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Northeast Endangered Species Determination Key Standing Analysis

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Prepared by: Sarah Nystrom, Northeast Regional Office

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1 INTRODUCTION

1.1 PURPOSE OF STANDING ANALYSIS

This Standing Analysis provides an optional, streamlined alternative consultation process for federal action agencies to address potential effects of future actions, pursuant to section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (Act). Species and critical habitats covered by this analysis are listed in Appendix B. The U.S. Fish and Wildlife Service (Service) developed this standing analysis to streamline the process of reviewing actions that would result in a “may affect, not likely to adversely affect” (NLAA) determination for the subject species and critical habitat(s). This standing analysis also provides proactive technical assistance to federal action agencies in making a “No Effect” determination.

This standing analysis provides an optional consultation process that is available to federal agencies for federal actions that meet the criteria described below as delivered through a Determination Key (DKey) in the Service’s Information for Planning and Consultation (IPaC) application. To obtain consultation documents, including technical assistance for NE and concurrence with NLAA determinations, federal agencies must use the associated DKey in IPaC to answer questions about the proposed action. By screening the project through the DKey, all or part of the standing analysis is adopted by the federal action agency and used to submit a concurrence request to support their NLAA determination. It also provides technical information to help agencies determine whether an action will have no effect on the species or critical habitat. Formal consultation under ESA Section 7(a)(2) is required for actions that "may affect" a listed species and critical habitat, unless the Service concurs in writing that actions are not likely to adversely affect listed species and critical habitat. Actions which an action agency determines will have no effect on species or critical habitat do not require submittal to the Service.

With the IPaC DKey established for this standing analysis, the action agency may receive a letter of concurrence for eligible projects by providing specific information requested by the DKey. Throughout the remainder of this document, statements regarding this standing analysis refer to both the standing analysis and the associated DKey.

1.2 BENEFITS OF THE STANDING ANALYSIS

For those federal actions that the Service has accumulated significant knowledge in analyzing previously, the Service is able to develop a standing analysis to streamline the consultation process for eligible federal actions. The streamlined process facilitated by this standing analysis will reduce the amount of Service staff time necessary to review actions requesting consultation and provide federal agencies, consultants, and other project proponents a predictable, consistent, and timely response for qualified actions. In addition, development of a standing analysis to assess the impacts of individual projects allows the Service to more efficiently track multiple independent actions on listed species and critical habitat.

1.3 ELIGIBILITY FOR USE OF THE STANDING ANALYSIS

A standing analysis does not convey concurrence with NLAA determinations for individual projects. Rather, it serves as a streamlining tool. Action agencies may use it to develop their request for concurrence from the Service and support their finding that the action is not likely to adversely affect species and critical habitat. The standing analysis also allows the Service to quickly evaluate an action agency’s analysis of effects to listed species and critical habitat. If the action agency’s proposed action is consistent with covered[1] area and covered activities, including any required conservation measures in the standing analysis, the Service will concur that the action will have insignificant, discountable, or completely beneficial effects on the relevant listed species and critical habitat (i.e., NLAA).

The standing analysis may also provide technical information to help agencies identify actions that will have no effects to the listed species and critical habitat. For projects that do not qualify to use the standing analysis, action agencies/project proponents should coordinate directly with the local Ecological Services Field Office (ESFO) and address any consultation requirements, as appropriate.

1.4 Ensuring Accurate Determinations

As is true in all consultation procedures, the Service relies on complete and accurate information provided by federal action agencies during consultation. To apply this standing analysis to a project, it is the responsibility of the action agency/project proponent to provide information that is truthful and accurate and that fully represents the entire scope of the project in order to comply with the Act.

Where appropriate in our analysis, we make note of which activities are expected to have no effects[2] on a species or critical habitat. This information is provided as technical assistance to action agencies making no effect/may affect determinations.

1.5 Updates to the Standing Analysis

This standing analysis will be reviewed annually and updated as needed to ensure the analysis contains the best scientific and commercial data available. This update process will include regular reviews to ensure that the analysis is accurate and valid, and that the standing analysis still meets the Act's requirements. All updates will also ensure that the logic is sound and determinations are appropriate for covered activities. Updates will be signed under an updated cover.

Projects reviewed under this standing analysis must rely on the version that is current on the date consultation is completed. For reference, both current and previous versions of the standing analysis will be maintained by the lead field office.

If we revise the standing analysis and determine reinitiation is required for any ongoing activities that used the previous standing analysis, the Services will contact the respective action agency and advise them of their need to reinitiate.

2 Covered Area

This standing analysis applies within the area described below, unless otherwise excluded (Section 3.1). In delineating the geographic scope of this standing analysis (coverage area), we determined the

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[1] The term "covered" is used throughout this document to define the limits of use of a standing analysis. However, although the area, activities, and species are "covered" by the standing analysis, the future activities themselves are not "covered" by the standing analysis; there are additional steps (with or without a DKey) that take place for an action agency to utilize the information in the standing analysis and to request FWS concurrence that their proposed action is NLAA for listed species and critical habitat.

[2] A "no effect" determination is appropriate when either the species is not present in the action area or is not exposed to any possible stressors or impacts from the proposed action, or the proposed action would not result in any physical, chemical, biotic changes to the environment that are reasonably certain to occur and would not occur but for the action (i.e., no action area can be defined).

appropriate extent based on the species and critical habitat(s) included and the activities covered herein. To qualify to use this standing analysis, a project's action area must fall completely within the covered area: the entire states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia, and the District of Columbia, within the Northeast Region of the Service. This key does not cover Virginia.

3 COVERED ACTIVITY DESCRIPTION

The activities described herein include all activities addressed in this standing analysis. The activity description, conservation measures, and covered area inform the standing analysis and describe which specific activities are appropriate for NE or NLAA outcomes under this analysis. The description of activities and their inclusion in the standing analysis should not be construed to indicate that these activities will always result in effects to the species or critical habitat(s), nor is it meant to cover activities that fall outside of the analysis as described below. Action agencies are not required to use this standing analysis; they continue to have the option to request individual consultation on a project; however, in most cases, we anticipate use of the standing analysis will substantially decrease consultation timeframes.

The proposed action is the compilation of many different types of projects that, depending on their size and specific location, often are not likely to adversely affect any federally listed threatened or endangered species or critical habitats in the Northeast Region. Common project types include, but are not limited to, the following:

- Vegetation management, including mowing, a subset of forestry activities, prescribed burning, and harvest
- Construction, maintenance, operation, and/or removal of:
    - Roads and trails
    - Communication towers
    - Transmission and utility lines
    - Bridges and culverts
    - Solar power facilities
    - Hydroelectric facilities/dams
    - Mines/quarries
    - Canals/levees/dikes
- Commercial, residential, and recreational developments
- Agricultural activities
- Site/habitat restoration/enhancement
- Shoreline protection/beach nourishment
- Dredging and filling of wetlands/waterbodies
- Military operations

Vegetation management is the practice of controlling and managing plant growth. Vegetation management can include the use of equipment, tools or hands to remove or modify vegetation through cutting, pulling, grinding, burning or other methods.

Construction, maintenance, operation and/or removal of objects, systems or organizations includes the use of equipment, tools or hands to build, create, attach or remove elements, materials, structures or pieces of equipment.

Commercial, residential, and recreational development includes creating new buildings or structures for business use, residential use, and recreational use respectively. Development encompasses various type of properties like office buildings, retail spaces, industrial facilities, family homes, apartments, facilities and spaces for recreational activities.

Agricultural activities encompass a wide range of practices involved in cultivating crops and raising livestock, including soil preparation, planting, irrigation, weeding, harvesting, mowing, and storage.

Site and habitat restoration or enhancement involves rehabilitating degraded eco-systems to restore their ecological function and diversity. Restoration efforts can include removing invasive species, planting native vegetation, and restoring natural waterways through in-stream or riparian activities.

Shoreline protection involved measures to reduce coastal erosion and mitigate the impacts of storms on shorelines. This can include both structural and non-structural approaches, such as building seawalls or groins, or using living shorelines with vegetation and natural materials. Beach nourishment involves adding sand or sediment to beaches to combat erosion and increase beach width.

Dredging and filling of wetlands or waterbodies are processes that involve moving and placing earth materials, particularly in water bodies. Dredging is the removal of sediment and other materials from the bottom or banks of a water body, while filling is the placement of materials, such as sand, rock, or other materials, into a water body or wetland.

Military operations encompass a wide range of organized, coordinated activities carried out by a state or non-state actor to achieve specific objectives. These operations can range from large-scale combat to humanitarian assistance and disaster relief and can involve various branches of the military. Military operations may include the movement of people or equipment, use of incendiary devices, use of projectiles or firing ranges, use of explosives, use of smoke or obscurants, use of aircraft, use of vehicles in road or off-road environments, maneuver, bivouac and field training exercises, climbing or survival exercises and/or subterranean training.

3.1 LIMITS/SIDEBOARDS

To assist action agencies/project proponents in determining whether their project meets the requirements of this standing analysis, the Service will provide a series of questions (Appendix A) to assess whether the action is not likely to adversely affect listed species or critical habitat because the impacts are either unable to be meaningfully measured, detected, or evaluated and, therefore, insignificant; or extremely unlikely to occur and, therefore, discountable. Any actions that are likely to adversely affect a listed species or critical habitat do not qualify under this standing analysis and require separate individual project review and consultation by the local ESFO.

Actions that include certain activities, occur in certain geographic areas, or meet one or more context-dependent conditions will not be eligible to use the standing analysis. For projects requiring consultation (i.e., that “may affect” listed species or critical habitats) that do not qualify due to one or more of these exclusions, action agencies/project proponents must contact the appropriate ESFO directly to complete their consultation requirements.

3.1.1 Activity Based Limits/Sideboards

To receive the Service’s technical assistance acknowledgement of an action agency’s NE determination or the Service’s concurrence for a NLAA determination, based on this standing analysis, actions and activities may NOT include the following:

1. Purposeful take of a listed animal (e.g., capture and handling for surveys or research).

2. Construction or operation of land-based or offshore wind turbines for listed birds (eastern black rail, Great Lakes piping plover, Atlantic Coast piping plover, red knot, roseate tern) or bats (gray bat, Indiana bat, Virginia big-eared bats). This activity is covered for other species within the key.

Purposeful take is not covered under this SA. Covered activities in this SA are limited to those where take is not the purpose of carrying out an otherwise lawful activity.

3.2 CONSERVATION MEASURES

This standing analysis applies conservation measures as design features to avoid adverse effects on an individual, population, or species. The Service has previously found that incorporation of certain conservation measures, while voluntarily adopted by action agencies, has reduced effects to the extent that the actions do not require formal consultation and the Service and the action agency have found that actions are not likely to adversely affect species and critical habitat. Projects using this standing analysis to support a determination of NE or NLAA must meet all the requirements of the standing analysis. The inability to voluntarily adopt certain conservation measures may result in a project not qualifying to use this standing analysis.

The following species- or taxon-specific exclusions and/or conservation measures must be met to use this standing analysis and receive a predetermined outcome of NE or NLAA from IPaC through the DKey. To ensure compliance with the ESA, individual project consultation (or other programmatic consultation, if applicable) with the Service may be necessary for projects that cannot make a "no effect" determination for any listed species that may occur in the project area and cannot apply the following conservation measures. Such projects would not necessarily result in significant adverse effects to federally listed species or their habitats.

3.2.1 Amphibians

3.2.1.1 Cheat Mountain Salamander

Projects that intersect the Species List Area (SLA) for Cheat Mountain salamander must not:

1. Permanently or temporarily modify suitable habitat, which includes hardwood forests and/or red spruce dominant forests above 2,000 feet in elevation
2. Harm the species indirectly by including activity within suitable habitat at any time of year

Avoiding any activities that may occur within Cheat Mountain salamander habitat will ensure that adverse effects are insignificant and/or discountable.

3.2.1.2 Eastern Hellbender

Projects that intersect the SLA for eastern hellbender must not:

1. Make any hydrological changes
2. Have any direct impacts to a stream or river (e.g., Horizontal Directional Drilling (HDD), hydrostatic testing, stream/road crossings, new stormwater outfall discharge, dams, other in-stream work, etc.)
3. Have the potential to impact the riparian zone or indirectly impact a stream/river (e.g., cut and fill; HDD; construction; vegetation removal; pesticide or fertilizer application; discharge; runoff of sediment or pollutants; increase in erosion, etc.)

Avoiding direct or indirect impacts to the stream and riparian zone, including changes to hydrology, will ensure adverse effects are insignificant and/or discountable.

3.2.2 Birds

3.2.2.1 Eastern Black Rail

Projects that intersect the eastern black rail SLA in suitable habitat[3] must not:

1. Result in changes to eastern black rail habitat quality, quantity, or availability (e.g., land management activities including mowing, haying, grazing, prescribed fire, and fire suppression; development; conversion of habitat to agriculture or other land type; herbicide application; changes in hydrology; etc.)
2. Directly or indirectly affect the eastern black rail (e.g., changes in hydrology; application of pesticides, including insecticide, fungicide, etc.; increased potential for oil and chemical spills; etc.)
3. Result in increased predation or human disturbance (e.g., posts or other avian predator perches, structures or habitat features likely to encourage predator nesting/denning, trash cans or other predator attractants, feral cat colonies, commercial/residential development, beach access structures, boardwalks, pavilions, bridges/roads/ferries/trails, marinas, etc.)

Avoiding direct or indirect impacts to eastern black rail, suitable habitat, including changes to hydrologic regimes, impacts to food sources, and limit human or animal disturbance will ensure adverse effects are insignificant and/or discountable.

3.2.2.2 Piping Plover (Atlantic Coast and Great Lakes Populations) and Great Lakes Piping Plover Critical Habitat

Projects that intersect the piping plover SLA (Atlantic Coast population or Great Lakes population) and contain suitable piping plover habitat; or intersect piping plover critical habitat (Great Lakes population) containing the primary constituent elements, must not result in:

1. Any changes to the quality, quantity, or availability[4] of suitable piping plover habitat[5] during the breeding season (April 15 through August 15) and/or during the non-breeding season if the impacts to quality, quantity, or availability of suitable piping plover habitat will continue into the breeding season (e.g., beach nourishment conducted during the non-breeding season may result in a loss of food sources that will persist into the breeding season if conducted without sufficient time for food sources to recover)
2. Any changes to the quality, quantity, or availability of CH at any time of year
3. Any permanent changes to suitable piping plover habitat[6] or CH
4. Increased human disturbance, dog activity, or an increase in potential predators such as raptors, or mammalian predators. within suitable piping plover habitat or CH
5. A new communication tower, high voltage transmission lines, or any other type of towers with or without guy wires that may post a collision risk to birds

If the project does not occur in suitable habitat along the Atlantic Coast or shoreline of Lake Erie, or if the critical habitat doesn't contain the physical and biological features essential to the conservation of piping plover (for details, refer to 66 FR 22938), piping plovers are not likely to be present in the action area. As

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[3] Eastern black rails nest in marshes, wet meadows, along creeks and rivers, and coastal prairies, as well as around farm ponds, hayfields with standing water, and impounded wetlands. All its habitats have stable shallow water, usually just 1.2 inches deep at most.
[4]For example, beach grooming, boardwalk actions, breakwaters, development, dredge deposition, etc.
[5]Piping plover habitat consists of open, sparsely vegetated sandy habitats, such as sand spits or sand beaches that are associated with wide, non-forested systems of dunes and inter-dune wetlands.
[6]In this context, we define permanent to be effects lasting in duration more than 3 weeks.

such, adverse effects are discountable. Projects that increase human or dog disturbance or potential for predation need further evaluation and do not qualify for the DKey.

3.2.2.3 Roseate Tern

Projects that intersect the roseate tern SLA must not result in:

1. Any changes to the quality, quantity, or availability[7] of suitable roseate tern habitat during the breeding season (April 1 through September 30)
2. Any permanent changes to suitable roseate tern habitat[8]
3. Increased human disturbance or predation[9] during the roseate tern migration windows (approximately April 1 – May 30 in the spring and August 15 -September 30 in the fall)
4. A new communication tower, high voltage transmission lines, or any other type of towers with or without guy wires that may post a collision risk to birds.

If the project does not occur in suitable habitat along the Atlantic Coast, roseate terns are not likely to be present in the action area. As such, adverse effects are discountable. Projects that increase human disturbance or potential for predation need further evaluation and do not qualify for the DKey. During migration, habitat loss, disturbance and increased predation could result in adverse effects and warrant additional evaluation separate from the DKey. If these actions occur outside of the migration window, adverse effects are discountable.

3.2.2.4 ***Rufa Red Knot***

Projects that intersect the rufa red knot SLA and occur within 0.25 mi of the Atlantic Coast shoreline must not:

1. Permanently modify beaches, dunes, mudflats, peat banks, sandbars, shoals, or other red knot habitats[10].
2. Any changes to the quality, quantity, or availability[11] of suitable red knot habitat during the migration season (April 15- June 15 OR July 15- November 20) and/or during the season when birds are not present if the impacts to quality, quantity, or availability of suitable red knot habitat will continue until birds return to the site (e.g., beach nourishment conducted outside of the migration season may result in a loss of food sources that will persist until birds return if conducted without sufficient time for food sources to recover).

[7]For example, beach grooming, boardwalk actions, breakwaters, development, dredge deposition, etc.
[8]In this context, we define permanent to be effects lasting in duration more than 3 weeks
[9]For example, the action is likely to indirectly increase access or use of red knot habitats by humans and/or predators at times of year that the birds are typically present (e.g., commercial/residential development, beach access structures, boardwalks, pavilions, bridges/roads/ferries/trails, marinas, posts or other avian predator perches, structures or habitat features likely to encourage predator nesting/denning, trash cans or other predator attractants, feral cat colonies, policy changes likely to increase human use).
[10]For example, the following actions may modify red knot habitat: groins, jetties, sea walls, revetments, bulkheads, riprap, beach nourishment, nearshore dredging, dredge spoil disposal, sand mining/borrowing, beach bulldozing, sandbagging, sand fencing, vegetation planting/alteration/removal, deliberate or possible introduction of non-native vegetation, beach raking/mechanized grooming, boardwalks, aquaculture development.

[11]For example, beach grooming, boardwalk actions, breakwaters, development, dredge deposition, etc.

3. Result in increased human disturbance or predation[12] during the red knot migration windows (April 1 - June 15 in the spring OR July 15 - November 20 in the fall).
4. A new communication tower, high voltage transmission lines, or any other type of towers with or without guy wires that may post a collision risk to birds.

During migration, habitat loss, disturbance and increased predation could result in adverse effects and warrant additional evaluation separate from the DKey. If these actions occur outside of the migration window, adverse effects are discountable.

3.2.3 Crustaceans

3.2.3.1 Big Sandy Crayfish and Guyandotte River Crayfish

Projects that intersect the SLA for Big Sandy crayfish and Guyandotte river crayfish must not:

4. Make any hydrological changes
5. Have any direct impacts to a stream or river (e.g., HDD, hydrostatic testing, stream/road crossings, new stormwater outfall discharge, dams, other in-stream work, etc.)
6. Have the potential to impact the riparian zone or indirectly impact a stream/river (e.g., cut and fill; HDD; construction; vegetation removal; pesticide or fertilizer application; discharge; runoff of sediment or pollutants; increase in erosion, etc.)

Avoiding direct or indirect impacts to the stream and riparian zone, including changes to hydrology, will ensure adverse effects are insignificant and/or discountable.

3.2.3.2 Madison Cave Isopod

Projects that intersect the SLA for Madison Cave isopod must not:

1. Make any hydrological changes
2. Have any direct impacts to a well, spring, sinkhole or cave (e.g., HDD, hydrostatic testing, stream/road crossings, new stormwater outfall discharge, dams, other in-stream work, etc.)
3. Have the potential to impact water quality and quantity (e.g., groundwater recharge, water levels) (e.g., cut and fill; HDD; vegetation removal; pesticide or fertilizer application; discharge; runoff of sediment or pollutants; increase in erosion, etc.)

Avoiding direct or indirect impacts to wells, springs, sinkholes or caves, including changes to hydrology and water quality, will ensure adverse effects are insignificant and/or discountable.

3.2.4 Fish

Projects that intersect the SLA for candy darter and diamond darter must not:

1. Make any hydrological changes
2. Have any direct impacts to a stream or river (e.g., HDD), hydrostatic testing, stream/road crossings, new stormwater outfall discharge, dams, other in-stream work, etc.)

[12]For example, the action is likely to indirectly increase access or use of red knot habitats by humans and/or predators at times of year that the birds are typically present (e.g., commercial/residential development, beach access structures, boardwalks, pavilions, bridges/roads/ferries/trails, marinas, posts or other avian predator perches, structures or habitat features likely to encourage predator nesting/denning, trash cans or other predator attractants, feral cat colonies, policy changes likely to increase human use).

3. Have the potential to impact the riparian zone or indirectly impact a stream/river (e.g., cut and fill; HDD; construction; vegetation removal; pesticide or fertilizer application; discharge; runoff of sediment or pollutants; increase in erosion, etc.)

Avoiding direct or indirect impacts to the stream and riparian zone, including changes to hydrology, will ensure adverse effects are insignificant and/or discountable.

3.2.5 Freshwater Mussels

Projects that intersect the SLA for Atlantic pigtoe, clubshell, dwarf wedgemussel, green floater, fanshell, fluted kidneyshell, James spinymussel, longsolid, northern riffleshell, pink mucket, purple cat's paw, rabbitsfoot, rayed bean, round hickorynut, salamander mussel, snuffbox, sheepnose, spectaclecase, tan riffleshell, and yellow lance mussels must not:

1. Make any hydrological changes (e.g., dams, change in the quantity or timing of water availability)
2. Have any direct impacts to a stream or river, identified as important to listed mussels, through in-stream work or equipment use, introduction of sediment, introduction of contaminants or change in water quality, quantity or timing (e.g., stream/road crossings, new stormwater outfall discharge, other in-stream work)
3. Have potential to impact a stream/river identified as important to listed mussels, or the riparian zone within 200 feet of a stream/river identified as important to listed mussels through introduction of sediment, introduction of chemicals, change in water quality, quantity or timing, vegetation removal, erosion, sedimentation (e.g., cut and fill, HDD, hydrostatic testing, stream/road crossings, new stormwater outfall discharge, dams, other in-stream work, etc.)

Avoiding direct or indirect impacts to the stream and riparian zone, including changes to hydrology, will ensure adverse effects are insignificant and/or discountable.

3.2.6 Insects

3.2.6.1 Bog Buck Moth

Projects that intersect the SLA for Bog Buck Moth must not:

1. Harm the species directly by including ground disturbance or vegetation removal within 300 feet of a freshwater wetland
2. Harm the species indirectly by including activity that could impact the quantity or quality of water available within ½ mile of a known or assumed bog buck moth wetland

Avoiding direct or indirect impacts to freshwater wetlands and/or bog buck moth wetlands, including hydrology, will ensure adverse effects are insignificant and/or discountable.

