higher than the optimum for growth, rising water levels actually serve to stimulate increased rates of root zone productivity, resulting in increasing rates of organic accretion. This is the mechanism by which Atlantic tidal marshes have kept pace with sea level rise over thousands of years (Redfield 1972). However, when marsh vegetation is at an elevation below growth optimal levels, the rising sea level will further inhibit root zone growth. In sediment-poor marsh systems, such as the system at Blackwater NWR, vertical marsh development is particularly dependent on organic accretion driven by below-ground biomass production (Cahoon et al. 2010).

The thin-layer deposition of sediments on a tidal marsh surface can increase marsh elevation and create soil conditions more conducive to healthy vegetation growth. Various techniques of sediment enhancement have been used in other US locations to increase marsh elevation, restore interior ponds to vegetated marsh and build wetland resilience to sea level rise or recover from a disturbance (Ford et al. 1999, Slocum *et al.* 2005, Schrift *et al.* 2008, and La Peyre *et al.* 2009). Sediment enhancement has been shown to increase soil aeration and reduce hydrogen sulfide

levels as well as building elevation (Slocum *et al.* 2005). Most studies report increased vegetation cover, in most cases *Spartina alterniflora*, but have not reported significant changes in species composition as a result of sediment enhancement (Ford *et al.* 1999, Slocum *et al.* 2005, La Peyre *et al.* 2009).

When artificial sediment enhancement techniques are used to build marsh elevations, the final elevation as it relates to local tide regimes is critical to the success of the project. Kirwan and Guntenspergen (2012) provide optimum elevation data for vegetation growth in the Blackwater River system. Threesquare (*Schoenoplectus americanus*) was found to have the highest plant growth at 20 cm NAVD88, while the optimal level for meadow cordgrass (*Spartina patens*) was 30 cm NAVD88. Elevations of emergent marshes in the Blackwater River vary, but are currently at 10-15cm NAVD88, significantly below the elevation required to support healthy irregularly-flooded high marsh vegetation. While lower elevations are now common (10-15 cm NAVD88), the historic Blackwater tidal marsh profile was likely much higher. Generally speaking, approximately 15-20 cm of material should be added to the typical marsh in the Blackwater River system to raise the surface elevation sufficiently to promote natural processes of marsh accretion and thus increase the longevity of these wetlands.

The proposed project would build marsh elevation through thin-layer sediment applications using material dredged from the adjacent Blackwater River. The sediment enhancement will offer a twofold ecological benefit to marsh resilience: 1) The longevity of the marsh receiving thin layer sediment application will be extended by virtue of the raised surface elevation in relation to the tidal regime; and 2) Root zone production, and consequently rates of vertical accretion, should increase. Root zone production is the main driver of vertical accretion rates in the Blackwater River system (Cahoon and Guntnerspergen 2010). Building the marsh platform to an elevation that maximizes plant productivity will take full advantage of the capacity of the marsh to continue to build future elevation (Kirwan and Guntenspergen 2012). The purpose of this project is to not only build near-term tidal marsh elevation capital but also to raise the elevation of the plant community to the level at which there is positive feedback between rising sea levels and increased below ground biomass production.

As mentioned earlier, the proposed thin-layering project at Shorter's Wharf is part of a larger strategy to preserve much of the large, still intact marsh identified by the BCAP as the Blackwater-Fishing Bay Marsh Conservation Zone (MCZ) (Lerner *et al.* 2013). The MCZ strategy acknowledges that it is not feasible to preserve and restore all of the tidal marsh in the southern Dorchester County marsh system under the predicted sea level rise scenarios, and recommends a focused conservation effort on retaining the areas representing the best remaining tidal marsh habitat. The MCZ was delineated using the following criteria applied to high marsh habitat:

- Greatest longevity predicted by SLAMM under sea level rise scenarios.
- Most intact current condition, defined by lack of interior ponding.
- Highest abundance of seven obligate salt marsh bird species as measured by SHARP surveys carried out by Audubon Maryland-DC during 2011-12 as part of the Saltmarsh Habitat Avian Research Program (SHARP: http://www.tidalmarshbirds.org/)
- Extent of contiguous interior high tidal marsh area.

In addition, the proposed project site at Shorter's Wharf occupies a strategic location within the MCZ, being near its edge and lying adjacent to the Blackwater River which is a net exporter of sediment (Ganju *et al.* 2013), making the site particularly vulnerable to erosion. Shoring up these marshes along the eroding edge of the MCZ through habitat restoration is critical to maintaining the integrity and contiguity of the Zone in the face of sea level rise.

The proposed project focuses on restoring and making high, irregularly-flooded, tidal marsh habitat within the project area more resilient to erosional forces. Blackwater NWR has been characterized by its abundance of high marsh habitats and lack of low marsh (USACE, 2002). The recent loss of black rail populations within the project area is indicative of recent declines in the amount of high marsh habitat available. Black rail require irregularly-flooded marsh habitat dominated by *Spartina patens*, a native marsh grass species typical of high marsh. While black rail were regularly detected in the project area in the early 1990s (Maryland DNR, unpublished data), they are no longer present (Audubon Maryland-DC, unpublished data), indicating a loss of former high marsh habitat. Black Rails are still present elsewhere in the MCZ and it is possible that the proposed project could return the project site to a condition suitable for this species.

Due to the context of this larger strategy, the proposed sediment enhancement project represents an innovative approach to high tidal marsh restoration driven by increasing rates of relative sea level rise and internal marsh collapse. Rather than attempting to restore a classic profile of high and low marsh along an eroding shoreline, we propose to prevent an area of interior high marsh from rapid conversion to open water. Thus the target condition of the sediment application site is 100% high marsh. Restoring marsh elevation through the addition of sediment will build marsh resiliency by increasing plant productivity that will in turn add more organic material in future years to allow surface levels to keep pace with the rising relative sea level.

1.3 Scope of Analysis

This Draft EA documents current environmental and habitat conditions on Blackwater NWR, an analysis of potential improvements in the study area, and a summary of future conditions with and without restoration. The evaluations of the alternatives and recommendations are based on site-specific technical information and literature research. This information includes recent surveys and new mapping, environmental habitat and geotechnical evaluations. Alternatives and

their resultant impacts include various approaches to build marsh elevation and increase resiliency to sea level rise and storm impacts.

1.4 Public Participation and Coordination

Outreach and coordination efforts for the proposed project have been carried out though a number of means. The proposed project was part of a highly competitive grant process (2013-2014) managed by the National Fish and Wildlife Foundation (Hurricane Sandy Competitive Coastal Resiliency Grants Program). It was selected to receive one of only 54 grants from among more than 375 applications from the 13 states affected by Hurricane Sandy by a team of Federal agency scientists and other experts. Presentations on the proposed project have been given at the 7th National Summit on Coastal and Estuarine Restoration (November 2014) in Washington D.C. as well as to a number of USFWS-led workshops, reaching a broad audience of government and non-government representatives.

Articles referencing the assessment and strategies for tidal marsh persistence, including the proposed project, appeared in a special issue of *Chesapeake Quarterly* and in the *Bay Journal* during 2014 and 2015. (Chesapeake Quarterly, Vol 13, Nos. 203, The Future of Blackwater (October 2104); and Bay Journal (April 13, 2015). During 2015, presentations were also given to the Dorchester Shoreline Erosion Group, a group of concerned citizens, and Friends of Blackwater, a non-profit citizens support group for the refuge.

As part of the development of this EA, refuge staff will hold a public meeting on the proposed project during the public comment period. The date and location of this meeting will be posted on the refuge website, as well as advertised through a press release.

Coordination with State and Federal agencies began with a meeting with staff from USACE and MDE at the Easton, MD office of USACE on January 17, 2014. The pre-application meeting for the joint tidal wetland permit was held on-site on July 23, 2015. The project was presented at the Joint Evaluation Team meeting in Annapolis, MD on September 30, 2015.

Chapter 2 Alternatives Including the Proposed Action

Several alternatives were evaluated during the development of this EA. Various strategies for raising the elevation of the marsh were evaluated, including the beneficial use of dredged materials from navigation channels or the addition of off-site materials, were considered, but eliminated from further discussion. The Proposed Action, which involves dredging material from the Blackwater River for the purpose of building marsh elevation, is considered the most

effective and efficient way of meeting the purpose and need of the project. The alternatives, including a No Action Alternative, are discussed in the following section.

2.1 Alternative A – Proposed Action

The proposed action will involve placing material excavated from the Blackwater River in thin layers to elevate surface levels for optimal native marsh grass production on up to 40 acres of inundated and declining marsh. The project site (Figure 6 and 7) is located east of Shorter's Wharf and is bounded to the east by the Blackwater River and to the west by a historical tidal pond and Maple Dam Road. Two placement methods will be utilized, namely aerial spraying and pipe discharge. The tidal channel entrance at the project area will be initially plugged using sand wrapped in biodegradable matting. In the initial aerial material placement project, up to 28,000 cubic yards of dredged sediment material will be sprayed to create a 300 foot wide perimeter for the project area. For the second phase of pipe discharged materials, up to 29,000 cubic yards of dredge sediment material will be placed at the plugged tidal ditch to fill the failed marsh areas. The ideal elevation to support healthy marsh vegetation is +30 cm (0.98 ft.) elevation NAVD 88 (Kirwan *et al*, 2012). The average surveyed marsh plain elevation is +0.58 ft. and -0.30 ft. for the failed marsh zones.

The Blackwater River bathymetric survey reveals approximately 57,000 cubic yards in the inner meander bend is available assuming a 12 foot cut. These depositional materials are being exported from eroding marshes upstream in the Blackwater National Wildlife Refuge to Fishing Bay at a rate of 97 tons per day on average (Ganju *et al*, 2013). To obtain sedimentary materials for the thin-layer elevation project, a hydraulic dredge outfitted with aerial spray technology will dredge the inner meander bends by cutting a series of one foot benches down and waterward on each dredge pass. This stair-stepped dredging pattern will avoid the creation of a vertical downcut from the river edge and help maintain overall bank stability. The inner meander bends of the river will not be dredged below the current maximum river depth. This dredging plan will maintain bank stability and avoid creating deep holes in the river bottom that could create anoxic environments that negatively impact fish. Refuge staff will work with appropriate agencies to identify the time of year where restoration work will avoid and/or otherwise minimize adverse impacts to fisheries.

Dredged material will be pumped initially to the boat-mounted aerial spray equipment and discharged along the project perimeter to enhance the natural containment provided by the existing (natural) levee bank. Dredged material contained in slurry will be sprayed from the dredge boat using high-pressure hoses fitted with bevel nozzles over the marsh surface to be restored. Any gully will be plugged with staked hay bales. The dredged material will be sprayed for distances of up 300 feet onto the marsh surfaces to be restored. The aerial spray equipment

will pivot to allow even placement of material across the marsh surface. Material will be sprayed at thicknesses to achieve elevation goal of + 30 cm NAVD 88 when consolidated. Construction survey control will be established to ensure a uniform placement of materials.

After the initial aerial spraying is completed, the direct pipe discharge will be established at the main tidal ditch plug. Again, dredged material will be pumped from the hydraulic dredge. Survey control will also be established for this project phase to ensure the uniform application of the dredge materials.

After the thin layered dredged material has stabilized, the exposed surface will be surveyed to define the native marsh vegetation re-establishment zones. In areas where above ground vegetation is still evident, natural re-colonization will be allowed. In areas where existing marsh vegetation was covered, establishment by seeding is anticipated. For the failed marsh zones, different methods of native plant (e.g., *Spartina patens*) re-establishment will be used, including planting live plugs of various stock types combined with seeding methods. The results will be monitored, and the more successful re-vegetation method will be used to establish full vegetated coverage of the project's elevated marsh area. All seeding and planting will occur early in the seasonal growth cycle for the region (April to June) to maximize success rates.

