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Electronic submission

RE: Horry County Solid Waste Authority Landfill Expansion, SAC-2025-00032, Horry County

Dear Mr. Bracey, Mr. Campanizzi, and Ms. Culbreath,

The South Carolina Department of Natural Resources (SCDNR) is the state agency charged by state law with the management, protection, and enhancement of wildlife, fisheries, and marine resources in South Carolina. In addition to natural resource management responsibilities through research, management and licensing, the SCDNR is also charged with statewide responsibilities for regulating watercraft operation and associated recreation on state waters, conducting geological surveys and mapping, promoting soil and water conservation, flood mitigation, drought response planning and coordination, and the coordination of the state scenic rivers program. SCDNR's mission is to serve as the principal advocate for and steward of South Carolina's natural resources. (SCDNR authorities and responsibilities are described in Titles 48, 49 and 50, South Carolina Code of Laws (1976), as amended). As such, personnel with the SCDNR have reviewed the proposed project, evaluated its impact on natural resources and offer the comments included below in response to a joint public notice published December 19, 2025, pursuant to Sections 401 and 404 of the Clean Water Act, and the South Carolina Coastal Zone Management Act.

Project Description

The proposed project is located south of and adjacent to S.C. Highway 90 Boulevard in Conway, Horry County, South Carolina. The proposed work consists of the expansion of the existing Horry County Solid Waste Management Facility. The proposed project involves the discharge of fill materials into freshwater wetlands and tributaries in order to expand the landfill to provide additional landfill capacity for 23.4 million tons of non-divertible waste expected over the next 45 years. The construction will consist of three new landfill cells (C&D Site 1, C&D Site 2, and MSW Site 1). The proposed construction of two of the three proposed landfill cells will require the applicant to amend the existing Declaration of Restrictive Covenants (SAC-2004-05388, Deed Book 4328, Page 2984). In total for the proposed construction of all three landfill cells, the applicant is requesting to impact approximately 102.4 acres of freshwater wetlands with fill

material, where 76.6 acres of freshwater wetlands and 600 LF (0.04 acres) of an intermittent stream are protected under restrictive covenants, and 28.17 acres of upland buffer with fill material that are protected under restrictive covenants. The applicant proposes to mitigate for the amendment of the existing Declaration of Restrictive Covenants, and the impacts to wetlands and/or waters of the United States by purchasing mitigation banking credits from an approved mitigation bank.

Agency Comments

Adjacent Public Lands

The proposed project is located near two areas of conservation importance. Immediately adjacent is the Independent Republic Heritage Preserve Mitigation Bank (IRHP) which serves a single client mitigation site for Horry County Government. This property is currently protected by a conservation easement held by Pee Dee Land Trust. Additionally, the proposed construction of the three landfill cells is approximately a little over 2 miles west of the Lewis Ocean Bay Heritage Preserve (LOBHP). This approximately 10,000-acre Heritage Preserve was acquired to protect South Carolina's best assemblage of Carolina Bays which are found in a mosaic of pine savannas and blackwater swamp forests.

LOBHP and IRHP are both areas that will be subject to frequent prescribed fire. Without annual burns, ecosystem quality and biodiversity would decline rapidly due to encroachment of hardwood species and the chance of accidental wildfires that pose a risk to both ecosystem integrity and adjacent landowners would increase. Therefore, please understand that during these prescribed burns, smoke can remain in the area for a few days after the burn, depending on weather conditions that can cause inversion (an atmospheric phenomenon that occurs when climate and meteorological conditions combine to trap smoke close to the ground at night). Some of these prescribed burns, and the incidental inversion that can occur, may also require the closure of International Drive.

The habitats of these conservation important properties includes Carolina bay and pocosin complexes that contain waxy evergreen fuels that are a volatile fuel source for wildfires. Peat soil type fires ignited under dry conditions, that are often the result of wildfires, can burn underground for months and often cause smoke management concerns. According to the S.C. Forestry Commission¹, wildfire is not uncommon on the Horry County landscape near the proposed project site and around what is now known as the LOBHP. Prior to the most destructive wildfire occurring in 2009, the area formerly known as the Buist tract, that included all of LOBHP, burned as a result of wildfire ten times from 1954 to date. The most recent wildfire occurred in 2024, the Covington Drive Complex which burned around 2600 acres and marked the longest wildfire from ignition to control on record in the state at 95 days. Additionally, the area has the state's most destructive wildfire on record with the 2009 Hwy 31 Fire that burned 19,130 acres.

The impacts of both prescribed fire management and road closures, as well as potential wildfire risk need to be considered in project plans for access to the site and emergency plans.

¹ <https://www.scfc.gov/protection/fire-burning/fire-resources/important-fires-in-sc/>

Aquatic Resources

The proposed project will directly impact approximately 102.4 acres of freshwater wetlands, consisting of both isolated and forested wetlands, and 600 LF (0.04 acres) of an intermittent stream that branches of South Prong Steritt Swamp. Such wetland systems provide a number of important ecological functions, including habitat for a variety of wildlife species. Isolated and depressional wetlands store precipitation that serves as an important water source for fish and wildlife, particularly during dry seasons and drought. Isolated wetlands also make significant contributions to local and regional water supplies via groundwater transport to underlying aquifers (Stone and Lindley Stone 1994). Furthermore, the predominance of woody plant communities and the abundance of snags associated with forested wetlands provide cover, foraging, and nesting habitat for birds, herptiles and mammals. Large contiguous areas of forested wetland are especially important as protective corridors for animal movements.

While the impacts proposed for streams within the proposed project are relatively minimal compared to the amount of freshwater wetland acres being impacted, in their natural state, streams perform a number of well-documented ecological functions. Streams provide an important link between upland watersheds and downstream aquatic environments. Detritus produced in these areas serves as an important energy source for aquatic food chains in adjoining creeks and receiving waterbodies. Small stream habitats can support a diverse community of indigenous aquatic organisms including resident fish species and macroinvertebrates. Physical alterations of streams and wetlands can result in adverse impacts to these habitats and to water quality in receiving waters downstream. Siltation and high turbidity could degrade water quality for several months after initial clearing and filling.

It is also worth noting that the proposed MSW Site 1 will have a leachate collection system. Undetected failures may cause leachate to build up on top of the liner, which can lead to failure of the liner system and contamination of groundwater. The soils in the proposed landfill cell are typical of low-lying areas and may drain into nearby receiving waterbodies. The added risk of groundwater contamination from leachate pollution (Masoner et al. 2014) may lead to increased impacts on nearby aquatic resources. As previously mentioned, the proposed project is directly adjacent to IRHP, a mitigation bank where the adjacent wetlands are being enhanced and preserved. The SCDNR recommends that the applicant provides information on any preventative measures taken to ensure that contamination of adjacent aquatic resources does not occur.

Compensatory Mitigation

Per the COE October 2010 “Guidelines for Preparing a Compensatory Mitigation Plan” Standard Operating Procedure, compensatory mitigation is necessary to offset these unavoidable impacts to aquatic resource functions and services and to meet the programmatic goal of “no overall net loss” of aquatic resource functions and services. The SCDNR has a number of concerns about the project as currently proposed. The proposed additions of the three landfill cells would result in a large area of impact to freshwater wetlands with fill material, where a majority of the impacts will take place on wetlands and streams under restrictive covenants. Assuming these areas that were placed under restrictive covenants were in order to obtain the full 25% credit reduction under the previous Charleston District Guidelines for Compensatory Mitigation (October 7, 2010). When this occurs the proposed acreage and/or linear footage that is protected

must be at least three times the acreage of aquatic resources that will be impacted by the proposed project. Therefore, to mitigate the potential adverse impacts associated with the proposed project by amending the existing Declaration of Restrictive Covenants and to address offsets to previously impacted aquatic resources and those proposed, the SCDNR recommends the applicant must mitigate by multiplying the proposed credit need for previously protected areas (for the impacts associate with C&D site 1 and C&D site 2) by two to fully offset the loss of function to the aquatic resources

Additionally, the SCDNR recommends purchasing stream mitigation credits for the proposed fill of an intermittent stream upstream of the South Prong Steritt Swamp. The SCDNR requests that this information be provided for review prior to the purchase of credits or the issuance of certifications or permit authorization.

Rare, Threatened, and Endangered Species

Because the project's location adjacent and near two important conservation areas, there are many protected species that could be present. Therefore, the SCDNR recommends that a protected species habitat assessment be compiled to describe the habitats onsite with representative photos and a discussion of whether suitable habitat exists for any federal or state protected species that could exist within the proposed project site. This is very important to determine what protected surveys or what avoidance and minimization measures may be needed. Habitats onsite should be described with as much detail as possible including type of aquatic features (e.g., streams, isolated wetlands, seeps, swamps, tidal creek, brackish water, etc.) with a description of the predominant vegetation community types. Habitat communities can be described using The Natural Communities of South Carolina², supplemented with the A Guide to the Wildflowers of South Carolina³ or the Flora of the Southeastern United States⁴.

The Protected Species Habitat Assessment should be compiled to include what suitable habitat exists onsite. Information regarding each species' habitat characteristics can be found in Appendix 1 and greater detail provided in the SCDNR's State Listed Species Protection Guidance⁵.

According to the SCDNR Natural Heritage Database, there are element occurrence records for rare, threatened or endangered species within Horry County including: American Chaffseed, Canby's Dropwort, Pondberry, Golden Sedge, Venus Flytrap, Monarch Butterfly, Red-cockaded Woodpecker, Wood Stork, Bald Eagle, Swallowed-tailed Kite, Northern Long-eared Bat, Tricolored Bat, Rafinesque's Big-eared Bat, Spotted Turtle, and Southern Hognose Snake.

Please review Appendix 1 that outlines SCDNR's comments and concerns related to the various species listed above that could exist within the proposed project site.

² <https://dc.statelibrary.sc.gov/server/api/core/bitstreams/5ebb01b5-82f2-4603-9a3a-f2f5185b8be0/content>

³ <http://www.namethatplant.net/community.shtml>

⁴ <https://www.dnr.sc.gov/environmental/docs/SCDNRStateListedSpeciesProtectionGuidance.pdf>

⁵ <https://www.dnr.sc.gov/environmental/docs/SCDNRStateListedSpeciesProtectionGuidance.pdf>

Stabilization and Stormwater

Many non-native stabilization seed mixes often include Sericea Lespedeza (*Lespedeza cuneata*). Native to eastern Asia, Sericea Lespedeza is considered a noxious, invasive plant pest. A study of a reclaimed mine in Virginia found that northern bobwhite (*Colinus virginianus*) populations were limited due to poor habitat quality resulting from the monoculture plantings of Sericea Lespedeza and Tall Fescue (*Festuca arundinacea*) (Stauffer 2011). At a former surface mine site in Kentucky (now Peabody Wildlife Management Area), a 2015 study demonstrated that areas dominated by Sericea Lespedeza were not preferred habitat for bobwhite (Unger et al. 2015), as it is not a preferred food for bobwhite (Ellis 1961), nor does it contain enough nutritional value to support a bobwhite population (Newlon et al. 1964). Due to its invasive nature and lack of benefit to wildlife, the SCDNR recommends against planting Sericea Lespedeza.