3.2.6.2 Karner Blue Butterfly

Projects that intersect the Karner Blue Butterfly SLA must avoid the following within suitable habitat[13]:

1. Application of insecticides
2. Temporary disturbance to any areas containing wild lupine
3. Any activities that may result in permanent loss of habitat

[13]This includes a variety of habitats containing wild lupine, including oak savanna, oak or pine barrens, openings within oak forest (including rights-of-way), or old fields in association with oak forest.

Avoiding areas containing wild lupine (the larval host plant) will ensure disturbance will have no adverse effects to KBB, however, consultation is needed if loss of KBB habitat will occur to ensure effects are insignificant or discountable.

3.2.6.3 Rusty Patched Bumble Bee

Projects that intersect the rusty patched bumblebee SLA must not:

1. Include native plant seed collection carried out more frequently that once every 3 years in the same 2 ac or larger area
2. Include or cause insect trapping, activities to control native rodent species, or application of insecticides or fungicides
3. Include herbicide application, but if it does, only spot spraying (application to individual weeds using a hand-held sprayer) and/or other methods that include only applications to individual weeds (e.g., wick wiping, cut-stump, or basal bark treatments) are permitted
4. Cause an increase in the extent or duration of surface flooding or soil saturation in rusty patched bumble bee habitat in a High Potential Zone
5. Cause ground disturbance that affects more than 0.25 acre (0.1 hectare) of rusty patched bumble bee nesting habitat (upland grasslands, shrublands, and forest and woodland edges that contain native sources of pollen and nectar) in a High Potential Zone during the nesting season
6. Cause effects to vegetation on 2.0 acres (0.8 ha) or more of rusty patched bumble bee foraging habitat during the species' active season? This excludes effects to vegetation in newly established habitats if they occur before the third growing season after the initial seeding/planting
7. Result in the permanent removal or conversion of more than 2.0 acres (0.8 ha) of rusty patched bumble bee habitat at any time of the year

Avoiding direct or indirect impacts to bumble bees, suitable habitat, and floral resources will ensure adverse effects are insignificant and/or discountable

3.2.7 Mammals

3.2.7.1 Bats

Projects that intersect the SLA for gray bat, Indiana bat and Virginia big-eared bat must not:

1. Result in incidental take within a known listed bat hibernaculum[14]
2. Result in the incidental take of listed bats by altering a known hibernaculum's entrance or interior environment if it impairs an essential behavioral pattern, including sheltering listed bats
3. Result in incidental take as a result of modifications to bridges or culverts used by listed bats as roosts
4. Land-based or offshore wind turbines that may post a collision risk to bats

Indiana Bat

In addition to conservation measures listed above, projects that contain known or potential Indiana bat habitat and include tree cutting/trimming, artificial lighting, blasting bridge or culvert work, herbicide application and/or prescribed fire must not:

1. Cut or trim any known Indiana bat roost trees.
2. Conduct tree cutting in moderate or high suitability habitat in West Virginia.
3. Conduct tree cutting within 300 feet of known roosts or known hibernacula in Pennsylvania.
4. Clear >1 acre of contiguous forested habitat within the maternity roost buffers that fall within the 0 – 20.9% forest density layer in Pennsylvania.
5. Clear >10 acres of contiguous forested habitat within the maternity roost buffers that fall within the 30 – 100% forest density layer in Pennsylvania.
6. Clear >10 acres of contiguous forested habitat within the hibernacula buffers that fall within the 30 – 100% forest density layer in Pennsylvania.
7. Clear >0.5 contiguous acres of forested habitat in areas that fall within the 0- 9.9% forest density category in Pennsylvania.
8. Clear >5 contiguous acres of forested habitat in areas that fall within the 10-19.9% forest density category in Pennsylvania.
9. Clear >10 contiguous acres of forested habitat in areas that fall within the 20-29.9% forest density category in Pennsylvania.
10. Clear >40 contiguous acres of forested habitat in areas that fall within the 30 - 100% forest density category in Pennsylvania.
11. Conduct any amount of tree cutting within suitable habitat for Indiana Bat in Maryland, New Jersey, New York, or Vermont.

Projects that contain known or potential Indiana bat habitat and include artificial lighting must:

1. When installing new or replacing existing permanent lights, use downward-facing, full cut-off lens lights (with same intensity or less for replacement lighting); or for those transportation agencies using the BUG system developed by the Illuminating Engineering Society, the goal is to be as close to 0 for all three ratings with a priority of “uplight” of 0 and “backlight” as low as practicable.
2. Direct temporary lighting away from suitable habitat when bats may be present.

Projects that contain known or potential Indiana bat habitat and include blasting must not:

1. Conduct blasting activities during the active season for Indiana bats.
2. Conduct blasting within the 0.25-mile buffer around known hibernacula in Pennsylvania.

Projects that include removal/modification of an existing bridge or culvert suitable for day-roosting Indiana bats must not:

1. Result in the permanent loss of known or potential roosting spaces.
2. Perform construction activities during the active season for Indiana bats.

Projects that contain known or potential Indiana bat habitat and include herbicide application must:

1. Include only targeted application methods (e.g., spot-spraying, hack-and-squirt, basal bark injections, cut-stump, or foliar spraying on individual plants).

Projects that contain known or potential Indiana bat habitat and include prescribed fire must not:

1. Conduct prescribed fire in forested habitats during the Indiana bat active season.
2. Conduct prescribed fire in areas that include suitable roost trees for Indiana bat (live trees and/or snags ≥5 inches dbh that have peeling bark, cracks, crevices, and/or cavities?)

Avoiding impacts to bat hibernacula through changes to the internal and external environment of hibernacula, loss of suitable roosting habitat, impacts to bats through disturbance as a result of noise, smoke, lighting, and direct take through collision with vehicles or structures will ensure that impacts to bats are insignificant or discountable.

3.2.7.2 Canada Lynx

Projects that intersect the Canada lynx SLA must not include any actions that would

1. Harm the species directly (e.g., mammal trapping, poison bait, etc.)
2. Harm the species indirectly (e.g., increased vehicle use that may result in vehicle strikes; removal of 10 acres or more of forest or is likely to significantly reduce snowshoe hare density over a 10-acre area
3. Result in changes to Canada lynx habitat quality, quantity, or availability (e.g., thinning and/or other timber management and logging practices; residential and commercial development; road, railroad and utility corridors development; mining activities; prescribed fire; trail development; winter activities that compact snow such as winter road use, snowmobiling, cross country skiing, and dog sledding)

Avoiding direct impacts to lynx from trapping, poison, vehicles, and/or fences will ensure that take of Canada lynx does not occur. Avoiding direct or indirect impacts to lynx habitat will ensure that adverse effects are insignificant and/or discountable.

3.2.8 Plants

In the Northeast Region, listed plants include American hart's-tongue fern, Furbish's lousewort, harperella, Houghton's goldenrod, Knieskern's beaked-rush, Leedy's roseroot, northeastern bulrush, northern wild monkshood, sandplain gerardia, seabeach amaranth, sensitive joint-vetch, shale barren rock cress, small whorled pogonia, swamp pink, and Virginia spiraea.

Projects that are funded, authorized, or carried out by a federal agency and intersect the SLA and/or buffered habitat of a federally listed plant and for which presence is either determined through a survey or assumed must not:

1. Disturb the ground or existing vegetation[15]
2. Indirectly alter the habitat or resources of the listed plant(s)[16]
3. Directly harm the listed plant(s)[17]

Avoiding direct and indirect effects to plants will ensure effects are insignificant or discountable.

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[15] This includes any off-road vehicle access, soil compaction, digging, seismic survey, directional drilling, heavy equipment, grading, trenching, placement of fill, pesticide application (herbicide, fungicide), vegetation management (including removal or maintenance using equipment or chemicals), cultivation, development, etc.

[16] For example, actions that cause a change in canopy cover, microclimate, humidity, increase in invasive species, or hydrologic alterations.

[17] For example, through prescribed fire, herbicide application, trampling, increased herbivory, cutting/clearing, cultivation, crushing by vehicle, or reduction to possession.

3.2.9 Reptiles

3.2.9.1 Bog Turtle

Projects that intersect the SLA for bog turtle must not:

1. Harm the species directly by including activity within 300 feet of a freshwater wetland.
2. Harm the species indirectly by including activity that could impact the quantity or quality of water available within ½ mile of a known or assumed bog turtle wetland.

In addition, the following project activities are not eligible for a predetermined outcome of no effect or NLAA:

1. Projects that include the use of pesticide within 50 feet of a freshwater wetland.
2. Projects that include ground disturbance, other than disking an existing crop field, within 300 feet of a freshwater wetland.
3. Projects that include mowing, disking, trail maintenance or use of heavy equipment within 300 feet of a freshwater wetland during the bog turtle active season (April 1 – October 31).
4. Project activities that include instream work, a stream crossing, or removal, replacement or maintenance of a culvert during the bog turtle active season (April 1 – October 31).

Avoiding direct or indirect impacts to freshwater wetlands and/or bog turtle wetlands, including hydrology, will ensure adverse effects are insignificant and/or discountable.

3.2.9.2 Eastern Massasauga

Projects that intersect the SLA for eastern massasauga must not:

5. Result in changes to eastern massasauga habitat quality, quantity, or availability (e.g., land management activities including vegetation removal, prescribed fire, and fire suppression; development; conversion of habitat to agriculture or other land type; herbicide application; changes in hydrology; etc.
6. Harm the species directly by including activity within a freshwater wetland.
7. Harm the species directly by including activities in upland area within 300 feet of a freshwater wetland, during the active season for eastern massasauga without clearing the area using a qualified biologist and wildlife safe fencing to prevent the presence of eastern massasauga in the project area.

In addition, the following project activities are not eligible for a predetermined outcome of no effect or NLAA:

1. Prescribed fire.
2. Pesticide use within 50 feet of potentially suitable habitat.
3. Projects that occur within wetland habitat.
4. Projects that include ground disturbance that will not revegetation disturbed areas with appropriate plant species and monitor plantings for proper establishment.
5. Projects that may result in the spread of invasive species to suitable habitat.
6. Projects that occur during the eastern massasauga active season (April 1 to October 31).

Avoiding direct or indirect impacts to freshwater wetlands and/or eastern massasauga rattlesnake wetlands, including hydrology, will ensure adverse effects are insignificant and/or discountable.

Application of the avoidance and minimization measures described for activities conducted in upland areas during the eastern massasauga active season will ensure that snakes are not present in the action area and will ensure adverse effects are insignificant and/or discountable.

3.2.10 Snails

3.2.10.1 Chittenango Ovate Amber Snail

Projects that intersect the SLA of Chittenango Ovate Amber Snail must not:

8. Directly impact snails, rocks or vegetation on the adjacent to the eastern side of the falls within Chittenango Falls State Park.
9. Impact the hydrology and/or water quality of the Chittenango Creek upstream of Chittenango Falls and/or Cazenovia Lake.

Avoiding impacts to the snails, or the rocks and vegetation that make up its habitat on the eastern side of the falls within Chittenango Falls State Park will ensure that direct impacts to the snails or their habitat will not occur. Avoiding impacts to the hydrology and water quality of Chittenango Creek and Cazenovia Lake will ensure adverse effects to Chittenango Ovate Amber Snail are insignificant and/or discountable.

3.2.10.2 Flat-spired Three-Toothed Land Snail

Projects that intersect the flat-spired three-toothed snail SLA must not:

1. Impact sandstone outcrops, cliff line features, emergent boulders or talus slopes in the Cheat River Gorge.

Avoiding impacts to suitable habitat for the flat-spired three-toothed snail in the Cheat River Gorge will ensure adverse effects to the snail are insignificant and/or discountable.

4 COVERED SPECIES AND CRITICAL HABITAT

The following section includes a summary of relevant background information on the species and critical habitat(s) used to develop this standing analysis. A complete description of the species can be found on ECOS (https://ecos.fws.gov). This overview is included to inform the reader of the species prior to the analysis of the effects of the action presented below. Species and critical habitats within a project's action area that may be affected by the proposed action, but are not covered by this standing analysis, will require individual consultation with the local ESFO.

4.1 *AMPHIBIANS*

4.1.1 Cheat Mountain Salamander

As with most woodland salamanders, the Cheat Mountain salamander (*Plethodon nettingi*) shows consistent patterns of daily and seasonal activities. During the day, Cheat Mountain salamanders take refuge in decayed logs, under logs, rocks, and leaf litter, or in rock crevices below the surface of the ground. At night, especially during rainy weather, they emerge to forage on the surface of the forest floor and occasionally climb trees or other plants for short distances (USFWS 2009a). Cheat Mountain salamanders generally over-winter under the surface and emerge to forage and breed in early spring, March to April (USFWS 2009a). Cheat Mountain salamanders typically remain on the surface into mid-October, however specific dates of emergence and submergence can vary from year to year, based on surface temperature and moisture conditions (USFWS 2009a). The diet of the Cheat Mountain salamander consists mainly of mites, springtails, beetles, flies, ants, and other insects (Pauley 1980 *in* USFWS 1991a).

There are no reported observations of mating for the Cheat Mountain salamander, but as in all other woodland salamanders, fertilization is internal and complete development takes place within the egg. Unlike some other woodland salamanders that travel to and use vernal pools and ponds for breeding (ex. Ambystoma salamanders) most Plethodontids, including the Cheat Mountain salamander, have no aquatic larval stage. Mating probably occurs in late April, May or early June but there may be an abbreviated mating period in late September and early October (Pauley 2008). In late April or early May, the Cheat Mountain salamander deposits egg masses containing five to eleven eggs, and the female attends the eggs until they hatch in about four months, late August to September (Pauley 2008). Nests are found under rocks, logs, and bark on logs and are frequently just two or three inches deep into the soil (Pauley 2008).

The age at which the Cheat Mountain salamander becomes sexually mature has not been determined. However, in a similar species, the Eastern red-backed salamander (*P. cinereus*), males become sexually mature at age three and females at age four (USFWS 1991a). While the life span of Cheat Mountain salamander has not been studied, most small Plethodontids live approximately 20 years (USFWS 1991a). Since eggs are probably laid in alternate years, females can potentially rear up to eight broods in their lifetimes (USFWS 1991a). While the typical size of a Cheat Mountain salamander's home range is not known, in a preliminary study, Pauley found that Cheat Mountain salamander probably did not move more than three feet, or one linear meter (USFWS 1991a). Several studies have been conducted on the home range of the Eastern red-backed salamander. Home range of that species in Michigan was 32 square feet for males, 262 square feet for females, and 138 square feet for juveniles (Kleeberger and Werner 1982 *in* Pauley 2008). Since Cheat Mountain salamander is of a similar size and occupies similar habitat to that species, it likely has a similar home range (Pauley 2008).

Although Cheat Mountain salamanders are generally territorial and are not thought to disperse great distances, some individuals, primarily males and juveniles, do disperse to find mates or establish new territories. These individuals are referred to as "floaters" (Anthony and Pfingsten 2013). The dispersal distance of non-territorial Cheat Mountain salamanders is not known and remains unstudied. However, recently a juvenile male Cheat Mountain salamander was documented approximately 50 feet from suitable occupied habitat in a pipeline corridor. Because there is so little information for the Cheat Mountain salamander, we rely on studies of this type of dispersal conducted on a congener, the Eastern red-backed salamander. In two studies that examined dispersal of this species, the maximum dispersal distance documented was a male that traveled 46 feet (Liebgold et al. 2011, Ousterhout and Liebgold 2010). In addition, the results of a homing experiment conducted by Marsh et al. (2004) showed that Eastern red-backed salamanders can home distances of up to 180 feet when displaced from their territories. However, because the red-backed salamander is considered a habitat generalist and can tolerate drier conditions than the Cheat Mountain salamander, Cheat Mountain salamander "floaters" are not expected to disperse and/or home further distances than those discussed above.

As described in Pauley (2007), the Cheat Mountain salamander is "presently known to occur in five counties in the Allegheny Mountains of eastern West Virginia: Randolph, Pendleton, Pocahontas, Tucker, and the most western edge of Grant County along the Allegheny Front. The total range extends from Blackwater River Canyon (Tucker County) in the north, south to Thorny Flat (Pocahontas County) (approximately 58 miles) and from Cheat Mountain in the west, east to the Allegheny Front (approximately 19 miles)." Within this overall range, the Cheat Mountain salamander is restricted to disjunct high elevation ridges and is only known to occur above elevations of 2000 feet in the northern part of the potential range and above 3500 feet in the southern part of the potential range (Pauley 2007).

Throughout the species range, approximately 80 discrete populations of the Cheat Mountain salamander have been documented since 1976 (Pauley 2008). Since that time, one of these populations and possibly two others have been extirpated, and two have been reduced in size (Pauley 2007). It is difficult to determine Cheat Mountain salamander abundances within each of the remaining populations because standard search times were not used during searches and more than one search has been conducted at some populations (Pauley 2008). Therefore, determination of population size is tentatively based on area, and Pauley (2008) defined those populations that cover greater than one acre as "large." If we assume that the home range of the Cheat Mountain salamander is similar to that of the Eastern red-backed salamander, it is estimated that one acre would provide adequate space to support the home ranges of approximately 160 female salamanders. Sixty-six of the known populations fall into the large population category (Pauley 2008).

Vegetative structure is known to affect salamander populations. Moist old growth stands have greater abundance and species richness than dry old growth or younger stands of various moisture levels (Welsh and Lind 1988 *in* USDA 2008a), probably due to the complex structure of older stands and resulting amenable microclimates. Old stands provide dense litter layers, abundant woody debris, and stratified canopies, which all enhance moisture retention (Petranka et al. 1994 *in* USDA 2008a) and limit moisture and temperature variations in the forest floor. Because Cheat Mountain salamanders are lungless, sufficient moisture must be present for respiratory exchange to occur directly through the skin (USFWS 1991a). Cheat Mountain salamanders require microhabitats with high relative humidity or moisture and acceptable temperatures (Feder 1983 *in* USDA 2008b, Feder and Pough 1975 *in* USDA 2008b).

Historically, large-scale timbering and burning that occurred throughout the Cheat Mountain salamander range in the last 100 years resulted in significant change and loss of Cheat Mountain salamander habitat (Pauley 2008, USFWS 1991a). Habitat modifications continue to be the primary factor affecting the habitat of the Cheat Mountain salamander today (USFWS 1991a, Pauley 2007, Pauley 2008). Habitat modifications can affect the Cheat Mountain salamander by 1) completely removing suitable habitat, 2) altering remaining habitat conditions and making the area less suitable to support the species, or 3) by fragmenting populations. Other threats to the Cheat Mountain salamander include inter-specific competition, acid precipitation, and drought.

Activities such as extensive tree removal, coal mining, and development can result in the extirpation or reduction of Cheat Mountain salamander populations by removing habitat that supports the species. Clearing and haul roads associated with mining activity also broaden the scope of the impact. Development of homes, recreational facilities, and other structures can also remove Cheat Mountain salamander habitat. Nearly every known population on either private or public land is impacted in some way by roads, ski slopes, timber harvesting, wildlife openings, utility rights-of-way, or gypsy moth infestations that have either removed the forest canopy or fragmented forested areas (Pauley 2008). These types of activities reduce the suitability of the remaining areas to Cheat Mountain salamander (Pauley 2008, USFWS 1991a). Habitat fragmentation and tree removal opens the interior of the forest floor to increased amounts of sunlight and wind, resulting in an increase in soil temperature and a decrease in soil moisture and changing the microclimatic conditions on the forest floor from a mesic to xeric (Pauley 2008, USFWS 1991a). Since the Cheat Mountain salamander requires moist, cool habitats, any alteration of the habitat that reduces soil moisture and/or relative humidity can lead to adverse effects such as reduced reproductive success through nest desiccation (Pauley 2008, USFWS 1991a). Pauley and Watson (2003) conducted a study of the effects of habitat alterations on Cheat Mountain salamander populations. This study found that the loss of soil and litter moisture and increased soil temperatures observed at the edges of disturbances may contribute to the loss of salamanders. Few Cheat Mountain salamanders were observed along the edges of disturbed areas and in general, the number of salamanders increased as the distance from the disturbance increased. Negative effects of fragmentation and edge effects can include extreme fluctuations in soil and subcanopy air temperature, reduced humidity and soil moisture, and/or increased light penetration. Other studies have also documented that these negative effects of fragmentation and edge effects on woodland salamanders can extend 65 to 115 feet or more into the forest interior, depending on the severity of the canopy removal (deMaynadier and Hunter 1998, Marsh and Beckman 2004, Wood and Williams 2013). Habitat modifications can also create conditions that are more conducive for predators such as snakes, birds, and mammals. Typically, snake species such as garter snakes (*Thamnophis sirtalis*), ring-necked snakes (*Diadophis punctatus edwardsii*), and red-bellied snakes (*Storeria occipitomaculata*) that prey on salamanders are less common in cool, moist forests where Cheat Mountain salamander are found (Pauley 2008).

Cheat Mountain salamander was listed as threatened under the ESA on September 18, 1989.

4.1.2 Eastern Hellbender

Eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) is a large, aquatic salamander found in perennial streams. Eastern hellbender is a long-lived species that inhabits fast-flowing, cool, and highly oxygenated streams with unembedded boulder, cobble and gravel substrates (USFWS 2024a). Eastern hellbenders respire through the skin, but also have lings and can use them for respiration under certain conditions. Hellbenders are not well adapted to low-oxygen conditions (USFWS 2024a).

Boulders, especially large slab rocks, act as cover and are consistently identified as the most important indicator of adult eastern hellbender habitat. Shelter rocks are typically partially embedded with a single opening usually facing downstream. Adult eastern hellbenders are typically found singly under shelter rocks, which they defend from other eastern hellbenders (USFWS 2024a). Juveniles have been found in the interstices of cobble piles and under large rocks. Larvae can be found under large rocks but are more often associated with the interstices of cobble and gravel, which may be due to the increased presence of macroinvertebrates that provide a food source (USFWS 2024a).

Eastern hellbenders generally breed between late August and early October. Nests have been found in bedrock fissures but are typically excavations beneath partially embedded flat rocks (USFWS 2024a). They reproduce via external fertilization (females deposit eggs under a nest rock and males fertilize the egg clutch) after which a single male defends the nest from other hellbenders. Multiple individuals (both males and females) have been observed under eastern hellbender nest rocks during the breeding season.

Adult eastern hellbenders eat crayfish and, to a lesser degree, small fish. Other occasional food items include insects, frogs and water snakes and hellbenders have also been observed scavenging dead fish. Diet of larval eastern hellbenders consists mainly of aquatic insects (USFWS 2024a). Survival and successful recruitment require abundant prey, and large (greater than 0.40 inches), flat rocks, for nests and shelter.

Adults are primarily nocturnal, remaining beneath cover during the day, although some diurnal activity has been observed, especially during the breeding season. Eastern hellbenders move by walking on stream bottoms but can swim short distances quickly, presumably to avoid predators. Studies have documented relatively small home ranges, with estimates ranging from approximately 322 square feet to approximately 23,810 square feet (USFWS 2024a). Despite having generally restricted home ranges, hellbenders are capable of long-distance movements and have been documented moving up to 8 miles (USFWS 2024a). Eastern hellbender populations typically consist of individuals dispersed among multiple patches of suitable habitat within a stream or a portion of a stream.