A monitoring plan is being developed to ensure the proposed restoration project is meeting the purpose and need. The plan will include site specific performance standards and monitoring protocols adequate to determine if the project is performing as anticipated. Metrics will likely include: density of vegetation, response of breeding bird community to restoration, changes in below-ground biomass production, marsh elevation trajectory, ratio of vegetated marsh to open water, plant community composition, and rate of accretion of material in the Blackwater River at excavation sites. We are developing partnerships with USGS, Maryland DNR and regional academic institutions to develop and fully implement the monitoring plan. Monitoring reports will be made available to all interested parties.

Figure 6. Project location, Blackwater NWR, Dorchester County, MD

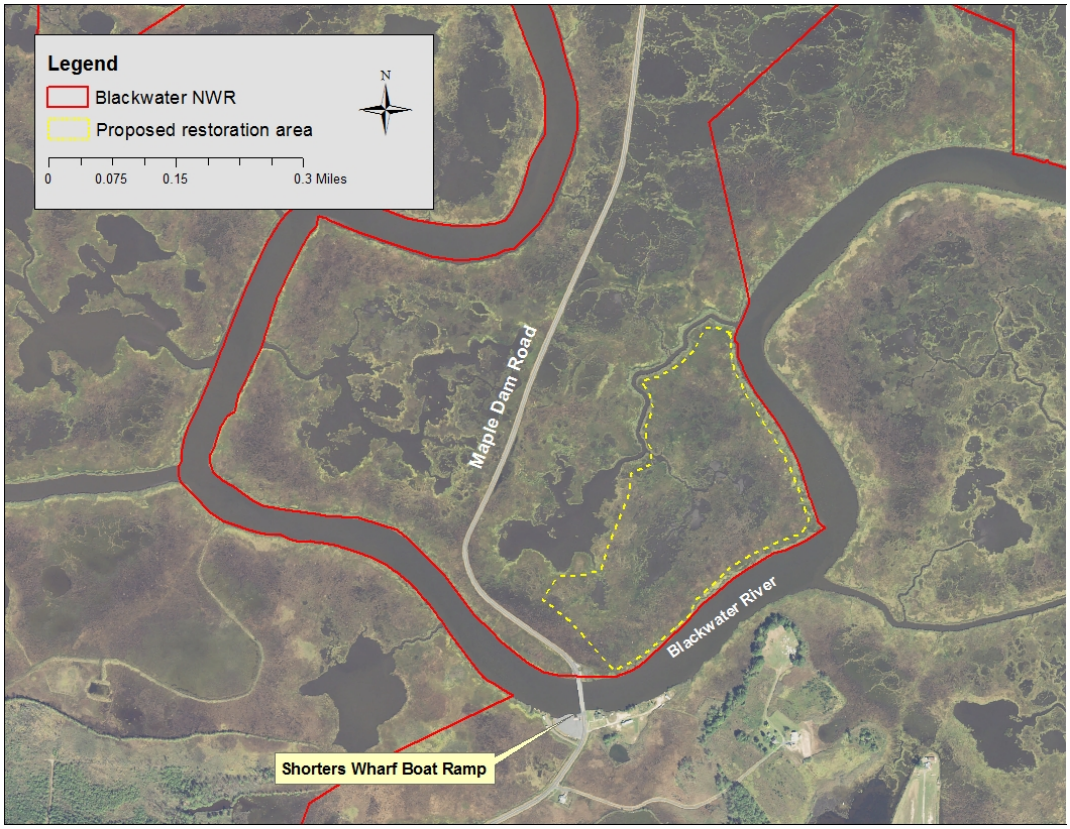
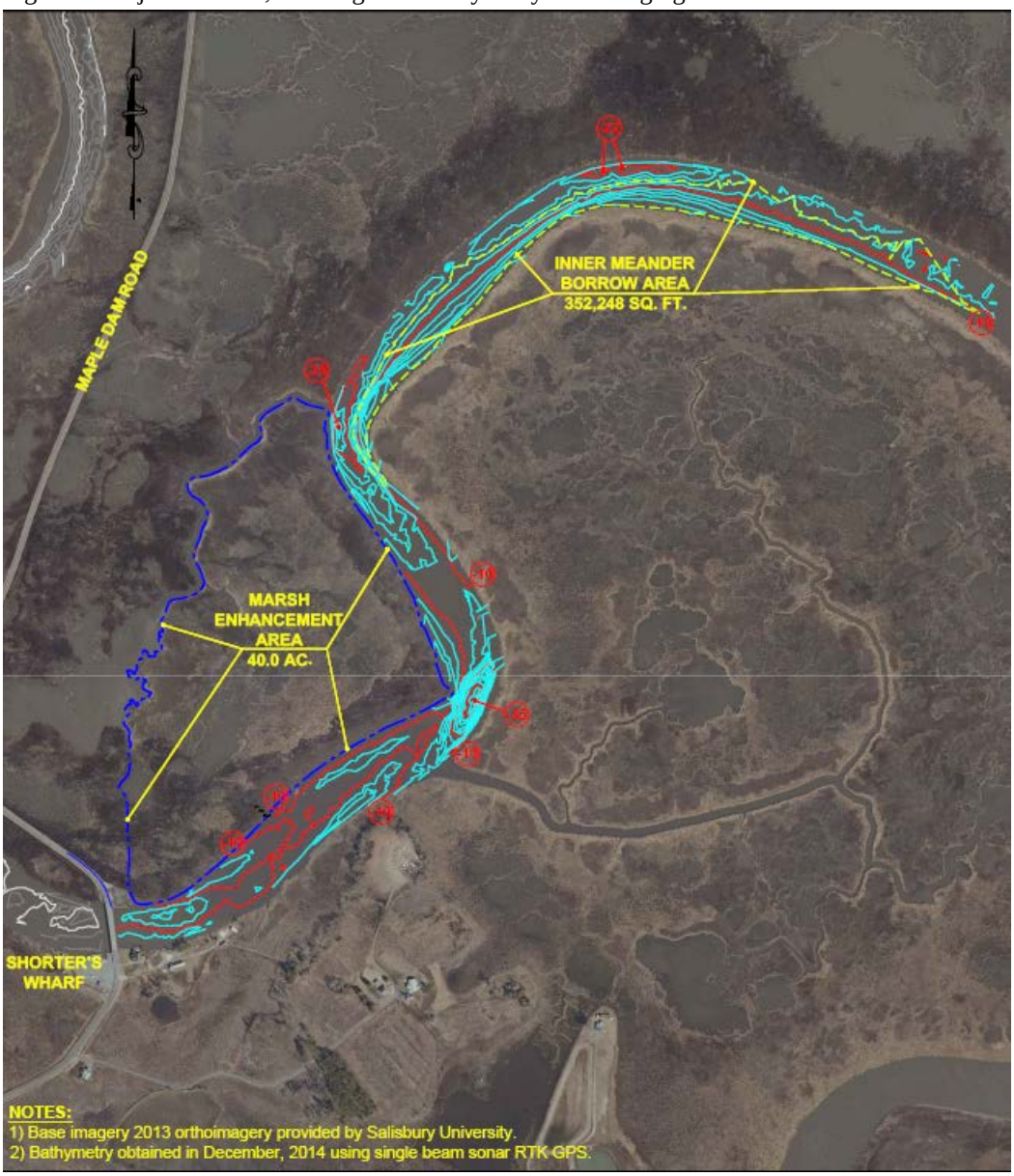


Figure 7. Project location, showing river bathymetry and dredging locations.



2.2 Alternative B – No Action

Inclusion of the No Action alternative is prescribed by Council of Environmental Quality (CEQ) regulations as the benchmark against which proposed Federal actions are to be evaluated. The No Action alternative is generally either 'no change' or 'do nothing' alternative to the Proposed Action. In this case, the No Action alternative involves not raising the elevation of the marsh to the proposed elevation of 30 cm NAVD88. Selecting the No Action alternative is equivalent to

allowing the existing baseline environmental conditions as identified in Chapter 3 of this document, to continue and deteriorate over time. Under the No Action alternative, rapid loss of tidal wetlands within the project area would continue, causing the loss of important fish and wildlife habitat as well as other associated ecosystem services. The full impact of the No Action and the Proposed Action are presented in Chapter 4 of this document.

2.3 Other Alternatives Considered

Additional alternatives were considered during the development of this EA but were eliminated from further discussion. These alternatives were dismissed because they do not meet the purpose and need of the project.

- One alternative to obtaining material from the Blackwater River would be the beneficial use of clean material from the maintenance dredging of navigation channels. The USACE has several navigation projects in the Fishing Bay area. However, dredging at these projects takes place only occasionally. Dredged material from these sources is not expected to be available in the foreseeable future. Additionally, the cost of transporting material to the project site would greatly increase the cost of the project, reducing the amount of habitat restored, and not meeting the purpose and need of the project.
- A second alternative to obtaining material from the Blackwater River would be the transportation of off-site material to the project, either via barge or truck. With this alternative, the cost of transportation would become the largest portion of the project cost, greatly reducing the amount of habitat restored and failing to meet the purpose and need of the project. Additionally, the transportation of material would create a relatively large carbon footprint, negating some of the benefits of this project which is being undertaken to counter the loss of tidal marsh due to the effects of climate-induced sea level rise.
- The addition of dredged material to an existing tidal marsh may cause temporary impacts to the wetland. An alternative to this approach would be postponing the project until the marsh has fully deteriorated through the effects of sea level rise and subsidence and has converted to open water. This alternative would require rebuilding a tidal marsh platform from a sub-tidal substrate. This would require the addition of much more material than need in the Proposed Action. This alternative would increase project costs, greatly decreasing the amount of habitat restored and failing to meet the purpose and need of the project. Based on rates of re-vegetation experienced on similar projects on Blackwater NWR, as well as recent work on Pepper Creek in Delaware, the temporary impacts caused by this project are expected to be brief, likely less than one growing season.

Chapter 3 Affected Environments and their Existing Conditions

This section provides a general overview of the physical environment, biological resources, and human community setting in the proposed project vicinity. Because all proposed work will occur within the tidal waters and tidal marsh of Blackwater National Wildlife Refuge, the refuge is the focus of discussion in this EA. Information on Fishing Bay and adjacent areas of Dorchester County is also provided where relevant or appropriate. The following description of affected environments is the result of a combination of literature reviews and site visits to the project area.

3.1 Physical Environment

3.1.1 Geologic Setting

Blackwater National Wildlife Refuge lies on the coastal plain physiographic province and is underlain by thick interbedded layers of ancient ocean, bay, and river sediments. Sea level has risen and fallen multiple times over geologic history. There were repeated cycles of incision and deposition during the Pleistocene as sea levels fluctuated. The marshes of the Blackwater River appear to have established approximately 910-690 years ago (DeJong *et al*, 2015) and have been building elevation in response to subsequent increases in sea level. Peats formed as the marshes accreted vertically while also expanding landward over uplands and non-tidal wetlands as sea level has risen. Peat deposits range from millimeters in thickness on the landward edge of marshes now forming on the drowning mainland, to about four meters thick on long established marshes, such as in the vicinity of Shorter's Wharf Road. Mineral sediments (such as clays and silts) that occur in the peats are provided to the marsh surface primarily by tidal waters. The marsh deposits contain a high proportion of organic matter (plant remains).