Instead of planting Sericea Lespedeza, the SCDNR prefers and recommends the use of native warm season grasses and/or other native forbs for stabilization that are beneficial for wildlife and pollinators. Native warm season grass species suggestions include: Indiangrass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*) and little bluestem (*Schizachyrium scoparium*). A variety of native pollinator plant species that will benefit wildlife can also be used

There are several areas throughout the project plans that include upland buffers adjacent to wetlands at the proposed C&D Site 1 and 2. Readily available scientific literature indicates that the ability of vegetated buffers to trap suspended sediments are positively correlated with width and negatively correlated with slope (Wenger 1999). A literature review performed by Castelle et al (1994), found that buffers must be 30 meters (100 ft) wide to maintain the health of the biota in nearby streams, but that this width would need to be increased for steeper slopes. Peterjohn and Correll (1984) found that for a 5% slope, only ninety percent of the suspended sediment was trapped in the first 19 meters (62 ft), and that the entire 60-meter (164 ft) buffer trapped only 94% of the sediment. Therefore, the SCDNR requests that upland buffers are also incorporated into the proposed plans for MSW Site 1 as well. Its recommended that adjacent streams and wetlands be protected by vegetated riparian buffers at least 150-feet wide wherever practicable. Please note that cleared/denuded vegetated buffer areas should be replanted in native woody vegetation in order to better protect adjacent aquatic resources. Some resources to assist in native plantings beneficial to wildlife can be found at the following resources:

- <https://www.xerces.org/publications/plant-lists/native-plants-for-pollinators-and-beneficial-insects-southeast>;
- <http://www.pollinator.org/guides>.

The SCDNR recommends the use of native plants for stormwater stabilization and any future landscape plantings that may occur around the site. All plantings should consist of appropriate native species for the ecoregion and should exclude plant species found on the exotic pest plant council list: https://www.se-eppc.org/southcarolina/SCEPPC_LIST2014finalOct.pdf, including those species that may be used for temporary stabilization.

Some resources to assist in native plantings beneficial to wildlife can be found at the following resources:

- <https://www.se-eppc.org/southcarolina/>
- <https://www.xerces.org/publications/plant-lists/native-plants-for-pollinators-and-beneficial-insects-southeast>
- <http://www.pollinator.org/guides>
- <https://hgic.clemson.edu/factsheet/an-introduction-to-native-plants-for-sc-landscapes/>.
- Additionally, the SCDNR recommends the applicant review the native planting recommendations and a list of native plant vendors that can be found in Appendix A and B respectively of the Technical Guidance for the Development of Wildlife and Pollinator Habitat at Solar Farms at <https://www.dnr.sc.gov/solar/assets/pdf/solarHabitatGuide.pdf>.

Summary

The proposed project will involve substantial impacts to wetlands, with 102.4 acres of wetland fill, and potential impacts to nearby conservation areas. Therefore, the SCDNR asks that careful consideration is given during the NEPA process to ensure avoidance and minimization of impacts to water quality, recreation, aquatic resources and important natural resources.

Based on the materials provided by the applicant, the SCDNR finds that additional information is needed to fully evaluate impacts to natural resources within the proposed project footprint. In summary, the SCDNR needs additional information on the following:

- Any additional information on preventative measures associated with the use of the leachate collection system.
- The proposed mitigation to offset the functional loss to the aquatic environment when it becomes finalized.
- Alternatives analysis for the site selection and proposed site configuration.
- Habitat assessment information for determining avoidance and minimization measures for state listed species potentially impacted by the project.
- Details on the proposed upland buffers surrounding wetlands at the MSW Site 1.

If suitable habitat is determined to be present on the proposed project site for any of the above species, the SCDNR recommends that species presence is assumed, and avoidance measures implemented on the project site.

The SCDNR recommends the following general best management practices are considered and incorporated as a part of the permitted project plans.

- Prior to beginning any land disturbing activity, appropriate erosion and siltation control measures (i.e. silt fences or barriers) must be in place and maintained in a functioning capacity until the area is permanently stabilized. Additionally, consideration for state protected species must be in place.
- All necessary measures must be taken to prevent oil, tar, trash and other pollutants from entering the adjacent offsite areas/wetlands/water.

- Once the project is initiated, it must be carried to completion in an expeditious manner to minimize the period of disturbance to the environment.
- Upon project completion, all disturbed areas must be permanently stabilized with vegetative cover (preferable), riprap or other erosion control methods as appropriate.
- The project must be in compliance with any applicable floodplain, stormwater, land disturbance, shoreline management guidance or riparian buffer ordinances.
- Land disturbing activities must avoid encroachment into any wetland areas (outside the permitted impact area). Wetlands that are unavoidably impacted must be appropriately mitigated.
- If temporary clearing must occur within wetlands and waters of the U.S., it must be conducted manually and low growing, woody vegetation and shrubs must be left intact to maintain stability and reduce erosion. Construction activities must avoid and minimize, to the greatest extent practicable, disturbance of woody vegetation within the project area. Removal of vegetation should be limited to only what is necessary for construction of the proposed structures.

Thank you for the opportunity to review this project and provide comments. Should you have any questions or need more information, please do not hesitate to contact me by email at AltabetK@dnr.sc.gov or by phone at 854-444-6117.

Sincerely,



Kolby Altabet
Environmental Review Project Manager
Office of Environmental Programs
South Carolina Department of Natural Resources

cc EPA
USFWS

Appendix 1. Avoidance and Minimization Measures for State-listed Species

The SCDNR offers the following comments for future assessments and consideration for protected species. Additional information regarding habitat assessments for state protected species can be found in the SCDNR State Listed Protection Guidance document found here: <https://dnr.sc.gov/environmental/docs/SCDNRStateListedSpeciesProtectionGuidance.pdf>.

1. Plants

In the interest of preserving native plant diversity, the South Carolina Plant Conservation Alliance performs native plant rescues. If you are interested in assisting with this important endeavor, please contact Botany@dnr.sc.gov before any development occurs onsite. There may be plants of interest on the project site that the Alliance would like to preserve.

1.1 American Chaffseed

American chaffseed (*Schwalbea americana*) is a federally endangered perennial herb which generally occurs in open forested areas, in ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems. Surveys to rule out American chaffseed within the project footprint is recommended. Should American chaffseed be found within the project footprint, please consult with the U.S. Fish & Wildlife Service

1.2 Canby's Dropwort

Canby's dropwort/cowbane (*Oxypolis canbyi*) is a federally endangered species of flowering plant which prefers wetland habitats and are often found along utility rights-of-way. The species is protected due to threats such as habitat loss, highway construction, maintenance, and improvement projects, and herbicide use. SCDNR recommends strong sediment and pollution control practices, limited use of herbicides, and avoiding impacts to the natural hydrology of a site to protect Canby's dropwort and its associated habitats. Should Canby's dropwort be found within the project footprint, please consult with the U.S. Fish & Wildlife Service (843-727-4707) and notify the SCDNR at Botany@dnr.sc.gov before proceeding with any construction activities.

1.3 Pondberry

Pondberry (*Lindera melissifolia*) is a federally endangered deciduous shrub typically associated with shaded edges of wetland habitats. Surveys to rule out pondberry within the project footprint is recommended during the months of February, March, September or October when the species is most easily identifiable. Should pondberry be found within the project footprint, please consult with the U.S. Fish & Wildlife Service (843-727-4707) and notify the SCDNR at Botany@dnr.sc.gov before proceeding with any construction activities.

1.4 Golden Sedge

Golden sedge (*Carex lutea*) is a federally endangered perennial sedge which typically grows in very wet, saturated, and periodically shallowly inundated sandy soils. Most often associated with wet pineland savannas, it can also be occasionally found in areas adjacent or within drainage ditches, along roadsides, and within power easements.

Should American chaffseed, Canby's dropwort, pondberry, or golden sedge be found within the project footprint, please consult with the U.S. Fish & Wildlife Service (USFWS) (843-727-4707) and notify the SCDNR at Botany@dnr.sc.gov before proceeding with any construction activities.

1.5 Venus Flytrap

Venus flytrap (*Dionaea muscipula*), a federal at-risk species and species of high conservation priority listed in the State Wildlife Action Plan, is known to be found nearby the project site. The abundance and range of Venus flytrap have been decimated by fire suppression and land conversion. It is now known from only a few populations in the world – two populations in Horry County, SC and in a few coastal counties of NC. The largest population of Venus flytrap in the state of South Carolina is found centered at Lewis Ocean Bay Heritage Preserve and is the only population within the state that is considered to have long-term viability. The species is thought to be extirpated from Georgetown and Berkeley counties because of fire suppression and land use changes.

The SCDNR recommends that proposed project area is assessed to determine if any populations are present within the construction limits. Should Venus flytrap be found within the project footprint, please notify the SCDNR at Botany@dnr.sc.gov before proceeding with any construction activities. While a landowner can provide consent legally for the cutting, collection, breaking or other destruction to this globally rare plant species pursuant to S.C. Code of Laws 16-11-590, the SCDNR requests that the landowner consults with the SCDNR to either reconfigure the proposed project impacts to minimize or eliminate destruction of Venus flytrap or work with SCDNR to remove and relocate these rare plants.

Wildlife

2. Monarch Butterfly

The Monarch butterfly was proposed for listing by the U.S. Fish and Wildlife Service on December 12, 2024⁶. This species requires habitat with milkweed (genus *Asclepias* or closely related genera) as a larval host plant and floral nectar sources for adults. Please consult with the USFWS regarding impacts to this species.

3. Red-cockaded Woodpecker

According to the SCDNR Natural Heritage Database, Red-cockaded woodpecker (*Leuconotopicus borealis*), a federal and state listed endangered species, is known to occur near the proposed project site within the Lewis Ocean Bay Heritage Preserve and Wildlife Management Area. Take of this state-listed species is prohibited under S.C. Code of Laws §50-15-30 except pursuant to 123-150(2) that allows for incidental take associated with the Safe Harbor program.

⁶ Please note that the U.S. Fish and Wildlife Service (USFWS) published a proposed rule to list the monarch butterfly as threatened with a 4(d) rule on December 17, 2024. The USFWS has 12 months from the posting of the rule before finalizing the rule. <https://www.regulations.gov/document/FWS-R3-ES-2024-0137-0001>

Red-cockaded woodpecker utilize open pine (e.g., longleaf pine ecosystems) or a combination of pine and hardwood habitat. Suitable habitat includes pine trees for both nesting and foraging habitat. Pine trees in excess of 50 years in age provide habitat that allow the excavation of nesting/roosting cavities, whereas foraging habitat consists of pines of any species that are at least 30 years old and are typically a minimum of 10 inches in diameter at breast height (DBH). Pine species should be the dominant trees (50% or greater) in a foraging stand. However, please note red-cockaded woodpecker can also use younger pine stands for both nesting and foraging as the use of artificial cavity inserts have allowed the colonization of red-cockaded woodpecker in younger pine stands.

The SCDNR recommends that the proposed project area should be assessed for potential impacts to red-cockaded woodpecker. For all habitat assessments and surveys for this species, please follow Appendix 4 of the U.S. Fish and Wildlife Service recovery plan – Guidelines for Surveys to Assess Potential Project Impacts to Red-cockaded Woodpecker Nesting and/or Foraging Habitat found at the following link: https://ecos.fws.gov/docs/recovery_plan/030320_2.pdf. Surveys to rule out red-cockaded woodpecker within the project footprint is advised, regardless of habitat condition.