In the northeast, eastern hellbender is currently found in New York, Pennsylvania, Virginia and West Virginia. The primary stressor to eastern hellbender is sedimentation caused by multiple sources, which is occurring throughout much of the species' range. Other major stressors include water quality degradation, habitat destruction and modification, disease, and direct mortality or removal of hellbenders from a population by collection, persecution, recreation, or gravel mining (USFWS 2024a).

Eastern Hellbender was proposed for listing as endangered on December 13, 2024.

4.2 Birds

4.2.1 Eastern Black Rail

The eastern black rail (*Laterallus jamaicensis jamaicensis*) is a subspecies of black rail that occurs in salt, brackish, and freshwater wetlands in the eastern United States (east of the Rocky Mountains), Mexico, Brazil, Central America, and the Caribbean (USFWS 2019a). A small, secretive marsh bird, the eastern black rail is a member of the family Rallidae (rails, gallinules, and coots) in the order Gruiformes (rails, cranes, and allies; USFWS 2019a).

Eastern black rails occur in fresh, brackish, and saltwater marshes with clumping grass, rushes, or sedges. The dense vegetation creates an over-arching canopy that is somewhat open at the base of the clumps where eastern black rails can move around under the overhead cover. Eastern black rails require dense vegetative cover that allows movement underneath the canopy, and, because birds are found in a variety of salt, brackish, and freshwater marsh habitats that can be tidally or non-tidally influenced, plant structure is considered more important than plant species composition in predicting habitat suitability (Flores and Eddleman 1995 *in* USFWS 2019a). Eastern black rails tolerate a few shrubs but are absent from woody or shrub dominated areas. Eastern black rails often occur in the ecotone between deeper marsh and higher ground or in a matrix of wetlands across the broader landscape.

Eastern black rails forage on seeds and various small aquatic and terrestrial invertebrates, especially insects. They breed in tidal wetlands or freshwater wetlands with suitable hydrology. They occur in areas with sheet flow or moving water and avoid stagnant water. Eastern black rails prefer areas with micro topographical variation, and adults prefer moist soil to 2.5 inches deep, whereas chicks use areas with moist soil to 0.8 inches deep. Eastern black rails also require adjacent areas of higher elevation (i.e., the wetland-upland transition zone) with dense cover to survive high water events due to the propensity of juvenile and adults to walk and run rather than fly. Flooding is a frequent cause of nest failure. For nests to be successful, water levels must be below the nests during egg laying and incubation, which occurs from approximately May through the end of August. After hatching, the chick stage lasts approximately 42 days, after which eastern black rails have obtained juvenile plumage and are capable of flight (USFWS 2019a).

Occupied habitats are reflective of the subspecies' movement habits. Eastern black rails fly little during the breeding and wintering seasons and will typically flush only for a short distance when pursued (Bent 1926 as cited in USFWS 2019a). Instead, the birds will remain on the ground, running quickly through dense vegetation likely using the runways of rodents and rabbits (e.g., *Microtus* spp.) (Armistead 2001), and are considered secretive because of this behavior. An early estimate of home range measured from recaptures and vocalizations during the breeding season was 3.24 hectares (ha) within a tidal salt marsh in Maryland (USFWS 2019a). In a study in Florida, also during the breeding season, males had significantly larger home ranges than females where the mean home range size for males (n = 9) was 1.3 ha, (range = 0.82–3.1 ha) and for females (n = 6) it was 0.62 ha (range = 0.51–0.86 ha). Radiotelemetry was only performed during the egg-laying and incubation stages, so the home ranges estimated in this study may be smaller than annual home ranges (USFWS 2019a).

Eastern black rail habitat can be tidally or non-tidally influenced, and range in salinity from salt to brackish to fresh. Tidal height and volume vary greatly between the Atlantic and Gulf coasts and therefore contribute to differences in salt marsh cover plants in the bird's habitat. In the northeastern United States, the eastern black rail can typically be found in salt and brackish marshes with dense cover but can also be found in upland areas of these marshes. Further south along the Atlantic coast, eastern black rail habitat includes impounded and un-impounded salt and brackish marshes.

There is less information for eastern black rail habitat in the winter range, but wintering habitat is presumably similar to breeding habitat since some sites in the southern portion of the breeding range are occupied year-round. Little is known about eastern black rails during migration, including migratory stopover habitat, but individuals seem to appear more frequently in wet prairies, wet meadows, or hay fields during migration than during the breeding and wintering seasons.

The SSA identifies at least 9 known threats to the eastern black rail; 1. Habitat fragmentation and conversion, 2. Altered plant communities, 3. Altered hydrology, 4. Land management, 5. Effects of climate change, 6. Environmental contaminants and chemical spills, 7. Disease, 8. Altered food webs and predation, and 9. Human disturbance (USFWS 2019a).

The eastern black rail was listed as threatened under the ESA on November 9, 2020.

4.2.2 Piping Plover – Atlantic Coast and Great Lakes Populations, Great Lakes CH

The piping plover (*Charadrius melodus*) is a small shorebird that nests in three separate geographic populations in the U.S.: the Great Plains states, the shores of the Great Lakes, and the shores of the Atlantic coast in the United States and Canada. Based on this distribution, three breeding populations of piping plovers have been described: the Northern Great Plains population, the Great Lakes population, and the Atlantic Coast population. The northern Great Plains breeding range extends from southern Alberta, northern Saskatchewan, and southern Manitoba, south to eastern Montana, the Dakotas, southeastern Colorado, Iowa, Minnesota, and Nebraska, and east to Lake of the Woods in north-central Minnesota.

Atlantic Coast Piping Plover

Along the Atlantic coast, Piping plover are present in the northeast during the breeding season, generally between March 1 and August 31, though migrants may be present through October. These territorial birds nest above the high tide line, usually on sandy ocean beaches and barrier islands, but also on gently sloping foredunes, blowout areas behind primary dunes, washover areas cut into or between dunes, the ends of sandspits, and deposits of suitable dredged or pumped sand. Piping plover nests consist of a shallow scrape in the sand, frequently line with shell fragments and often located near small clumps of vegetation. Females lay four eggs that hatch in about 25 days, and surviving chicks learn to fly (fledge) after about 25 to 35 days. The flightless chicks follow their parents to feeding areas, which include the intertidal zone of ocean beaches, ocean washover areas, mudflats, sandflats, wrack lines, and the shorelines of coastal ponds, lagoons, and salt marshes. Piping plover adults and chicks feed on marine macroinvertebrates such as worms, fly larvae, beetles and crustaceans (USFWS 1996a).

Threats to piping plovers on the Atlantic Coast include habitat loss, human disturbance of nesting birds, predation, and oil spills and other contaminants. Habitat loss results from development, as well as from beach stabilization, beach nourishment, beach raking, dune stabilization, and other physical alterations to the beach ecosystem. Human disturbance of nesting birds includes foot traffic, sunbathing, kites, pets, fireworks, mechanical raking, construction, and vehicle use. These disturbances can result in crushing of eggs, failure of eggs to hatch and death of chicks. Predation on piping plover chicks and eggs is intensified by development because predators such as foxes (*Vulpes vulpes*), rats (*Rattus norvegicus*), raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), crows (*Corvus* spp.) and gulls (*Larus* spp.) thrive in developed areas and are attracted to beaches by human food scraps and trash. Unleashed and feral dogs (*Canis familiaris*) and cats (*Felis domesticus*) also disturb courtship and incubation and prey on chicks and adults (USFWS 1996a).

Currently, the rangewide status of the Atlantic Coast piping plover is stable to increasing. However, productivity rates continue to fall short of the recovery criterion, and rangewide population growth is tempered by geographic and temporal variability. Periodic regional declines illustrate the continued risk of rapid reversals in abundance trends. Examples include decreases of 21 percent in the Eastern Canada population in just 3 years (2002 to 2005), and 68 percent in the southern half of the Southern recovery unity during the 7-year period from 1995-2001. A 64 percent decline in the Maine population between 2002 and 2008, from 66 pairs to 24 pairs, came after only a few years of decreased productivity (USFWS 2016a).

Great Lakes Piping Plover

In the Great Lakes, piping plovers nest, feed, and rear their young in open, sparsely vegetated sandy areas, including sand spits and sand beaches with wide, unforested dunes and swales or in the flat pans behind the primary dune. Piping plovers begin arriving in Minnesota and Wisconsin in mid-March to early April, and most mated pairs are nesting by mid to late May. Eggs typically hatch from late May to late July, with chicks fledging 21 to 30 days after hatching. Although piping plovers typically produce one brood per year, they sometimes bring off two broods during a summer. Piping plovers feed on exposed beach surfaces by pecking for invertebrates that are 1/2 inch or less below the surface. They feed mostly during the day and eat insects, marine worms, crustaceans, and mollusks as well as eggs and larvae of flies and beetles. Most adults depart for their wintering grounds by mid-August. Young birds hatched during the summer start their migration a few weeks later than adults, and most are gone from the Great Lakes by late August.

The Great Lakes population of the piping plover was listed as endangered in 1986. An active recovery program, aided by many volunteers, has helped the plover population to steadily increase. In 2019, there were 71 breeding pairs (142 individuals) (USFWS unpubl. data 2020). Of these, ten pairs nested in Wisconsin, while 61 pairs were found outside the state, including 49 pairs in Michigan, one pair in Chicago, Illinois, one pair in Pennsylvania, and nine pairs in Ontario, Canada. A single breeding pair discovered in 2007 in the Great Lakes region of Canada represented the first confirmed piping plover nest there in over 30 years. In 2019, a pair of piping plovers had their first successful nesting site at Montrose Beach in Chicago, Illinois in more than 60 years.

The species remains extremely vulnerable to extinction from factors that include disease, habitat destruction, and unpredictable changes in the environment. Recent studies of Great Lakes Piping Plovers indicate that predation and human-caused disturbance also continue to negatively affect the population. During 2019, as many as 11 adults were lost due to predation by merlins, snowy owls, and off-leash dogs (USFWS unpubl. data 2020).

The Atlantic Coast and Great Plains populations of the piping plover were listed as threatened under the ESA on January 10, 1986. The Great Lakes population of piping plover was listed as endangered under the ESA on January 10, 1986.

Critical Habitat

Critical habitat was designated for wintering piping plovers on the Atlantic Coast on August 9, 2001. No critical habitat units were designated in the northeast.

Under the terms of a court order, the Service designated CH for the Great Lakes breeding population of the piping plover on May 7, 2001. This includes 35 units in 8 states:

- St. Louis County, Minnesota
- Douglas, Ashland, Marinette, and Manitowoc Counties, Wisconsin
- Lake County, Illinois
- Porter County, Indiana
- Erie and Lake Counties, Ohio
- Erie County, Pennsylvania
- Oswego and Jefferson Counties, New York
- Alger, Schoolcraft, Luce, Mackinac, Chippewa, Iosco, Presque Isle, Cheboygan, Emmet, Charlevoix, Leelanau, Benzie, Mason and Muskegon Counties, Michigan.

The final CH designation includes approximately 201 miles (325 km) of mainland and island shoreline for the Great Lakes breeding population in these 26 counties. Within the 35 critical habitat units, only the areas that contain the primary constituent elements of piping plover habitat, as described above, are designated as CH.

4.2.3 Roseate Tern

The roseate tern (*Sterna dougallii dougallii*) is a medium-sized, gull-like tern about 15 inches long. When not in breeding season, it has a black bill, black legs, white forehead and most of the crown, and a long, deeply forked tail. During this time, the roseate tern is often difficult to distinguish from common terns, among which it nests in the Northeast. During breeding season, it is paler than other terns, with most of its plumage turning silver-gray above and creamy white below a rosy-pink chest and a black cap. It also develops long white tail-streamers that it loses after the breeding season. In the northeastern birds, the black bill becomes orange red at the base and the black legs also turn orange red. The roseate tern is a specialist feeder eating almost exclusively small fish, primarily the American sand lance in northeastern populations. It captures food mainly by plunge diving, completely submerging its body underwater to catch prey, but it also feeds in shallow waters and even steals food from common terns. Roseate terns nest on small barrier islands, often at ends or breaks. Roseate terns in northeastern North America almost always nest in colonies with common terns. Roseate terns begin arriving to breeding areas at the end of April and begin laying eggs as early as the third or fourth week of May. In the winter, roseate terns migrate south in late August to early September. They migrate from the northeastern U.S. to the waters off Trinidad and northern South America from the Pacific coast of Columbia to eastern Brazil.

The roseate tern was federally listed as endangered in 1987 (USFWS 1987). Roseate terns are mainly found in the Northern Hemisphere on the northeastern coast of North America, extending from Nova Scotia to the southern tip of Florida, as well as several islands in the Caribbean Sea. The roseate tern is divided into four subspecies based on small differences in size and bill color. The North American subspecies is divided into two separate breeding populations: one in the northeastern U.S. and Nova Scotia and another in the southeastern U.S. and Caribbean. Roseate terns are most common in the central portion of this range, from Massachusetts to Long Island, N.Y. Populations in the northeastern U.S. greatly declined in the late 19th century due to hunting for the millinery, or hat trade. In the 1930s, protected under the Migratory Bird Act Treaty, the population reached a high of about 8,500, but since then, population numbers have declined and stayed in the low range of 2,500 to 3,300.

Roseate terns nest on small barrier islands and occasionally barrier beaches. They nest in hollows or under dense vegetation, debris or rocks hidden from predators. Terns forage in ocean waters from coastlines to deep water. Habitat for northeastern North American populations has been greatly reduced by human activity and development on barrier islands, predation, and competition from expanding numbers of large gulls. Roseate terns are highly sensitive to disturbances and will desert a whole colony if they feel threatened. The move to less desirable, often inadequate areas exposes the roseate tern to high predation and affects its ability to reproduce. The loss of habitat from erosion, a possible result of rising sea levels, is another major factor contributing to the decline of roseate tern populations. The spit—a narrow land comprised of gravel and sand extending into the ocean—on Falkner Island, in the Long Island sound, is home to one of the largest tern populations in the northeastern U.S. It is estimated that Falkner Island is losing about 800 to 900 square feet per year due to erosion, and in the next two to five years, the spit will be in a tidal zone, leaving roseate terns without their prime habitat. In areas like Falkner Island, biologists work hard to create artificial habitats for the terns to counteract the move and make new, less desirable sites appealing. Inverted boxes or half buried tires are commonly used to provide covered nesting sites.

Roseate terns no longer breed in Virginia, Maryland, New Jersey, and western and central Long Island (Nisbet et al. 2014) due to a combination of factors including increased predation, disturbance, erosion, and changes in habitat structure. Small breeding colonies in the cold-water subregion demonstrate high year-to-year variability in use, particularly in Nova Scotia where small numbers of roseate terns (one to five pairs) may nest on islands for a year or two. Many islands in Maine, Nova Scotia and Quebec that had small numbers of breeding roseate terns prior to 2014 no longer support roseate tern colonies (USFWS 2020a); however, as a whole the northern extent of the breeding range has not contracted.

The rangewide breeding population of roseate terns was estimated to be 4,374 breeding pairs at peak period count in 2019, down slightly from 4,593 in 2018. The U.S. roseate tern breeding population has exceeded 4,000 breeding pairs annually since 2016. Canada's total roseate tern population has been below 100 breeding pairs since 2008, hovering between 50 and 65 breeding pairs. It should be noted, that first, second and third-year nonbreeding individuals may be present in the summer roseate tern population in addition to the breeding pairs counted at colonies. Preliminary resighting data suggest that a greater proportion of 1-year old birds migrate north to the summer breeding range than previously thought. Most 2- and 3-year-old birds migrate north to the summer breeding range (USFWS 2020a).

The coastal islands and barrier beaches used for nesting by roseate terns in the Northeast are subject to dynamic changes both in formation and vegetative cover. Erosion of low-lying nesting habitat is increasingly affecting some large and small breeding colonies. Lack of sand deposition to naturally restore habitat may be a function of hardened structures built elsewhere that affect sand transport, or sea level rise and climate change. Breeding colonies require annual ongoing habitat management to maintain appropriate vegetative structure (e.g., invasive plant treatments) and cover for nesting (e.g., nest box installation; USFWS 2020a).

Roseate tern was listed as endangered under the ESA on December 2, 1987.

4.2.4 Rufa Red Knot

The rufa red knot (*Calidris canutus rufa*) is a migratory shorebird that breeds in the Canadian Arctic and winters in parts of the United States, the Caribbean, and South America. Some of these robin-sized shorebirds fly more than 9,300 miles from south to north every spring and reverse the trip every autumn making the rufa red knot one of the longest-distance migrating animals. Major migration stopover areas occur along the Gulf coast and Atlantic coasts of North and South America. However, red knots have been regularly sighted in inland areas of the United States within the Atlantic and central flyways, including the coasts of the Great Lakes in Minnesota and Wisconsin.

The rufa red knot is a large, bulky sandpiper at 9 to 10 inches long. As with most shorebirds, the long-winged, strong-flying knots fly in groups, sometimes with other species. Red knots feed on invertebrates, especially small clams, mussels, and snails, but also crustaceans, marine worms, and horseshoe crab eggs. On the breeding grounds, knots mainly eat insects. Small numbers of knots may occur in New Jersey year-round, while large numbers of birds rely on New Jersey's coastal stopover habitats during the spring (May through early June) and fall (late-July through November) migration periods. Smaller numbers of knots may spend all or part of the winter in New Jersey (USFWS 2014).

The primary wintering areas for the red knot include the southern tip of South America (including Tierra del Fuego), northern Brazil, the Caribbean, and the southeastern and Gulf coasts of the U.S. The red knot breeds in the tundra of the central Canadian Arctic. Some of these robin-sized shorebirds fly more than 9,300 miles from south to north every spring and reverse the trip every autumn making the rufa red knot one of the longest-distance migrating animals. Migrating red knots can complete non-stop flights of 1,500 miles or more, converging on vital stopover areas to rest and refuel along the way. Large flocks of red knots arrive at stopover areas along the Delaware Bay and New Jersey's Atlantic coast each spring, with many of the birds having flown directly from northern Brazil. The spring migration is timed to coincide with the spawning season for the horseshoe crab (*Limulus polyphemus*). Horseshoe crab eggs provide a rich, easily digestible food source for migrating birds. Mussel beds on New Jersey's southern Atlantic coast are also an important food source for migrating birds. Birds arrive at stopover areas with depleted energy reserves and must quickly rebuild their body fat to complete their migration to Arctic breeding areas. During their brief 10 to 14-day spring stay in the mid-Atlantic, red knots can nearly double their body weight (USFWS 2014).

Coastal habitats used by red knots in migration and wintering areas are similar in character (Harrington 2001), generally coastal marine and estuarine habitats with large areas of exposed intertidal segments. Migration and wintering habitats include both high-energy oceanfront or bayfront areas, as well as tidal flats in more sheltered bays and lagoons (Harrington 2001). Preferred wintering and migration microhabitats are muddy or sandy coastal areas, specifically, the mouths of bays and estuaries, tidal flats, and unimproved tidal inlets (Lott et al. 2009, Niles et al. 2008, Harrington 2001). In many wintering and stopover areas, quality high-tide roosting habitat (i.e., close to feeding areas, protected from predators, with sufficient space during the highest tides, free from excessive human disturbance) is limited (USFWS 2014). In nonbreeding habitats, red knots require sparse vegetation to avoid predation (Niles et al. 2008, Piersma et al. 1993).

For many shorebirds, the supra-tidal (above the high tide) sandy habitats of inlets provide important areas for roosting, especially at higher tides when intertidal habitats are inundated (Harrington 2008). For red knots, unimproved tidal inlets are a preferred nonbreeding habitat (Lott et al. 2009, Niles et al. 2008, Harrington 2008). Along the Atlantic coast, dynamic and ephemeral features are important red knot habitats, including sand spits, islets, shoals, and sandbars, features often associated with inlets (Harrington 2008). From South Carolina to Florida, red knots are found in significantly higher numbers at inlets than at other coastal sites (Harrington 2008).

The red knot population that winters on Tierra del Fuego declined approximately 70 to 75 percent from the 1980s to the 2000s and remains at a low level. Annual peak spring counts in Delaware Bay decline by about the same amount over the same period. Threats to the red knot include sea level rise, coastal development, shoreline stabilization, dredging, reduced food availability at stopover areas, disturbance by vehicles, people, dogs, aircraft, and boats, and climate change (USFWS 2014).

The rufa subspecies of red knot was listed as threatened under the ESA on January 12, 2015.

4.3 *CRUSTACEANS*

4.3.1 Big Sandy Crayfish and Guyandotte River Crayfish

The Big Sandy crayfish (*Cambarus callainus*) and Guyandotte River crayfish (*Cambarus veteranus*) are freshwater, tertiary burrowing crustaceans of the Cambaridae family. Tertiary burrowing crayfish do not exhibit complex burrowing behavior; instead, they shelter in shallow excavations under loose cobbles and boulders on the stream bottom. The Big Sandy crayfish is closely related to the Guyandotte River crayfish and both species share many basic physical characteristics. Adult body lengths range from 3 to 4 inches, and the cephalothorax (main body section) is streamlined and elongate and has two well-defined cervical spines. The elongate convergent rostrum (the beak-like shell extension located between the crayfish's eyes) lacks spines or tubercles (bumps). The gonopods (modified legs used for reproductive purposes) of Form I males (those in the breeding stage) are bent 90 degrees to the gonopod shaft (Loughman 2014). Diagnostic characteristics that distinguish the Big Sandy crayfish from the Guyandotte River crayfish include the former's narrower, more elongate rostrum; narrower, more elongate claw; and lack of a well-pronounced lateral impression at the base of the claw's immovable finger (Thoma et al. 2014). Carapace (shell) coloration ranges from olive brown to light green, and the cervical groove is outlined in light blue, aqua, or turquoise. The rostral margins and post orbital (behind the eye) ridges are crimson red. The abdominal terga (dorsal plates covering the crayfish's abdomen) range from olive brown to light brown to light green and are outlined in red. The walking legs of the Big Sandy crayfish range from light green to green blue to green, and the chelae are usually aqua but sometimes green blue to blue (Loughman 2014; Thoma et al. 2014).

Big Sandy crayfish and Guyandotte River crayfish have four identified life stages: fertilized eggs, juveniles, nonbreeding adults, and breeding adults. Mating occurs in June through July, egg extrusion occurs in July through September, and females have been identified with young attached in September, October, and March. Big Sandy crayfish likely live 5 to 7 years but may live up to 10 years. Crayfish are highly mobile animals and may move up to 800 meters in 10 days.

The Big Sandy crayfish is endemic to the Levisa Fork, Tug Fork, and Russell Fork watersheds in the upper Big Sandy River basin of Kentucky, Virginia, and West Virginia (Thoma et al. 2014). Commercial logging, coal mining, development in the narrow valley riparian zones of the region, sewage discharges, road construction, and similar activities throughout the Big Sandy basin have contributed to aquatic systems degradation resulting in the extirpation of the Big Sandy crayfish from many sub watersheds within its historical range. The Guyandotte River crayfish is endemic to the Upper Guyandotte River basin of West Virginia (Thoma et al. 2014).