Ponds within the Blackwater marsh have formed from marsh drowning in place and converting to open water. Marshes in interior areas most isolated from tidal channels typically fail first. The substrates of these interior marshes are high in organic matter content and low in mineral sediment content, and their surfaces are less stable under conditions of continuously rising sea level. Once formed, ponds gradually increase in area as a consequence of continued marsh drowning and shoreline erosion. The rate of shoreline erosion increases as the ponds increase in size since this allows wind to produce larger waves within the pond.

Comparison of historic maps from the 1800s and 1900s and aerial photographs from the 1930s onward indicates that the Blackwater River and other channels of the marsh system have meandered little if at all over this period of time. Peat deposits in close proximity to the river channel with higher mineral content may serve to help control the channel positions, and inhibit meandering. As the marsh system fails, those marshes lining channels typically fail last. Upon

failure of the marshes defining the channels' positions, the channels cease to be defined features within the marsh, and connect instead to the growing expanse of open water habitat in what was formerly marsh.

Marsh failure generates substantial quantities of sediments that are then re-deposited locally or exported down the Blackwater River to Fishing Bay. These depositional materials are from the eroding marshes upstream in the Blackwater National Wildlife Refuge that is being exported to Fishing Bay at a rate of 97 tons per day on average (Ganju *et al*, 2013).

3.1.1.1 Sea Level Rise and Subsidence

Blackwater NWR faces threats from subsidence and sea level rise. Although marshes build elevation over time, primarily through plant growth, organic matter accumulation, and sediment deposition, many wetlands in the Chesapeake Bay are not able to keep pace with relative sea level rise.

Rising sea levels were part of the process that has been creating the Chesapeake Bay over the last 20,000 years. Tide gauges show that sea levels continued to rise in Maryland by 1 foot in the last century, a rate which appears to be twice the global average of 1.8 mm/yr. during the same time frame (Miller and Douglas, 2004). Global absolute sea levels calculated based on satellite altimetry from 1993-2008, the time period satellites have been available for this purpose, show a higher rate of sea level rise of 3.2 + 0.4 mm/yr. which indicate an increasing rate of sea level rise in recent years (Univ. of Colorado 2009).

Subsidence is a natural phenomenon, caused by rebound from the previous glacial period, which increases relative sea level rise on top of the accelerating pace due to climate change. Subsidence can be caused by deep shifts in the earth due to glaciations, plate tectonics and collapse of bulges in the earth's mantle. In the Mid-Atlantic, glacial isostatic adjustment appears to be occurring. The melting and retreat of glaciers have allowed some lands to rise in the northeast and others to collapse in the south leading to greater observed subsidence in the Mid-Atlantic (1.7 mm/yr) than in the Carolinas to the south (<0.9 mm/yr) or Maine to the north (<0.8 mm/yr.) (Engelhart et al. 2009). Subsidence in Dorchester County is 1.64 mm/yr. (Boon et al. 2010). Subsidence may also be caused by local or shallow changes in the land due to groundwater extraction, wetland drainage, deforestation, impoundments or other forms of sediment compression. These local factors, which have occurred in Dorchester County through ditching for mosquito control, hydrologic changes from development, and marsh destruction by invasive nutria, may also be partially responsible for the observed subsidence.

Relative sea level rise, based on tide gauges which do not separate absolute sea level from subsidence, is 3.44 + 0.49 mm/yr. for Cambridge, MD (Boon et al. 2010). The rate of sea level rise has increased since the late 19th century and is predicted to accelerate in the future. An analysis by the Scientific and Technical Workgroup of the Maryland Commission on Climate Change indicates that sea level could rise from 0.6 to 1.3 feet (0.18 to 0.39 meters) by the middle of this century. The analysis also states that accelerated melting could produce a relative sea level rise at the end of the century from 2.7 feet (0.82 meters), under a lower emissions scenario, to 3.4 feet (1.03 meters) under a higher emissions scenario. At this pace, 66% of existing tidal marshes in the county could be lost by the year 2050. The state estimates sea level will rise 3 ft (1.03 meters) by the year 2100 (MCCC 2008).

While SLAMM models are extremely useful for understanding how coastal habitats are likely to respond to sea level rise, they have limitations, particularly regarding the specific timing of the predicted habitat changes. Most importantly, the interactions between inundation, plant growth, organic matter accretion, and sediment deposition in tidal wetlands are non-linear (Kirwan et al. 2010). Where marsh platform elevation is high relative to local tides, increases in sea level can lead to an increase in plant root growth and a subsequent increase in marsh elevation, giving some marshes the ability to increase rate of elevation gain in response to rising sea levels. This important eco-geomorphic feedback is not accounted for in the current SLAMM.

3.1.1.2 Marsh deterioration

A major historical trend in the tidal marshes of southern Dorchester County has been the deterioration and loss of marshes from the Blackwater-Nanticoke marsh system. Marsh loss has been documented at Blackwater NWR by Stevenson et al (1985, 2002) and Scott et al (2009), and in the Nanticoke estuary by Kearney et al (1988).

Evidence from early USGS maps suggests that the Blackwater River marshes were relatively intact at the beginning of the 20th Century. However, the first aerial photographs available for the area show that by 1938 significant marsh loss had occurred near the confluence of the Big Blackwater and Little Blackwater Rivers through ponding in the marsh interior. By the 1980s the marsh had eroded to the point that the confluence of these rivers had become an open lake, now called Lake Blackwater. A similar pattern of marsh loss had occurred throughout the Blackwater system.

Changes in marsh extent at Blackwater NWR were measured by Scott et al (2009) from aerial photographs. Between 1938 and 2006 the refuge lost 5,028 acres (51.7%) of its marsh to open water, an average of 74 acres per year. During the same period the refuge gained 2,949 acres of marsh at the upland edge, presumably through upslope migration of marsh with rising sea levels.

These figures are subject to errors arising from suboptimal quality of the orthophotography (Scott et al 2009).

The principal process of marsh loss in the Blackwater-Nanticoke system has been the interior breakup and fragmentation of formerly contiguous marsh, leading to the formation of ponds in the marsh interior, which expand via wave erosion and coalesce into larger ponds. The mechanisms causing marsh loss are generally attributed to a combination of sea level rise, subsidence, and herbivory by nutria. In the marshes of the Blackwater River, studies indicate that vertical development of the marsh surface, either through accretion or the development of belowground biomass, does not appear to be keeping pace with rates of relative sea level rise (Cahoon et al. 2010).

The tidal marsh at the site of the proposed action at Shorter's Wharf is in early stages of deterioration. Although native marsh vegetation, mostly threesquare and smooth cordgrass (*Spartina alterniflora*), covers nearly all of the marsh surface, and bare mud is very infrequent, the root mat is in a state of decay with deep holes between individual plants. The instability of the marsh surface is evident from the softness of the ground when walking across the marsh.

3.1.2 Soils

Soils of the Blackwater tidal marshes are mapped as being of the Bestpitch-Transquaking series (these soils were formerly mapped as Tidal marsh). These soils are subject to flooding by salt water and occupy a majority of the current refuge. Bestpitch and Transquaking soils formed in moderately decomposed organic deposits from salt marsh plants that overlie clayey mineral estuarine sediments. The Bestpitch-Transquaking soils consist of 40 to 60 inches of organic deposits overlying clayey estuarine sediments, and have a low load-bearing capacity. As a consequence of being flooding by brackish water, these soils are saturated and have high sulfur contents; the soils become acidic if drained and dried.

3.1.3 Bathymetry

South of Shorter's Wharf Road, adjacent to the proposed project area, tidal scour serves to maintain a relatively deep channel within the Blackwater River. Water depths within the river channel are typically 10-15 feet deep in this area. Isolated holes of over 30 feet deep have been found on the outside of meander bends in the channel (Sustainable Science, LLC, unpublished data, 2015).

Water depths within the central part of the Blackwater River tend to vary depending on substrate type, the presence of submerged river and creek channels, historic ponds, and/or the length of time since marsh deterioration. Where the failed marsh root mat is relatively intact, or where

tree stumps are still present, tend to be the shallowest. Recent bathymetric surveys of waters immediately east of SH 335 found the elevations of failed marsh root mat ranged from 0-0.20 feet NAVD88 (GBA 2010). Nearby waters were 2 – 2.6 feet deep. Many of the historic named ponds that are now contained within larger open water areas were historically several feet or more deep. These historic pond areas have now generally shallowed as a consequence of sedimentation from marsh failure.

3.1.4 Hydrology

There are two high and two low astronomical tides daily (semidiurnal tides) in the study area. The astronomical tidal range in Fishing Bay is about 2.0 feet. Astronomical tides within the marshes of Blackwater National Wildlife Refuge are dampened from those of Fishing Bay because the marshes are connected to the tides only through the Blackwater River. The central part of the Blackwater River, adjacent to SH 335, is essentially non-tidal (Allen and Gill, NOAA, unpublished data).

Winds greatly influence tides of the area, and wind-driven tides often predominate over the astronomical tides. Wind-driven tides show pronounced seasonality, with water levels typically being higher in the summer when prevailing winds tend to blow water into Fishing Bay, and lower in the winter when prevailing winds tend to blow water out of Fishing Bay.

The main section of the refuge is drained by the Blackwater River, which flows southeastwardly into Fishing Bay. Major tributaries of the Blackwater River include Buttons Creek, Little Blackwater River, and Backgarden Creek on the north, and Meekins Creek, Coles Creek, and Raccoon Creek on the south. Buttons Creek flows southwardly into the Blackwater River about 1½ mile to the west of the Little Blackwater River.

The upper two-thirds of the Blackwater River is separated from the lower third by Maple Dam Road, which is a substantial barrier for water, sediment, and chemical transport. Maple Dam Road, also called Shorter's Wharf Road, runs north and south along the west side of Green Brier Swamp and then through the marshes for approximately 6.1 miles with no culverts.

The marshes of Blackwater are irregularly flooded by the tides. This irregularity occurs as a consequence of the variability in wind tides (as discussed above), as well as the ecological process by which tidal marshes are built that promotes surface accretion to about mean high water. The surface of tidal marshes may be dry or flooded for extended periods depending on prevailing winds.

3.1.5 Water Quality

The Blackwater River serves as the principal route for salt water from the bay to penetrate the refuge. Saltwater also penetrates the refuge through Parson's Creek and other smaller sources of saltwater intrusion into the upper reaches of the Blackwater River. Salinity in the refuge varies as a function of proximity to these sources. The freshest water is consistently found near the mouth of Buttons Creek. Tidal waters of the refuge are brackish for much of the year, but salinity in the refuge fluctuates seasonally. During the winter with high rates of runoff, the entire river system within the refuge is nearly fresh. Following major precipitation events, freshwater runoff can also greatly lower marsh salinity. In contrast, storm tides associated with hurricanes or Nor'easters can inundate large areas with salt water, causing major tree mortality in swamps and upland areas. Drought conditions also promote greater salinities in the tidal wetlands. During the period of 2009 to 2013, salinities at the Shorter's Wharf Bridge typically reached a high of 10-18 ppt in the late summer or fall. Lowest salinities found during the winter months, reaching as low as < 1 ppt some winters (USFWS, unpublished data).

Salinities of the Blackwater tidal wetlands are continuously increasing over the long-term as the sea floods the land; this increase can be expected to continue into the future. Human actions have likely caused alteration of salinity patterns that would otherwise prevail. Shorter's Wharf Road may contribute to maintenance of lower salinity waters in the refuge than would otherwise occur were more frequent exchange of tidal waters across the marsh from Fishing Bay occurring. Drainage of non-tidal wetlands bordering the tidal marsh has presumably caused greater salinity variations in tidal marshes of Blackwater than characterized this system prior to ditching. Although precipitation is received relatively evenly throughout the year (there are no wet or dry seasons), evaporation is most intense in warm weather months.