4. Wood Stork

According to the SCDNR Natural Heritage Database, Wood stork, a state endangered species, is known to occur within 1.5 miles of the proposed project area. Take of this state-listed species is prohibited under S.C. Code of Laws §50-15-30 until such time regulations are promulgated. Also, please note take of an active nest or the eggs of a wild bird are prohibited under S.C. Code of Laws §50-11-840; however, the department may issue a permit for the removal of an active nest or eggs that constitute a public safety threat or when birds are causing damage to property.

Wood stork utilize fresh and estuarine waters for nesting and foraging. Nesting habitat occurs in trees or shrubs that are found in standing water or along the edges of ponds, impoundments or marshes. The species will forage in isolated depressions, ponds, marshes, tidal creeks, tidal pools, and even roadside ditches with water levels that are 6 to 10 inches deep and little to no canopy cover (GADNR 2022). The foraging areas are typically located within 20 km of a breeding colony or rookery.

The SCDNR recommends that the proposed project area should be assessed for potential impacts to wood stork. While nesting sites may not be located on the project site, wood storks and other wading birds may seasonally use the water features if any are within the project footprint. If wood storks are found to be within the project area, please also consult with the U.S. Fish and Wildlife Service before proceeding with construction or other management activities

5. Bald Eagle

According to the SCDNR Natural Heritage Database, Bald Eagle nests are known to occur nearby within the proposed project area in the Clear Pond subdivision. Bald Eagle utilize a variety of habitats near fresh and saltwater for foraging and nesting. Suitable habitat for nesting includes large trees, typically pines, but occasionally cypress trees and hardwood trees, that stand above the canopy within contiguous forest. Nests are located almost near the top of the tree where the branches whorl out above the trunk. Nest sites are typically located near foraging sites.

Bald Eagles forage in fresh and salt water along reservoirs, impoundments and rivers, but they will also forage and nest near locations that provide scavenging opportunities (e.g., landfills).

Surveys to rule out nests in the project area are advised to avoid negative impacts to Bald Eagle. Bald Eagles are a state listed threatened species and are federally protected under the Bald and Golden Eagle Protection Act. Eagle nests are protected at all times under this Act. If Bald Eagle nests are found to be within the project area, please consult with the U.S. Fish and Wildlife Service and follow the National Bald Eagle Management Guidelines to ensure that impacts are avoided to this species before proceeding with any construction activities. These guidelines, along with more information about eagle disturbance, nest protections, and permitting, can be found at the following link: <https://www.fws.gov/program/eagle-management/eagle-incident-disturbance-and-nest-take-permits>

Survey Protocol

Surveys should be performed by a biologist with Bald Eagle survey experience. Visual pedestrian transect surveys for Bald Eagle nests may be completed year-round. Surveys between February 1 and April 30 have a greater chance of capturing eagle presence and possible nest activity. Binoculars or spotting scope shall be used to scan suitable habitat for Bald Eagles or their nests prior to conducting transects and occasionally along transects. The detection of a Bald Eagle may indicate a nest is nearby. Surveyors shall walk transects across suitable habitat at a spacing based on the density of onsite vegetation. Line of sight should always be maintained between surveyors. Surveyors should be spaced in a manner where all area in between them will be inspected with a slight overlap (ex. closer for densely vegetated habitat vs. open habitat). Movement shall be at a slow pace with minimal noise to avoid disturbance, particularly between September to May while Bald Eagles are breeding. Should transect surveys be prohibitive due to the size of the area needing to be surveyed, the SCDNR finds the use of aerial surveys would be appropriate.

Aerial surveys should be completed using a slow-flying (approximately 45-80 mph) light aircraft (helicopter preferred) at about 500ft or closer to tree-top level. Aerial surveys may be completed year-round. Surveys between February 1 and April 30 have a greater chance of capturing eagle presence and possible nest activity. Flights should occur during the mid-portion of the day with good visibility, clear weather, and with less than 15 mph. Surveys must thoroughly cover all potential habitat (Call 1978). Survey results must be reported to SCDNR biologist if a known or new bald eagle nest is located within 660 feet of the project area via email at baldeagle@dnr.sc.gov.

6. Swallow-tailed Kite

While there are no element occurrence records of Swallow-tailed kite, a state endangered species, within the proposed project site, this species is known to occur in Horry County and adjacent Georgetown County. These counties are the Northern limit of the swallow-tailed kite breeding range. Take of this state-listed species is prohibited under S.C. Code of Laws §50-15-30 until such time regulations are promulgated. Also, please note take of an active nest or the eggs of a wild bird are prohibited under S.C. Code of Laws §50-11-840; however, the department may issue a permit for the removal of an active nest or eggs that constitute a public safety threat or when birds are causing damage to property.

Swallow-tailed kite inhabit forested wetlands associated with Coastal Plain rivers, streams and swamps that are also associated with open areas for foraging (open pine forests, agricultural fields, clear cuts and other habitat types in early succession). In South Carolina, the swallow-tailed kite is closely associated with large tracts of forested wetlands such as those found in the Francis Marion National Forest and along the lower Savannah, Salkehatchie, Coosawhatchie, Edisto, Santee, Black, Great Pee Dee and Waccamaw Rivers. Although there is the potential for nesting along all of the major river swamps of the coastal plain inland to the fall line (Cely and Day unpublished data). The species shows a strong preference for nesting in dominant or co-dominant loblolly pines (*Pinus taeda*) or bald cypress (*Taxodium distichum*) growing within or sometimes on the edges of wetland forests (SWAP 2015). However, keep in mind, this species has also been recorded nesting in water tupelo (*Nyssa aquatica*), sweetgum (*Liquidambar styraciflua*), and willow oak (*Quercus phellos*). Swallow-tailed kite are a state endangered species.

If suitable habitat exists on the project site, the SCDNR recommends an avoidance window for all tree clearing from March 1 to July 31. Should the applicant prefer to conduct a survey, the protocol below should be used during the time when Swallow-tailed Kite have initiated nesting.

If the avoidance window for all tree clearing cannot be observed, the SCDNR recommends that surveys are conducted for nesting trees. The SCDNR recommends the establishment of a 450-foot buffer zone around any nesting tree where tree clearing would be prohibited from March 1 to July 31. After the nesting season and kites have successfully reared young, clearing may occur within the 450-foot buffer.

Survey Protocol

A visual pedestrian transect survey for Swallow-tailed Kite nests may be completed from April 1 to June 30. It can be easier to find Swallow-tailed Kite nests during nest construction, typically in early April (Cely and Day unpublished data). Surveys should be performed by a biologist with Swallow-tailed Kite survey experience. Binoculars or spotting scope shall be used to scan the suitable habitat for Swallow-tailed Kites or their nests prior to conducting transects and occasionally along transects. The detection of a Swallow-tailed Kite may indicate a nest is nearby. Surveyors shall walk transects across suitable habitat at an appropriate spacing based on the density of onsite vegetation. Line of sight should always be maintained between surveyors. Surveyors should be spaced in a manner where all area in between them will be inspected with a slight overlap (ex. closer for densely vegetated habitat vs. open habitat). Movement shall be at a slow pace with minimal noise to avoid disturbance.

Alternatively, helicopter aerial surveys for Swallow-tailed Kite nests can be completed from April to June. Surveys should be performed by a biologist with aerial Swallow-tailed Kite survey experience. Fixed-wing aircraft are inadequate because of high ground speeds and altitudes (Cely and Day unpublished data). Swallow-tailed Kite nests are usually at the top of the tallest trees available, and the white heads of incubating adults can be noticeable against the dark green forest foliage. Conditions permitting, searches should generally be made at elevations of 200 feet and

air speeds of 40-50 kts. The low elevation results in a narrow transect width. Surveyors shall fly across suitable habitat at a spacing with a slight overlap between transects.

7. Bats

Although no element of occurrence records are known for cavity- and tree-roosting bat species on the property, several species of protected bats are known to occur in Beaufort County and adjacent counties including: the federally endangered Northern long-eared bat (*Myotis septentrionalis*), the federally proposed endangered tricolored bat (*Perimyotis subflavus*); and the state endangered Rafinesque's big-eared bat (*Corynorhinus rafinesquii*).

7.1 Northern Long-eared Bat

Please note that the northern long-eared bat is now listed as federally endangered as of March 31, 2023, making the take of the NLEB prohibited under Section 9 of the Endangered Species Act. Therefore, please consult with the USFWS regarding impacts to this species.

7.2 Tricolored Bat

Tricolored bat were proposed for listing by the U.S. Fish and Wildlife Service on September 13, 2022⁷. This species utilizes caves, rock crevices, tree foliage and basal cavities, Spanish moss and man-made structures, such as houses, barns and culverts, as roosts during the summer months and they will use more than one roost location. Please consult with the USFWS regarding impacts to this species.

7.3 Rafinesque's Big-eared Bat

Suitable habitat for Rafinesque's big-eared bat is defined as swamp forests, hardwood or mixed mature bottomlands, maritime forests and black gum (*Nyssa aquatica*) and water tupelo (*Nyssa sylvatica*) stands (Cochran 1999, Hofmann et al. 1999, Lance et al. 2001, Gooding and Langford 2004, Trousdale and Beckett 2005).

- *Option 1*

If suitable habitat exists within the project, the SCDNR recommends assumption of presence of Rafinesque's big-eared bat within areas of forested wetlands and to further protect these areas, surround them with a 1000-foot buffers and avoid tree clearing from May 1st to July 31st to minimize disturbance and destruction of habitat that may be used by females during gestation or maternal care for pups.

All other tree clearing may occur in areas that are not wetlands or other aquatic resources in non- Rafinesque's big-eared bat maternity roosting habitat anytime. Where wetlands occur but do not include Rafinesque's big-eared bat habitat (i.e., spotted turtle habitat), tree clearing should only occur August to December to prevent

⁷ Please note that the U.S. Fish and Wildlife Service (USFWS) published a proposed rule to list the tricolored bat as endangered on September 14, 2022. The USFWS has yet to finalize the rule. <https://www.federalregister.gov/documents/2022/09/14/2022-18852/endangered-and-threatened-wildlife-and-plants-endangered-species-status-for-tricolored-bat>

impacts to spotted turtles during reproduction. However, if wetlands are dry during January to July – they may be cleared, but they must be completely dry. Please note, additional measures related to other proposed activities, such as excavation and fill, may be needed to avoid adverse impacts to the state protected spotted turtle.

- *Option 2*

To further define areas of Rafinesque’s big-eared bat habitat identified in option 1 and to reduce the number of areas being avoided during maternity season, surveys for maternity roosts may be conducted. To identify potential maternity trees, surveyors shall walk transects across suitable habitat at a spacing based on the density of onsite vegetation. Line of sight should always be maintained between surveyors. Surveyors should be spaced in a manner where all area in between them will be inspected with a slight overlap (e.g., closer for densely vegetated habitat vs. open habitat). Any maternity roost tree identified must then be buffered with a 1000-foot radius and an avoidance for tree clearing implemented May 1st to July 31st. Maternity roost trees are defined as trees standing 59 to 82 feet tall with large, hollow, cavities – 4 feet tall by 1 feet wide external width, with large basal cavities potentially being preferential (Mirowsky 1998, Gooding and Langford 2004, Trousdale and Beckett 2005, Carver and Ashley 2008, Bat Conservation International and Southeastern Bat Diversity Network 2013).