Both crayfish shelter in shallow excavations on the stream bottom under loose cobble and boulders. Suitable habitat consists of third order or larger, fast-flowing permanent streams and rivers with instream habitat consisting of unembedded slab boulders on bedrock, cobble, or sand substrates. These crayfish rarely inhabit pool areas, displaying marked preference for fast flowing runs and riffles (Thoma et al. 2014, Loughman 2014). In Kentucky and Virginia, the most abundant populations were found in streams with riffles approximately 15 feet wide. Crayfish are opportunistic omnivores. They feed on both plants and animals, living and dead, that are readily available in their habitat.

Big Sandy crayfish was listed as threatened under the ESA on May 9, 2016. Guyandotte River crayfish was listed as endangered under the ESA on May 9, 2016.

Critical Habitat

Critical habitat was designated for Big Sandy crayfish and Guyandotte River crayfish on April 14, 2022.

Critical habitat units for Big Sandy crayfish were designated in Upper Levisa Fork – Dismal Creek, Buchanan County, VA; Russel Fork, Buchanan, Dickenson, and Wise Counties, VA; Hurricane Creek, Buchanan County, VA; Indian Creek, Buchanan and Dickenson Counties, VA; Fryingpan Creek, Dickenson County, VA; Lick Creek, Dickenson County, VA; Russell Prater Creek, Dickenson County, VA; Fork and McClure Creek, Dickenson County, VA; Cranes Nest River and Birchfield Creek, Dickenson and Wise Counties, VA; Pound River, Dickenson and Wise Counties, VA; Tug Fork, McDowell, Mingo and Wayne Counties, WV, and Buchanan County, VA; Dry Fork and Bradshaw Creek, McDowell County, WV; Panther Creek, McDowell County, WV; Knox Creek, Buchanan County, VA; and Pigeon Creek and Laurel Fork, Mingo County, WV.

Critical habitat units for Guyandotte River crayfish were designated in Clear Fork and Laurel Fork, Wyoming County, WV; Guyandotte River, Wyoming County, WV; Indian Creek, Wyoming County, WV; and Huff Creek, Wyoming and Logan Counties, WV.

The physical and biological features essential to the conservation of the big sandy crayfish and Guyandotte River crayfish include 1) fast-flowing stream reaches with unembedded slab boulders, cobbles, or isolated boulder clusters within an unobstructed stream continuum of permanent, moderate- to large-sized streams and rivers, 2) streams and rivers with natural variations of flow and seasonal flooding sufficient to effectively transport sediment and prevent substrate embeddedness, 3) water quality characterized by seasonally moderated temperatures and physical and chemical parameters sufficient for the normal behavior, growth, reproduction, and viability of all life stages, 4) an adequate food base, 5) aquatic habitats protected from riparian and instream activities, and 6) an interconnected network of streams and rivers that have the physical and biological features described above that allow for the movement of individual crayfish in response to environmental physiological, or behavioral drivers.

4.3.2 Madison Cave Isopod

Madison Cave isopods (*Antrolana lira*) are predominantly adapted to unlighted deep karst aquifers and subsurface lakes where the water temperature ranges from 51.8 to 57.2°F and the water is supersaturated with calcium carbonates (USFWS 1996b). In the karst geology, subsurface waters (both water contained in the bedrock and water contained in open spaces) are dynamic and may move quickly through voids in the bedrock. For this reason, bedrock is not likely to be an effective sediment filter for subsurface waters. Because the presence or absence of voids, fractures, and solution cavities within bedrock is unpredictable in karst geology, there may be instances where surface waters directly connect to subsurface waters.

Madison Cave Isopods have evolved into obligate stygobites, having lost their eyes and all traces of pigment in their exoskeleton. Their body is flattened and has seven pairs of long walking legs. The first pair of legs is adapted as grasping structures. They have a pair of short antennae and a pair of long antennae. Males reach a length of 0.6 inches; females reach a length of 0.7 inches. This species is a strong swimmer and a benthic walker. Because this species lives in a habitat that is difficult to study, relatively little is known about its reproduction, home range, trends in population, lifespan, life cycle, and ecological relationships. The limited knowledge of its feeding habits suggests it is an omnivore, likely acting both as a predator and scavenger. It is thought to feed on small pieces of plants and animals flushed in from surface opening (USFWS 1996b).

The population size of the Madison Cave Isopod is unknown at most sites. MCI can be difficult to capture at known locations other than Madison Cave and Steger' s Fissure, so little information is available on abundance for most sites and no meaningful population trend data is available. To date, Madison Cave and the adjacent Steger's Fissure have consistently yielded numerous individuals when sampled. Population abundance has been calculated for those sites and Irvin King Well #2, West Virginia. Fong (2007) conducted a series of mark re-capture studies at the Madison Cave and Steger's Fissure sites. He sampled in 1995, 1997, 2004, and 2006. His work estimated the population in Madison Cave ranged from 360 to 1,020 individuals and from 2,240 to 3,420 individuals in Steger's Fissure. Between 1997 and 2006 there was little fluctuation. Four sites were sampled in Jefferson County, West Virginia where MCI was known to occur (Hutchins and Orndorff 2009). Marked animals were recaptured from only one site, Irvin King Well #2. Estimated abundance at this site was 112 ± 110 individuals. The large confidence intervals indicate a high degree of uncertainty in this population size estimate. They did not estimate population trends.

The MCI lives underground in the flooded ionically saturated waters of deep karst aquifers of Cambro-Ordovician aged carbonate bedrock (limestone and dolostone). Little is known about the physical and chemical conditions of the habitat of Madison Cave isopod. The temperature of the water ranges from 51.8 to 57.2°F, as is typical of groundwater for the latitude. Rafts of calcite plates are usually present on the surface of the aquifers, indicating that the water is supersaturated with calcium carbonates, a condition also typical of groundwater in areas of limestone. The level of the karst aquifers can fluctuate for tens of yards at some sites. The extent of the recharge zone of the aquifer at any site is unknown (USFWS 1996b). Orndorff and Hobson (2007) delineated MCI potential habitat based on the extent of carbonate bedrock in which MCI has been found. Their layer extends through 10 counties, from Rockbridge County, Virginia to Jefferson County, West Virginia and represents approximately 865,028 surface acres.

When the recovery plan was written the taxon was known initially from deep (phreatic) cave lakes and streams fed by deep cave lakes from seven sites and thought to be endemic to Virginia. Increased survey efforts have more than doubled its known range. Recently Madison Cave isopods were discovered in wells that intersect phreatic or groundwater habitats, where there is no obvious nutrient source or visible indication that the area was inhabited by Madison Cave isopods. At these sites, it is likely the water is flowing from nutrient-rich to nutrient-poor areas.

Presence/absence sampling for this species has numerous uncertainties, which make data difficult to interpret. Sampling for MCI requires access to phreatic water, which fluctuates in depth depending on water table levels. Without knowing how large an area the baited traps are sampling, it is unclear how large an area the survey results at discrete sampling points represent. We expect hydrologic conditions such as water level and flow would affect the size of the sampling area. Repeat sampling at known locations does not indicate a change in the populations. Sites that have traditionally yielded a large number of MCI such as Steger' s Fissure and Madison Cave continue to produce large numbers. Sites that have more moderate or low numbers continue to produce similar numbers. The known species range has increased; we assume this is due to increased survey efforts rather than a species expansion. Currently MCI have been recorded from 16 locations within the Shenandoah Valley from Leetown, West Virginia south to Lexington, Virginia: a range 136.4 miles long and 24.8 miles wide (Hutchins 2007).

Because the recharge zone of the aquifer at any of the Madison Cave isopod sites is unknown, the zone of potential sources of contamination is also unknown. Expanding urban development, especially in the northern part of the range, has increased the probability of pollutants entering the groundwater. Pollution from agricultural runoff is a real threat because of extensive agriculture in the Shenandoah Valley. Of special concern is the rapid expansion of intensive poultry farming practices in karst regions (Berryhill 1994).

Human disturbance at these sites, with the exception of Madison Saltpetre Cave, is likely to be minor because of the low intensity of visits. All seven sites are located on privately owned property, and the owners discourage casual visits to the caves. The technically difficult nature of the entrances and passages in these caves also filters out many potential cave visitors, and the deep aquifer habitat is inaccessible to most cave visitors. Madison Saltpetre Cave, however, presents no technical challenge and, indeed, was open in the past for commercial tours and experienced extensive damage from vandalism. Whether the past commercial operation and intensive use affected the isopod population in this cave is unknown. The cave is now protected by a gate and is being managed by its owner along with the Cave Conservancy of the Virginias for conservation purposes (USFWS 1996b).

Madison Cave Isopod conservation needs include assessing "thermal and chemical pollution from urban development and agricultural runoff, physical pollution, and human disturbance (cave vandalism and visitation)." Currently, the rangewide status of the species appears to be stable. The primary factors influencing the status include risks posed by habitat degradation from altering streams, isolation of populations from physical barriers, shifts in subterranean sediment associated with development, and groundwater contamination. Current threats include thermal and chemical pollution from urban development and agricultural runoff (e.g., poultry farming), physical pollution, and human disturbance (cave vandalism and visitation). Obstacles to recovery include a lack of ecological and life history information for MCI and a lack of information regarding the physical limits of recharge zones that affect MCI habitat (USFWS 1996b).

Madison Cave Isopod was listed as threatened under the ESA on November 3, 1982.

4.4 *FISH*

4.4.1 Candy Darter

Candy darter (*Etheostoma osburni*) is a small freshwater fish that generally grows between 2 inches and 3.4 inches in length. Males are very brightly colored, especially during the breeding season. The species can be identified by 5 distinctive black saddles on its back and 9 to 11 vertical blue-green bars alternating with narrow bright red-orange bars along its sides. The females maintain a similar general pattern, but the colors are much more subdued, appearing a general olive hue overall (USFWS 2018a).

Candy darter is endemic to 2nd order and larger streams and rivers within portions of the upper Kanawha River basin, which is synonymous with the Gauley and greater New River watersheds in Virginia and West Virginia (USFWS 2018a). Candy Darter is described as a habitat specialist, being most often associated with faster flowing stream segments with coarse bottom substrate (e.g., gravel, cobble, rocks, and boulders), that provides shelter for individual darters. Candy darters are intolerant of excessive sedimentation and stream bottom embeddedness (the degree to which gravel, cobble, rocks, and boulders are surrounded by, or covered with, fine sediment particles). Occurrence data indicate the species prefers cool or cold-water temperatures, but that warm water conditions may also be tolerated. The fish are opportunistic feeders, eating mostly benthic macroinvertebrates such as mayflies and caddisflies. In streams maintaining favorable habitat conditions, through natural or managed condition, candy darters can be abundant throughout the stream continuum (USFWS 2018a).

Candy darter was listed as endangered under the ESA on December 21, 2018.

Critical Habitat

Critical habitat for candy darter was designated on May 7, 2021. Critical habitat units were designated in the Greenbrier River, East Fork of the Greenbrier River, and West Fork of the Greenbrier, Pocahontas County, WV; Sitlington Creek, Pocahontas County, WV; Knapp Creek, Pocahontas County, WV; Middle New, in Bland and Giles Counties, VA; Dismal Creek, Bland and Giles Counties, VA; Laurel Creek, Bland County, VA; Lower Gauley River, Nicholas County, WV; Upper New, Cripple Creek, Wythe County, VA; Upper Gauley, Nicholas, Greenbrier, Pocahontas and Webster Counties, WV; Gauley Headwaters, Webster County, WV; per Gauley River, Nicholas and Webster Counties, WV; Panther Creek, Nicholas County, WV; Williams River, Pocahontas and Webster Counties, WV; Cranberry River, Nicholas and Webster Counties, WV; and Cherry River, Greenbrier and Nicholas Counties, WV.

Physical or biological features essential to the conservation of candy darter include 1) ratios or densities of nonnative species that allow for maintaining populations of candy darter, 2) a blend of unembedded gravel and cobble that allows for normal breeding, feeding and sheltering; 3) adequate water quality characterized by seasonally moderated temperatures and physical and chemical parameters that support normal behavior, growth and viability of all life stages of the candy darter, 4) an abundant, diverse benthic macroinvertebrate community that allows for normal feeding behavior, and 5) sufficient water quantity and velocities the support normal behavior, growth, and viability of all life stages of the candy darter.

4.4.2 Diamond Darter

Diamond darter (*Crystallaria cincotta*) is a member of the Perch family (Percidae), a group characterized by the presence of a dorsal fin separated into two parts, one spiny and the other soft. The darters differ from other percids in being much smaller in overall size and having a more slender shape. Some darters, including those in the genus *Crystallaria*, lack a swim bladder. The diamond darter is overall translucent and is a silvery white on the underside of the body and head. It has four wide, olive-brown saddles on the back and upper side (USFWS 2013a).

Diamond darter inhabits medium to large, warm water streams with moderate current and clean sand and gravel substrates. Diamond darter has been collected from riffles and pools where swift currents result in clean swept, predominately sand and gravel substrates that lack silty depositions (USFWS 2013b). Diamond darters are most active during the night and may stay partially buried in the stream substrates during the day. Adult diamond darters primarily feed on stream bottom-dwelling invertebrates. The diamond darter is now known to occur only within the lower Elk River in West Virginia (USFWS 2013a).

Diamond darter was listed as endangered under the ESA on August 26, 2013.

Critical Habitat

Critical habitat for the diamond darter was designated on September 23, 2013.

Critical habitat units were designated in the Lower Elk River, Kanawha and Clay Counties, WV and the Green River, Edmonson, Hart and Green Counties, KY.

Physical or biological features essential to the conservation of diamond darter include 1) connected riffle-pool complexes in moderate- to large-sized (fourth- to eight-order), warmwater streams that are geomorphically stable with moderate current, clean sand and gravel substrates, and low levels of siltation; 2) perennial streams with moderate velocities, seasonally moderated temperatures, good water quality, loose sand and gravel substrates, and healthy populations of benthic invertebrates and fish larvae for prey items; 3) riffle-pool transition areas with relatively silt-free sand and gravel substrates, as well as access to a variety of other substrate and habitat types, including pool habitats; 4) streams with naturally fluctuating and seasonally moderated water temperatures, high dissolved oxygen levels, and clean, relatively silt-free sand and gravel substrates; and 5) stable, undisturbed streambeds and banks, and ability for populations to be distributed in multiple moderate- to large-sized (fourth- to eighth-order) streams throughout the Ohio River watershed.

4.5 *FRESHWATER MUSSELS*

As a group, mussels are long-lived, with individuals surviving up to several decades, and sometimes up to 100 to 200 years. The life cycle of freshwater mussels is complex and includes a stage parasitic on fish or other host species. Males release sperm into the river current. As females siphon water for food and respiration, they also siphon sperm that fertilizes their eggs. Within special gill chambers, fertilized eggs develop into microscopic larvae called glochidia. After they mature, female mussels expel the glochidia, which must then attach to the gills or fins of a specific species, usually a fish, to continue developing into a juvenile mussel.

If glochidia successfully attach to a host, they mature into juvenile mussels, and then drop off. If they land in a suitable area, glochidia grow into adult mussels. Using fish (or other aquatic species) as a host allows freshwater mussels to move upstream and populate habitats they could not otherwise reach. Not all species of fish can successfully serve as hosts because infection resistance varies depending on the biological characteristics of the fish and mussel species. Therefore, conservation measures used to protect threatened and endangered mussels include the conservation of native fish communities. Other conservation measures include maintaining adequate water flow that mussels rely on for oxygen, food, and metabolic waste removal. Habitat modification, sedimentation, eutrophication, and other forms of water quality degradation are one of the primary causes of mussel population decline. These fish host species do not generally tolerate impoundment and are sensitive to water quality degradation.

Unfortunately, knowledge of the essential features required for the survival of any freshwater mussel species consists primarily of basic concepts with few specifics. Among the difficulties in defining habitat parameters for mussels are that physical and chemical conditions (e.g., water chemistry, flow) can vary widely within and across stream channels occupied by a species according to seasons, precipitation, and human activities within the watershed. Given this complexity, no strong correlations have been found between mussel distributions and microhabitat variables, e.g., substrate composition, water depth, water temperature, and current velocity (Williams et al. 2008). Freshwater mussels are generally found in small to large rivers that have slow to swift currents and stabilized substrates composed of silt, sand, gravel, and/or cobble. The presence of suitable host fish is also an essential element in these mussels' distribution and occurrence.

Historically, freshwater mussels were widely distributed across small to medium-sized rivers and tributaries across the Appalachians and the southeastern U.S. However, the ranges of many of these species have become reduced due to habitat alterations and population declines. Freshwater mussel populations have declined due to disease, invasive exotic species and the loss of suitable habitat—in part because water quality degradations and habitat alteration (e.g., the construction of dams and impoundments along rivers have disrupted the natural flow characteristics) and prevent natural population dispersal

Mussels are sedentary filter-feeders, and some species are intolerant of low-flow impounded water areas. Mussel populations can be abundant in impounded rivers if the flow conditions are suitable for their specific needs. Mussel habitat below the impoundment is also affected and can sometimes be improved. Downstream water temperatures, for example, might be either warmer or colder than normal, depending on whether sun-heated, slow-moving impoundment water spills over the top of the dam or deep, cold water is released from the bottom of the impoundment. Organic matter carried from upstream areas drops out of suspension in the slow-moving impoundment water and is trapped behind the dam instead of being transported further downstream where it would serve as a food source for small freshwater mussels. In addition, dams and impoundments are designed to meet specific project purposes but often alter flows in a manner that reduces the variability of seasonal water flows and the natural patterns of downstream sediment scour and deposition that create ideal mussel habitat (Vaughn and Taylor 1999).

Mussels are particularly sensitive to poor water quality (Haag 2012). Suitable habitat for mussels includes streams that have un-altered thermal regimes, average pH, low salinity, and negligible chemical pollution. Optimal habitats for many mussels are perennial streams with continuous, year-round flow. While mussels can survive low flows and (random) periodic drying events, intermittent stream habitats cannot support mussel populations. Mussel habitat must have adequate flow to deliver oxygen, enable passive reproduction, and deliver food to filter-feeding mussels. Further, flow removes contaminants and fine sediments from interstitial spaces preventing mussel suffocation. Riparian condition strongly influences the composition and stability of substrates that mussels inhabit (Allan et al. 1997). Streams with urbanized or agriculturally dominated riparian corridors are subject to increased sediment-loading from unstable banks and/or impervious surface run-off, resulting in less suitable in-stream habitat for mussels as compared to habitat with forested corridors (Allan et al. 1997). The fragmentation of river habitat by dams and other aquatic barriers (like perched or undersized culverts) is one of the primary threats to aquatic species in the U.S. (Martin and Apse 2014). Dams (whether man-made or nature-made (e.g., from beavers or windthrow)) have a profound impact on in-stream habitat as they can change lotic systems to lentic systems. Moreover, fragmentation by dams or culverts generally involves loss of access to quality habitat for one or more life stages of freshwater species. In the case of mussels, fragmentation can result in barriers to host fish movement which, in turn, may impact mussel distributions. Mussels that use smaller host fish (e.g., darters and minnows) are more susceptible to impacts from habitat fragmentation due to increasing distance between suitable habitat patches and low likelihood of host fish swimming over that distance. Barriers to movement can cause isolated or patchy distributions of mussels which may limit both genetic exchange and recolonization (e.g., after a high flow, scouring event).

4.5.1 Atlantic Pigtoe and CH

The Atlantic pigtoe (*Fusconaia masoni*) is dependent on clean, moderate flowing water with high dissolved oxygen content in creek and riverine environments. Historically, the best populations existed in creeks and rivers with excellent water quality, where stream flows were sufficient to maintain clean, silt-free substrates. Because this species prefers more pristine conditions, it typically occurs in headwaters and rural watersheds. It is associated with gravel and coarse sand substrates at the downstream edge of riffles, and less commonly occurs in cobble, silt, or sand detritus mixtures (USFWS 2019b).

The Atlantic pigtoe's historical range included all major river basins in the Atlantic coastal drainages from the James River Basin in Virginia south to the Altamaha River Basin in Georgia. The Atlantic pigtoe has been documented from multiple physiographic provinces, from the foothills of the Appalachian Mountains through the Piedmont and into the Coastal Plain, in streams ranging in size from < 1 meter wide up to some of the largest Atlantic Slope rivers within the species' range.

The Atlantic pigtoe SSA Report (USFWS 2021a) delineates populations using the 12 river basins that Atlantic pigtoe has historically occupied. This includes the James, Chowan, Roanoke, Tar, Neuse, Cape Fear, Pee Dee, Catawba, Edisto, Savannah, Ogeechee, and Altamaha River basins. Of 12 historical populations, seven populations within Virginia and North Carolina have observations in the last 12 years, though the majority of occurrences were limited to a single location within the river basin. The Atlantic pigtoe is presumed extirpated from the southern portion of the range in South Carolina and Georgia.

Atlantic pigtoe is found in North Carolina and Virginia. The species currently occupies approximately 40% of its historical range (USFWS 2021a). Most of the remaining populations are small and fragmented, only occupying a fraction of reaches that were historically occupied. This decrease in abundance and distribution has resulted in largely isolated contemporary populations. Evidence suggests that the range reduction of the species corresponds to habitat degradation resulting from the cumulative impacts of land use change and associated watershed-level effects on water quality, water quantity, habitat connectivity, and instream habitat suitability (USFWS 2019b).

The breeding, feeding, and sheltering needs of Atlantic pigtoe include successful host fish infestation and dispersal, adequate food delivery, and suitable stable habitat. All of these needs are influenced by water quality, water quantity, suitable in-stream substrate, and habitat connectivity. For additional detailed information, see USFWS (2021a).

Atlantic pigtoe was listed as threatened under the ESA on December 16, 2021.

Critical Habitat

Critical habitat was designated for Atlantic pigtoe on December 16, 2021. In total, approximately 563 river miles fall within 17 units of critical habitat in Bath, Botetourt, Brunswick, Craig, Dinwiddie, Greensville, Halifax, Lunenburg, Mecklenburg, Nottoway, Pittsylvania, and Sussex Counties, VA, and in Durham, Edgecombe, Franklin, Granville, Halifax, Johnston, Montgomery, Nash, Orange, Person, Pitt, Randolph, Rockingham, Vance, Wake, Warren, and Wilson Counties, NC.

The following physical or biological features are essential to the conservation of Atlantic pigtoe: (1) Suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (i.e., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussel and native fish (such as stable riffle-run-pool habitats that provide flow refuges consisting of silt-free gravel and coarse sand substrates). (2) Adequate flows, or a hydrologic flow regime (which includes the severity, frequency, duration, and seasonality of discharge over time), necessary to maintain benthic habitats where the species is found and to maintain connectivity of streams with the floodplain, allowing the exchange of nutrients and sediment for maintenance of the mussels' and fish hosts' habitat, food availability, spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats. (3) Water and sediment quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages. (4) The presence and abundance of fish hosts necessary for recruitment of the Atlantic pigtoe.