3.1.6 Air Quality

The ambient air quality in Maryland is determined by measuring the ambient pollutant concentrations in the air and comparing the measurements to a corresponding standard. The Environmental Protection Agency (EPA) has designated Dorchester County as an area for achieving attainment for nitrous oxides (NOx), sulfur dioxide (SO2), ozone (O3), lead particulate matter and carbon monoxide (CO). (U.S. Environmental Protection Agency, 1992).

3.1.7 Climate

The influence of the Atlantic Ocean and Chesapeake Bay cause the Eastern Shore to have generally mild winters, and summers with high humidity and relatively warm days and nights. Summer temperatures normally reach into the upper 80s °F and occasionally climb into the 90s °F. July is the warmest month. February is the coldest month, with an average daily minimum temperature of 26°F. The watershed has a frost-free period of approximately 183 days.

During the colder half of the year (October-March), a frequent succession of high and low pressure systems bring alternate surges of cold, dry air from the north, and warm, humid air from the south. During the summer, moist air spreads northward from the south and southwest, and remains over the area much of the season. Intense low pressure storms (hurricanes and northeasters) can bring torrential rains and winds of hurricane force to the Eastern Shore especially during the months of August, September, and October. Average annual rainfall is approximately 43 inches. Of this, about 23 inches, or 53%, usually falls in April through September during the growing season for most crops, however droughty conditions are common during extended periods without precipitation. Thunderstorms occur most frequently in July. Normally, August is the wettest month and October the driest. Average snowfall is 15 inches. The prevailing wind is from the south. Average wind speed is highest, 11.0 miles per hour, in March.

3.2 Biological Environment

3.2.1 Vegetation

3.2.1.1 Intertidal Zone

Blackwater National Wildlife Refuge is dominated by tidal wetlands. Tidal wetland vegetative character is controlled by several factors, including salinity, frequency and duration of tidal flooding, substrate character, and frequency and severity of disturbances. Nearly all the tidal wetlands in the project area are irregularly flooded by tidal waters, and as such represent high marsh. Since brackish water conditions predominate in the tidal waters of the refuge and salinities are sufficiently strong to kill trees and shrubs in the majority of the tidal wetlands, the majority of the tidal wetlands are vegetated by marsh plants that can grow in brackish water salinities. The tidal marshes of Blackwater have been periodically burned since colonial times, and are currently still burned frequently to promote marsh vegetation that will support desired game species. Consequently, fire is an important variable controlling marsh species distribution.

Several plant associations occur within the irregularly-flooded brackish tidal marshes. Three-square dominates the tidal marshes of Blackwater. The three-square marshes are what has historically made Blackwater world famous as a haven to waterfowl. Three-square thrives in highly organic marsh soils characteristic of the refuge, however three-square dominance has been maintained by frequent marsh burning.

Other important plant species of the brackish marsh includes needlerush *(Juncus roemerianus*), smooth cordgrass, meadow cordgrass, spikegrass *(Distichlis spicata)*, big cordgrass *(Spartina cynosuroides)*, and cattail *(Typha* spp.). Phragmites is common on the refuge and considered

dominant in some areas. Cattail is found in the least saline areas. Stands of big cordgrass tend to occur along the banks of the rivers, creeks and guts.

At the Shorter's Wharf project site marsh vegetation is dominated by a patchwork of threesquare and smooth cordgrass, existing mostly as monotypic stands. Threesquare predominates in the lower areas. Areas dominated by *S. alterniflora* frequently have *S. patens* as a minor constituent. Patches of *S. patens* are present mostly close to the river edge where the ground is higher. Big Cordgrass forms a fringe along portions of the bank of the Blackwater River and along interior creeks.

3.2.1.2 Uplands

Upland vegetation at Blackwater NWR includes evergreen forests of loblolly pine, deciduous forests, and small amounts of cropland that are managed for wildlife use. The project site at Shorter's Wharf does not contain any uplands.

3.2.1.3 Submerged Aquatic Vegetation (SAV)

Only small amounts of SAV can be found in the Blackwater system. Widgeongrass (*Ruppia maritima*) will occasionally be found on sunken mats of marsh peat. These mats are frequently dewatered during strong wind events and rarely produce viable stands of SAV. There are no records of SAV within the project area.

3.2.2 Aquatic Species

3.2.2.1 Finfish and Shellfish

The tidal creeks and shallow ponds at Blackwater NWR provide spawning, nursery, and/or feeding habitat for a variety of finfish and shellfish. Many fish species move into shallow waters in summer and out to deeper waters in the Chesapeake Bay in the fall. The most common finfish found on Blackwater NWR include black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), brown bullhead (*Ameirus nebulosus*), common carp (*Cyprinus carpio*), gizzard shad (*Dorosoma cepedianum*), pumpkinseed (*Lepomis gibbosus*), and white perch (*Morone americana*) (Love et al. 2008). Northern snakehead (*Channa argus*), an invasive species, was first recorded in the Blackwater River on March 16, 2012 and have been recorded on the refuge every year since (USFWS, unpublished data). Most of the records are from the upper parts of the Blackwater River, but the species has been observed on Shorter's Wharf Road during flooded conditions.

White and yellow perch are semi-anadromous species that likely spawn in the refuge. Semi-anadromous fish species spawn in low salinity and freshwaters, then travel to the bays to spend

much of their adult life. The waters of the upper Blackwater River were historically a significant spawning ground for anadromous fish, however the river is now probably too salty.

3.2.2.2 Benthos

Benthos are bottom dwelling organisms in aquatic ecosystems and provide important functional processes of energy transfer and carbon sequestration. Although some benthos and other larger invertebrates are commercially valuable, the ecological significance of most benthic communities lies in their contributions to the food web.

Five grab samples were collected from tidal and subtidal habitats as part of a preliminary assessment of benthic communities on the refuge (Berger/EA Joint Venture 2004). Amphipods (*Gammarus sp.* and *Monoculodes edwardsi*) and/or Chironomids (*Chironomus sp.*) were numerically dominant in all samples.

3.2.3 Essential Fish Habitat

Nine species that are managed under the Magnuson-Stevens Fisheries Conservation Act (species for which the Chesapeake Bay provides Essential Fish Habitat [EFH]) were identified in the vicinity of the project area. A full analysis for EFH in the Project Area is presented in Appendix A.

3.2.4 Wildlife

Blackwater supports abundant wildlife, including many that are strongly associated with tidal marshes. Several amphibian and reptile species can be found in the brackish marshes of the refuge. Southern leopard frog (*Rana utricularia*), and northern water snake (*Nerodia sipedon sipedon*) all venture into the brackish marshes, although they are more commonly associated with freshwater habitats. The diamondback terrapin (*Malaclemys terrapin*) is the turtle species most closely associated with the refuge's tidal habitats; it generally doesn't venture into freshwater. Snapping turtle (*Chelydra serpentina*) and eastern mud turtle (*Kinosternon subrubrum*) also frequent the brackish marshes, although these latter species are more frequently encountered in freshwater habitats.

Many bird species utilize the wetland and open water habitats of the refuge. The refuge is notable as an important resting and feeding area for migrating and wintering waterfowl along the Atlantic flyway. Wintering waterfowl species include tundra swan (*Cygnus columbianus*), Canada goose (*Branta canadensis*), snow goose (*Chen caerulscens*), and more than 20 duck species. Typical species of duck include include American black duck (*Anas rubripes*), mallard (*A. platyrhynchos*), blue-winged teal (*A. discors*), green-winged teal (*A. crecca*), northern pintail (*A. acuta*), American wigeon (*A. americana*), and gadwall (*A. strepera*). Although most

waterfowl migrate north in the spring, some remain through the summer to raise their young. Wood duck (*Aix sponsa*) and mallard are the most common nesting duck species on the refuge. Canada Geese nest in the refuge, although historically they only utilized the area during migration or as a wintering ground.

Nesting species of raptors that use tidal marsh habitat at the refuge include: osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), northern harrier (*Circus cyaneus*), and barn owl (*Tyto alba*). In Maryland, northern harriers are largely confined to tidal marshes in the breeding season, and southern Dorchester County, including the refuge, supports a significant portion of the state's breeding harrier population, though none are known to nest in the project area. Additional raptor species frequent the marshes in low numbers during winter, including short-eared owl (*Asio flammeus*) and rough-legged hawk (*Buteo lagopus*).

During spring and fall, flocks of migrant shorebirds visit the refuge to rest and forage. Pools in the tidal marsh are the principal habitat used. Flocks can number in the hundreds, and the most abundant species include: dunlin (*Calidris alpina*) , greater and lesser yellowlegs (*Tringa melanoleuca* and *T. flavipes*), semipalmated sandpiper (*Calidris pusilla*), least sandpiper (*Calidris minutilla*), short-billed dowitcher (*Limnodromus griseus*), Wilson's snipe (*Gallinago delicate*), semipalmated plover (*Charadrius semipalmatus*). One shorebird species, willet (*Catoptrophorus semipalmatus*), breeds in tidal marshes at the refuge.

A variety of wadingbirds nesting on islands in the Chesapeake Bay visit the refuge's tidal marshes to forage, though only great blue heron (*Ardea herodias)* and green heron (*Butorides virescens*) nest along the Blackwater River. American bitterns (*Botaurus lentiginosus*) occur at Blackwater in small numbers in fall and winter and least bittern (*Ixobrychus exilis*) nests in tidal marsh at the refuge.

The tidal marshes at Blackwater support an assemblage of bird species that are specialists of salt marsh habitats and several of these are salt marsh obligates. These include American black duck, clapper rail (*Rallus longirostris*), black rail, coastal plain swamp sparrow (*Melospiza georgiana nigrescens*), saltmarsh sparrow, seaside sparrow (*Ammodramus maritimus*), and willet. Coastal plain swamp sparrow, saltmarsh sparrow and seaside sparrow are confined entirely to tidal marshes as are Atlantic coast subspecies of clapper rail and willet.

In 2015, marsh bird surveys were conducted at the Shorter's Wharf project site in order to gather baseline data on bird occurrence and abundance in the breeding season. A salt marsh obligate species, seaside sparrow, was the most abundant species at the site (Table 1). Other salt marsh specialists found at the project site were American black duck, clapper rail and willet. These are species for which the Blackwater-Fishing Bay Marsh Conservation Zone was identified.

Saltmarsh sparrow and coastal plain swamp sparrow were not detected at the project site but are known to occur at nearby locations on the refuge.

Table 1. Mean relative abundance (detections/survey point) of birds in tidal marsh at Shorter's Wharf (sediment application site – pre-treatment). 3 visits during May-July 2015.

Species	Detections within 100m of survey point	Detected only outside survey radius or survey period
American Black Duck (*Anas rubripes*)	0.16	
American Crow (*Corvus brachyrhynchos*)	0.08	
Bald Eagle (*Haliaeetus leucocephalus*)		P
Barn Swallow (*Hirundo rustica*)	0.08	
Caspian Tern (*Sterna caspia*)		P
Clapper Rail (*Rallus longirostris*)		P
Common Grackle (*Quiscalus quiscula*)	0.08	
Forster's Tern *(Sterna forsteri*)		P
Great Blue Heron (*Ardea herodias)*		P
Indigo bunting (*Passerina cyanea*)	0.08	
Laughing Gull (*Larus atricilla*)	0.17	
Least Bittern *(Ixobrychus exilis*)	0.33	
Mallard (*Anas platyrhynchos*)	0.17	
Marsh Wren (*Cistothorus palustris*)	3.84	
Northern Harrier (*Circus cyaneus*)		P
Osprey (*Pandion haliaetus*)	0.67	
Purple Martin (*Progne subis*)		P
Red-winged Blackbird (*Agelaius phoeniceus*)	7.67	
Semipalmated Sandpiper (*Calidris pusilla*)	0.08	
Seaside Sparrow (*Ammodramus maritimus*)	10.73	
Tree Swallow (*Tachycineta bicolor*)	0.16	
Virginia Rail (*Rallus limicola*)	0.42	
Willet (*Catoptrophorus semipalmatus*)	0.58	

The extensive wetland habitats on the refuge support many wetland dependent mammal species such as muskrat (*Ondatra zibethicus*) and river otters (*Lutra canadensis*). Red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*) and sika (*Cervus nippon*) are also found at Blackwater. Nutria, an invasive species, was formerly present at Blackwater in very high numbers. Nutria populations were responsible for a great deal of marsh

loss and habitat destruction. However, the Chesapeake Bay Nutria Eradication Project has successfully reduced nutria numbers on the refuge to near zero.