All other tree clearing may occur in areas that are not wetlands or other aquatic resources in non-Rafinesque’s big-eared bat maternity roosting habitat anytime. Where wetlands occur that are not Rafinesque’s big-eared bat habitat, but they are spotted turtle habitat, tree clearing should only occur August to December to prevent impacts to spotted turtles during reproduction. However, if wetlands are dry January to June, they may be cleared, but they must be completely dry (no surface water present).

The following bat species are considered a species of highest conservation concern in the SCDNR State Wildlife Action Plan (SWAP) can also be found within Horry County; big brown bat (*Eptesicus fuscus*), Eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), Seminole bat (*Lasiurus seminolus*), and Southeastern bat (*Myotis austroriparius*). Species are listed in the SWAP because they are rare or designated as at-risk due to knowledge deficiencies; species common in South Carolina listed rare or declining elsewhere; or species that serve as indicators of detrimental environmental conditions. SCDNR recommends that appropriate measures should be taken to minimize or avoid impacts to these species of concern.

If any of the above species are found on-site, please contact the U.S. Fish & Wildlife Service and SCDNR. In summary, the SCDNR recommends the applicant assume presence of the aforementioned species and abide by a clearing moratorium from May 1st to July 31st if suitable habitat for the above species is likely or are explicitly identified

within the project footprint. Additional details regarding suitable habitat for these species can be found at: <https://www.dnr.sc.gov/wildlife/bats/batconsplan.html>.

8. *Spotted Turtle*

According to the SCDNR Natural Heritage Database, the spotted turtle (*Clemmys guttata*), a state-threatened species and a federal At-Risk species (ARS), has an element occurrence record within 3.6 miles of the proposed project area. Pursuant to S.C. Code of Laws §50-15-20 and §50-15-70, it is unlawful for any person to take, possess, transport, import, export, process, sell, or offer for sale spotted turtle except as outlined in S.C. Code of Regulations 123-151.1(A) for scientific and conservation purposes. Suitable habitat includes heavily vegetated, shallow wetlands with standing or flowing water including Carolina Bays, bogs, swamps, marshes, and wet meadows (wetlands with soft, mucky substrates are preferred) (Jensen et al. 2008). While often associated predominantly with wetlands, spotted turtle spend a considerable amount of time on land throughout the year; however, preferred upland habitat types have not been identified. Keep in mind that spotted turtles are known to move considerable distances between and within habitats; a male can have a home range of 5 hectares, where females have been documented to have home ranges of 16 hectares (Litzgus and Mousseau 2004).

If suitable habitat is found to be present the SCDNR recommends the applicant assume spotted turtle presence on the proposed project site. To prevent the take of a spotted turtle the applicant can either choose to avoid any construction in areas within or adjacent to aquatic resources (wetlands, streams, etc.) from January 15th through July 15th or utilize exclusion methods outlined below.

For areas where wetlands are being avoided, the SCDNR recommends the following:

- Prior to any construction activity, install silt fencing from November 15th through January 15th. Silt fencing should include 45-degree arms to direct spotted turtles to the uplands adjacent to the waterbody and away from the construction site. The 45-degree arms should be placed at a minimum of 100 ft from the waterbody and no more than 300 ft from the waterbody. Additionally, silt fence arms should extend at least 50-ft and extend in each direction so that the ends of each 45-degree angle to the fence meet to form a triangle. Silt fencing should remain in place throughout the duration of the proposed construction activities. If silt fencing cannot be placed in accordance with this timing, see additional silt fencing exclusion below.
- Prior to construction, monitor the silt fencing to ensure it is effectively working properly on a monthly basis. This should effectively exclude the species from the project area prior to construction activities. Once construction activities begin, the silt fence should be monitored weekly, at a minimum, for the integrity of the fencing and the presence of spotted turtles or other herpetofauna or small wildlife species. The SCDNR recommends that a permit is in hand prior to exclusion to address handling and relocation of any spotted turtles encountered during the project; see the Spotted Turtle Temporary Relocation Guidance below.

Should the applicant find that the spotted turtle avoidance and minimization measures cannot be completed, the SCDNR would then request that a trap survey for the presence of spotted turtle be

completed. Pursuant to S.C. Code of Regulations 123-151.1(A), a conservation permit will be needed from SCDNR prior to completing the survey.

Survey Protocol

All surveys must be completed when water is present in the wetlands. Spotted turtles utilize wetland habitat during certain times of the year, but during periods of drought or low water levels, spotted turtles will aestivate in the surrounding forests adjacent to wetlands. Surveys should be conducted from March 1st – May 15th when air temperatures are between 60-88°F and water temperatures between 60-82°F. Surveys can be conducted using visual survey or trap surveys; however, the SCDNR recommends only the use of trap surveys due to the low detectability of spotted turtle with the use of visual survey only. Trap surveys should be conducted between March 1st and May 15th. Further survey details can be found in the Spotted Turtle Assessment Protocol developed by the Spotted Turtle Working Group.

Trap Surveys

Trapping is usually most effective March to May. Further survey details for trapping can be found in the Spotted Turtle Assessment Protocol developed by the Spotted Turtle Working Group. However, please note that if spotted turtle are detected in areas to be impacted that the applicant would either then need to implement exclusion methods or additional trapping survey efforts for the purposes of relocation. At a minimum, sites should be trapped for three weeks during the active season from March 1st to May 15th. Each week of trapping should include a 4-night trap run for a total of at least 12 nights during the entire spotted turtle active season. Due to time constraints associated with trapping and project development, the SCDNR strongly recommends that any trapping effort follow the Demographic High Density Trapping guidelines found in the Spotted Turtle Assessment Protocol developed by the Spotted Turtle Working Group.

If silt fencing for exclusion cannot be placed at the appropriate time outlined above, then the following should be abided:

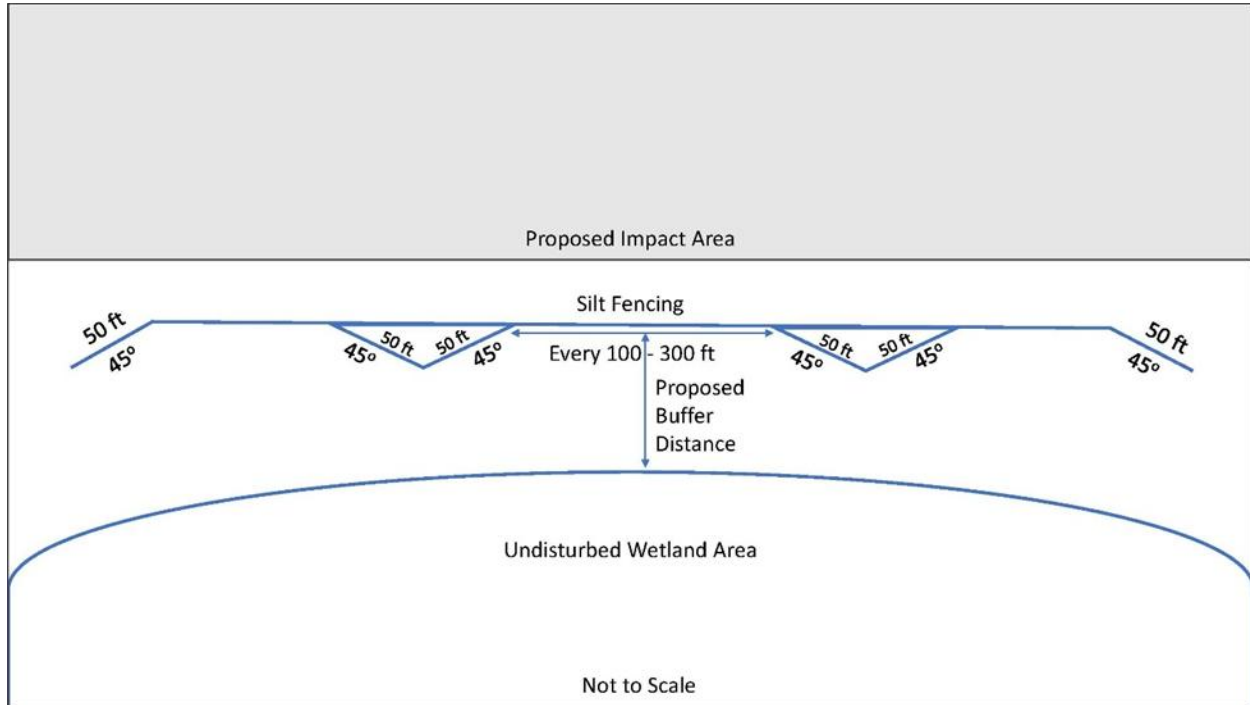
Should the applicant not be able to install the silt fencing in accordance with the proposed window, it will require the applicant to install the exclusion fencing when the species is more active and has the potential to trap individuals with the area of proposed construction. Therefore, the SCDNR recommends checking the perimeter of the fencing twice daily for 14 days prior to ground disturbance and/or clearing in areas adjacent to and near these wetlands to ensure that spotted turtles are not trapped within the proposed project footprint.

Any turtles found within the construction area during this initial monitoring period and the construction monitoring period described below must be relocated. The relocation plan must be submitted to the SCDNR Permitting Biologist⁸ and a permit received from SCDNR prior to the installation of the silt fencing.

During the initial 14 days of monitoring, the construction area should be entirely enclosed within the exclusion fence. After the 14-day installation period, a single point of access may be

⁸ <https://www.dnr.sc.gov/wildlife/scientificcollinstructions.pdf>

established in the exclusion fence, utilizing four 45-degree arms (two facing inward and two facing outwards (e.g., ---< >---) as outlined in the guidance below. Please note that the following guidance necessitates that a minimum 100' upland buffer be established between the affected area and the adjacent wetlands.



- Silt fencing should include 45-degree arms to direct spotted turtles to the uplands adjacent to the waterbody and away from the construction site. The 45-degree arms should be placed at a minimum of 100 ft from the waterbody and no more than 300 ft from the waterbody. Additionally, silt fence arms should extend at least 50-ft and extend in each direction so that the ends of each 45-degree angle to the fence meet to form a triangle. Silt fencing should remain in place throughout the duration of the proposed construction activities.
- Prior to construction, monitor the silt fencing to ensure it is working properly on a monthly basis. This should effectively exclude the species from the project area prior to construction activities. Once construction activities begin, the silt fence should be monitored weekly for the integrity of the fencing and the presence of spotted turtles or other herpetofauna or small wildlife species. The SCDNR recommends that a permit is in hand prior to exclusion to address handling and relocation of any spotted turtles encountered during the project; see the Spotted Turtle Temporary Relocation Guidance below.