4.5.2 Clubshell

Clubshell (*Pleurobema clava*) is typically found in medium-sized and large rivers and typically burrows completely beneath the substrate. Consequently, the species is very susceptible to siltation, which clogs the spaces between sediment particles and suffocates the animal. Clubshell is generally found in clear, coarse sand and gravel in runs, often just downstream of a riffle. Because up to 70% of a clubshell population can be distributed below the substrate surface (Smith et al. 2001), this species is presumed to be highly dependent on interstitial flow through the substrate for oxygen and food and therefore is highly susceptible to siltation that fills interstitial voids (USFWS 2019c)

In the northeast region, clubshell occurs in New York, Pennsylvania and West Virginia. Although population numbers are relatively high in a few localized areas, the remaining clubshell populations are now sparsely distributed across the range of the species. Of 100 streams once known to be occupied by clubshell, the species is now limited to 11 extant populations occupying 19 streams, including those where the species has been reintroduced or augmented between 2014 and 2018. Eight populations show signs of successful recruitment. Augmentation and reintroduction sites have not shown evidence of successful reproduction as of 2018; however, clubshells take a number of years to reach a size likely to be detected. Impoundments and degraded habitat separate most populations from each other, eliminating the potential for natural recolonization if a catastrophic even temporarily degrades habitat (e.g., toxic spill event, flood). Ongoing threats to the clubshell include water quality degradation from point and non-point sources, particularly in small tributaries that have limited capability to dilute and assimilate sewage, agricultural runoff, and other pollutants. In addition, clubshell is affected by hydrologic and water quality alterations resulting from the operation of impoundments. The presence of impoundments may have ameliorated the effects of downstream siltation, but these structures also control river discharges (and the many environmental parameters influence by discharge), which may profoundly affect the ability of these populations to occupy or successfully reproduce in downstream habitats (USFWS 2019c).

A variety of instream activities continue to threaten clubshell populations, including sand and gravel dredging, gravel bar removal, bridge construction, and pipeline construction. Protecting clubshell populations from direct physical disturbance of these activities depends on accurately identifying the location of the populations, which is difficult with a cryptic species such as the clubshell. The indirect effects of altering the streambed configuration following instream disturbances can result in long-lasting alteration of streamflow patterns that may result in head-cutting and channel reconfiguration, thereby eliminating previously suitable habitat some distance from the disturbance.

Clubshell was listed as endangered under the ESA on February 22, 1993.

4.5.3 Dwarf Wedgemussel

The dwarf wedge mussel (*Alasmidonta heterodon*) occurs in small creeks to deep rivers in stable habitat with substrates ranging from mixed sand, pebble and gravel to clay and silty sand. The dwarf wedge mussel is found in creeks and rivers of varying sizes, in areas of slow to moderate current and little silt deposition. In the southern portion of its range, it is often found buried under logs or root mats in shallow water (USFWS 1993a); whereas in the northern portion of its range, it may be found in firm substrates of mixed sand, gravel or cobble, or embedded in clay banks in water depths of a few inches to greater than 20 feet (Fichtel and Smith 1995, Gabriel 1995, Gabriel 1996, Nedeau and Werle 2003, Nedeau 2004a, Nedeau 2004b, Nedeau 2006).

The dwarf wedgemussel is found in Atlantic Coast drainage streams and rivers of various sizes and moderate current. It currently ranges from New Hampshire to North Carolina. North Carolina's Neuse River Basin tributaries represent the southern range of the species. The dwarf wedgemussel has been documented in 16 major drainages, comprising approximately 70 sites. However, at least 45 of these sites are based on less than five individuals or solely on relic shells (USFWS 2007a; USFWS 2013c).

Viable populations (i.e., containing a sufficient number of reproducing adults to maintain genetic variability and in which annual recruitment is adequate to sustain a stable population, USFWS 1993a) in the northeastern United States include the Ashuelot River in New Hampshire and the Flat Brook in New Jersey. The Connecticut River in New Hampshire and Vermont, the Farmington River in Connecticut, Paulins Kill in New Jersey, and the Neversink River in New York may harbor viable populations, but more survey work is needed (USFWS 2013c). Because of the qualitative survey methods used to assess the populations, it is not possible to estimate the number of individuals in these populations at this time. However, recent surveys indicate that dwarf wedgemussel numbers may be declining at some locations in the Connecticut River and Ashuelot River (Biodrawversity LLC 2013; Biodrawversity LLC et al. 2014).

Although remaining populations from New Jersey south to North Carolina are much smaller, the Upper Tar River and Upper Fishing Creek in North Carolina are thought to harbor viable populations. Other populations in North Carolina, Virginia, and Maryland appear to be declining as evidenced by low densities, lack of reproduction, or inability to relocate any dwarf wedgemussel in follow-up surveys (USFWS 2013c). The dwarf wedgemussel population in Swift Creek appears viable (Three Oaks 2016) but with a high risk of local extirpation due to low population abundance and lack of dispersal (Smith et al. 2015).

Human activity has significantly degraded dwarf wedgemussel habitat causing a general decline in populations and a reduction in distribution of the species. Some factors responsible for the decline of the dwarf wedgemussel include: 1) impoundment of river systems, 2) pollution, 3) alteration of riverbanks, 4) siltation, and 5) extreme weather events (e.g., floods and drought) (USFWS 1993a, USFWS 2013c). Damming and channelization of rivers throughout the dwarf wedgemussel's range have resulted in the elimination or alteration of much mussel habitat (Watters 2000). Domestic and industrial pollution was the primary cause for mussel extirpation at many historical sites. Mussels are known to be sensitive to a variety of heavy metals, inorganic salts, and ammonia (Wang et al. 2017). Mussel die-offs have been attributed to chemical spills, agricultural waste run-off, and low dissolved oxygen levels.

Because freshwater mussels are relatively sedentary and cannot move quickly or for long distances, they cannot easily escape when silt is deposited over their habitat. Siltation has been 12 documented to be extremely detrimental to mussel populations by degrading substrate and water quality, increasing exposure to other pollutants, and by direct smothering of mussels (Ellis 1936, Marking and Bills 1980). In Massachusetts, a bridge construction project decimated a population of dwarf wedgemussel by accelerated sedimentation and erosion (Smith 1981).

Extreme weather events like flooding and drought have had an impact on dwarf wedgemussel. Surveys in 2006 indicated that the dwarf wedgemussel population in the Neversink River (formerly one of the most robust populations of dwarf wedgemussel) was adversely affected by flood events, and it remains to be seen if this population can rebound. Drought also appears to have adverse effects on dwarf wedgemussel populations. This is evident in the upper Tar River watershed in North Carolina, where severe population declines followed a substantial drought in 2007 (USFWS 2013c).

Most dwarf wedgemussel populations are small and geographically isolated from each other. This isolation restricts exchange of genetic material among populations and reduces genetic variability within populations (USFWS 1993a). Recent studies investigating the range-wide phylogeographic structure of dwarf wedgemussel indicate that the low degree (or absence) of gene flow between and within drainages suggests that individual host fish do not move between drainages, nor do they exhibit effective movement (resulting in gene flow) within drainages (USFWS 2013c).

Dwarf wedgemussel was listed as endangered under the ESA on April 13, 1990.

4.5.4 Fanshell

Characteristic habitat for fanshell (*Cyprogenia stegaria*) is medium to large rivers (Dennis, 1984; USFWS 1991b). They are typically found in stable stream channels where many other mussels of multiple other species are concentrated (i.e., a mussel bed). These areas of suitable habitat naturally occur in relatively small patches separated by longer reaches of unsuitable habitat (Vaughn and Pyron 1995). Fanshell can be found in a range of substrates and substrate mixtures including gravel, cobble, boulder, and occasionally mud or sand (Call 1990, Goodrich and Van der Schalie 1944, Cummings and Mayer 1992, Oesch 1995, Buchanan 1979, 1980, and 1994, Gordon 1991). However, they are most commonly reported from a gravel/sand mixture with various levels of cobble and silt (Buchanan 1980, Roberts and Bruenderman 2000). Fanshell requires flowing water and is considered a typical riffle species, however, fanshell can occupy a wide range of currents and water depths (Hickman 1937, Yokley 1972, Buchanan 1980, Clarke 1982, Oesch 1995, Roberts and Bruenderman 2000).

Historically, fanshell was widely distributed in the Ohio, Wabash, Cumberland, and Tennessee Rivers and their larger tributaries in Pennsylvania, Ohio, West Virginia, Illinois, Indiana, Kentucky, Tennessee, Alabama and Virginia (USFWS 1991b). Currently, it is estimated that a total of 472 miles of rivers throughout the U.S. contain populations of fanshell, which represents less than ten percent of its historic range. The best populations of the fanshell mussel occur in the Licking, Green, and Rolling Fork Rivers in Kentucky, and in the Clinch River in Tennessee and Virginia. These populations are considered healthy with evidence of recruitment over several years or even decades, with multiple year classes present. Extant populations of the fanshell mussel also currently exist in portions of the following rivers: Muskingum (Ohio), Kanawha (West Virginia), Ohio (West Virginia, Ohio), Wabash (Illinois, Indiana), East Fork White (Indiana), Tippecanoe (Indiana), and Tennessee (Tennessee). Each of these populations is susceptible to single damaging events. This includes both natural stochastic events, such as floods, and anthropogenic threats, such as toxic spills (Butler 2010).

Fanshell was listed as endangered under the ESA on July 23, 1990.

4.5.5 Fluted Kidneyshell

The Fluted Kidneyshell (*Ptychobranchus subtentus*) is a relatively large mussel that reaches about 5 inches in length (Parmalee and Bogan 1998). The Fluted Kidneyshell primarily occupies shoal habitat in small to large rivers (Williams et al. 2008). It is typically found in substrates mixed with sand and gravel, and occasionally found near or under cobble and boulders that have smaller substrates near the margins. The species does not appear to do well in lentic habitats or areas with heavy deposits of fine material (Parmalee and Bogan 1998, Williams et al. 2008). This species inhabits small to medium rivers in areas with swift current or riffles, although a few populations were recorded from larger rivers in shoal areas. Fluted kidneyshell requires flowing, well-oxygenated waters.

The fluted kidneyshell is endemic to the Cumberland and Tennessee River drainages of the Ohio River Basin and was reported historically from Alabama, Kentucky, Tennessee, and Virginia. In the Cumberland drainage, most records have come from the Upper Cumberland USGS 6-digit hydrological unit code (HUC6) drainage, in tributaries (e.g., Big South Fork Cumberland River, Wolf River, Buck Creek, and Rockcastle River) and in the mainstem Cumberland River below Cumberland Falls. In the Lower Cumberland River drainage, a single record is available from the Harpeth River. In 2019, a weathered specimen of the species was found in the Red River, a tributary to the lower Cumberland River, in Robertson County, Tennessee (USFWS 2021b). This represents a new historical population that was unknown at the time of listing and was not included in the SSA. The Red River mussel fauna experienced a major decline in species richness and abundance between 1966 and 1998 (Haag 2019). We presume that this population of the fluted kidneyshell is now extirpated. Archeological accounts suggest the species may have also occupied the lower Cumberland River mainstem and other tributaries (Parmalee and Bogan 1998, Haag and Cicerello 2016). In the Tennessee River drainage, the species primarily occurred in headwater tributaries in Virginia and Tennessee (e.g., French Broad, Nolichucky, Holston, Clinch, Powell rivers) and in a few western tributaries of the lower Tennessee River (e.g., Duck and Elk rivers).

The final listing rule includes 40 historical populations delineated by streams or contiguous segments of multiple streams (USFWS 2013d). Of those 40 historical populations, 17 were believed to be extant at the time of listing. Including the recently discovered historical Red River population, there are 21 known historical populations (excluding potential populations based only on archeological records) (USFWS 2021b). After assessing available data and literature, ten populations are currently considered to be extant (USFWS 2021c). The Rockcastle population, considered extant at the time of listing, is now considered extirpated. Of the ten extant populations, five are considered to have low resiliency, and the remaining five are considered to have moderate resiliency. Three of the populations are extant due to recent reintroductions (the Upper Duck and Nolichucky in 2004; the Lower Elk in 2016). The Obey population is likely extant based on records for the species in the Wolf River from 2005-2006 (Moles et al. 2007). A recent survey in August 2020 confirmed that fluted kidneyshell persists in the Wolf River.

The final listing rule (USFWS 2013d) identified habitat modification as the primary cause of the species' decline and cited impoundments, gravel and coal mining, sedimentation, water pollution, and stream channel alterations as major causes of habitat loss and degradation. The construction of dams within the range of the fluted kidneyshell has resulted in major enduring effects to the species by isolating populations, altering the physical habitat, and changing flow and temperature regimes. A variety of other human activities, especially those associated with urban development, agriculture, and resource extraction, have changed and continue to alter physical stream habitats and water quality.

Sedimentation is a major impairment of physical stream habitat. Excessive sediments will accumulate and cover the stream channel and fill the interstitial spaces with finer substrates, homogenizing the habitat and making it unsuitable for mussels. Sedimentation may additionally impair mussel reproduction by disrupting the fish-host relationship (USFWS 2021c). For example, the fluted kidneyshell utilizes fish hosts that sight-feed on its conglutinates (packets of larval mussels that resemble prey to host fish) to reproduce, so increased turbidity can lower visibility and foraging efficiency of host fish during critical reproductive periods (McLeod et al. 2017).

Historically, the fluted kidneyshell was a widespread Cumberlandian mussel species. Of the 21 historical populations, 10 populations remain: 3 of 6 historical populations in the Cumberland River drainage, and 7 of 15 in the Tennessee River drainage. Of the ten extant populations, we consider half to have low resiliency and half to have moderate resiliency. Reservoir construction has impounded and fragmented much of the habitat within the species' range; these habitat changes continue to have lasting effects through isolation of extant populations making them vulnerable to catastrophic events and to the negative impacts to fitness from reduced genetic diversity. Habitat degradation and water quality threats from land use activities (e.g., agriculture, development) continue at varying levels across the species' range. Additionally, climate change, possibly pathogens, and/or other undefined threats may be affecting the species or could affect the species in the future; however, we do not know which specific factor or combination of factors are most significant in the continued decline of the species. The unknown causes of recent die-offs in the Clinch River and the enigmatic declines that have occurred in other populations demonstrate the precarious status of these populations and reveal our poor understanding of the threats to the species.

Fluted kidneyshell was listed as endangered under the ESA on October 28, 2013.

4.5.6 Green Floater and CH

Green floater (*Lasmigona subviridis*) has a length of up to 2.5 inches. The periostracum is green to tawny or brown, usually with variable green rays (Williams et al. 2008). Green floater occurs primarily in creeks to small rivers and occasionally in large rivers. Generally not found in swift current, green floater is found in pools, eddies, or along stream margins with mud, sand or gravel substrates (Williams et al. 2008).

Green floaters are relatively short lived with variable annual recruitment, suggesting they maximize population growth during periods of favorable conditions. Green floaters are hermaphroditic and have the ability to self-fertilize, which increases the probability of fertilization. Spawning and fertilization likely occur during the late summer or early fall. Over the winter months, they have the fairly unique ability to directly metamorphose larvae (called glochidia), releasing juveniles into the water column during the spring without requiring an intermediate host. Like most freshwater mussels, green floaters can also use fish hosts such as mottled sculpin, rock bass, central stone roller, blacknose dace, and margined madtom (USFWS 2021d).

Green floater occurs in Atlantic Coast drainages from the St. Lawrence and Hudson River drainages in New York south to the Cape Fear River drainage in North Carolina. Disjunct populations occur in the Kanawha River system of the Ohio River drainage in North Carolina, Virginia and West Virginia

(Williams et al. 2008, USFWS 2021d). In the northeast, green floater is found in Maryland, New Jersey, New York, Pennsylvania, Virginia and West Virginia.

Green floater was proposed as threatened under the ESA on July 26, 2023.

Critical Habitat

Green floater critical habitat was proposed on July 26, 2023.

The proposed critical habitat includes 1,585 river miles in eight units in the following watersheds: (1) Southwestern Lake Ontario, (2) Susquehanna, (3) Potomac, (4) Kanawha, (5) Lower Chesapeake, (6) Chowan- Roanoke, (7) Neuse-Pamlico, and (8) Upper Tennessee. In the northeast, units are designated in the Genesee River, Livingston County, NY; Susquehanna Watershed in Broome, Chemung, Chenango, Cortland, Delaware, Herkimer, Madison, Otsego, Steuben, and Tioga Counties. NY and Bradford, Clinton, Columbia, Dauphin, Lackawanna, Luzerne, Lycoming, Montour, Northumberland, Perry, Snyder, Tioga, Union, and Wyoming Counties, PA; Potomac Watershed in Bedford and Fulton Counties, PA, Allegany and Washington Counties, MD and Berkeley, Hampshire, Hardy, Mineral, and Morgan Counties, WV; Kanawha Watershed, in Carroll and Grayson Counties, VA and Greenbrier, Monroe, Pocahontas and Summers Counties, WV; Lower Chesapeake Watershed in Amherst, Buckingham, and Nelson Counties, VA; Chowan-Roanoke watershed in Rockingham and Stokes Counties, VA;

The following physical or biological features are essential to the conservation of green floater: (1) Flows adequate to maintain both benthic habitats and stream connectivity, allow glochidia and juveniles to become established in their habitats, allow the exchange of nutrients and oxygen to mussels, and maintain food availability and spawning habitat for host fishes. The characteristics of such flows include a stable, not flashy, flow regime, with slow to moderate currents to provide refugia during periods of higher flows. (2) Suitable sand and gravel substrates and connected instream habitats characterized by stable stream channels and banks and by minimal sedimentation and erosion. (3) Sufficient amount of food resources, including microscopic particulate matter (plankton, bacteria, detritus, or dissolved organic matter). detritus, or dissolved organic matter). (4) Water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages, including, but not limited to, those general to other mussel species: adequate dissolved oxygen; low salinity; low temperature (generally below 86 °F (30 °C)); low ammonia (generally below 0.5 parts per million total ammonia nitrogen), PAHs, PCBs, and heavy metal concentrations; and no excessive total suspended solids and other pollutants, including contaminants of emerging concern. (5) The presence and abundance of fish hosts necessary for recruitment of the green floater (including, but not limited to, mottled sculpin (*Cottus bairdii*), rock bass (*Ambloplites rupestris*), central stoneroller (*Campostoma anomalum*), blacknose dace (*Rhinichthys atratulus*), and margined madtom (*Noturus insignis*)).

4.5.7 James Spinymussel

Suitable habitat for James spinymussel (*Pleurobema collina*) includes free-flowing freshwater streams 1 to 25 yards wide and 6 to 40 inches deep. James spiny mussel is found in substrate of cobble and sand with a slow to medium current (Clarke and Neves 1984). Substrate preferences for James spinymussel appear particularly nonspecific. Petty (2005) found the species more abundant in slack water or low-velocity areas with sand/gravel bars present.

James spinymussel is found in the James River drainage and the Dan/Mayo River systems within the Roanoke River drainages in Virginia, North Carolina, and West Virginia. James spinymussel was historically widespread in the James River drainage of Virginia. Much of the decline of James spinymussel has occurred in the last 30 years. James spinymussel remained widespread through the mid-1960s (USFWS 1990a). By 1990, James spinymussel appeared to be extirpated from approximately 90 percent of its historic range, with survival documented only in a few creeks and small rivers in the James River basin (USFWS 1990). Since 1990, James spinymussel populations have been found in three tributaries to the Dan River in Virginia and North Carolina, which is outside of the species range known at the time of listing. Since 1991, James spinymussel has been consistently documented in relatively low numbers (Ostby et al. 2009).

The average fecundity of James spinymussel is lower than most other freshwater mussels. Most freshwater mussels brood between 75,000 and 3,000,000 glochidia/female. Gravid James spinymussels brood approximately 13,400 glochidia/female (Hove and Neves 1994). This relatively low fecundity compared to other mussel species may result in reduced population stability during disturbance events or changes within their environment compared to other mussel species.

Little is known about the population dynamics of James spinymussel. Individuals usually number <10 at any one reach or site, and often only one individual is found. Low densities may lead to reduced reproductive success due to the low likelihood of successful fertilization resulting from the distance between individuals being too great. A limited knowledge of abundance and range at the time of listing in combination with limited information on the dynamics of James spinymussel populations makes it difficult to characterize the status and trajectory of an individual population.

The primary reasons for the decline of the James spinymussel include habitat loss and degradation (USFWS 1990a). Current threats to James spinymussel include siltation, possible competition with non-native bivalves, impoundment of waterways, water pollution, stream channelization, sewage discharge, agricultural runoff such as pesticides and fertilizers, poor logging practices, road and bridge construction, and discharge of chemicals (Johnson and Neves 2004). The ongoing demographic consequences of these impacts, including low density and small population sizes also affect the species.

Small population sizes, and the demographic and genetic consequences associated with reduced population sizes also likely affect some James spinymussel populations. Habitat degradation or previous impacts in some areas may have reduced the population density to a level where reproduction and recruitment are limited and may not be sufficient to maintain the population over long periods.

James spinymussel was listed as endangered under the ESA on August 22, 1988.

4.5.8 Longsolid and CH

Longsolid (*Fusconaia subrotunda*) is a medium-sized mussel, up to 5 inches in size. Longsolid is a relatively long-lived species averaging 25 to 35 years, but given the large size it can attain, possibly living up to 50 years. As a result, we rely on the best available information for other closely related species to help summarize life history characteristics of this species.

Longsolid is found in small streams to large rivers (such as the Ohio River mainstem) with natural flow regimes, and prefers a mixture of sand, gravel and cobble substrate but also may be found coarse gravel and cobble in larger rivers (USFWS 2022). In streams and rivers, they can be found at depths less than 2 ft, but in large rivers can be commonly found at depths of 12 to 18 ft (Parmalee and Bogan 1998). In a study of mussel habitat preferences in the lower Clinch River, Virginia, longsolid were most associated with slower, deeper microhabitats with low shear stress values (Ostby 2005), and were placed in a slow-flow tolerant guild, indicating that the species has a greater tolerance for pool and run habitats. Additionally, based on this study, longsolid is more frequently encountered in the lower reaches of rivers such as the Clinch River (Ostby 2005).

The longsolid is a short-term brooder, typically gravid from May- July (Gordon and Layzer 1989). Host fish species are unknown, but based on other species of *Fusconaia*, likely hosts are minnows of the family Cyprinidae and genera *Campostoma, Cyprinella, Notropis*, and *Luxilus* as well as potentially sculpins of family Cottidae, genus *Cottus* (Bruenderman and Neves 1993, USFWS 2022). Little information is known or available on the life history of the longsolid.

Longsolid has suffered negative influences from habitat fragmentation from dams and other barriers, habitat loss, degraded water quality from chemical contamination and erosion from poorly managed development, agriculture, mining and timber operations, and the proliferation of invasive species, such as the zebra mussel (USFWS 2022).

The longsolid is historically known from 12 states, though now only occurs in nine. It is currently found in three major river basins: the Ohio (where it is most prevalent), Cumberland (where it is rarest), and Tennessee. It is considered extirpated from the Great Lakes Basin (USFWS 2022). In the northeast, longsolid is found in New York, Pennsylvania, Virginia and West Virginia.

Longsolid was listed as threatened under the ESA on April 10, 2023.