3.2.5 Threatened and Endangered Species

Until recently, the Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*) was the only known federally listed threatened or endangered terrestrial species to occur on Blackwater NWR. The U.S. Department of the Interior recently announced that the best available scientific data indicate that the species has recovered. Therefore, under the authority of the Endangered Species Act of 1973, as amended, the USFWS removed the species from the Federal List of Endangered and Threatened Wildlife (List). This determination was based on a review of all available information, which indicates that the subspecies is sufficiently abundant and well distributed to withstand foreseeable threats and no longer meets the definition of an endangered or threatened species under the Endangered Species Act. The final rule removing the Delmarva Peninsula fox squirrel from the List was published in the Federal Register on November 16, 2015 and takes effect on December 16, 2015. As such, there are now no known federally listed Threatened or endangered terrestrial species in the project area. Upland and non-tidal wetland on the refuge support a significant population of Delmarva Peninsula fox squirrels. These squirrels occur in forested habitats of the refuge and will venture into adjacent agricultural fields and early successional habitat. They are not associated with tidal marshes and are not found in the project area.

Bird species listed by the State of Maryland as rare, threatened, endangered are shown in Table 2. American bittern and short-eared owl occur in small numbers during migration and winter in marsh habitat. Least bittern and northern harrier nest in marshes at the refuge and both were seen at the project site in 2015, although neither species was nesting within the project area. Least bittern occupies taller marsh vegetation, including threesquare, which is present at the project site. Black rail used to be present in the breeding season at the Shorter's Wharf project site, and was detected at multiple locations there during 1990-92 by the Maryland DNR black rail survey. However, when this survey was repeated in 2006-7 and again in 2014 no black rails were recorded at the project site. Currently, the black rail's preferred habitat (marsh dominated by *Spartina patens*) is not present at the project site.

Table 2. State Listed Rare, Threatened and Endangered Species Known to Visit tidal marsh habitats at Blackwater National Wildlife Refuge

Species	**Status in Maryland**
American Bittern (*Botaurus lentiginosus*)	In Need of Conservation
Least Bittern (*Ixobrychus exilis*)	In Need of Conservation
Northern Harrier (*Circus cyaneus*)	In Need of Conservation
Black Rail (*Laterallus jamaicensis*)	Endangered
Forster's Tern (*Sterna forsteri*)	In Need of Conservation

Least Tern *(Sterna antillarum*)	Threatened
Short-eared Owl *(Asio flammeus)*	Endangered
Barn Owl (*Tyto alba*)	In Need of Conservation
Saltmarsh Sparrow (*Ammodramus caudacutus*)	In Need of Conservation
Coastal Plain Swamp Sparrow (*Melospiza georgiana nigrescens*)	In Need of Conservation

Forster's Tern visits the Blackwater River and marsh pools at the project site for foraging. Least terns can be found foraging on the refuge later in the summer. A small number of barn owls nest in artificial structures maintained by refuge staff and are resident in marsh habitats.

3.3 Cultural Resources

Although Dorchester County is known to have significant cultural resources, these sites are not located within or near the project area. Most existing sites are located in the areas of historic upland surrounding the marsh. The Blackwater River marshes were used by the Native Americans as a hunting area, seasonally used to supplement their diet. Historically, early settlement in Dorchester County centered on the scattered upland areas, which were logged and drained for farming.

The Maryland Historical Trust records contained a Quad File note indicating the historic Shorter's Wharf may have been located on the southern shore of the river immediately east of the location of the existing bridge. No other indications of known archaeological sites within the Area of Potential Effects (APE) were found.

3.4 Socio-Economic Resources and Environmental Justice

Dorchester County is located approximately 100 miles southeast of Washington, D.C., and is bordered by the Chesapeake Bay to its west, Talbot County to the north, Wicomico County to the east, and Somerset County to the south. Population data since 2010 indicate no significant increases or decreases in recent years. The population of Dorchester County was estimated to be 32,578 in 2014 (US Census Bureau 2015).

Dorchester County, containing 350,300 acres of land, is Maryland's largest county. Compared to other Maryland counties, Dorchester County is relatively poor. Dorchester has a high proportion of low and moderate income households, and lower effective buying income. Persons below the poverty level, 2009-2012, was estimated to be 16.5% for the county, compared to 9.8% for the state. Agriculture is a key industry for Dorchester County. Blackwater NWR generates a significant proportion of the county's tourism revenue.

3.5 Transportation

Shorter's Wharf Road (Maple Dam Road) is one of only three main routes connecting residents from the southern part of Dorchester County with points north. The road (located within Blackwater NWR) is owned and maintained by Dorchester County. Approximately 520 vehicles per day use the road (Dorchester County, unpublished data 2008).

3.6 Noise

The project area is bounded on the west by Shorter's Wharf Road (Maple Dam Road) and on the south by the Blackwater River. Additionally, the primary boat ramp for this section of the Blackwater River is close to the project area. Traffic and noise associated with these transportation routes and recreation hubs are the primary sources of noise in the project area.

3.7 Recreation and Tourism

Given the counties' composition of agriculture, forests, wetlands and waters, there is a long history of shellfishing, trapping, and hunting as the principal forms of recreation as well as income. Fishing and hunting continue to be major recreational activities on and around the refuge. Those who are engaged in wildlife observation and photography are a rapidly growing segment of the population whose contribution to the economy is also substantial.

The signing of the National Wildlife Refuge System Improvement Act of 1997 sanctioned hunting, fishing, environmental education, wildlife interpretation, wildlife photography, and wildlife observation as priority uses of the National Wildlife Refuge System. Blackwater NWR supports all six of these priority uses. Refuge visitors make a significant economic contribution to the economy of Dorchester County. According to the *2010 Dorchester Tourism Year End Report*, in 2009, visitors spent $53 million in food, lodging, shopping, entertainment, etc. Tourism brought $13.3 million in federal state and local taxes, and provided more than 900 jobs, $29.4 million in wages.

Chapter 4 Environmental Consequences and Cumulative Impacts

This section includes a detailed consideration of impacts of the Proposed Action. Direct impacts would occur during dredging and application of material onto the Blackwater marshes. Indirect impacts would occur as natural processes modify the dredged area and redistribute the material that is placed on the marsh surface. Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions.

4.1 Physical Environment

4.1.1 Geologic Setting, Sea Level Rise, Subsidence, and Marsh Deterioration

The impacts of the Proposed Action on the geologic setting, in light of sea level rise, subsidence and marsh deterioration, will largely be beneficial. Building of marsh elevation and the expected increase in below ground biomass production should reduce marsh deterioration and increase overall resiliency of the wetlands to future relative sea level rise. Dredged sediments that will be sprayed to restore marsh surfaces will be largely consistent with the character of adjacent marsh surfaces, thus no substantial change in marsh surface character is expected. However, the sprayed material will initially be largely lacking in root material of marsh plants.

Following construction, some of the placed material will be redistributed by wind and waves. However, no significant movement of material off the marsh surface is expected since the area has generally low wave energy, and sprayed areas will likely be protected by adjacent wetland vegetation. Because material will be placed thinly, no increased compaction or subsidence of underlying marsh deposits is expected.

If the Proposed Action is not implemented the current deterioration of irregularly flooded high marsh habitat and subsequent conversion to open water can be expected.

4.1.2 Soils

The Proposed Action will increase the elevation of the project area, but will remain irregularly flooded high tidal marsh. The action will slow the rate of marsh loss and preserve the integrity of wetland soils. If the Proposed Action is not implemented, the continued deterioration of irregularly flooded high marsh habitat and subsequent conversion to open water can be expected.

4.1.3 Bathymetry

Dredging activities associated with the Proposed Action will not cause any long term changes to the bathymetry of the Blackwater River. To obtain sedimentary materials for the thin-layer elevation project, a hydraulic dredge will dredge the inner meander bends by cutting a series of one foot benches down and waterward on each dredge pass. This stair-stepped dredging pattern will avoid the creation of a vertical downcut from the river edge and help maintain overall bank stability. The inner meander bends of the river will not be dredged below the current maximum river depth. This dredging plan will maintain bank stability and avoid creating deep holes in the river bottom that could create anoxic environments that negatively impact fish.

Based on the amount of material being dredged for the project, the amount of material being exported annually to Fishing Bay (Ganju *et al*, 2013), and other factors, it is expected the river will shoal to pre-project depths within 3-4 years. No change is expected in adjacent areas.

There will be some loss of shallow open water and tidal flats within the deposition area. While the Proposed Action is focused on increasing the elevation of the existing marsh, small areas where the marsh has previously broken up and converted to open water or intertidal mud will be restored to marsh.

If the Proposed Action is not implemented, there would likely be no change to the bathymetry of the Blackwater River channel. Without the Proposed Action, the tidal marsh in the project area can be expected to convert to shallow open water, following the pattern seen on over 5000 acres of tidal marsh on the refuge since 1938 (Scott, et al. 2009).

4.1.4 Hydrology

The Proposed Action is not expected to cause anything other than very minor impacts to water movement within open water areas. Restored marsh surfaces may flood less frequently than the failing marsh surface currently does. No other changes are expected.

If the Proposed Action is not implemented the marsh in the project area will likely convert to open water in the foreseeable future. This will increase the hydrological connectivity between this section of the Blackwater River and adjacent open water areas created through marsh deterioration.

4.1.5 Water Quality

Minor, local, and temporary detrimental impacts to water quality during dredging and thin layer elevation process will occur as result of increased turbidity and reduced dissolved oxygen from resuspension of bottom materials and runoff of turbid materials from marsh areas during spraying. However, Refuge waters are naturally turbid anyway, and the increase in turbidity is generally expected to be minor. Refuge waters are naturally low in oxygen during warm weather months, thus detrimental impacts are expected to be minor.

Following completion of spraying, minimal runoff of material from the restored marsh surface is expected. Some areas will be planted to help stabilize the marsh surface. The effects of planting will be closely monitored. During precipitation events prior to marsh vegetation establishment, impacts from rain are expected and may lead to some erosion of the restored marsh surfaces and cause minor increases in turbidity.

Water quality would likely remain unchanged if the Proposed Action is not implemented.

4.1.6 Air Quality

While dredging and placement activities proceed, minor emissions from construction and dredging equipment will occur in the vicinity of the proposed action. These emissions will cease once the dredging and placement activities end.

Air quality would likely remain unchanged if the Proposed Action is not implemented.