For areas where construction will occur in wetlands, the SCDNR recommends the following:

In wetlands that will be impacted and cannot be avoided, trap surveys for the presence of spotted turtle in wetlands should occur. Prior to trapping a relocation plan should be developed and

submitted to SCDNR for review by the SCDNR Herpetologist (herps@dnr.sc.gov); the SCDNR has provided relocation plan guidance below. Following completion of surveys, the results should be submitted to SCDNR regardless of whether spotted turtle were found to be present onsite. Should spotted turtle be found, the SCDNR should be notified immediately via herps@dnr.sc.gov. For trapping with the goal of relocation, the SCDNR recommends that the trapping plan should follow the Demographic High Density Trapping guidelines found in the Spotted Turtle Assessment Protocol developed by the Spotted Turtle Working Group and that the number of traps should be doubled (i.e., 40 traps total) to ensure the maximum amount of spotted turtle can be relocated prior to impacts occurring. Trapping must occur at a minimum of 2 weeks/month in March, April and May; each week of trapping should include 4 trap nights. This equates to a total of 24 trap nights during the entire trapping window. The relocation plan must be submitted to the SCDNR Permitting Biologist⁹ and a permit received from SCDNR prior to the installation of any silt fencing for construction.

All surveys must be completed when water is present in the wetlands. Spotted turtles utilize wetland habitat during certain times of the year, but during periods of drought or low water levels, spotted turtles will aestivate in the surrounding forests adjacent to wetlands. Surveys should be conducted from March 1st – May 15th when air temperatures are between 60-88°F and water temperatures between 60-82°F. Further survey details can be found in the Spotted Turtle Assessment Protocol developed by the Spotted Turtle Working Group.

SCDNR Spotted Turtle Relocation Guidance

Relocation can occur moving animals to similar habitats onsite or to suitable habitat offsite. The relocation plan for moving spotted turtles away from areas they will be impacted must be submitted to SCDNR for review prior to the installation of the silt fencing and the proper permits acquired from the SCDNR Permitting Biologist¹⁰ for the movement of a state protected species. If you have questions, please contact the State Herpetologist by emailing herps@dnr.sc.gov.

The relocation plan should include the following:

- Maps of where habitat will be impacted and the proposed relocation area.
- Photos of suitable habitat in the proposed relocation area.
- **Temporary Relocations** generally entail translocating individuals immediately outside of exclusion fencing and into adjacent or nearby areas outside of areas of active construction where they were encountered and only in areas that provide similar suitable habitat and cover. Protocols for temporary relocations should include silt fencing monitoring plan and may also include the following best management practices:
 - Reptiles may move during the night and seek shelter; therefore, all machinery and construction materials or debris that remain overnight at the work area shall be inspected by a designated and qualified environmental inspector. All personnel will be responsible for visually inspecting vehicles and equipment throughout the lifecycle of the Project. Details outlining visual inspections will be provided

⁹ <https://www.dnr.sc.gov/wildlife/scientificcollinstructions.pdf>

¹⁰ <https://www.dnr.sc.gov/wildlife/scientificcollinstructions.pdf>

during a Project-specific training for all on-site Project personnel. Project-specific training material for protected species conservation will be developed and used to inform onsite workers of spotted turtles.

- Depending upon the specific location for clearing or intrusive work, if a spotted turtle is encountered during the daily pre-work examination, field work/construction may be delayed temporarily in the immediate vicinity until after the animal has voluntarily moved outside the work area or is relocated.
- If work is in progress after completion of the pre-work examination and a worker observes an animal that may be a spotted turtle, all workers within a 50-foot radius shall cease work immediately and all machines within the same radius shall be turned off. The permit holder's environmental professional shall be contacted immediately. The person that detected the reptile will maintain observation of the specimen until the designated professional arrives, while maintaining a separation distance of no less than 25 feet from the reptile, to avoid being detected and cause the animal to hide. Upon arrival of the approved designated professional, the person that encountered the individual animal will show the professional where the turtle is for relocation as needed.
- **Relocation Trap Assessments** are a more intensive method intended to facilitate the collection of all individuals in an area that will be impacted or completely lost. For trapping with the goal of relocation, the SCDNR recommends that the trapping plan should follow the Demographic High Density Trapping guidelines found in the Spotted Turtle Assessment Protocol developed by the Spotted Turtle Working Group and the number of traps should be doubled (40 traps total) to ensure the maximum amount of spotted turtle can be relocated prior to impacts occurring. Trapping must occur at a minimum of 2 weeks/month in March, April and May; each week of trapping should include 4 trap nights (24 nights total). The relocation plan must include a trapping protocol and survey schedule with maps that show all wetlands and trapping schedule/plots/protocol/density of traps when applicable.

Trap Configuration

- Within each of the four circular sampling plots, place ten traps (recommended: ProMar TR-502 or TR-503 24 or 36"x12" collapsible turtle traps OR crab traps utilized in FL/GA, see equipment section, below) 0–200 m from the reference point at the plot centroid (40 traps total over the four reference plots) in areas within the project footprint that will be impacted.
- Ideally, all ten traps within a single reference plot should be the same trap type, though different reference plots could have different trap types. The ten traps per sampling plot can be placed in any number of wetlands (e.g., one large wetland or as many as five small wetlands). Ideally, traps should be placed at least 30 m intervals (the average daily movement distance of females in the spring observed by Litzgus and Mosseau [2004] in South Carolina) in different directions from the reference point (e.g., 30 m to NW; 60 m to NE, etc.); however, the configuration and wetlands and microhabitat will often preclude this strategy. In instances where the wetland configuration is a single linear feature (e.g., a ditch or canal), the traps may be placed in a line along the wetland, separated by at least 30 m, ideally.

Trap Placement

- *Microhabitat*.—Traps should be located within high potential use areas, if they exist in the project footprint to be impacted. High potential microhabitat is as follows:
 - In shallow (≤ 0.2 m, $<$ trap diameter) flow channels that may direct movement of individuals;
 - At the edge of thick vegetation (e.g., sedges, grasses, shrubs) or structure (e.g., logs, debris);
 - Proximal to basking sites;
 - At sites with good solar exposure;
 - Surrounded by cover that conceals traps;

If high potential use areas aren't available in the project footprint to be surveyed, the consultant should use their expertise of the species to place traps in locations that have the highest potential for capturing spotted turtles.

- *Placement*.—Traps should be firmly staked into the ground (e.g., with 4' plastic-wire coated tomato stakes) or affixed to adjacent structures (e.g., using rope) at two locations to prevent animals, wind, etc. from moving them. The traps should be set so that turtles have adequate headspace to breathe. For ProMar traps, place 1–2 empty plastic bottles (16 oz, with caps on tight) within traps or pool noodles along the outside of traps to ensure breathing space. GPS coordinates should be recorded at each trap once they are placed, and traps should be flagged or marked in accordance with each researcher's preference, including the reference number and trap number. In locations where traps may be seen by the public (e.g., roadsides, boardwalks, etc.), traps can be inconspicuously labeled, instead, so as to not attract attention. On the day of trap deployment, complete the trap set-up field form including habitat suitability information. Surveyors must watch forecast weather conditions and pull or monitor traps if heavy precipitation or flooding is expected. During subsequent DA trap placements, traps should generally be placed in the same location as during the previous run, unless this is impossible due to changing water levels.
- *Trap Checks*.—Traps should be checked at least every 24 hours. On each trap-check day, the trap-check field form should be completed, and the turtle individual field form should be completed for each Spotted Turtle captured in the trap (see protocol for processing individual turtles). Traps should be baited with $\sim\frac{1}{2}$ can of sardines in oil (e.g., Beach Cliff) and rebaited every 24 hours.
- Protocol for handling captured animals (including target and non-target organisms) – photos verification of each individual and documentation of other species (see photo verification details below). Captured animals shall never be left in the sun, and if relocation cannot take place immediately, animals must be placed in a shaded, cool, dry place that is clear of vehicles and heavy equipment, human activity, and project activities. If an animal needs to be temporarily housed, a labeled, disinfected, plastic container with a lid that has air holes may be used, however, the individual must be relocated within 24 hours. In the event an individual is killed or dies during holding, it will immediately be reported to SCDNR, and the permittee will implement any instruction requested by SCDNR accordingly for specimen disposition. If individuals are encountered, sub-meter accurate GPS coordinates will be collected for the collection location and the

translocation location. Any data or information collected during the Project will be compiled and provided to SCDNR. Data will include photographs, GPS coordinates, and any other relevant data available to collect or requested during observations and/or collection.

- Handling and capture of protected species will only occur if individuals are encountered inside the construction areas and relocation will result in avoiding inadvertent adverse impacts to these species. No other handling or capture of these species are allowed.
- Protocol for transporting and releasing captured animals to relocation site including details on when and where.
- Resumes/curriculum vitae of entities completing this work; reptile and amphibian survey trapping experience is required.

Photo Voucher Protocol

General photography procedures

The camera used for photo vouchers should be 1024 x 768 pixels or higher. For all voucher photographs of each individual should include at a minimum, a photo the dorsal view (from above), ventral view (belly) and lateral view should be obtained. It is ideal to photograph the specimen on a light background including a ruler to show size. Photographs in an individual's hand is also acceptable if no other options are available. This also helps to capture the size, but please keep in mind to try to allow the animal to occupy as much of the field of view as possible to capture the detail necessary for identification. In general, effort should be made to photograph any distinguishing features.

Example Photo Vouchers of a Gopher Frog as a reference

Photo 1 (Dorsal view)



Photo 2 (Lateral View)



9. Southern Hognose Snake

According to the SCDNR Natural Heritage Database, the southern hognose snake (*Heterodon simus*), a state threatened species that was proposed for listing as threatened with a 4(d) Rule by the U.S. Fish and Wildlife Service on August 29, 2025¹¹, has an historical element occurrence record within 5 miles of the proposed project area. This species is often associated with open pine habitats. Suitable habitat can be broadly defined as open longleaf pine habitat in sandy soils. However, to be specific, suitable habitat also includes sandhills that typically consists of a rolling topography and deep sand substrate within a savanna of widely spaced longleaf pine (*Pinus palustris*) and/or turkey oak (*Quercus laevis*), often with a wiregrass (*Aristida stricta*) understory; or scrubby pine flatwoods with low relief having deep, sandy soils within a savanna of widely spaced longleaf pine, with a wiregrass and scrub-shrub understory (FNAI, 2012). However, hognose snake can be found on a variety of xeric habitats with well-drained, sandy soils in addition to the typical fire maintained longleaf pine, sandhills and scrubby pine flatwoods including ruderal and agricultural habitats with similar characteristics (Jensen, 2008; Jordan, 1998). Typically, where found in altered habitat, there is also a diverse herbaceous groundcover. While altered and not ideal, these habitats can also serve as suitable habitat (although more limited). Habitat assessments to identify suitable habitat should be conducted via pedestrian surveys and can be conducted year-round. Please note that take of this state-listed species is prohibited under S.C. Code of Laws §50-15-20(C).

Because Southern hognose snakes are highly fossorial, the SCDNR finds that surveys detectability is extremely low. Therefore, the SCDNR recommends activities, especially the use of heavy equipment, is minimized when the hognose snake is most active and vulnerable above ground during the spring (March-April) and fall (September-early November) to reduce impacts to this species from soil compaction and crushing in lieu of surveys.