Critical Habitat

Critical habitat was designated for longsolid on April 10, 2023. The critical habitat designation included 1,115 river miles. In the northeast, critical habitat units for longsolid were designated in French Creek, Allegheny River, and Shenango River, PA; Middle Island Creek, Little Kanawha River, Elk River and Kanawha River, WV.

The physical or biological features essential to the conservation of the longsolid consist of the following components: (i) Adequate flows, or a hydrologic flow regime (magnitude, timing, frequency, duration, rate of change, and overall seasonality of discharge over time), necessary to maintain benthic habitats where the species is found and to maintain stream connectivity, specifically providing for the exchange of nutrients and sediment for maintenance of the mussel and fish host's habitat and food availability, maintenance of spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats. Adequate flows ensure delivery of oxygen, enable reproduction, deliver food to filter-feeding mussels, and reduce contaminants and fine sediments from interstitial spaces. Stream velocity is not static over time, and variations may be attributed to seasonal changes (with higher flows in winter/spring and lower flows in summer/fall), extreme weather events (e.g., drought or floods), or anthropogenic influence (e.g., flow regulation via impoundments). (ii) Suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (i.e., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussel and native fish (such as, stable riffle-run-pool habitats that provide flow refuges consisting of predominantly silt-free, stable sand, gravel, and cobble substrates). (iii) Water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages, including (but not limited to): Dissolved oxygen (generally above 2 to 3 parts per million (ppm)), salinity (generally below 2 to 4 ppm), and temperature (generally below 86 °Fahrenheit (°F) (30 °Celsius (°C)). Additionally, water and sediment should be low in ammonia (generally below 0.5 ppm total ammonia-nitrogen) and heavy metal concentrations and lack excessive total suspended solids and other pollutants. (iv) The presence and abundance of fish hosts necessary for recruitment of the longsolid (currently unknown, likely includes the minnows of the family Cyprinidae and banded sculpin (*Cottus carolinae*)).

4.5.9 Northern Riffleshell

The northern riffleshell (*Epioblasma rangiana*) is a small to medium size (up to 3 inches long) freshwater mussel that occurs in packed sand and gravel in riffles and runs. The species buries itself to the posterior margin of the shell, although females may be more exposed, especially during breeding season (USFWS 1994a).

The common name 'riffleshell' implies that riffle habitat often associated with the genus is required; however, the habitat requirement of the northern riffleshell may not be as narrowing constrained as the name implies. The northern riffleshell is also known to occur in relatively slow flowing, more lentic, or deep run habitats. The species also occurred in Lake Erie, where wave action likely provided needed water flow. Northern riffleshells have also been found in the Allegheny River in run-of-the-river navigation pools 8 and 9 that are impounded to facilitate navigation and may only experience water flow during high river discharge periods. It is not clear if specimens living in more typical riffle/run areas can adapt to slower water should conditions change. Use of low-flow areas may also be limited in more turbid waters, where concomitant silt deposition may limit survival or successful reproduction.

Riffleshell mussels appear to have a relatively short lifespan for a freshwater mussel. Sexual maturity can be reached in as little as three years, and most individuals probably live for only 7 to 15 years (Rodgers et al. 2001, Crabtree and Smith 2007). Like other mussels, the northern riffleshell probably experiences very low annual juvenile survival.

Northern riffleshell mussels appear to be restricted to four successfully recruiting populations in the Ohio and St. Lawrence River Basins, specifically the East Branch Sydenham River, Allegheny River, French Creek, and Ausable River populations. The Elk River population is probably extant, but recruitment has not been documented recently. Since the species was listed as endangered, populations in Fish Creek, Detroit River, Green River, Big Darby Creek, and Tippecanoe River have undergone severe declines and recent surveys failed to locate living specimens. Although additional surveys are ongoing, northern riffleshell mussels may have been extirpated from these systems.

The rangewide status of the northern riffleshell is declining (USFWS 2008). Ongoing threats to the northern riffleshell include water quality degradation from point and non-point sources, particularly in tributaries that have limited capability to dilute and assimilate sewage, agricultural runoff, and other pollutants. In addition, the species is affected by hydrologic and water quality alterations resulting from the operation of impoundments. A variety of instream activities continue to threaten northern riffleshell populations, including sand and gravel dredging, gravel bar removal, bridge construction, and pipeline construction. The indirect effects of altering the streambed configuration following instream disturbance can result in long-lasting alteration of streamflow patterns that may cause head-cutting and channel reconfiguration, thereby eliminating previously suitable habitat some distance from the disturbance. Coal, oil, and natural gas resources are present in some of the watersheds known to support northern riffleshell. Exploration and extraction of these resources can result in increased siltation, a changed hydrograph, and altered water quality, even at a distance from the mine or well field. Land-based development near streams of occurrence, including residential development and agriculture, often results in loss of riparian habitat, increased stormwater runoff due to increased impervious surfaces, increased sedimentation due to loss of streamside vegetation, and subsequent degradation of streambanks. Development has also resulted in an increased number of sewage treatment plants in drainages that support clubshell as well as an increase in the amount of sewage discharged from existing plants. Mounting evidence indicates that freshwater mussels are more sensitive to several components of treated sewage effluent (e.g., ammonia, chlorine and copper) than are the typical organisms used to establish criteria protective of aquatic life. Additional threats could include overutilization for commercial, recreational, scientific, or educational purposes, disease or predation, inadequacy of existing regulatory mechanisms, and other natural or manmade factors affecting its continued existence.

Northern riffleshell was listed as endangered under the ESA on February 22, 1993.

4.5.10 Pink Mucket Pearlymussel

Characteristic habitat for pink mucket (*Lampsilis abrupta*) is medium to large rivers (Dennis, 1984; USFWS 1985). They are typically found in stable stream channels where a variety of other mussels are concentrated (i.e., a mussel bed). These areas of suitable habitat naturally occur in relatively small patches separated by longer reaches of unsuitable habitat (Vaughn and Pyron 1995). Pink mucket can be found in a range of substrates and substrate mixtures including gravel, cobble, boulder, and occasionally mud or sand (Call 1990, Goodrich and Van der Schalie 1944, Cummings and Mayer 1992, Oesch 1995, Buchanan 1979, 1980, and 1994, Gordon 1991). However, they are most commonly reported from a gravel/sand mixture with various levels of cobble and silt (Buchanan 1980, Roberts and Bruenderman 2000). Pink mucket requires flowing water and is considered a typical riffle species, however, pink mucket can occupy a wide range of currents and water depths (Hickman 1937, Yokley 1972, Buchanan 1980, Clarke 1982, Oesch 1995, Roberts and Bruenderman 2000).

Pink mucket is characterized as a large river species (Dennis 1984) associated with fast-flowing waters, although in recent years it has been able to survive and reproduce in impoundments with river-lake conditions but never in standing pools of water (USFWS 1985). Found in waters with strong currents, rocky or boulder substrates, with depths up to about 1 m, but is also found in deeper waters with slower currents and sand and gravel substrates (Gordon and Layzer 1989, USFWS 1985).

Pink mucket was historically widespread throughout the Mississippi River basin, occurring in 48 rivers. It was known mainly from the Tennessee, Cumberland, and Ohio River drainages with occasional records from elsewhere within the Mississippi River drainage. While the species was widespread, it was never known to occur in larger numbers from any one site, and therefore, it has usually been considered rare (USFWS 1985). At the present time, only 29 populations are considered extant. The largest and most significant populations are currently known to occur in the Tennessee, Saline, Cumberland, Osage, and Meramec Rivers. Of these extant populations, only a few have shown recent evidence of recruitment. With few exceptions, the 29 extant populations are extremely small and occur in relatively short river reaches despite the extent of seemingly suitable habitat in many streams. A majority of populations are essentially limited to discrete reaches making the species in these streams highly susceptible to elimination from catastrophic stochastic events (Butler 2010).

Pink mucket was listed as endangered under the ESA on July 14, 1976.

4.5.11 Purple Cat’s Paw Pearlymussel

The purple cat’s paw (*Epioblasma obliquata*) inhabits boulder to sandy substrates in large rivers of the Ohio River basin. Little is known of this rare species’ life history. The purple cat’s paw, which is characterized as a large-river species (USFWS 1990b), has been found inhabiting water of shallow to moderate depth and with moderate to swift currents (Bogan and Parmalee 1983, Gordon and Layzer 1989). The subspecies has been reported from boulder and sand substrates. The specific food habits of the purple cat’s paw are unknown, but it likely feeds on food items similar to those consumed by other freshwater mussels. Freshwater mussels are known to feed on detritus, diatoms, phytoplankton, and zooplankton.

At the time the recovery plan was issued, the purple cat’s paw was only known to be extant in two river reaches – the middle Cumberland River in Tennessee and the Green River in Kentucky (USFWS 1990b). However, no living or fresh dead purple cat’s paw pearlymussels have been collected in these two rivers in over 30 years. The species is likely extirpated from the Cumberland River. The species was also likely extirpated from the Green River. However, as discussed below, an effort to reestablish a purple cat’s paw population in the Green River was initiated in 2017. In 1994, a small population of the purple cat’s paw was discovered in Killbuck Creek in Coshocton County, Ohio (USFWS 2020b).

There is currently one reproducing population (Killbuck Creek) and five reintroduced populations (Walhonding River, Ohio River, Green River, Licking River, and Duck River). Long-term viability of the Killbuck Creek is questionable due to the low density, though some recent recruitment has occurred, and the population was augmented with captively propagated juveniles in 2018. The five reintroduced populations contain only young individuals. While some of these may have reached sexual maturity, evidence of reproduction has not yet been documented (USFWS 2020b).

The subspecies’ distribution and reproductive capacity have been seriously impacted by the construction and operation of reservoirs on these large rivers (USFWS 1990b). Unless reproducing populations are found or created and existing populations are maintained, this subspecies will likely become extinct in the foreseeable future.

The purple cat’s paw was listed as Endangered under the ESA on August 10, 1990.

4.5.12 Rabbitsfoot and CH

The rabbitsfoot (*Quadrula cylindrica cylindrica*) primarily inhabits small-to medium-sized streams and some large rivers where bottom substrates generally include sand and gravel (Parmalee and Bogan 1998). This species usually occurs in shallow areas along the bank and adjacent runs, riffles and shoals where the water velocity is reduced. Rabbitsfoot generally lie on their side atop the substrate surface (Ortmann 1919) and is dependent on flow refuges where shear stress is low, and sediments remain stable during flood events. These patches of stable habitat may be highly important for the rabbitsfoot since it typically does not burrow, making it more susceptible to displacement into unsuitable habitat.

In at least one survey in the Tennessee River, rabbitsfoot was most abundant on marginal shelves of sandy clay in 6 to 10 feet of water (Bogan and Parmalee 1983). It may also occupy deep water runs, having been reported in 9 to 12 feet of water. Bottom substrates generally include sand and gravel. In smaller streams it inhabits bars or gravel and cobble close to the fast current. Found in medium to large rivers in sand and gravel (Cummings and Mayer 1992). The lifespan of the rabbitsfoot is thought to be 20 years or more. Age at sexual maturity for the rabbitsfoot is unknown. Fertilization success is apparently influenced by mussel density and flow conditions. The female rabbitsfoot utilizes all four gills as a marsupium for its glochidia and is considered to be a short-term brooder with an inferred brooding period from May to July. The decline of the rabbitsfoot is primarily the result of habitat loss and degradation from impoundments, sedimentation, and pollution.

Rabbitsfoot was widespread and locally common in many Mississippi River Basin streams. Quantitative historical abundance data are rare, but relative abundance information can be gathered from the size and number of museum lots. The historical museum data (pre-1980) indicate that good rabbitsfoot populations occurred in many rivers, including the Ohio River. When experts started attempts to compile lists of imperiled mussels, the rabbitsfoot was considered a rare species as early as 1970. Many recent studies have indicated the rabbitsfoot is rare, sporadic, or extirpated throughout most of its range. The compilation of distributional information in the status review by Butler (2005) indicates a severe reduction in range over the past 40 years. About 66 percent of the historical streams have lost their rabbitsfoot populations. Populations in 91 streams of known historical populations are now considered extirpated. It is very likely that other poorly sampled or totally unsampled stream populations of this species have experienced similar declines. The amount of habitat loss and the extirpation of this species from thousands of miles of habitat within its range indicate catastrophic population losses as well. Total range reduction and overall population loss for the rabbitsfoot realistically approaches, if not exceeds, 90 percent.

Rabbitsfoot has disappeared from portions of its natural range due to the combined influences of numerous threats to its environment including degradation and loss of riverine habitat and poor water and sediment quality caused by excessive sedimentation, channel modification, bed destabilization, and environmental contaminants. Its stream habitats are vulnerable to degradation and alteration from a variety of sources including adjacent land use activities, mining, effluent discharges, and impoundments. It also is threatened by the introduction of nonnative species, population fragmentation and small population sizes, accidental spills, and the effects of catastrophic natural events like droughts and floods. These stressors have profound adverse effects on Rabbitsfoot populations, its habitat, and fish hosts (USFWS 2013e).

Rabbitsfoot was listed as threatened under the ESA on October 17, 2013.

Critical Habitat

Rabbitsfoot critical habitat was designated on June 1, 2015. Approximately 1,437 river miles in 31 units were designated in the Neosho, Spring (Arkansas River system), Verdigris, Black, Buffalo, Little, Ouachita, Saline, Middle Fork Little Red, Spring (White River system), South Fork Spring, Strawberry, White, St. Francis, Big Sunflower, Big Black, Paint Rock, Duck, Tennessee, Red, Ohio, Allegheny, Green, Tippecanoe, Walhonding, Middle Branch North Fork Vermilion, and North Fork Vermilion Rivers, and Bear, French, Muddy, Little Darby, and Fish Creeks. In the northeast, units were designated in the French Creek, Crawford, Erie, Mercer, and Venango Counties, PA; Allegheny River, Venango County, PA; Muddy Creek, Crawford County, PA; and the Shenango River, Mercer County, PA (USFWS 2015).

Physical and biological features of critical habitat for rabbitsfoot include adequate water quantity, stream channel stability, and floodplain connectivity.

4.5.13 Rayed Bean and CH

The rayed bean mussel (*Vilosa fabalis*) is a small native freshwater unionid mussel, usually less than 1.5 inches in length (Cummings and Mayer 1992, Parmalee and Bogan 1998, West et al. 2000), with a smooth textured, green to yellow-green or brown colored shell with dark green rays. The rayed bean mussel is found in sand and gravel areas of small headwater creeks to large rivers (historically found in Lake Erie), and typically found in or near shoals or riffle areas and often found among aquatic vegetation. (USFWS 2018b).

The rayed bean generally lives in smaller, headwater creeks but is sometimes found in large rivers and wave-washed areas of glacial lakes. It prefers gravel or sand substrates and is often found in and around roots of aquatic vegetation. Adults spend their entire lives partially or completely buried in substrate (USFWS 2012).

Rayed bean mussels need clean flowing water with appropriate temperatures, gravel or sand substrate, with aquatic vegetation and food resources such as detritus, dissolved organic matter, algae, and bacteria. Host fish for the rayed bean include darter and sculpin species (USFWS 2024b).

The rayed bean mussel was historically found in 115 streams, canals, and lakes. At the time of listing, it was found in 31 streams and one lake in Indiana, Michigan, New York, Ohio, Pennsylvania, Tennessee, West Virginia and Ontario, Canada. This species has declined over much of its range, mostly as a result of habitat loss and stream degradation. The overall current rangewide status of the species had not improved since listing, and threats such as habitat degradation and climate change effects still persist (USFWS 2018b).

Populations of rayed bean mussels rangewide are small and restricted to short river reaches which increases their vulnerability to stochastic and catastrophic events. The rayed bean mussel occurs in 13 streams in the Lower Great Lakes sub-basin, 20 streams and 1 lake in the Ohio River system and 1 stream in the Tennessee River system (USFWS 2018b). Since captive propagation and reintroduction has not been initiated for this species, the status of the species has yet to improve (USFWS 2018b). The species is considered extirpated from Illinois, Kentucky, Virginia, and the upper Great Lakes sub-basin. The rayed bean mussel has been reintroduced/restored to Tennessee and West Virginia.

Of the remaining populations, 5 populations (14 percent) are considered to be large, stable populations. These five populations are the Sydenham River, Ontario; Swan Creek and Blanchard River, OH; and Allegheny River and French Creek, PA.

Rayed bean was listed as endangered under the ESA on March 15, 2012.

Critical Habitat

Critical habitat was proposed for Rayed Bean on December 13, 2024. In the northeast, critical habitat units have been designated in the Allegheny River, in Allegany and Cattaraugus Counties, NY and McKean County, PA; the Middle Allegheny River, in Armstrong, Butler, Clarion, Forest, Venango, and Warren Counties, PA; and French Creek, in Crawford, Erie, Mercer, and Venango Counties, PA (USFWS 2024b).

Physical and biological features essential to the conservation of the rayed bean include 1) adequate flows or a hydrological regime necessary to maintain benthic habitats where the species is found and to maintain stream connectivity, 2) suitable substrates and connected instream habitats, characterized by geomorphologically stable stream channels and banks, 3) water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth and viability of all life stages, include appropriate levels of dissolved oxygen, salinity, and temperature, and 4) the presence and abundance of host fishes necessary for recruitment of the species (USFWS 2024b).

4.5.14 Round Hickorynut and CH

A variety of river and stream habitat conditions are necessary for round hickorynut (*Obovaria subrotunda*). The round hickorynut exhibits a preference for sand and gravel in riffle, run, and pool habitats in streams and rivers, but also may be found in sandy mud (Watters et al. 2009). They can be found in shallow habitats with gentle flows at less than 1 foot with abundant American water-willow (*Justicia americana*) (USFWS 2019d), but in larger rivers are commonly found up to depths of 6.5 ft (Gordon and Layzer 1989). Round hickorynut is found in medium-sized to large rivers with sand and gravel substrates with moderate flow, usually at depths of less than six feet (Parmalee and Bogan 1998). Generally speaking, Round hickorynut habitat is in rivers and streams with natural flow regimes (USFWS 2019d).

Round hickorynut is currently found in the Great Lakes, Ohio, Cumberland, Tennessee, and Lower Mississippi River major river basins, within the states of Alabama, Indiana, Kentucky, Michigan, Mississippi, Ohio, Pennsylvania, Tennessee, and West Virginia. It is considered extirpated from Georgia, Illinois, and New York. The species' current condition includes populations within small streams such as Mill Creek in the Great Lakes basin, and Meathouse Fork and Richland Creek in the Ohio River basin. In these smaller streams, the species frequently exists near the mouths, thereby giving them ready access to a larger parent stream. Populations of round hickorynut in small streams are considered extirpated from the Cumberland and Tennessee basins (Irwin and Alford 2018). However, it appears in surveys of small to large rivers. The round hickorynut attains a larger size in big rivers, such as in the Tennessee and Ohio River mainstems (Williams et al. 2008). Additionally, although it is now considered extirpated from the mainstem Cumberland River and Mississippi River, it formerly occurred in both these large rivers prior to impoundment and was considered common in the upper and lower Cumberland River (Wilson and Clark 1914; Casey 1986; Wesler 2001).

Mussel declines in the Ohio, Cumberland, Tennessee, and Lower Mississippi basins are primarily the result of habitat and water quality loss and degradation (Neves 1993). The invasion of nonnative species such as the Zebra Mussel (*Dreissena polymorpha*) has resulted in substantial decline in Great Lakes basin mussel populations and shifts in ecosystem function (Conroy and Culver 2005, Schloesser et al. 2006). The chief causes of lost or declining populations of mussels within these basins occupied by the round hickorynut are a combination of impairments resulting from impoundments, channelization, nonnative species, chemical contaminants, mining, agriculture, and sedimentation (Neves 1993, Watters 2000).

Round hickorynut was listed as threatened under the ESA on April 10, 2023.

Critical Habitat

Critical habitat was designated for round hickorynut on April 10, 2023. The critical habitat designation included 921 river miles. In the northeast, critical habitat units for round hickorynut were designated in Shenango River, PA, Middle Island Creek, Little Kanawha River, Elk River, and Kanawha River, WV.

The physical or biological features essential to the conservation of the round hickorynut consist of the following components: (i) Adequate flows, or a hydrologic flow regime (magnitude, timing, frequency, duration, rate of change, and overall seasonality of discharge over time), necessary to maintain benthic habitats where the species is found and to maintain stream connectivity, specifically providing for the exchange of nutrients and sediment for maintenance of the mussel and fish host's habitat and food availability, maintenance of spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats. Adequate flows ensure delivery of oxygen, enable reproduction, deliver food to filter-feeding mussels, and reduce contaminants and fine sediments from interstitial spaces. Stream velocity is not static over time, and variations may be attributed to seasonal changes (with higher flows in winter/spring and lower flows in summer/fall), extreme weather events (e.g., drought or floods), or anthropogenic influence (e.g., flow regulation via impoundments). (ii) Suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (i.e., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussel and native fish (such as, stable riffle-run-pool habitats that provide flow refuges consisting of predominantly silt-free, stable sand, gravel, and cobble substrates). (iii) Water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages, including (but not limited to): Dissolved oxygen (generally above 2 to 3 parts per million (ppm)), salinity (generally below 2 to 4 ppm), and temperature (generally below 86 °F (°F) (30 °Celsius (°C)). Additionally, water and sediment should be low in ammonia (generally below 0.5 ppm total ammonia-nitrogen) and heavy metal concentrations and lack excessive total suspended solids and other pollutants. (iv) The presence and abundance of fish hosts necessary for recruitment of the round hickorynut (i.e., eastern sand darter (*Ammocrypta pellucida*), emerald darter (*Etheostoma baileyi*), greenside darter (*E. blennioides*), Iowa darter (*E. exile*), fantail darter (*E. flabellare*), Cumberland darter (*E. susanae*), spangled darter (*E. obama*), variegate darter (*E. variatum*), blackside darter (*Percina maculata*), frecklebelly darter (*P. stictogaster*), and banded sculpin (*Cottus carolinae*)).

4.5.15 Salamander Mussel and CH

The salamander mussel (*Simpsonaias ambigua*) is frequently found bedding under flat rocks in rivers, streams, creeks, or lakes of moderate flow. They are a small, thin-shelled mussel ranging around 2-inches long and 1-inch high (Parmalee and Bogan 1998). The salamander mussel lives for approximately 10 years. Age of sexual maturity is not known. Salamander mussels spawn in the spring and is a long-term brooder. The females hold the glochidia in their marsupial gills over the winter until they are released the following spring or summer (USFWS 2023a).