4.2 Biological Environment

4.2.1 Vegetation

Up to 40 acres of failed and failing brackish marsh will be restored to its historic condition. After the thin layered dredged material has stabilized, the exposed surface will be surveyed to define the native marsh vegetation re-establishment zones. In areas where above ground vegetation is still evident, natural recovery and/or re-colonization will be allowed. In areas where existing marsh vegetation was covered, establishment by seeding is anticipated. Different methods of native plant (e.g., *Spartina patens*) re-establishment will be used, including planting live plugs of various stock types combined with seeding methods. The results will be monitored, and the more successful re-vegetation method will be used to establish full vegetated coverage of the project's elevated marsh area.

Plant growth within the treated marsh is expected to increase following sediment enhancement. Increased elevation will promote increased root growth and overall plant health.

If the Proposed Action is not implemented the current deterioration of irregularly flooded high marsh habitat and subsequent conversion to open water can be expected.

No impacts to upland vegetation are expected since all work will take place within open water and marsh areas of the refuge where no upland vegetation is present.

No direct or indirect impacts are expected since SAV is nearly absent from the waters of the project area.

4.2.2 Aquatic Species, Finfish, Shellfish, and Benthos

The Proposed Action may cause a short-term increase in turbidity during dredging and resulting disturbance will cause some fish and invertebrates to temporarily relocate. These impacts are expected to be insignificant to fish populations because only a relatively small area will be impacted, and there are substantial areas to relocate to. Some fish may be entrained into the dredge and destroyed during dredging. Although individuals may be destroyed, no impacts to fish populations are expected. Impacts to anadromous and semi-anadromous fish species that utilize the marsh will be minimized through a time of year restriction on construction activities.

Dredging and sediment deposition activities may destroy relatively nonmotile bottom-dwelling invertebrates over the project area, however it is expected that many organisms will survive. Minor localized food web disruption will occur as invertebrates are destroyed and organisms that feed on these invertebrates are disfavored. Colonization of disturbed areas by invertebrates is expected within several months to a year following dredging, and long-term impacts are expected to be insignificant. Colonization of the restored marsh surface by invertebrates to levels characteristic of adjacent marshes is expected within several months to years.

Since the area is undergoing dramatic change anyway as a result of massive marsh failure, it is not expected that the environmental changes indirectly attributable to the aerial placement project will have any significant long-term impact on fish in light of this background trend.

If the Proposed Action were not conducted, emergent marsh habitats will continue to degrade and convert to open water, creating additional habitat for fish and benthic organisms. However, the resulting expanse of open water will not contain the mosaic of tidal marsh and open water habitats that are favorable to many fish species, particularly as nursery habitat. Additionally, the current trend in conversion of tidal marsh to open water is creating more and more open water habitat each year.

4.2.3 Essential Fish Habitat

Nine species that are managed under the Magnuson-Stevens Fisheries Conservation Act (species for which the Chesapeake Bay provides Essential Fish Habitat [EFH]) were identified in the vicinity of the project area. A full analysis for EFH in the Project Area is presented in Appendix A.

4.2.4 Wildlife

Disturbance from noise created by the Proposed Action may cause wildlife disturbed by these activities to temporarily relocate to other areas. Habitat comparable to the areas where work is

taking place is abundant in the refuge, thus avoidance of the area will cause no significant impacts to wildlife.

Construction activities will likely take place during the summer months, causing a displacement of birds that nest in the project area, primarily seaside sparrow, red-winged blackbird and marsh wren. There is still vast expanse of similar habitat on the refuge to provide nesting areas for these species. Additionally, the Proposed Action will strengthen the resiliency of tidal marsh habitat in the project area, creating a long-term benefit to these species.

If the Proposed Action is not implemented the current deterioration of irregularly flooded high marsh habitat and subsequent conversion to open water can be expected. This loss of habitat will negatively impact the wildlife that depends on it. While not implementing the Proposed Action would have no short-term impacts on wildlife, it would have negative impacts in the foreseeable future as tidal marsh habitat converts to open water.

4.2.5 Threatened and Endangered Species

There are no Federally listed or proposed threatened or endangered species known to exist in the project area. There may be short-term impacts to some species listed as in need of conservation by the State of Maryland. Least bittern and northern harrier were both observed in the project area during the 2015 breeding season, but no indication of nesting was found. Disruptions associated with the Proposed Action may cause these species to temporarily relocate to other areas. Habitat comparable to the areas where work is taking place is abundant in the refuge, thus avoidance of the area will cause no significant impacts to these species.

While not implementing the Proposed Action would have no short-term impacts on these species, it would have negative impacts in the foreseeable future as tidal marsh habitat converts to open water.

4.3 Cultural Resources

Because there are no inventoried archaeological sites or historic resources located within the project area, and because the marsh setting exhibits low archaeological sensitivity, no effects on historic properties are expected.

4.4 Socio-Economic Resources and Environmental Justice

By maintaining emergent wetlands, and subsequently fish and wildlife resources, the Preferred Alternative would help to maintain that portion of the local economy dependent on the recreational and commercial fish and wildlife resources found within the project area.

There are no segments of the population being preferentially singled out by the Proposed Action. There are no minority or low-income neighborhoods in the vicinity that could be affected by the Proposed Action. It does not preferentially benefit any demographic group to the detriment of any other.

If the Proposed Action is not implemented, the economic benefits associated with tidal wetlands in the project area, such as tourism and hunting revenues, would decline as the marsh deteriorates.

4.5 Transportation

The Proposed Action is not expected to have any significant impacts on transportation. Dredging is expected to occur during the recreational boating and fishing season and may cause people to avoid use of the area. Dredging equipment will be well-marked to minimize the risk of collisions.

Maple Dam Road is frequently used and one of the main roads connecting the southern part of the county with points north. A buffer between the restoration area and the paved road will be maintained to minimize the likelihood of sediment interfering with transportation.

Transportation would likely remain unchanged if the Proposed Action is not implemented.

4.6 Noise

Noise during construction will be produced by the dredge, trucks, and workboats, and will cause a temporary disruption to the quiet and solitude of the refuge. None are expected since no noise will be produced following project construction.

Noise levels would likely remain unchanged if the Proposed Action is not implemented.

4.7 Recreation and Tourism

Recreational opportunities within the project area, such as bird watching, may increase with the increased formation of emergent marsh and other fish and wildlife habitats. An increase in habitat value would likely result in increased fish and wildlife usage of the project area.

If the Proposed Action is not implemented, the recreation and tourism associated with tidal wetlands in the project area would decline as the marsh deteriorates.

4.8 Cumulative Impacts

The cumulative impacts of the Proposed Action are expected to be beneficial to the Blackwater River ecosystem, providing direct and incidental benefits to tidal wetlands, and to the associated fish and wildlife that reside within these habitat areas. Potential negative impacts of the Proposed Action include localized and temporary disturbance to fish and wildlife resulting from construction activities, as well as the loss of shallow water habitat because of the footprint of the restored marsh. While these impacts need to be carefully considered, they are outweighed by the overall positive impacts to area flora, fauna, and ecosystem services. The Proposed Action will ensure the greatest potential for a diverse mosaic of habitat conditions that will be both resilient and resistant to stressful changes over time, with long-term benefits for the inhabiting flora and fauna within the ecological setting.

Cumulative effects of conversion of bottom habitat through wetland restoration will not cause significant detrimental environmental effects to SAV beds, oyster beds, or other highly valued Chesapeake Bay bottom habitats. Over 5000 acres of tidal wetlands have converted to shallow open water on Blackwater NWR since 1938 (Scott, et al. 2009). With the reduction in nutria populations on and around the refuge this rate of change should slow, but is still expected to continue at a reduced rate because of relative sea level rise. Since the area is undergoing dramatic change as a result of ongoing marsh failure and conversion to open water, it is not expected that the environmental changes indirectly attributable to the wetland restoration project will have any significant long-term impact on fish in light of this background trend.

The Proposed Action involves excavating approximately 57,700 cubic yards of material from the inner meander bends of the Blackwater River channel using a hydraulic dredge. Dredging activities associated with the Proposed Action are not expected to cause any long term changes to the bathymetry of the Blackwater River. Sedimentary materials will be removed from the inner meander bends in a way that maintains the stability of the river bank and does not cut below the existing river bottom, avoiding the creation of anoxic environments. Additionally, sediments are being exported from the upstream portions of the Blackwater River at a very high rate (Ganju et al, 2013). Based on the amount of material being dredged for the project, the amount of material being exported annually to Fishing Bay, and other factors, it is expected the river will shoal to pre-project depths within 3-4 years.

Minor impacts to water quality during dredging and sediment placement may occur as result of increased turbidity and reduced dissolved oxygen from re-suspension of bottom materials and runoff of turbid materials from marsh areas during spraying. However, Refuge waters are

naturally turbid, and the increase in turbidity is generally expected to be minor. Refuge waters are naturally low in oxygen during warm weather months, thus detrimental impacts are expected to be minor.

The Proposed Action may cause some fish and invertebrates to temporarily relocate. These impacts are expected to be insignificant to fish populations because only a relatively small area will be impacted, and there are substantial areas to relocate to. Some fish may be entrained into the dredge and destroyed during dredging. Although individuals may be destroyed, no impacts to fish populations are expected. Impacts to anadromous and semi-anadromous fish species that utilize the marsh will be minimized through a time of year restriction on construction activities.

The proposed project is only one among a group of projects funded through a grant awarded to The Conservation Fund by the National Fish and Wildlife Foundation (Hurricane Sandy Competitive Coastal Resiliency Grants Program). Other projects associated with this grant that are taking place in this area consist of continued nutria eradication efforts, hydrological investigation of the Farm Creek marsh, and Phragmites control work. Additionally, ongoing management of Blackwater NWR, Fishing Bay Wildlife Management Area, and adjacent private lands continue. Typical land management activities occurring in these habitats consist of furbearer trapping and prescribed burning. It is unlikely that the interaction between these activities, in addition to the Proposed Action, will have any cumulative negative effects upon the natural or human environment.

The impacts of the current Proposed Action must be weighed to determine whether the additive effects of these actions will result in a significant cumulative impact on the natural and human environment of the area. Cumulative impacts analysis requires consideration both of impacts of coastal wetlands restoration, as well as impacts to the sites where coastal wetlands are restored. This project, in combination with other tidal marsh creation and restoration efforts currently underway and expected to be underway in the near future, as well as regulatory efforts that strictly protect coastal wetlands resources, will contribute towards maintenance of the coastal wetlands resource base in the Chesapeake Bay watershed. This will cause a cumulative beneficial impact to Chesapeake Bay habitats and ecosystem services.

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Chapter 6 List of Preparers

This Draft Environmental Assessment was prepared by Erik Meyers (The Conservation Fund), David Curson (Audubon Maryland-DC), Matt Whitbeck (USFWS) and Thomas Bonetti (USFWS).

Three documents served as the foundation for this Draft Environmental Assessment. The 2002 FONSI and EA for marsh restoration work on Blackwater NWR, prepared by the U.S. Army Corps of Engineers Baltimore District, provided much of the Affected Environment, Environmental Consequences, and Essential Fish Habitat sections of the document. Learner et al. 2012 and Learner et al. 2013 provided a large portion of the Purpose and Need and Affected Environment sections.

APPENDIX A

ESSENTIAL FISH HABITAT

ESSENTIAL FISH HABITAT ASSESSMENT

Shorter's Wharf Tidal
Marsh Restoration Project
Blackwater National Wildlife Refuge
Dorchester County, Maryland

December 2015

INTRODUCTION

The proposed restoration work will prevent the loss of approximately 40 acres of high tidal marsh within Blackwater NWR at Shorter's Wharf to erosion. The proposed project will build elevation capital and increase plant vigor and resiliency by elevating the marsh surface. The marsh at the project site is deteriorating via disintegration of the root mat and expansion of interior ponds. SLAMM predicts that, without the proposed restoration, the project site will convert from irregularly flooded high marsh to daily flooded low marsh under 42 cm of sea level rise (expected by 2050) and will fully convert to open water under 72 cm of sea level rise (expected by 2075; The Conservation Fund *et al*. 2012). The proposed restoration project is expected to increase the life span of the marsh well beyond the SLAMM predictions.