Exclusion measures may also be used in areas of suitable habitat to minimize impact to the species. The SCDNR recommends the following exclusionary methods:

¹¹ <https://www.govinfo.gov/content/pkg/FR-2025-08-29/pdf/2025-16688.pdf>

- Erect silt fencing around the project area in the winter when snakes are dormant (and spotted turtles will be in the wetlands). If the timing of this would impact project timelines, the SCDNR asks that the silt fencing be erected now and that a monitoring plan be in place to walk the perimeter of the silt fence daily the week prior to construction beginning to ensure that any herpetofauna within the project footprint along the fencing be moved to outside of the project area prior to any work taking place.
- Monitor the silt fencing to ensure it is effectively working properly on a monthly basis prior to construction activities occurring. This should effectively exclude any herpetofauna and other small wildlife species from the project area prior to excavation.
- Once construction activities begin, the silt fence should be monitored weekly, at a minimum, for the integrity of the fencing and the presence of hognose snake or other herpetofauna or small wildlife species. If southern hognose are encountered, please notify the SCDNR by emailing photos of the individuals, date of capture, coordinates where capture occurred and if the animal had to be relocated where it was released to herps@dnr.sc.gov. The SCDNR recommends the applicant acquire a permit to relocate any hognose snake that may be encountered on the project site and needs to be relocated. Permit instructions can be found at www.dnr.sc.gov/wildlife/scientificcollinstructions.pdf.

Because of the proposed listing, the SCDNR recommends consulting with the USFWS regarding impacts to this species prior to land disturbing activities.

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Regional Spotted Turtle Assessment Protocol

Spotted Turtle Working Group¹

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through the USFWS Competitive State Wildlife Grants Program
and the Northeast Regional Conservation Needs (RCN) Program
www.northeastturtles.org*

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This document outlines a standardized and flexible methodology for sampling Spotted Turtle (*Clemmys guttata*) populations in the eastern part of the species' range (Maine to Florida). This protocol is adapted in part from the Northeast Blanding's Turtle Sampling Protocol developed by the Northeast Blanding's Turtle Working Group (www.blandingsturtle.org) and funded by a US Fish and Wildlife Service Competitive State Wildlife Grant to the Virginia Department of Game and Inland Fisheries. The protocol was refined based upon an expert poll completed by experts from Maine to Florida, and was updated in 2019 based on results from 2018 sampling.

Two basic methodologies are outlined: trap-based assessments and visual assessments without traps. Two levels of trap-based assessments—**Rapid** and **Demographic**—are described. The protocol for Rapid Assessments is simply a reduced-effort version of the Demographic Assessment protocol. A visual Rapid Assessment is also described. To summarize the protocol: (1) delineate potential Spotted Turtle habitat using a geographic information system (e.g., Google Earth or ArcGIS) and recent aerial imagery; (2) place up to four 200-m radius plots centered on potential Spotted Turtle habitat with plot centroids up to 800 m apart; (3) conduct a Trap-based Rapid Assessment (TRA), Demographic Assessment (DA; trap-based), or Visual Rapid Assessment (VRA). For TRAs, place five traps ≥ 30 m apart within the reference plots. Traps may be set anytime during the Spotted Turtle activity season in your region. Check all traps every 24 hours for four consecutive days. For DAs, conduct the TRA protocol three times (for a total of 12 nights). For VRAs, two types of assessments are possible—**time constrained** and **unconstrained**. In both cases, a single observer visits a site three times during the survey season and during each visit, actively searches for turtles on foot. For time constrained surveys, the surveyor searches for 20 minutes per reference plot (up to 80 minutes total per visit), recording start and stop time and location of each survey. For unconstrained surveys, the surveyor walks a meandering transect anywhere within each reference plot, for as long as the survey takes, recording start and end time and GPS track.

¹ For a list of partners and additional information, see: www.northeastturtles.org or www.americanturtles.org. Protocol development sub-group: Liz Willey (American Turtle Observatory [ATO] and Antioch University New England), Mike Jones (Massachusetts Division of Fisheries and Wildlife), Patrick Roberts (University of Massachusetts and ATO), Kat Lauer (Antioch University New England), Tom Akre (Smithsonian Conservation Biology Institute), Lori Erb (Mid-Atlantic Center for Herpetology and Conservation), Derek Yorks (Maine Department of Inland Fisheries and Wildlife), Jonathan Mays (Florida Fish and Wildlife Conservation Commission), and JD Kleopfer (Virginia Dept. of Game and Inland Fisheries). For questions, contact: info@americanturtles.org.

The methodology outlined in this document is designed to be relatively simple, flexible, fit within existing research programs, and accommodate regional differences in seasonal activity period, habitat structure, and research priorities. Broad regional participation is encouraged to increase the size of the representative sample. Data collected through the regional effort are maintained in a centralized database at the American Turtle Observatory (www.americanturtles.org) for pooled analysis.

Planning Phase

Step 1: Select a wetland complex

Identify and delineate a wetland or wetland complex that is suitable for study. It may either be (A) an area known to be occupied by Spotted Turtles; (B) a data-deficient site with potentially suitable Spotted Turtle habitat; (C) randomly-selected areas of potential habitat and occurrence (to be added in Year 2; 2019). When selecting a wetland complex for surveys, remember that Spotted Turtles are associated with a *wide array* of wetland habitats that vary regionally including, but not limited to, emergent marshes, deciduous shrub swamps, forested wetlands, seasonal pools, sphagnum bogs and seeps, linear ditches and canals, floodplain forests, and beaver impoundments. Whenever possible, use leaf-off or spring season aerial images when determining plot locations, as they allow greater visibility when mapping small seasonal pools in deciduous forest habitats (Fig. 1). In some cases, additional examination of leaf-on imagery may assist plot placement. Surveyors should confirm that property access is allowed by the landowner, and that the site has diverse wetland habitat suitable for Spotted Turtles, either through aerial photo interpretation or field reconnaissance. As an approximate guide, the focus area should be $\geq 800 \text{ m}^2$ and $\leq 2 \text{ km}^2$ (though if much larger, multiple groups of four reference plots could be delineated).

Step 2: Develop reference plots

Within the focus area, identify four reference points separated by 400 to 800 m using Google Earth or a similar GIS program (Fig. 1). Reference points should be centered on areas of highly suitable Spotted Turtle habitat (i.e., high potential use wetlands). Points may fall either on constellations of small wetlands (e.g., seasonal pools) or on portions of a single large wetland. Delimit 200-m radius (see distance justification, below) circular plots around reference points. All sampling should be conducted within these circular plots. Although four plots are ideal for spatial replication and to adequately sample larger landscapes, surveyors may place fewer than the recommended four reference plots if there is not enough suitable habitat available or if access is unavailable.

Step 3: Conduct an optional reconnaissance site visit

If you have not visited the site already, consider conducting a reconnaissance visit to make sure that property access is feasible and that the study plots should not be re-situated. Use this visit to identify potentially ideal trap locations and locations for visual surveys.



Figure 1. Illustration of study site delineation in Google Earth. The yellow central dots illustrate Reference Points centered on areas of suitable (or potentially suitable) Spotted Turtle habitat, surrounded by reference plots with 200-m radius.

Survey Phase

Option 1: Conduct a Trap Assessment (Rapid or Demographic Assessment)

Trap Assessment Types

Trap-based sampling may take the form of either rapid or demographic assessments. These assessment types differ in intensity (i.e., trap nights), but utilize the same trapping methodology and are therefore directly comparable.

Rapid.—Trap-based Rapid Assessments (TRA) are intended to serve as a method for quickly collecting baseline occurrence and abundance information. TRAs require four consecutive nights of trapping at a site during the Spotted Turtle active period.

Demographic.—Long-Term Trap Assessments (DA) are a more intensive method intended to facilitate the collection of population information that will allow for more precise estimates of population size, age structure, sex ratios, and additional population information via mark recapture. DA sites should be trapped for 3, 4-night trap runs (3 TRAs) for a total of at least 12 nights during the Spotted Turtle active season.

Trap Configuration

Within each of the four circular sampling plots, place five traps (recommended: ProMar TR-502 or TR-503 24or36"x12" collapsible turtle traps OR crab traps utilized in FL/GA, see equipment section, below) 0–200 m from the reference point at the plot centroid (20 traps total over the four reference plots) in high potential use areas, as determined by the researcher in accordance with

expert opinion. Ideally, all five traps within a single reference plot should be the same trap type, though different reference plots could have different trap types. The five traps per sampling plot can be placed in any number of wetlands (e.g., one large wetland or as many as five small wetlands). Ideally, traps should be placed at least 30 m intervals (the average daily movement distance of females in the spring observed by Litzgus and Mosseau [2004] in South Carolina, see movement justification, below) in different directions from the reference point (e.g., 30 m to NW; 60 m to NE, etc.); however, the configuration and wetlands and microhabitat will often preclude this strategy. In instances where the wetland configuration is a single linear feature (e.g., a ditch or canal), the traps may be placed in a line along the wetland, separated by at least 30 m, ideally. Emphasis should be placed on habitat suitability rather than strict adherence to these distance rules, but traps should be at least 15 m apart if 30 m is not possible.

Demographic, High Density Trapping.—At sites with low turtle density, low recapture rates, low trap success, or extremely narrow opportunities for detection, and where the recommended DA protocol described above would yield too few captures for a population estimate, researchers may choose to conduct high density trapping within 1 or more reference plots. At least 1 four-night run at four reference plots with the recommended trap density (5 traps / reference plot) should occur (so that results can be compared with other sites throughout the region). In addition to the initial four night trap-run (equivalent to a TRA), researchers can then place 10 traps in each reference plot (in 1 to 3 plots, if necessary) for the remaining 8 (or more) trap nights. All reference plots should receive the same number of traps each night and all trap sets and checks should be recorded on the *high density trapping forms*.

Trap Placement

Microhabitat.—Traps should be located within high potential use areas as follows:

- In shallow (≤ 0.2 m, $<$ trap diameter) flow channels that may direct movement of individuals
- At the edge of thick vegetation (e.g., sedges, grasses, shrubs) or structure (e.g., logs, debris)
- Proximal to basking sites
- At sites with good solar exposure
- Surrounded by cover that conceals traps

Placement.—Traps should be placed by experienced researchers or researchers that have undergone training to ensure the safety of the animals. Traps should be firmly staked into the ground (e.g., with 4' plastic-wire coated tomato stakes) or affixed to adjacent structures (e.g., using rope) at two locations to prevent animals, wind, etc. from moving them. Enough slack should be present in the rope to accommodate rising water levels. The traps should be set so that turtles have adequate headspace to breathe. For ProMar traps, place 1–2 empty plastic bottles (16 oz, with caps on tight) within traps or pool noodles along the outside of traps to ensure breathing space. GPS coordinates should be recorded at each trap once they are placed, and traps should be flagged or marked in accordance with each researcher's preference, including the reference number and trap number. In locations where traps may be seen by the public (e.g., roadsides, boardwalks, etc.), traps can be inconspicuously labeled, instead, so as to not attract attention, but it is of paramount importance that the trap be locatable so that traps are checked every 24 hours to ensure the safety of the animals. On the day of trap deployment, complete the trap set-up field form including habitat suitability information. **Surveyors must watch forecast weather conditions and pull or monitor traps if heavy precipitation or flooding is expected.** During subsequent DA trap

placements, traps should generally be placed in the same location as during the previous run, unless this is impossible due to changing water levels.