It is the only North American freshwater mussel species within the Unionidae family known to have a non-fish host, the mudpuppy (*Necturus maculosus*), as a host for the developing glochidia (Parmalee and Bogan 1998). Salamander Mussel prefers shelter habitat with space under slab rock/ bedrock crevice type structures that are dark, where they are in contact with a solid surface, and there is stability from swift current (Stegman 2020). Often these rock structures have small amounts of sediment and silt present but are swept fairly clean of excessive silt and fine sediments (USFWS 2023a). Salamander mussel generally occurs in a sandy substrate. In some cases, it also occurs in mud or on gravel (Parmalee and Bogan 1998). Mudpuppies also shelter under rocks, creating greater opportunity for the mussel to complete its lifecycle utilizing the external gills of its host. Salamander mussel has been observed to be one of the most mobile mussels, capable of climbing up vertical surfaces, including plastic (Stegman 2020). Being highly mobile may be an adaptation that helps them respond to substrate changes that might occur in swift current within rocky crevices or structures and allows them to seek more suitable habitat or disperse to new habitat from high density areas (Stegman 2020).

Salamander mussels are historically found in small streams or large rivers throughout 14 states (Arkansas, Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Tennessee, Virginia and Wisconsin). The current distribution of salamander mussel in the northeast includes occupied stream extents within the Great Lakes basin and the Ohio Basin. The Great Lakes Basin includes portions of New York and Pennsylvania along the south shore of Lake Erie. Within the Great Lakes Basin, 11 populations are considered extant or presumed extant. The Ohio Basin includes portions of New York, Pennsylvania and West Virginia that drain into the Ohio River. There are 35 populations of salamander mussel within the Ohio basin, 25 extant and 10 presumed extant (USFWS 2023a).

The primary threat to survival of this species in contaminants, hydrological regime, landscape alterations, lack of connectivity, invasive species, and host vulnerability. Movement and presence of host species are critical to the development and distribution of mussels (USFWS 2023a).

Salamander mussel was proposed for listing as endangered under the ESA on August 22, 2023.

Critical Habitat

Critical habitat was proposed for the salamander mussel on August 22, 2023. In the northeast, critical habitat units were proposed in Tonawanda Creek, Niagara, Erie, Genesee, and Wyoming Counties, NY; Conneaut Creek, in Erie and Crawford Counties, PA; French Creek, in Mercer, Erie, Crawford, and Venango Counties, PA; Allegheny River, in Armstrong County, PA; Fish Creek, Marshall County, WV; Fishing Creek, Wetzel County, WV; Middle Island Creek, Doddridge, Tyler, and Pleasants Counties, WV; Little Kanawha River, Wood and Wirt Counties, WV; South Fork Hughes River, Doddridge, Wirt, and Ritchie Counties, WV (USFWS 2023b).

The physical or biological features essential to the conservation of the salamander mussel consist of the following components: (i) Adequate flows, or a hydrologic flow regime (magnitude, timing, frequency, duration, rate of change, and overall seasonality of discharge over time), necessary to maintain benthic habitats where the salamander mussel and its host, the mudpuppy, are found and to maintain stream connectivity. (ii) Suitable substrates and connected instream habitats, characterized by geomorphologically stable stream channels and banks (i.e., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support the salamander mussel and mudpuppy (e.g., large rock shelters, woody debris, and bedrock crevices within stable zones of swift current with low amounts of fine sediment silt). (iii) Water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages, including (but not limited to) dissolved oxygen (generally above 2 to 3 parts per million (ppm)), salinity (generally below 2 to 4 ppm), and temperature (generally below 86 °F) (30 °C)). Additionally, concentrations of contaminants, including (but not limited to) ammonia, nitrate, copper, and chloride, are below acute toxicity levels for mussels. (iv) The presence and abundance of the mudpuppy host.

4.5.16 Sheepnose and CH

The sheepnose (*Plethobasus cyphyus*) is found across the Midwest and Southeast. However, it has been eliminated from two-thirds of the streams from which it was known historically; 25 streams are currently occupied compared to 76 in the past. Additionally, the sheepnose was eliminated from hundreds of miles of rivers in the Illinois, Cumberland, Mississippi and Tennessee River basins. The sheepnose is now found in Alabama, Illinois, Indiana, Iowa, Kentucky, Minnesota, Mississippi, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and Wisconsin.

As a group, mussels are long-lived, with individuals living up to several decades and sometimes up to 100 to 200 years. Sheepnose are reported to live as long as 30 years.

Sheepnose mussels live in larger rivers and streams where they are usually found in shallow areas with moderate to swift currents that flow over coarse sand and gravel. However, they have also been found in areas of mud, cobble and boulders, and in large rivers they may be found in deep runs. Sheepnose in larger rivers may occur at depths exceeding 19.7 feet and may occur in deep runs (Parmalee and Bogan 1998). Adults are suspension-feeders. They siphon water and feed on suspended algae, bacteria, detritus and microscopic animals. Adult mussels spend their entire lives partially or completely buried in the river bottom.

Dams affect both upstream and downstream mussel populations by disrupting seasonal flow patterns, scouring river bottoms, changing water temperatures and eliminating river habitat. Large rivers throughout most of the sheepnose mussel's range have been dammed, leaving short, isolated patches of habitat below dams. The sheepnose depends on fish to move upstream. Host fish for sheepnose include the mimic shiner (*Notropis volucellus*) and sauger (*Sander canadensis*) (USFWS 2024b). Dams that block fish movement also prevent mussels from moving upstream. Upstream mussels become isolated from downstream populations, leading to small, unstable populations that are more likely to die out.

Most populations of sheepnose are small and geographically isolated. These small populations, which live in short sections of rivers, are susceptible to extirpation from single catastrophic events, such as toxic spills. Also, isolation makes natural repopulation impossible without human assistance.

Poor land use practices, dredging, intensive timber harvests, road construction and other activities accelerate erosion, which increases sedimentation. Sediment that blankets a river bottom may suffocate mussels. Large amounts of sediment in the water also reduce the ability of mussels to remove food and oxygen, which can lead to decreased growth, reproduction and survival.

Adult mussels are easily harmed by toxins and degraded water quality from pollution because they are sedentary (they tend to stay in one place). Pollution may come from specific, identifiable sources such as accidental spills, factory discharges, sewage treatment plants and landfills. Pollution also comes from diffuse sources like runoff from fields, construction sites and roads. Contaminants may kill mussels directly, but they may also indirectly harm sheepnose by reducing water quality, which reduces survival and reproduction and lowers the numbers of host fish.

Dredging and channelization have profoundly changed rivers nationwide. Channelization physically alters rivers by accelerating erosion, reducing depths, decreasing habitat diversity, destabilizing stream bottoms, and removing riparian vegetation.

Nonnative Species: The invasion of the nonnative zebra mussel into the United States poses a serious threat to native mussels. Zebra mussels proliferate to such an extent that they deplete food resources. They also attach to native mussel shells in such large numbers that the native mussel cannot open its shell to eat or breath.

Sheepnose was listed as Endangered on April 12, 2012

Critical Habitat

Critical habitat was proposed for Sheepnose on December 13, 2024. In the northeast, critical habitat units were proposed in the Middle Allegheny-Tionesta, in Forest and Venango Counties, PA; Upper Clink River, in Russell, Scott, and Wise Counties, VA; and Powell River, in Lee County, VA.

Physical and biological features essential to the conservation of the sheepnose include 1) adequate flows or a hydrological regime necessary to maintain benthic habitats where the species is found and to maintain stream connectivity, 2) suitable substrates and connected instream habitats, characterized by geomorphologically stable stream channels and banks, 3) water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth and viability of all life stages, include appropriate levels of dissolved oxygen, salinity, and temperature, and 4) the presence and abundance of host fishes necessary for recruitment of the species (USFWS 2024b).

4.5.17 Snuffbox and CH

The snuffbox (*Epioblasma triquetra*) is usually found in small- to medium-sized creeks, inhabiting areas with a swift current, although it is also found in Lake Erie and some larger rivers. Adults often burrow deep in sand, gravel, or cobble substrates, except when they are spawning or the females are attempting to attract host fish, including log perch (*Percina caprodes*) and darter and sculpin species. They are suspension feeders, typically feeding on algae, bacteria, detritus, microscopic animals, and dissolved organic material.

Snuffbox was listed as endangered in 2012. Snuffbox was historically known from 211 streams and lakes in 18 states and Canada (USFWS 2018c). The current distribution has been reduced to only 84 streams in 14 states (Alabama, Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin) and Ontario, Canada (USFWS 2018c). Currently there are 7 stronghold populations, 24 significant populations, and 51 marginal populations of snuffbox. Most populations are small and geographically isolated from one another, further increasing their risk of extinction.

Habitat loss and degradation continues to be one of the major threats to snuffbox (USFWS 2018c). Water quality degradation from point and non-point sources including agricultural runoff, municipal effluents, industrial sources, and spills continue to contribute sediment, organic compounds, heavy metals, pesticides, and a wide variety of newly emerging contaminants to the aquatic environment. Other factors contributing to the reduction in range include dredging and channelization, oil and gas production (including water withdrawal), sand and gravel mining, and development. Exotic species, including the zebra mussel, Asian clam, round goby, and black carp, threaten the snuffbox, or its host fish, or both, through mechanisms such as habitat modification, competition, and predation (USFWS 2018c).

Snuffbox was listed as endangered under the ESA on March 15, 2012.

Critical Habitat

Critical habitat was proposed for snuffbox on December 13, 2024. In the northeast, critical habitat units for snuffbox were proposed in the Allegheny River, in Venango County, PA; French Creek, in Crawford, Erie, Lebanon, Mercer, and Venango Counties, PA; Shenango River, Crawford and Mercer Counties, PA; West Fork River, in Harrison and Lewis Counties, WV; Middle Island Creek, in Doddridge, Tyler, and Pleasants Counties, WV; Little Kanawha River, in Braxton, Calhoun, Gilmer, Ritchie, Wirt, and Wood Counties, WV; and the Kanawha River, in Braxton, Clay, and Kanawha Counties, WV (USFWS 2024b).

Physical and biological features essential to the conservation of the snuffbox include 1) adequate flows or a hydrological regime necessary to maintain benthic habitats where the species is found and to maintain stream connectivity, 2) suitable substrates and connected instream habitats, characterized by geomorphologically stable stream channels and banks, 3) water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth and viability of all life stages, include appropriate levels of dissolved oxygen, salinity, and temperature, and 4) the presence and abundance of host fishes necessary for recruitment of the species (USFWS 2024b).

4.5.18 Spectaclecase and CH

As a group, mussels are long-lived, with individuals surviving up to several decades, and sometimes up to 100 to 200 years. The oldest documented spectaclecase (*Cumberlandia monodonta*) was thought to be 70 years old.

Spectaclecase mussels are found in large rivers where they live in areas sheltered from the main force of the river current. It occurs in substrate from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current (Baird 2000, Buchanan 1980, Parmalee and Bogan 1998). This species often clusters in firm mud and in sheltered areas, such as beneath rock slabs, between boulders and even under tree roots. Spectaclecase occurrences tend to be aggregated, particularly under slab boulders or bedrock shelves (Baird 2000, Buchanan 1980, Parmalee and Bogan 1998, Gordon and Layzer 1989), where they are protected from the current. Unlike most species that move about to some degree, the spectaclecase may seldom if ever more except to burrow deeper and may die from stranding during droughts (Oesch 1984). Adult spectaclecase are suspension-feeders, siphoning water and feeding on suspended algae, bacteria, detritus, microscopic animals and dissolved organic material. Adult mussels spend their entire lives partially or completely buried within river bottom substrates.

Historically, the spectaclecase was found in at least 44 streams of the Mississippi, Ohio and Missouri River basins in 14 states. It has been extirpated from 3 states and today is found in only 20 streams. The spectaclecase current range includes Alabama, Arkansas, Illinois, Iowa, Kentucky, Minnesota, Missouri, Tennessee, Virginia, West Virginia, and Wisconsin. With few exceptions, spectaclecase populations are fragmented and restricted to short stream reaches.

Population losses due to dams have contributed more to the decline and potential extinction of the spectaclecase than any other factor. Dams affect both upstream and downstream populations by disrupting seasonal flow patterns, scouring river bottoms, changing water temperatures and eliminating river habitat. Large rivers throughout nearly all of the spectaclecase mussel's range have been dammed, leaving short, isolated patches of habitat between dams. Spectaclecase mussels depend on a fish species, individuals of either mooneye (*Hiodon tergisus*) or goldeye (*H. alosoides*), to move upstream (USFWS 2024b). Because dams block fish passage, mussels are also prevented from moving upstream. This isolates upstream populations from those downstream, leading to small, unstable populations, which are more likely to die out.

Most remaining populations of spectaclecase are small and geographically isolated. Small populations remaining in short sections of rivers are susceptible to extirpation from single catastrophic events, such as a toxic spill. Also, this level of isolation makes natural repopulation of areas that once supported mussels impossible without human intervention.

Poor land use practices, dredging, intensive timber harvests, highway construction, and other activities accelerate erosion and increase sedimentation. Sediment that blankets a river bottom can suffocate mussels since they cannot move to avoid the impact. Also, large amounts of sediment in the water column reduce the ability of mussels to remove food and oxygen, which can lead to reduced growth, reproduction and survival.

Adult mussels are easily harmed by toxins and degraded water quality from pollution because they are sedentary (they tend to stay in one place). Pollution may come from specific, identifiable locations such as accidental spills, factory discharges, sewage treatment plants and landfills, or from diffuse sources like runoff from fields, feedlots, mines, construction sites and roads. Contaminants may directly kill mussels, but they may also indirectly harm spectaclecase by reducing water quality, affecting the ability of surviving mussels to reproduce and lowering the numbers of host fish.

Dredging and channelization have profoundly altered riverine habitats nationwide. Channelization physically changes streams by accelerating erosion, reducing depths, decreasing habitat diversity, destabilizing stream bottoms and removing riparian vegetation.

The invasion of the nonnative zebra mussel into the United States poses a serious threat to native mussels. Zebra mussels proliferate in such high numbers that they use up food resources. They attach to native mussel shells in such large numbers that the native mussel cannot open its shell to eat or breath.

Spectaclecase was listed as endangered under the ESA on April 12, 2012

Critical Habitat

Critical habitat was proposed for spectaclecase on December 13, 2024. In the northeast, critical habitat units for spectaclecase were proposed in the Kanawha River, Kanawha County, WV.

Physical and biological features essential to the conservation of the spectaclecase include 1) adequate flows or a hydrological regime necessary to maintain benthic habitats where the species is found and to maintain stream connectivity, 2) suitable substrates and connected instream habitats, characterized by geomorphologically stable stream channels and banks, 3) water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth and viability of all life stages, include appropriate levels of dissolved oxygen, salinity, and temperature, and 4) the presence and abundance of host fishes necessary for recruitment of the species (USFWS 2024b).

4.5.19 Tan Riffleshell

Tan riffleshell (*Epioblasma florentina walkeri (=E. walkeri*)) is a medium-sized species characterized by dull brownish-green or yellowish-green periostracum with numerous faint green rays evenly distributed over the valve surface (USFWS 1984b). It rarely exceeds 2.3 inches. Tan riffleshell has been recorded to live at least 12 years (Rogers et al. 2001). Extant populations of Tan riffleshell in the Clinch River occur in a substrate of coarse sand, gravel and some silt, in current and in less than three feet of water (Parmalee and Bogan 1998).

Tan riffleshell is a long-term brooder with spawning occurring in August and September (Rogers et al. 2001). Females become gravid by late fall or early winter and release glochidia principally in May and June. Host fishes identified through laboratory induced infections include greenside, fantail, redline, and Tennessee darters and sculpins. Similar species of *Epioblasma* have been shown to be host trappers, grasping darters with their valve edges and ejecting glochidia into their buccal cavity, resulting in infection gill tissues with glochidia. It is likely that tan riffleshell displaying females use a mantle lure that mimics small fish. Females will respond to touch by quickly closing their shells, capturing a host fish and infesting the fish with glochidia (Jones and Neves 2010).

Tan riffleshell can be found in the Tennessee River drainage and the Cumberland River. The tan riffleshell was rediscovered in the upper Cumberland River drainage in Big South Fork, Kentucky and

Tennessee (USFWS 2021e). Additional upper Tennessee River drainage populations include Hiwassee River, TN and Indian Creek/Clinch River, VA, in 1995–1996 (Winston and Neves 1997). The study conducted by Jones et al. (2006) showed that the population of *Epioblasma florentina walkeri* in Indian Creek, VA, a tributary to the upper Clinch River, was distinct from the population in the Big South Fork Cumberland River, TN and KY (Jones and Neves 2010). The Big South Fork population is recruiting and viable but limited to a 12-mile reach of stream. It now represents the best population of the species rangewide (USFWS 2021e). In Indian Creek/Clinch River, the Clinch River component of the population was lost due to a catastrophic chemical spill in 1998, resulting to the current restriction of the tan riffleshell to less than two miles of lowermost Indian Creek (Jones et al. 2001). The species was recruiting to some degree up to a decade ago, but its current status appears to be in decline. The Indian Creek population is much smaller than its counterpart in Big South Fork (Rogers et al. 2001; USFWS 2021e). Several surveys over the past decade have failed to detect evidence for an extant population in Hiwassee River leading experts to consider this population to be extirpated. Big South Fork and Indian Creek appear to be the only streams where tan riffleshell populations are currently extant.

The upper Clinch River, upper North Fork and South Fork Holston Rivers, Copper Creek in the Tennessee River drainage in Virginia may serve as possible reintroduction streams for this species.

Tan riffleshell was listed as endangered under the ESA on September 26, 1977.

4.5.20 Yellow Lance and CH

The yellow lance (*Elliptio lanceolata*) is a sand-loving species often found buried deep in clean, coarse to medium sand, although it can sometimes be found in gravel substrates. Yellow lance are often moved with shifting sand and eventually settle in sand at the downstream end of stable sand and gravel bars. This species depends on clean, moderate flowing water with high dissolved oxygen and is found in medium-sized rivers to smaller streams. The yellow lance is an omnivore that primarily filter feeds on a wide variety of microscopic particulate matter suspended in the water column, including phytoplankton, zooplankton, bacteria, detritus, and dissolved organic matter (Haag 2012). Juveniles likely use their feet to feed in the sediment, whereas adults filter-feed from the water column.

The yellow lance has a historical range from the Patuxent River Basin in Maryland to the Neuse River Basin in North Carolina and has been documented from multiple physiographic provinces, from the foothills of the Appalachian Mountains through the Piedmont and into the Coastal Plain, from small streams to large rivers. The Yellow Lance SSA Report (USFWS 2019e) delineates populations by using the eight river basins that Yellow Lance has historically occupied. This includes the Patuxent, Potomac, Rappahannock, York, James, Chowan, Tar, and Neuse River basins in Maryland, Virginia, and North Carolina. Because the river basin level is at a very coarse scale, populations were further delineated using management units (MUs). MUs were defined as one or more HUC10 watersheds that species experts identified as most appropriate for assessing population-level resiliency. Of eight historical populations, six are known to have had a yellow lance occurrence in the last 10 years, though the majority of those occurrences were limited to a single location within the river basin. For more detailed information regarding the current condition of yellow lance populations across its range, see USFWS (2019e) and the listing documents (83 FR 14189-14198).

The breeding, feeding, and sheltering needs of yellow lance include successful host fish infestation and dispersal, adequate food delivery, and suitable stable habitat. All of these needs are influenced by water quality, water quantity, suitable in-stream substrate, and habitat connectivity. For additional detailed information, see USFWS (2019e).

Yellow lance was listed as threatened under the ESA on May 3, 2018.

Critical Habitat

Critical habitat for yellow lance was designated on May 10, 2021.

Critical habitat includes approximately 319 river mi (514 km) in 11 units in North Carolina, Virginia, and Maryland. In the northeast, critical habitat units were designated in the Patuxent River and Hawlings River, Montgomery and Howard Counties, MD; Rappahannock Subbasin, Hungry Run, Thumb Run, South Run/Carter Run, Great Run and Rappahannock River, Fauquier and Culpeper Counties, VA; Rapidan Subbasin, Marsh Run, Blue Run, and Rapidan River in Madison and Orange Counties, VA; York Population, South Anna River, Louisa County, VA; Johns Creek, Craig County, VA; Nottoway Subbasin, Crooked Creek, Sturgeon Creek and Nottoway River, Nottoway, Lunenburg, Brunswick and Dinwiddie Counties, VA.

We have determined that the following physical or biological features are essential to yellow lance conservation: (1) Suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (i.e., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussels and native fish (such as stable riffle-run-pool habitats that provide flow refuges consisting of silt-free gravel and coarse sand substrates). (2) Adequate flows, or a hydrologic flow regime (which includes the severity, frequency, duration, and seasonality of discharge over time), necessary to maintain benthic habitats where the species is found and to maintain connectivity of streams with the floodplain, allowing the exchange of nutrients and sediment for maintenance of the mussel and fish host's habitat, food availability, spawning habitat for native fishes, and the ability of newly transformed juveniles to settle and become established in their habitats. (3) Water and sediment quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages. (4) The presence and abundance of fish hosts necessary for yellow lance recruitment.

4.6 *INSECTS*

4.6.1 Bog Buck Moth

The bog buck moth (*Hemileuca maia menyanthevora (=H. iroquois)*) is a fairly large-bodied, day-flying moth limited in occurrence to a few locations near Lake Ontario in New York and in Ontario, Canada (USFWS 2020c). The bog buck moth is a silk moth (family = Saturniidae) in the buck moth genus. Their life cycle is similar to other *Hemileuca* species and generally completed within 1 year. Nonfeeding adults emerge in the fall. After mating, female buck moths lay one large cluster of eggs on sturdy stems of a variety of plant species. The eggs overwinter until the following spring when they hatch into larvae that initially rely primarily on the host plant *Menyanthes trifoliata* (commonly referred to as bogbean, bog buckbean, or buckbean) for food and shelter. Larvae burrow into the peat mat or leaf litter to pupate (Pryor 1998, Stanton 2000) by mid-July and the pupal stage lasts about 2 months. They do not enclose themselves in cocoons but may spin a loose silk web to pull leaf matter around themselves (Stanton 1998). While not specifically documented for bog buck moth, in other *Hemileuca* species, individual pupae may remain dormant until the following fall or possibly the fall after that (Cryan and Dirig 1977, Tuskes et al. 1996).

Adults are diurnal (fly during the day) avoiding cooler fall night temperatures (Tuskes et al. 1996, Pryor 1998). Bog buck moths fly when temperatures are generally above 68 degrees Fahrenheit (F) and when winds are less than 15 miles per hour (Stanton 1998). Pryor (1998) observed no flights when temperatures were below 53.6 degrees F, during rainstorms, or during high winds. Flights may occur throughout the day with peak male flights concentrated between 11 a.m. and 2 p.m. and some female flights after that (Pryor 1998). Males and females differ in flight patterns with males flying large, circular paths and females making short, direct, frequent flights (Pryor 1998). Adult males fly for longer periods as well, covering the open area of the fen for approximately 10 minutes compared to females flying short distances lasting a matter of seconds (Pryor 1998). Mate-finding is apparently based on pheromones rather than visual cues (Pryor 1998). Adult males typically fly 3.3 feet (ft) above the ground (Pryor 1998) searching for females. Females remain hidden and emit attractant pheromones luring males to their location (Pryor 1998, Stanton 2000).