The proposed action will involve placing material excavated from the Blackwater River in thin layers to elevate surface levels for optimal native marsh grass production on up to 40 acres of inundated and declining marsh. The project site is located east of Shorter's Wharf and is bounded to the east by the Blackwater River and to the west by a historical tidal pond and Maple Dam Road. Two placement methods will be utilized, namely aerial spraying and pipe discharge. In the initial aerial material placement project, up to 28,000 cubic yards of dredged sediment material will be sprayed to create a 300 foot wide perimeter for the project area. For the second phase of pipe discharged materials, up to 29,000 cubic yards of dredge sediment material will be placed at the plugged tidal ditch to fill the failed marsh areas. The ideal elevation to support healthy marsh vegetation is +30 cm (0.98 ft.) elevation NAVD 88 (Kirwan *et al*, 2012). The average surveyed marsh plain elevation within the proposed project location is +0.58 ft. and -0.30 ft. for the failed marsh zones. Based on these data, we expect to add approximately 0.40' of material to the existing marsh and approximately 1.28' to the failed marsh areas. The Blackwater River bathymetric survey reveals approximately 57,000 cubic yards in the inner meander bend is available assuming a 12 foot cut. These depositional materials are being exported from eroding marshes upstream in the Blackwater National Wildlife Refuge to Fishing Bay at a rate of 97 tons per day on average (Ganju *et al*, 2013).

To obtain sedimentary materials for the thin-layer elevation project, a hydraulic dredge outfitted with aerial spray technology will dredge the inner meander bends by cutting a series of one foot benches down and waterward on each dredge pass. This stair-stepped dredging pattern will avoid the creation of a vertical downcut from the river edge and help maintain overall bank stability. The inner meander bends of the river will not be dredged below the current maximum river depth. This dredging plan will maintain bank stability and avoid creating deep holes in the river bottom that could create anoxic environments that negatively impact fish. Refuge staff will work with appropriate agencies to identify the time of year where restoration work will avoid and/or otherwise minimize adverse impacts to fisheries.

Provisions of the Magnuson-Stevens Act require that all Federal agencies consult with the National Marine Fisheries Service (NMFS) on all Federal actions that may adversely affect Essential Fish Habitat (EFH). EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity.” In accordance with requirements, this assessment includes the following required parts integrated into the document: identification of species of concern; a description of the proposed action; an analysis of the effects of the proposed action; the Federal agency's views regarding the effects of the proposed action; and proposed mitigation.

BLACKWATER NWR ENVIRONMENTAL CHARACTERISTICS

Blackwater NWR is characterized by large open water ponds, and vast areas of tidal marsh and intertidal flats along the Blackwater River and its tidal tributaries. Tidal marsh occurs at intertidal elevations controlled by sea level. The main section of the refuge is drained by the Blackwater River, which flows southeastwardly into Fishing Bay. The channel of the Blackwater River is poorly defined to undefined within much of refuge waters, but is well-defined in the project area.

South of Shorter’s Wharf Road, adjacent to the proposed project area, tidal scour serves to maintain a relatively deep channel within the Blackwater River. Water depths within the river channel are typically 10-15 feet deep in this area. Isolated holes over 30 feet deep have been found on the outside of meander bends in the channel (Sustainable Science, LLC, unpublished data). Velocities during ebb tide are substantial in this section of the River.

Further into the refuge interior, north and west of Shorter’s Wharf Road, much of the historic brackish marsh has converted to open water in recent decades because of nutria herbivory and relative sea level rise. Water depths in the historic river channel in this area have shallowed, and are now only several feet deep in many areas. Currents are weak and variable. Water depths in areas where marshes have converted to open water range from several inches to a couple of feet

in depth. Many of the historic named ponds that are now contained within larger open water areas were historically several feet deep.

The Blackwater River serves as the principal route for salt water from the bay to penetrate the refuge. To a lesser extent, saltwater also penetrates the refuge through Parson's Creek and other smaller sources of saltwater intrusion into the upper reaches of the Blackwater River. Salinity within the refuge varies as a function of proximity to these sources. The freshest water is consistently found near the mouth of Buttons Creek. Tidal waters of the refuge are brackish for much of the year, but salinity in the refuge fluctuates seasonally. During the winter with high rates of runoff, the entire river system within the refuge is nearly fresh. Following major precipitation events, freshwater runoff can also greatly lower marsh salinity. In contrast, storm tides associated with hurricanes or Nor'easters can inundate large areas with salt water, causing major tree mortality in swamps and upland areas. Drought conditions also promote greater salinities in the tidal wetlands. During the period of 2009 to 2013, salinities at the Shorters Wharf Bridge typically reached a high of 10-18 ppt in the late summer or fall. Lowest salinities are found during the winter months, reaching as low as < 1 ppt some winters (USFWS, unpublished data).

Dissolved oxygen levels of refuge waters are generally in healthy levels of greater than 5 milligrams per liter (mg/l) in cool weather months but can drop to very low levels in warm weather months. Low oxygen conditions less than 5 mg/l are stressful to many forms of aquatic life.

Substrates within the deeper intact areas of the Blackwater River channel with high velocities and scouring include a mixture of sands, silts, and clays. Bottom sediments in areas of historic marsh include relict in-place drowned highly organic marsh peats, as well as highly organic Holocene sediments.

POTENTIAL SPECIES OF CONCERN

Identification of species of concern for this assessment was accomplished in four steps. First, a list of potential species for which the Blackwater region might constitute EFH was obtained from the NOAA website (http://www.greateratlantic.fisheries.noaa.gov/hcd/index2a.htm). The Tangier/Pocomoke Sound area was used as the most appropriate reference for the proposed project area. This preliminary list was supplemented with species of skate identified on the Essential Fish Habitat Designations for New England Skate Complex list (http://www.greateratlantic.fisheries.noaa.gov/hcd/skateefhmaps.htm). Second, life history information for each of these species was compiled, primarily from the NOAA website (http://www.greateratlantic.fisheries.noaa.gov/hcd/list.htm). Third, local information on species collected within Blackwater and Fishing Bay was compiled. Fourth, utilizing this information,

species for which Blackwater region is unlikely to constitute EFH were screened from further consideration, and those species for which Blackwater may constitute EFH were determined.

Potential species of concern, as identified on the NOAA websites, are presented in Table 1. The area is not listed as EFH for any species of spawning adults.

Table 1. Fish species and their life history stages for which the Tangier/Pocomoke Sound area are designated as EFH.

	Eggs	Larvae	Juveniles	Adults
windowpane flounder *(Scopthalmus aquosus)*			M	M
bluefish *(Pomatomus saltatrix)*			M	M
summer flounder *(Paralicthys dentatus)*			M	M
king mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
cobia *(Rachycentron canadum)*	X	X	X	X
clearnose skate (*Raja eglanteria*)			X	X
little skate (*Raja erinacea*)			X	X
winter skate (*Leucoraja ocellata*)			X	X

1. Windowpane flounder

Juveniles: Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where windowpane flounder juveniles are found: water temperatures below 25° C, depths from 1 – 100 meters, and salinities between 5.5 - 36‰.

Adults: Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border. Generally, the following conditions exist where windowpane flounder adults are found: water temperatures below 26.8° C, depths from 1 - 75 meters, and salinities between 5.5 - 36‰.

2. Bluefish

Juveniles: 1) North of Cape Hatteras, EFH is pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ) from Nantucket Island, Massachusetts south to Cape

Hatteras, in the highest 90% of the area where juvenile bluefish are collected in the NEFSC trawl survey. 2) South of Cape Hatteras, EFH is 100% of the pelagic waters over the Continental Shelf (from the coast out to the eastern wall of the Gulf Stream) through Key West, Florida. 3) EFH also includes the "slope sea" and Gulf Stream between latitudes 29° 00 N and 40° 00 N. 4) Inshore, EFH is all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Generally juvenile bluefish occur in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from May through October, and South Atlantic estuaries March through December, within the "mixing" and "seawater" zones (Nelson *et al.* 1991, Jury *et al*. 1994, Stone *et al.* 1994). Distribution of juveniles by temperature, salinity, and depth over the continental shelf is undescribed (Fahay 1998).

Adults: 1) North of Cape Hatteras, EFH is the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from Cape Cod Bay, Massachusetts south to Cape Hatteras, in the highest 90% of the area where adult bluefish were collected in the NEFSC trawl survey. 2) South of Cape Hatteras, EFH is 100% of the pelagic waters over the Continental Shelf (from the coast out to the eastern wall of the Gulf Stream) through Key West, Florida. 3) Inshore, EFH is all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Adult bluefish are found in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from April through October, and in South Atlantic estuaries from May through January in the "mixing" and "seawater" zones (Nelson *et al.* 1991, Jury *et al*. 1994, Stone *et al.* 1994). Bluefish adults are highly migratory and distribution varies seasonally and according to the size of the individuals comprising the schools. Bluefish generally found in normal shelf salinities (> 25 ppt).

3. Summer flounder

Juveniles: 1) North of Cape Hatteras, EFH is the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares for the area where juvenile summer flounder are collected in the NEFSC trawl survey. 2) South of Cape Hatteras, EFH is the waters over the Continental Shelf (from the coast out to the limits of the EEZ) to depths of 500 ft, from Cape Hatteras, North Carolina to Cape Canaveral, Florida. 3) Inshore, EFH is all of the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database for the "mixing" and "seawater" salinity zones. In general, juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in water temperatures greater than 37 ^{o}F and salinities from 10 to 30 ppt range.

Adults: 1) North of Cape Hatteras, EFH is the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares for the area where adult summer flounder are collected in the NEFSC trawl survey. 2) South of Cape Hatteras, EFH is the waters over the Continental Shelf (from the coast out to the limits of the EEZ) to depths of 500 ft, from Cape Hatteras, North Carolina to Cape Canaveral, Florida. 3) Inshore, EFH is the estuaries where summer flounder were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Generally summer flounder inhabit shallow coastal and estuarine waters during warmer months and move offshore on the outer Continental Shelf at depths of 500 ft in colder months.

Habitat Areas of Particular Concern - The specific designation of HAPC for summer flounder is as follows: All native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH is HAPC. If native species of SAV are eliminated then exotic species should be protected because of functional value, however, all efforts should be made to restore native species.

4. King mackerel

King mackerel weight up to 90-lbs. King mackerel range from the Gulf of Maine to South America but regularly occur off the coast of Virginia and North Carolina and not usually found in the Chesapeake Bay. King mackerel is primarily open water schooling fish. Essential fish habitat for coastal migratory pelagic species includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including Sargassum. In addition, all coastal inlets, and all state designated nursery habitats of particular importance to coastal migratory pelagics are EFH. For king mackerel essential fish habitat occurs in the South Atlantic and Mid-Atlantic Bights. It is a coastal pelagic species and generally not found beyond the continental shelf. King mackerel migrate seasonally with changes in temperature. During the summer they are found in the northern part of their range and in the winter they are found in South Florida.

Eggs: Spawning occurs over the middle and outer portions of the Atlantic continental shelf from July through September.

Larvae: Found in Atlantic Ocean.

Juveniles: Found in Atlantic Ocean.

Adult: King mackerel adults are mainly found in large schools of similar sized fish migrating along the Atlantic coast. They are occasional visitors to the Bay and are rare in the upper Bay (Murdy, 1997).