Trap Checks.—Traps should be checked every 24 hours. On each trap-check day, the trap-check field form should be completed, and the turtle individual field form should be completed for each Spotted Turtle captured in the trap (see protocol for processing individual turtles), including for turtles that have been captured before (recaptures). Traps should be baited with $\sim\frac{1}{2}$ can of sardines in oil (e.g., Beach Cliff) and rebaited every 24 hours. If traps are baited with other forms of bait, please indicate this on the field form. Air temperature should be recorded once in each reference plot and water temperature at each trap. Air temperature should be measured in the shade. Water temperature should be measured 10 cm below the surface, adjacent to a trap. If a trap had malfunctioned for some reason (e.g., raccoon predation), please indicate that on the field form. For additional details, see field-form instructions. If raccoon predation has occurred or is suspected, the trap should be pulled or replaced with a hard-sided trap to ensure the safety of the animals.

Option 2: Conduct a Visual Rapid Assessment

Visual Rapid Assessments (VRA) serve as a second method of rapid assessment intended to facilitate population assessments in regions or terrain where trap-based assessments may not be feasible as well as in habitats and portions of the species range where trapping appears to be less effective. VRAs and trap assessments can be applied at the same site, but *time-constrained* VRAs and trap assessments generally should not occur at the same time. However, a researcher who wishes to conduct unconstrained VRAs during trap checks (or while setting traps) could do so by recording visual survey effort between traps using tracks and processing turtles visually encountered using the unconstrained VRA protocol described below.

A single VRA is made up of three separate visits to one site within a four-week window of time in the active survey season. VRAs consist of active searching for turtles within wetlands on foot. There are two main approaches to distributing time throughout a reference plot and recording information during a VRA: Time constrained surveys and unconstrained surveys.

Time Constrained

If you are conducting a time-constrained survey, a total of 20 minutes should be spent surveying each reference plot (for a total of 80 minutes for 4 reference plots) on a given day. The information to record for each survey depends on the configuration of the wetland in the reference plot.

A) **Time Constrained 1:** For small (<0.1 ha) seasonal wetlands, observers should record the location of the wetland using GPS and the start time of the survey. The survey should continue until the entire wetland has been searched by the observer (or the water becomes too cloudy for the survey to be effective), and the end time of the survey should be recorded. The surveyor can then move on to another wetland in the reference plot until a total of 20 minutes has been spent in the reference plot on that day.

B) **Time Constrained 2:** For straight, linear wetland features (e.g., canals or ditches), the observer should record the start time and location (using GPS) of the survey, and proceed to survey the linear wetland until either 20 minutes has elapsed, the entire segment of the wetland in the

reference plot has been surveyed, or the water becomes too cloudy for the survey to be effective. The surveyor should then record the time and GPS location at the end of the survey and then move on to another wetland in the reference plot, if there are any, until a total of 20 minutes has been spent in the reference plot on that day.

C) **Time Constrained 3:** For larger or amorphous wetlands that make up the majority or entirety of a reference plot, the observer records the time and GPS location of the start of the survey and surveys throughout the wetland, within the reference plot, until 20 minutes has elapsed, and the surveyor then records the time and location of the end of the survey.

For each of the time-constrained VRA approaches, each visit requires 20 minutes of active searching per reference plot for a total of 80 minutes of active searching throughout the site. If animals are processed during a survey, the clock should be stopped during processing. As noted above, the observer should keep track of the amount of time not spent actively searching for turtles (e.g., when handling turtles) per sampling plot, and GPS waypoints should be recorded at the beginning and end of each sampling plot survey. The observer should attempt to visit all wetlands within the sampling plot during the allotted 20-minute window.

Unconstrained VRA

Instead of spending 20 minutes/plot, a surveyor may choose an unconstrained visual survey approach. For this method, the surveyor records the starting time and location of a survey and begins recording a GPS track. The surveyor then conducts a visual survey on foot anywhere within a reference plot for as long as it takes to adequately sample the plot, regardless of wetland configuration (i.e., the surveyor may move between wetlands). At the end of the reference plot survey, the surveyor records the end location and time of the survey and any processing time that occurred during the survey time, and stores the GPSTrack for the survey, before moving on to the next reference plot. For unconstrained surveys, each reference plot should be surveyed 3 times.

Regardless of the approach selected (constrained or unconstrained), a VRA field form should be filled out for each site visit. Air and water temperature should be recorded once within each sampling plot.

Number of observers

For consistency and to avoid scaring turtles, we recommend that only one observer should perform each VRA site-visit, but subsequent visits should ideally be conducted by different observers to reduce observer-related bias. If two observers are in the field together, we suggest they conduct surveys in different reference plots. For example, on survey day 1, observer 1 could sample plots 1 and 2 and observer 2 could sample plots 3 and 4. On survey day 2, they could switch: observer 1 could sample plots 3 and 4 and observer 2 could sample plots 1 and 2. If it is necessary for more than one observer to conduct a survey within a single reference plot at the same time, please designate one person as the **lead observer** and note that on the field form. The lead observer should survey the wetland independently and unimpeded by the additional observer(s) who should trail behind and be sure not to influence the survey of the lead observer. The total number of turtles, as well as the number observed by the lead observer should be recorded on the VRA field form.

Protocol for Processing Individual Turtles

When a spotted turtle is captured (either during trapping or visual surveys), the turtle observation field form should be completed, and the following protocols are recommended. Turtles should not be removed from the site, should be restrained for as little time as possible, and should be returned to their capture location. NOTE: each time a turtle is recaptured in a season, please complete another individual form for the turtle, even though one has already been completed. It is not necessary to re-measure the turtle (the turtle ID, date, and location fields, at a minimum, should be completed).

Morphometrics. Record shell dimensions in mm. At a minimum, record SCL_{min} (straight carapace length) and SPL_{min} (straight plastron length). Optionally, also record: PW @ H-P seam (plastron width at humeral/pectoral seam), CW @ V3/4 (carapace width at the 2nd and 3rd vertebral line), and SH (shell height at the 2nd and 3rd vertebral line). Dial calipers 6"/500 mm are recommended.

Weight. Record animal mass in g (Pesola scale 250 g or 500 g).

Age and Plastral Wear: Assess the animal's age if new growth is visible along the medial seams and the plastral scutes are only lightly worn. Otherwise, report the minimum number of annuli visible and whether the plastral scutes are "not worn" ($\leq 10\%$ wear), "partly worn" ($< 50\%$), "mostly worn" (50%-90%) or "worn" ($> 90\%$).

Individual marking. Turtles should be individually notched as directed by state coordinators. Secondary recognition is recommended using photographs, injuries, deformities, PIT tags, etc. Only trained researchers should insert PIT tags. When marking animals, we recommend the use of a numeric notching code (e.g., Cagle 1939 or Ernst et al. 1974) where numbers are added to obtain a single ID number, rather than a code that refers to scute locations only (e.g., R2 R3), because scute code data are harder to manage than numeric data.

Photographs. Photograph carapace and plastron with animal ID visible in photo (or sorted/ tagged post-capture). If possible, photograph lateral head shot and limbs/tail, as well as obvious injuries or deformities.

Injuries and general health. Note missing or injured limbs, tail, eyes, etc., as well as the presence of skin or upper respiratory tract infection or lethargic condition.

Scute morphology and other deformities. Note any major scute or other deformities, including less than or more than 12 marginals on either or both sides.

Tissue collection for genetic analysis. With approval from state coordinators, trained researchers may consider collecting blood or tissue samples for genetic sampling. See tissue collection protocol.

Required Equipment

The following equipment is required to complete the protocol: field forms, writing implements, GPS for recording trap locations and visual survey points/tracks, flagging for marking traps, calipers (~6 in), Pesola scale ≥ 500 g, extra slim taper triangular file (for marking turtles), camera or cell phone for photographing turtles, air and water thermometers, and 20 traps/site operated at a time with associated stakes, ties, and bait. Additional optional equipment may also be necessary

including waders, polarized sunglasses, binoculars, disinfecting equipment, and/or blood sampling equipment. Because researchers currently have a range of available equipment, specifications are flexible. Any traps >0.2 m in diameter with < 3 cm mesh are acceptable, though we recommend that all five traps within a single reference plot be the same type of trap. These variations will be incorporated as a covariate in the modeling process. To help standardize future equipment purchases, we recommend medium or large sized ProMar, collapsible minnow traps (Model TR502 or TR503, 12" diameter by 24" or 36" length with 5" dual openings. <https://promarnets.com/product/deep-water-crawfish-crab-nets/> (Fig. 2). [Note: we do NOT recommend the smaller, square, red ProMar model]). This model trap has been used successfully by researchers throughout the species range for over a decade. Alternatively, we recommend hard-sided crab traps like those used in Georgia and Florida (Chandler et al. 2017). Hard-sided traps are particularly useful in areas where raccoons or other predators are an issue. Alternatively, to prevent raccoon depredation, researchers have had success retrofitting ProMar traps with chicken wire or hardware cloth on the outside (Fig. 3).



Figure 2. Promar TR502 (left) and modified crab trap from Chandler et al. (2017).



Figure 3. ProMar retrofitted with chicken wire to prevent raccoon predation (J. Meck)

Trap identification: Assign unique ID to each trap and label trap in the field and on the corresponding field form.

Trap location/operation: Record trap ID, lat/long (decimal degrees), and functional period (mm/dd-mm/dd), and complete appropriate field form upon trap placement.

Bait: Sardines in oil (Beach Cliff or other brand).

Re-bait frequency: 24 hr (puncture can, do not open entirely, or use part of a can in a container that allows the oil to escape, but not the fish).

Trap check frequency: 24 hr with more frequent checks as required by agencies/partners or flood conditions.

General protocols to reduce likelihood of disease transfer.

Several states and research teams within the region already have a standard decontamination procedure in place to prevent the spread of disease, and teams should follow their local practices and procedures. For those teams without a decontamination protocol, we suggest several precautionary measures to prevent the spread of disease. A 3% bleach solution may be used to disinfect traps and clothing between sites. After bathing or spraying tools and clothing in the bleach solution, items should be rinsed with clean water. Captured turtles from different sites and those displaying signs of illness should be held separately during processing, and equipment should be sterilized between turtles. Calipers should be swabbed with alcohol, files can be burned, and notches should be dabbed with Betadyne. Latex gloves for handling turtles are an additional precautionary suggestion. The Northeast Partners for Amphibian and Reptile Conservation (NEPARC) Disinfection Protocol contains additional recommendations (<http://northeastparc.org/disinfection-protocol>).

Data Entry

For any of the protocols, enter your data onto the standardized field forms available at <http://northeastturtles.org> while in the field. Upon returning to the office, electronically enter data as soon as possible into the formatted Excel Worksheet also available on the website.

Data Analysis

Data will be managed at the regional level by CSWG partners, including American Turtle Observatory, Smithsonian Conservation Biology Institute, and Mid-Atlantic Center for Herpetology and Conservation. Rapid Assessments will be analyzed in a mixture modeling framework (Royle 2004) using the unmarked (Fiske and Chandler 2011) package in R (R Core Team 2018). Demographic Assessment sites will be analyzed in a capture mark recapture framework using the Rcapture (Baillargeon and Rivest 2011) package or spatially explicit capture recapture techniques (Royle et al. 2011) using the secr package (Efford 2017) in R.