5. Spanish mackerel

Spanish mackerel is small fish that can weigh up to 20-lbs. Spanish Mackerel range from the Gulf of Maine to the Yucatan Peninsula and are most abundant from the mouth of the Chesapeake Bay region to south Florida. They seasonally migrate along the Atlantic coast to the Gulf of Mexico.

The Maryland DNR provided data from a pound net in the vicinity of Reedville VA, across the bay from Smith Island. Spanish mackerel was caught in the Reedville net from the last week in May through the middle of September. Although Spanish mackerel primarily occurred in the lower Chesapeake Bay, there were regular occurrences and occasionally high numbers of mackerel caught at Reedville.

Spanish Mackerel prefer polyhaline regions (18-30ppt) but can also be found in the saltier portions of mesohaline (5-18ppt) waters. Spanish mackerel occurs in the Bay when water temperatures near the Bay mouth exceed about 17 C and become abundant at about 20 C.

Eggs: Spanish mackerel spawn off the western shore of Virginia in the Chesapeake Bay from late spring through late summer (Murdy, 1997).

Larvae: Larvae occur in the water column in inland waters, mainly in the lower bay, of higher salinity.

Juvenile: Juvenile Spanish mackerel can be found in estuaries and in near shore waters, mainly in the lower Bay.

Spawning Adult: Spanish mackerel has a protracted spawning period and larvae have been found from April through September in the Atlantic Ocean.

6. Cobia

Cobia is a larger fish (up to 100 lbs.) that can often be found around bottom structures such as pilings and wrecks. Essential fish habitat for coastal migratory pelagic species includes sandy shoals off of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including Sargassum. Other habitat includes coastal inlets. For cobia, essential fish habitat includes high salinity bays, estuaries, and seagrass habitat. In addition, the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse coastal migratory pelagic larvae. For cobia, essential fish habitat occurs in the South Atlantic and Mid-Atlantic Bights.

Eggs: Spawning occurs from mid-June to mid-August near the Bay mouth or just offshore, where cobia form aggregations (Murdy, 1997). The eggs are buoyant in the water column.

Larvae: Larvae are found in the coastal Atlantic Ocean.

Juveniles: The Chesapeake Bay serves as a nursery ground for cobia.

Adult: Adults frequent the Chesapeake Bay beginning in late May and migrate out of the Bay and south by mid-October (Murdy, 1997).

7. Clearnose skate

Clearnose skates are a southern species, occurring primarily in the inshore Middle Atlantic and inshore Southern New England. North of Cape Hatteras, it moves inshore and northward along the continental shelf during the spring and early summer, and offshore and southward during autumn and early winter (Bigelow and Schroeder 1953b). Clearnose skate has been found in Chesapeake Bay from April to December (Geer 2002). They were most abundant near the Bay mouth during spring and summer, but appeared throughout the Bay during all four seasons, and rarely appeared in the tributaries (Geer 2002).

8. Little skate

The range of the little skate extends from southern New England and down the Mid-Atlantic Bight to Cape Hatteras (Packer et al., 2003). Little skate have been found in lower Chesapeake Bay in December and in March while more recently they were mostly found around the Bay mouth in high salinity waters during April and May (Geer 2002).

9. Winter skate

The winter skate range extends from southern New England and down the Mid-Atlantic Bight to northern North Carolina (Bigelow and Schroeder 1953). It has also been reported from Chesapeake Bay from December to April (Geer 2002). Generally, invertebrates such as decapod crustaceans and amphipods are the most important prey items, followed by polychaetes for the three named skate species (Bigelow and Schroeder 1953). Other important prey items include isopods, bivalves, and fishes (McEachran 1973).

DISTRIBUTION OF POTENTIAL EFH SPECIES IN PROJECT AREA

Only limited information on occurrence of these species and their life history stages of concern in the potential project area are available. The U.S. Fish and Wildlife Service sampled more than 10 sites among the ponds and channels of Blackwater in September 1995 using a seine and trawl.

Although they collected more than 15 species of finfish in their sampling, including many fish that provide forage for larger fish, they detected none of the EFH potential species of concern.

Maryland DNR and the U.S. Fish and Wildlife Service studied fish populations on Blackwater NWR in 2005 and 2006 (Love et al, 2008). While most of their study sites were lower salinity than the proposed project area, the sites on the upper Blackwater River were comparable, and captured species typical of salt marshes (hogchoker (*Trinectes maculatus*), killifish, and silversides). None of the potential species of concern were detected during this work.

The Blackwater River near Route 335 was surveyed for northern snakehead in May of 2012 (Maryland DNR, unpublished data). The area was surveyed with a fyke net for six days. Sixteen species of fish were caught, primarily white perch and brown bullhead. None of the nine species of potential concern were detected during this survey work.

None of the nine species of potential concern are known to be caught by recreational fishermen within the refuge.

DETERMINATION OF SPECIES OF CONCERN AND ANALYSIS OF EFFECTS OF PROPOSED ACTION

Many of these species are primarily found in deeper water and/or higher salinities, well downstream and offshore of the proposed project area on the Blackwater River. This applies to king mackerel, Spanish mackerel, and cobia. These fish predominately inhabit waters deeper or higher in salinity than those found within the refuge and the proposed project area. No impacts to any of these species are expected to occur as a result of the proposed project. No impacts to spawning, egg, or larvae habitat is expected as these areas are not in the proposed project footprint. Any juvenile and adults species in the area will be able to easily swim away and relocate to adjacent areas to avoid direct detrimental impacts. Alterations of bottom habitat are unlikely to impact these species because of the minor scale of impact compared to abundant bottom in the area.

No impacts are expected to clearnose, little and winter skates during the proposed activities. These species tend to be found south of the refuge near the mouth of the Chesapeake Bay and out into the ocean waters and are not of main concern with this project for any expected impacts. Juveniles and adults that are present in the project area during construction could easily swim away and relocate to adjacent areas to avoid direct detrimental impacts.

Following this initial screening, only windowpane flounder, summer flounder, and bluefish (juvenile and adult for all species) remain for further consideration in this assessment. Although there is no actual evidence indicating that any of these species are present on the refuge or within

the proposed project area, it is appropriate to err on the side of caution and evaluate potential impacts to these species.

Direct impacts to windowpane flounder, summer flounder and/or bluefish populations due to application of dredged material for wetland restoration are expected to be negligible. Adult and juveniles of all three species may be in the project area during construction occurring during warmer weather months when salinities are higher. However, adults and juveniles should easily be able to avoid any detrimental impacts associated with application of material and can relocate elsewhere within the abundant shallow water habitat of the region because of their high mobility. Neither juveniles nor adults are likely to be present if construction occurs during cooler weather months because they typically leave the area.

Indirect impacts to windowpane flounder, summer flounder and/or bluefish populations due to application of dredged material for wetland restoration are expected to be negligible. Indirect turbidity impacts will occur as a portion of material placed onto the site is transported off-site into surrounding waters. Some movement of placed material may occur during storms; however, minimal movement of material is expected once vegetation becomes established on the placed material. Loss of shallow open water caused by restoring brackish marsh to historic conditions would cause a minor adverse indirect impact as a consequence of open water habitat loss. However, this loss will be readily balanced by conversion of brackish marsh to open water habitat elsewhere on the refuge by erosion and relative sea level rise.

Direct impacts of dredging to windowpane flounder, summer flounder and/or bluefish populations are expected to be negligible. Individuals may be present in the project area during dredging taking place during warmer weather months, particularly when salinities are higher. Because of their great mobility, individuals should easily be able to relocate elsewhere and avoid any detrimental impacts from dredging. Windowpane and summer flounder, because they are demersal, may remain on the bottom during dredging. Any flounder remaining on the bottom or venturing too close to the dredge intake could be entrained and destroyed; juveniles would probably be more vulnerable than adults because of their slower swimming speed. Given the very low likelihood that individuals would be present in the project area, and the small scale of the dredging operation, few if any windowpane or summer flounder are expected to be impacted. If the dredging impacts a few individuals, at most, the impact to the population would be negligible.

Sediments suspended during dredging may cause fish to temporarily avoid the area. However, the area is naturally characterized by high turbidities as a consequence of marsh erosion and failure, and it is likely that project turbidities will be within the range of natural turbidities at the site, thereby limiting the potential for any significant adverse consequences to finfish. Sediments are currently being exported from eroding marshes upstream in the

Blackwater National Wildlife Refuge to Fishing Bay at a rate of 97 tons per day on average (Ganju *et al,* 2013).

No significant indirect impacts from temporary food web impacts associated with destruction of benthos during dredging are expected to occur because the impacts will be temporary and their food is derived from a wide area. In addition, benthos within the historic ponds and channel to be dredged are expected to be relatively depauperate and tolerant of disturbance because the sites are characterized by low dissolved oxygen concentrations during warm weather months, and high turbidities and accumulating sediments year round. Recolonization of the substrate by benthos is expected to be facilitated by the adjacent presence of undisturbed bay bottom providing a source of benthos. Consequently, substantial recovery of these areas should occur within several months following dredging. Full recovery of benthos to a condition resembling pre-project conditions may take several years.

The numerous pockets of failed marsh found in the project area likely provides habitat for forage fish, some of which may provide a food base for some species of concern. The Proposed Action would restore the areas of failed marsh to irregularly flooded tidal marsh, a habitat considered lower quality for forage fish. While this may have an indirect negative effect on some species of concern, this impact would be negligible considering the large expanse of deteriorating tidal marsh in the immediate area.

Dredging activities associated with the Proposed Action will not cause any long term changes to the bathymetry of the Blackwater River. To obtain sedimentary materials for the thin-layer elevation project, a hydraulic dredge will dredge the inner meander bends by cutting a series of one foot benches down and waterward on each dredge pass. This stair-stepped dredging pattern will avoid the creation of a vertical downcut from the river edge and help maintain overall bank stability. The inner meander bends of the river will not be dredged below the current maximum river depth. This dredging plan will maintain bank stability and avoid creating deep holes in the river bottom that could create anoxic environments that negatively impact fish. Based on the amount of material being dredged for the project, the amount of material being exported from the refuge annually (Ganju *et al,* 2013), and other factors, it is expected the river will shoal to pre-project depths within 3-4 years. No change is expected in adjacent areas.

Fishery Management Councils identify EFH Habitat Areas of Particular Concern (HAPC). HAPC is a subset of EFH that is rare, particularly susceptible to human-induced degradation, especially ecologically important, or locates in an environmentally stressed area (NMFS 1998). The specific designation of HAPC for summer flounder is as follows: All native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH is HAPC. If native species of SAV are eliminated then exotic species should be protected because of functional value, however, all

efforts should be made to restore native species. SAV is limited on the refuge and absent in the project area, therefore no direct or indirect impacts to summer flounder HAPC is expected.

No impacts are expected to adult or juveniles windowpane flounder, summer flounder or bluefish populations during the proposed dredging and wetland restoration activities. Due to the small scope of the dredging activity, the likelihood of these species being present is very small. Even if they are present in the area to be dredged the impact to the populations of these species will be very minor and temporary. If the hydraulic dredging (at most) impacts a few individuals, the population will rebound within the next season.

CONCLUSION

The Shorter's Wharf Tidal Marsh Restoration Project is intended to build resiliency in existing tidal marshes and partially compensate for historic and ongoing losses of brackish marsh in the area. While there may be some loss of existing shallow open water habitat caused by restoring brackish marsh to historic conditions, this loss will be readily balanced by conversion of brackish marsh to open water habitat elsewhere on the refuge by erosion and relative sea level rise. There will be no significant direct or indirect impacts to EFH or HAPC caused by the implementation of the Proposed Action.