Plot Size and Trap Night Justification

To determine appropriate plot sizes and trap distances for sampling design, we reviewed the literature to evaluate known movement distances for Spotted Turtle. Ideally, each reference plot would be independent at the scale of an entire sampling event (an active season) and therefore be larger than, but the same order of magnitude as, a spotted turtle home range, and large enough to encompass many spotted turtle home ranges. A 200-m radius plot is equivalent to a 12.6 ha plot, slightly larger than three times the size of the average minimum convex polygon (MCP) measured via radio-telemetry by Milam and Melvin (2001), between the average size of male and female MCPs observed by Litzgus and Mosseau in South Carolina (2004), and large enough to encompass the home ranges of multiple individuals. Thirteen turtles tracked for a year in Florida by J. Mays (unpublished data) fell within a 13ha area. It should be noted that some individuals move much farther, however; Milam and Melvin (2001) tracked an individual 1125m in a year, J. Mays has tracked males in Florida that moved over 1200 m straight line over the course of a year, but both are within the order of magnitude of the reference plots we suggest.

The four combined reference plots would be equivalent to about 50 ha. In the expert poll, respondents stated that known Spotted Turtle populations from Maine to Florida range in size from 0.7 ha to over 100 ha. The proposed four-reference plot arrangement allows for a broad configuration of sites to be sampled, and encompasses all of the size classes provided by experts.

Traps themselves should be far enough away to be independent at the scale of a single trap night, so that animals are not observed in different traps on the same day, but close enough that animals might be recaptured in adjacent traps on different nights. The recommended 30 m separation distance represents the average daily movement distance observed by Litzgus and Mosseau (2004) by females during the spring season in South Carolina (Table 1). In addition, 30 m is consistent with the trap separation distance most often used by experts from Maine to Florida.

Table 1. Movement and home range distances of spotted turtles from previous studies.

Author	Location	Sample Size, method	Mean home range area (ha)	Home range length (m)	Mean Daily Movement (m/day)
Beaudry et al. 2007, Maine Beaudry et al. 2008		40 radio-telemetry	9.3 ha (95% FKE, Range 0.3 - 64.0) or 7.9 ha (MCP, Range 0.4 - 40.0)		102 (SD = 0, range: 18– 251) using thread trailing
Milam and Melvin, 2001.	Massachusetts	26 (10M, 16F), radio-telemetry	3.5 ha (Range: 0.2-53.1)	313 (Range: 115-1125)	
Buchanan et al., 2017.	Rhode Island	12 radio-telemetry	1.95 ha (MCP) Range=0.59-4.07ha		
Litzgus and Mosseau, 2004	South Carolina	31 (9M 22F), radio-telemetry	Male: MCP = 5.15±1.13, Kernel 95% = 4.67±0.61; Gravid Female: MCP = 19.06±6.75, Kernel 95% = 10.35±2.29		Male (n=7-9): Spring =21.77±0.39, nesting = 10.7±0.22, late summer = 10.41±0.28, fall = 10.34±0.3, winter = 7.13±0.28; Gravid Female (n=16-20): Spring = 26.96±0.36, nesting = 19.89±0.17, late summer = 33.44±0.45, fall = 8.04±0.11, winter = 2.33±0.07
Mays, unpublished data	Florida	29 (11M, 18F)	MCP=2.3 (range=0.1-20.6); 95% kernel=4.5 (range= 0.4-40.3)		

Similarly, to estimate the required number of trap nights, we reviewed recent literature and compiled information from experts across the region. Across studies in Rhode Island, Massachusetts, Maryland and Florida, traps yielded an average of 0.3 Spotted Turtle captures/trap night (Table 2). Region-wide in 2018, 8020 trap nights across 57 sites yielded 714 spotted turtle captures, for an average region-wide capture rate of 0.089 turtles/TN or 11.2 TN for 1 Spotted Turtle. Though this was substantially lower than our estimate based on previous data, it included many exploratory sites rather than primarily known populations that were included in Table 2. Excluding sites where no turtles were captured in 2018, trap success averaged 0.13 turtles/TN in 2018.

As expected, capture rates in 2018 were highly variable across sites, and ranged from 0 turtles/TN (for 26 sites, including one site that was trapped as many as 320 TN) to 0.675 turtles/TN. Once covariates (such as weather and time of year) are included in the model, some of this variation may be explained. There will always be errors of omission with any protocol, but with a few exceptions, results from 2018 suggest that the 80 TN design seems sufficient to identify very high density sites.

To assess whether the 240 TN DA protocol was sufficient, we used the package *rcapture* (Baillargeon and Rivest 2011) in R (R Core Team 2019) to calculate rough population estimates for DA sites trapped in 2018. Of the 12 sites trapped using the DA framework for which data were available, four sites yielded estimates with relatively tight confidence intervals (95% CI range was 16 turtles or less), 4 sites yielded estimates with confidence intervals 50 to 100 turtles wide, and four sites yielded estimates with 95% confidence intervals greater than 174 turtles wide (including two sites with no recaptures at all) (Fig. 4). This suggests that although the DA protocol works well for some sites, some sites with a lower density or lower recapture rate may require additional trap nights or higher trap density. Based on these results from the 2018, it was determined that higher densities of traps may be necessary for better demographic estimates at some sites, and the Working Group added the *Demographic, High Density Trapping* protocol described above.

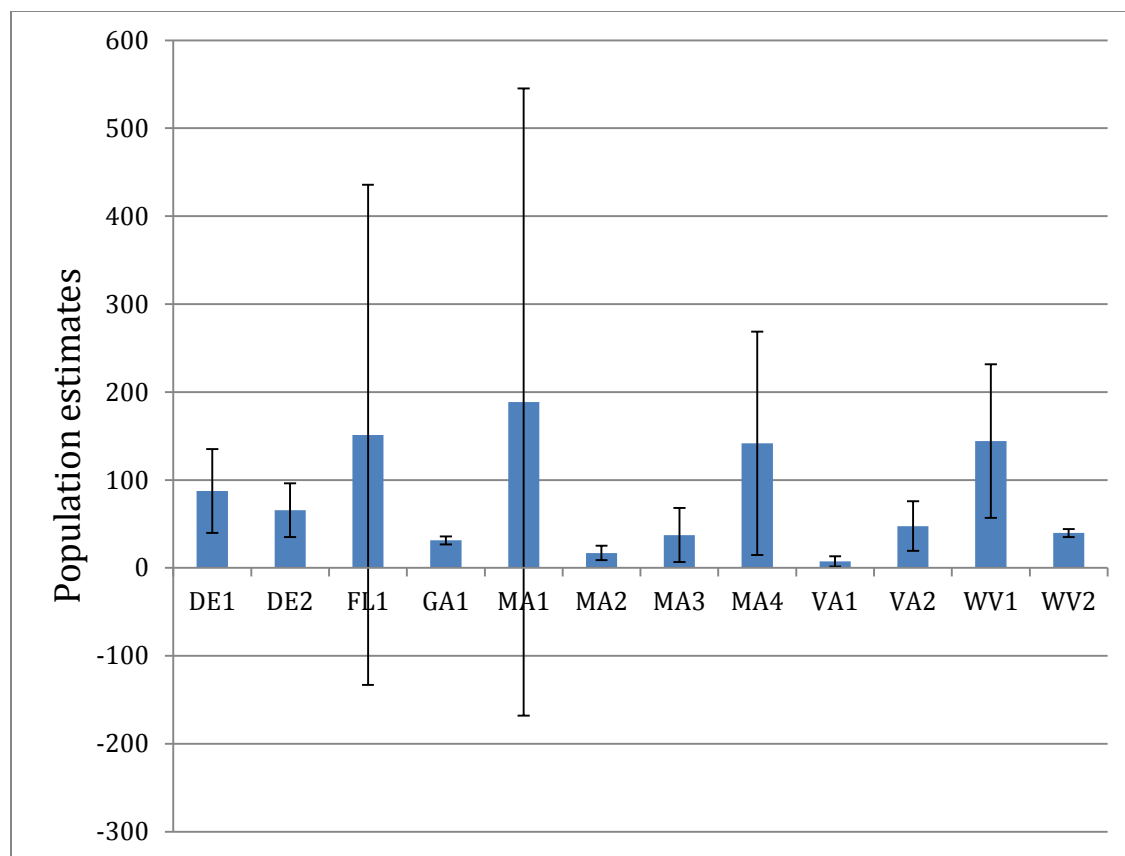


Figure 4. Population estimates and 95% confidence intervals for sites that used the DA protocol in 2018.

Table 2. Capture rates and population estimates with known trapping effort from previous studies

Authors	Location	Total TN	Individuals	Captures	Turtles/T N	Population Estimate	Estimate Standard Error
Buchanan, pers. comm.	Rhode Island	40	21	24	0.6		
Willey, Jones, Milam, unpublished data, 2014	Massachusetts Total	216	23	58	0.27		
Willey, Jones, Milam, unpublished data, 2014	MA Site 1- Hampshire Co.	109	13			11.3	SE=0.6
Willey, Jones, Milam, unpublished data, 2014	MA Site 2- Franklin Co.	107	10			21.2	SE=7.8
Mays, in Chandler et al. 2017	Florida	698		32	0.05		
Chandler et al. 2017	Georgia	866		146	0.17		
Howell, unpublished data	Maryland				0.79		
Liebgold, unpublished data	Maryland				0.02		
Approximate average (assuming equal trap effort)					0.32		

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Spotted Turtle Monitoring Protocol Overview

PLANNING PHASE

- Select and delineate a wetland complex
 - Select sites with a known population OR potentially suitable habitat
 - Use leaf-off aerial imagery
 - Confirm permission to access property
- Place up to four 200-m radius reference plots centered on suitable Spotted Turtle habitat
 - Reference plot centroids should be 400–800 m apart
- Conduct a reconnaissance visit

SURVEY PHASE

- Option 1: Trap-based assessments (rapid or long-term)
 - Set five traps (recommended: ProMar TR-502 24"x12" collapsible turtle traps [optional: with chicken wire retrofit] or FL/GA crab traps) per sampling plot (20 total per site)
 - Complete the trap set-up field form
 - Place traps:
 - Ideally 30 m apart (no less than 15 m)
 - In high potential use wetlands and microhabitat
 - Such that there is adequate headspace for turtles to breathe
 - Affix traps at two locations (at least) to ensure they cannot be moved by animals
 - Bait traps with ½ can of sardines in oil and rebait every 24 hours (note if a different bait is used on the field form)
 - Check traps every 24 hours
 - Complete a trap check field form whenever traps are checked
 - Complete an individual turtle form for each Spotted Turtle captured
 - Trap-based Rapid Assessment (TRA)
 - A single trap-run (using the above methodology) consisting of four nights
 - Demographic Assessment (DA)
 - Three, 4 night trap-runs, for a total of 12 trap-nights (using the above methodology). Nights 5-12 could use higher trap densities under the DA, High Density Trapping protocol.
- Option 2: Visual Rapid Assessment (VRA)
 - On foot, actively search each reference plot for 20 minutes (80 minutes per visit to a site)
 - A) Small seasonal pools should be searched in their entirety before moving to the next wetland in the reference plot
 - B) The beginning and ending points of surveys for long, linear wetland features (ditches or canals) should be recorded
 - C) In larger wetlands, a meandering transect survey should be conducted and GPS track should be logged.
 - A VRA is complete when three surveys are conducted at a site within a four-week window
 - Complete a VRA field form for each visit to a site
 - Each visit should be conducted by a single observer

- Attempt to rotate observers for consecutive visits to a site to reduce bias
- Record GPS tracks as well as start and end coordinates