The bog buck moth is restricted to open, calcareous, low shrub fens containing large amounts of buckbean. The sites in New York are considered medium fens. Medium fens are fed by waters that are moderately mineralized with pH values generally ranging from 4.5 to 6.5. The buckbean is intolerant of shade and is not found under shrubs. In addition to requiring buckbean and supplemental host plants for larval feeding, the species also requires plants with sturdy upright stems for oviposition.

The primary threats to bog buck moth include reduced habitat availability and flooding, combined with natural boom and bust cycles. There is one known extant population of bog buck moth in New York, with two known populations in Canada.

Bog buck moth was listed as endangered on April 14, 2023.

4.6.2 Karner Blue Butterfly

The Karner blue butterfly (*Lycaeides melissa samuelis*) was historically associated with native barrens and savanna ecosystems, but is now found in remnant barrens, savannas, highway and utility rights-of-way, gaps within forest stands, young forest stands, trails, and military camps that occur on the landscapes previously occupied by native prairie and savannas. The larvae are dependent upon wild lupine (*Lupinus perennis*), the only known larval food source, while wild adults use a variety of forbs for nectar.

The butterfly is most widespread in Wisconsin, but is also found in portions of Indiana, Michigan, Minnesota, New Hampshire, New York, and Ohio. The species is likely extirpated from the Minnesota; however, restoration efforts continue at Whitewater Wildlife Management Area and St. Croix State Park, where lupine and suitable nectar plants have been observed, but there are currently no records of KBBs. Swengel and Swengel (2018) compared survey trends on Wisconsin sites over 17 years for the KBB and reported declining trends.

Habitat throughout the range of the Karner blue butterfly has been lost because of land development and lack of natural disturbance, primarily wildfire. Such disturbance helps maintain the butterfly's habitat by setting back encroaching forests and encouraging lupine and flowering plant growth. Additionally, the Karner blue butterfly's rarity and beauty make it a desirable addition to butterfly collections. Because butterfly numbers are so low, the collection of even a few individuals could harm the species' populations.

Karner blue Butterfly was listed as endangered under the ESA on December 14, 1992.

4.6.3 Northeastern Beach Tiger Beetle

The northeastern beach tiger beetle (*Habroscelimorpha dorsalis dorsalis*) can be recognized by its distinct coloring. It has a bronze-green head and thorax, with white or tan elytra (hardened forewings) often covered with several gray-green lines. Northeastern beach tiger beetles live their entire life on the beach, they are typically found on long, wide beaches that have little human activity, and prefer medium to medium-coarse sand for larval burrows. Adult Northeastern beach tiger beetles are active, diurnal surface predators. They forage along the water's edge on small amphipods, flies, and other beach arthropods, or scavenge on dead amphipods, crabs, and fish (Knisley 1987a, USFWS 1994b). Most foraging occurs in the damp sand of the intertidal zone and scavenging has been observed to occur more often than predation (Knisley 1987a). Adult Northeastern beach tiger beetles are present on beaches from early June through early September and spend most of the day along the water's edge (Knisley 1987a). Adults are active on warm, sunny days when they can be seen feeding, mating, or basking (USFWS 1994b). They are less active on rainy, cool, or cloudy days because they cannot maintain their body temperature. They rely on a variety of behaviors, such as foraging and basking, to maintain their high body temperatures (Knisley et al. 1987a).

Adults mate and lay eggs on the beach during the summer (starting in June and ending by mid-July). Eggs are deposited near the sand surface or in shallow pits excavated by adults, usually within 1 inch of the beach surface (Knisley 1997). Females are believed to lay eggs at night in shallow burrows in the mid- to high tide zone of the coast. The eggs hatch in 10-14 days, depending on soil moisture, and spend the following 1-2 years of their larval life cycle in vertical burrows in damp sand. Northeastern beach tiger beetle larvae pass through three developmental stages (instars) over 2 years, over- wintering twice as larvae, pupating at the bottom of their burrows, and emerging as winged adults during their third summer (USFWS 1994b). Due to the length of the larval life cycle, individuals from different larval stages may occur on the same site at the same time.

Larvae remain active into November and hibernate in winter. Larvae have been observed to temporary emerge from the burrows and reburrow in new locations. They can travel across the beach quickly in a cartwheeling locomotion behavior, where the larvae attach from head to foot in a circle and are moved around by the wind. The larval life cycle can take up to two years to complete; therefore, larvae are present on the beach all year around with individual animals continually present for up to two years. First emergence of adults ranged from May 30 - June 13 in Virginia. Rainfall appears to enhance emergence since numbers of adults usually increase after a rainfall. The number of adult tiger beetles increases rapidly in June, peaks in mid-July, begins to decline through August, and few adults can be found in September. Larvae are sedentary ambush predators, feeding on prey that happens to pass by their burrows.

The northeastern beach tiger beetle is an indicator of a healthy beach community, as are other rare beach—dwellers such as the piping plover (*Charadrius melodus*) and seabeach amaranth (*Amaranthus pumilis*). The presence or absence of such rare, habitat—specific organisms can often help differentiate a healthy wild beach from degraded beach conditions. The beach ecosystem conducive to Northeastern beach tiger beetle survival is undisturbed by heavy human use, highly dynamic, and subject to natural erosion and accretion processes. This type of beach habitat, along with its associated species, has been seriously reduced along much of the Atlantic and Gulf coasts of the United States, and particularly so in the Northeast as a result of intense coastal development, shoreline stabilization, recreational use, and possibly other causes, such as sea level rise and coastal storms.

Northeastern beach tiger beetle has a coastal distribution along the Atlantic Coast from Cape Cod south to central New Jersey and along both shores of the Chesapeake Bay in Maryland and Virginia. Northeastern beach tiger beetle habitat in the northern portion of the range (MA through NJ) is located on beaches exposed to the Atlantic Ocean, which results in higher wave action. The degree of tidal flux and storm activity is much greater along Atlantic Coast beaches than within the Chesapeake Bay. The more dynamic coastal beaches, often exposed to direct ocean waves, change in profile and position annually in response to violent winter storms and summer conditions. In MA, the larvae move 20 – 50 m up the beach to overwinter on higher ground. This migration has apparently evolved as an adaptive behavior to avoid being washed out to sea during winter months (USFWS 1994b). Northeastern beach tiger beetle populations in MA are exposed to cooler, windier weather, which may impact beetle activity and behavior. On warm, calm evenings during peak summer activity in Maryland, well over 50% of the adult population seen during the day may also be nocturnally active. At Martha's Vineyard, a maximum of only about 25% of the adults have been observed at night, as compared with the Chesapeake Bay area (USFWS 1994b).

Larval beetles occur in a relatively narrow band of the upper intertidal to high drift zone, where they can be regularly inundated by high tides. Larvae typically occur in an area of beach 26 to 39 feet wide within and above the intertidal zone. However, the area where larvae occur may be wider in areas of washover or where the upper beach is flat and is periodically inundated by high tides (USFWS 1994b). Larvae can survive flooding for 3 to 6 days but lack a hard cuticle and are susceptible to desiccation. They tend to become inactive during hot, dry conditions.

Northeastern beach tiger beetles inhabit wide, sandy, ocean beaches from the intertidal zone to the upper beach. Beetles are rarely found on beaches less than 6.5 feet in width (Drummond 2002). Beetles are typically found on highly dynamic beaches with back beach vegetation, and they prefer long, wide beaches that have low human and vehicular activity, fine sand particle size, and a high degree of exposure (Knisley 1987a). Drummond (2002) found a correlation between the extent of shallow water fronting the beach and the number of tiger beetles present (the more sand bars, the more beetles). Adults tend to be concentrated in wider sections of beach and occur in smaller numbers or may even be absent from nearby areas of narrow beach (USFWS 1994b). A beetle with sedentary larvae is susceptible to wave impacts, and work by Rosen (1980) has shown that the greater the shallow zone fronting a beach, the lower the wave energy. Knisley (1997) found that larval densities were highly variable relative to sand particle size, and that larvae are rare at sites with greater than 60 percent coarse sand (100-size mesh sieve) (Knisley 1997). Drummond (2002) found that adults occupied beaches with 40 to 80 percent coarse sand. If the sand size is too coarse, too fine, or contains a high organic content, it appears unsuitable for the larvae to burrow and maintain a larval tube. Thermal and moisture microhabitat gradients are important for larvae (USFWS 1994b).

Northeastern beach tiger beetle was listed as threatened under the ESA on September 6, 1990.

4.6.4 Puritan Tiger Beetle

The Puritan tiger beetle (*Ellipsoptera puritana*) is a medium sized terrestrial beetle of the family Cicindelidae. Males average 0.45 inches and females average 0.5 inches in Calvert County, Maryland, along the Chesapeake Bay. Puritan tiger beetles are brownish bronze above with a metallic blue underside and narrow white lines on each wing. Along the Chesapeake Bay, adult Puritan tiger beetles are first seen in June and July when they emerge to feed and mate along the beach area. After mating the females move up onto the cliffs to deposit their eggs. Newly hatched larvae construct burrows in the cliffs and pass through 3 larval stages before metamorphosing in the adult form. It takes two years for the Puritan tiger beetle to complete its life cycle. Puritan tiger beetles in New England are found on sandy beaches along the Connecticut River.

Puritan tiger beetles typically undergo a two-year larval period before emergence. Larvae hatch in late July or August as first instars. This stage lasts 2—4 weeks; larvae then molt and become second instars. Larvae generally over—winter as second instars and become active again (as evidenced by open burrows) the following spring, when they molt to the third instar. Recent observations indicate that the third instar may last another year, but further studies are required to substantiate this finding. Larvae tend to be most active (as evidenced by open burrows) in the fall, with lesser numbers appearing in the spring and summer. Pupation occurs in late spring, and in Maryland adults emerge during mid- to late-June (Hill and Knisley 1991). The timing of adult emergence is 2-3 weeks later in the Connecticut River populations. The adult populations peak in late June to early July and begin to decline in late July. Population size then decreases rapidly until the middle of August, when only a few adults remain. A sympatric species, *Cicindela repanda*, exhibits an opposite seasonality, with adults emerging during the spring and fall, and larval activity occurring mostly during the summer months, although there is some interspecific overlap of both adults and larvae (USFWS 1993b).

Adult Puritan tiger beetles are active both day and night. Adults feed throughout the day, and mating activities are commonly observed during the afternoon. Pairing activity increases in late afternoon and seems to peak in the early evening. Larvae are active (as evidenced by open burrows) day and night during cool weather in late spring and early fall (USFWS 1993b).

Knowledge of adult and larval feeding behavior is also limited. The larvae firmly position themselves at the mouths of their burrows by means of abdominal hooks and wait for small invertebrates to pass by. Adults feed actively in the wrack along the shoreline and probably also to some extent on the bluff face. Smaller invertebrates probably comprise the bulk of their diet (USFWS 1993b).

The Puritan tiger beetle is found in shoreline habitat along the Connecticut River in New England and the Chesapeake Bay in Maryland. The species has disappeared from a large part of its range in New England, and the Chesapeake Bay populations appear to be highly susceptible to habitat loss and degradation. The Puritan tiger beetle populations in these two regions have probably been separated for thousands of years and have developed significant genetic and ecological differences.

The Chesapeake Bay contains only two metapopulations along its shorelines, one on the western shore and one on the eastern shore. In Maryland, the Puritan tiger beetle has very specific habitat requirements. The larvae occupy only naturally eroding cliffs, where they live in deep burrows after digging in sandy deposits on non-vegetated portions of the bluff face or at the base of the cliffs. They are most abundant at sites where the bluffs are long and high with little or no vegetation and composed in part of yellow or red sandy soil. Erosion results in the loss of some larval beetles but is necessary to maintain the bare bluff faces they require. Knisley (1987b) and Hill and Knisley (1991) have found Chesapeake Bay populations to be most abundant where bluffs are long and high, with little or no vegetation, and composed at least in part of yellow or red sandy soil. Wave—producing storms and concomitant erosion of bluffs are necessary to maintain the bare bluff faces required for larval habitat. Larvae will not utilize densely vegetated bluffs; for instance, Hill and Knisley (1991) found that no tiger beetle larvae or adults occupied bluffs stabilized by kudzu at Calvert Beach, Maryland, although both *E. puritana* and *C. repanda* were numerous on adjacent natural bluffs.

Only a few small populations, comprising a single metapopulation (a group of spatially separated subpopulations of the same species which interact at some level) of Puritan tiger beetles remain in New

England; one along the Connecticut River, near Hadley, Massachusetts and the others near Cromwell, Connecticut. Because of dam-building and modifications of the Connecticut River, only a remnant of the once extensive Puritan tiger beetle populations remains there. In New England, Puritan tiger beetle distribution follows the sand and clay deposits formed by glacial lakes during the last ice age. Larvae at the two extant populations on the Connecticut River generally do not use the low bluffs; instead, their burrows are found among scattered herbaceous vegetation at the upper portions of sandy beaches and occasionally near the water's edge. At the lower Connecticut River site, the larvae are thus subject to tidal flooding twice daily. It is not known whether the differences in habitat preference are inherent or have resulted from recent habitat changes. However, recent observation indicates the potential for some flexibility in larval behavior.

Adult Puritan tiger beetles also exhibit some flexibility in habitat preference. Adult beetles often use wide, sandy beaches, but have also been found on narrow beaches below sandy clay banks. Both of the Connecticut River sites occur on sediment deposits along large river bends. Apparently, the composition of the sediment deposits (perhaps in combination with the dynamic river flow at these sites) provides a suitable substrate for larval burrows.

Puritan tiger beetle was listed as threatened under the ESA on September 6, 1990.

4.6.5 Rusty Patched Bumble Bee

The rusty patched bumble bee (*Bombus affinis*) is a social species with an annual cycle that starts in early spring when colonies are initiated by solitary queens emerging from overwintering sites, progresses with the production of workers throughout the summer, and ends with the production of males and new queens in late summer and early fall. Survival and successful recruitment require food from floral resources from early spring through fall, undisturbed nesting habitat in proximity to foraging resources, and overwintering habitat for the next year's queens.

Rusty patched bumble bees have been observed in a variety of habitats, including prairies, woodlands, marshes, agricultural landscapes, and residential parks and gardens (Colla and Packer 2008; Colla and Dumesh 2010; USFWS unpublished geodatabase 2016). The rusty patched bumble bee requires areas that support sufficient food (nectar and pollen from diverse and abundant flowers), undisturbed nesting sites in proximity to floral resources, and overwintering sites for hibernating queens (Goulson et al. 2015; Potts et al. 2010).

Rusty patched bumble bee habitat can be divided conceptually into nesting and wintering and foraging habitat types based on relative timing of pollen and nectar availability. The locations of pollen and nectar sources for the rusty patched bumble bee may vary throughout the growing season.

We assume that the rusty patched bumble bee nests in upland grasslands and shrublands that contain forage during the summer and fall and as far as 30 meters into the edges of forest and woodland. Lanternman et al. (2019) summarized 451 observations of nest-searching behavior by queens of nine bumble bee species. Although the rusty patched bumble bee was not among the nine species observed, their observations may shed some light on how the species searches for nest sites. The authors observed queens searching for nesting sites in open grassland habitats, but nest-seeking queens favored woody transitional habitats over open habitats (Lanternman et al. 2019).

Rusty patched bumble bee nests are typically one to four feet underground in abandoned rodent nests or other mammal burrows and occasionally at the soil surface or aboveground (Plath 1922, Macfarlane 1994). Among the 43 rusty patched bumble bee nest records cited by Macfarlane (1994), 95% were underground. Queens may locate abandoned rodent burrows by using olfactory or chemical cues (Lanternman et al. 2019).

Little is known about the overwintering habitats of rusty patched bumble bee queens but based on observations of other species we assume that rusty patched bumble bee queens overwinter in upland forest and woodlands. Other species of Bombus typically form a chamber in loose, soft soil, a few centimeters deep in bare earth, moss, under tree litter, or in bare patches within short grass" and may avoid areas with dense vegetation (Liczner and Colla 2019). Overwintering habitat preferences may be species-specific and dependent on factors such as slope orientation and timing of emergence. Most queens in England were found in well-drained soil, shaded from direct sunlight in banks or under trees, and free from living ground vegetation (Alford 1969). A recent review of published literature shows that overwintering queens have been found mostly in shaded areas, usually near trees and in banks without dense vegetation (Liczner and Colla 2019). The only known documented overwintering rusty patched bumble bee queen, discovered in a maple oak-woodland (about 550 yards into the woodlands) in Wisconsin in 2016, was found under about an inch of leaf litter and loose soil (USFWS 2016b).

Historically, the rusty patched bumble bee was broadly distributed across the eastern United States and upper Midwest, from Maine in the United States and southern Quebec and Ontario in Canada, south to the northeast corner of Georgia, reaching west to the eastern edges of North and South Dakota (USFWS 2016b). The species is extant in Wisconsin and Minnesota. The USFWS has also developed maps that indicate where we consider the species to be extant.

Prior to its listing, the species experienced a widespread and steep decline. The exact cause of the decline is unknown, but evidence suggests a synergistic interaction between an introduced pathogen and exposure to pesticides (specifically, insecticides and fungicides; USFWS 2016b). The remaining populations are exposed to several interacting stressors, including pathogens, pesticides, habitat loss and degradation, non-native and managed bees, the effects of climate change, and small population biology (USFWS 2016b). These stressors likely operate independently and synergistically. For example, dietary stress due to insufficient floral resources may reduce an individual's resiliency to pathogens and pesticides, exposure to insecticides can reduce resistance to disease, and exposure to fungicides can increase insecticide toxicity (USFWS 2016b).

Rusty patched bumble bee was listed as federally endangered under the ESA on March 21, 2017.

4.7 *MAMMALS*

4.7.1 Canada Lynx and CH

Canada lynx (*Lynx canadensis*) and snowshoe hares are strongly associated with moist, cool, boreal spruce-fir forests. Landscapes with high snowshoe hare densities are optimal for lynx survival and reproduction, and research suggests that hare densities consistently at or above 0.5 hares per hectare (0.2 hares/acre) are needed to support persistent lynx populations. Hares are most abundant in young regenerating or mature multistoried forests with dense understory vegetation that provides food and cover. In the northern contiguous U.S., boreal forests become naturally patchy and marginal for lynx as they transition to temperate forest types that support lower hare densities. Such forests cannot support lynx populations, even though snowshoe hares may still be present. Snow also influences lynx distribution, and populations typically occur where continuous snow cover lasts four months or longer. Such areas are believed to provide lynx with a seasonal competitive advantage over other terrestrial hare predators like bobcats and coyotes.

Lynx are broadly distributed across most of Canada and Alaska, which combined encompass about 98% of the species breeding range. The contiguous U.S. distinct population segment (DPS) accounts for the other two percent, and includes resident breeding populations in northern Maine, northeastern Minnesota, northwestern Montana/northern Idaho, and north-central Washington. An introduced population also occurs in western Colorado, and several other areas may have historically supported small resident populations (e.g., northern New Hampshire, Isle Royale, Michigan, northeastern Washington, and the Greater Yellowstone area of southwestern Montana and northwestern Wyoming). Lynx also have occurred temporarily in many other states, typically during irruptions (mass dispersal events) from Canada, when northern hare populations underwent dramatic cyclic declines roughly every 10 years. The Contiguous U.S. DPS of lynx was listed as threatened in 2000 because regulations on some Federal lands at that time were inadequate to ensure the conservation of lynx populations and habitats.

In the Northeast, lynx are found in the boreal forests of northern Maine, and New Hampshire. Currently, northern Maine is thought to support many more resident lynx than likely occurred historically and many more than was known or suspected at the time the DPS was listed, and recent information suggests that resident lynx may be expanding to the south of the core population area. This is due to the large amount and broad distribution of high-quality lynx and hare habitat that currently exists as a result of landscape-level clearcutting on private commercial timber lands in response to a major spruce budworm (*Choristoneura fumiferana*) outbreak in the 1970s and 1980s. These dense regenerating conifer stands are much more extensive than they are thought to have been historically under natural disturbance regimes. The State of Maine suggests that this unit currently may support 750-1,000 or more resident lynx (USFWS 2017). This geographic unit also may be the source of dispersing lynx that recently recolonized northern New Hampshire as well as several that temporarily established residency in northern Vermont. Some reproduction has been verified recently in both states, although neither was occupied when the DPS was listed, and resident lynx were thought to have been extirpated from New Hampshire.

Canada Lynx was listed as threatened under the ESA on April 24, 2000.

Critical Habitat

The Service designated CH for Canada lynx on September 12, 2014, consisting of 38,954 mi^2 of critical habitat in five units in the states of Idaho, Maine, Minnesota, Montana, Washington, and Wyoming.

4.7.2 Gray Bat

The gray bat (*Myotis grisescens*) is a medium-sized species with a forearm length of 1.5 to 1.8 inches and a wingspan approximately 10 to 11 inches that weighs 0.24 to 0.56 ounces. The gray bat can be distinguished from other *Myotis* spp. by the uniform color of its dorsal fur, in which hair shafts are gray from base to tip; dark ears that are usually black and longer than in any other *Myotis* spp.; a wing membrane that attaches at the ankle of the foot instead of at the base of the toes; and a notch in the claws of its hind feet (USFWS 1982, USFWS 2009b).

Breeding begins in the fall when the male gray bats arrive at hibernacula. Females enter hibernation first, immediately following copulation (typically in September or October). They do not become pregnant until emergence from hibernation in late March or early April. Males may remain active until mid-November before entering hibernation (USFWS 1982, USFWS 2009b).

In late May or early June pregnant females give birth to a single pup that is capable of flight within 20 to 25 days. Newborn young weigh approximately one-third of their mother's weight. In summer, female gray bats form maternity colonies of a few hundred to many thousands of individuals. Nursery colonies typically form on domed ceilings of caves that are capable of trapping the combined body heat from clustered individuals and where the temperature ranges between 57- and 77-degrees Fahrenheit (°F) (USFWS 2009b). Females typically do not give birth until their second year of growth (USFWS 1982, USFWS 2009b). The maximum life span of this species is approximately 14 to 15 years.

Gray bats emerge at night to forage in forested areas along banks of streams and lakes; they are highly dependent on aquatic insects, especially mayflies, caddisflies, stoneflies beetles, and moths (USFWS 2009b). With rare exceptions, gray bats live in caves year-round. In winter, gray bats hibernate in deep vertical caves that trap large volumes of cold air. The species typically forms large clusters with some in the hundreds of thousands of individuals. The caves the species chooses as hibernacula often have multiple entrances, good air flow, and temperatures of approximately 41 to 48 °F (USFWS 2009b).

In the summer, gray bats roost in limestone karst caves scattered along rivers. Foraging areas are strongly correlated with the open water of rivers, streams, lakes, or reservoirs. Gray bats have been documented living in bridges and culverts as well as using them for maternity roosts (Keeley and Tuttle 1999). Although the species might travel up to 21 miles between prime feeding areas over lakes or rivers, most maternity colonies are usually located 0.6 to 2.5 miles from foraging locations. Newly volant gray bats travel up to 4 miles between roost caves and foraging areas. Gray bats generally return to the same summering and wintering sites; however, males and yearling females seem less restricted to specific cave and roost locations (USFWS 1982, 2009b). Transportation projects that include bridges and culverts could be suitable roosting habitat.

Gray bat can be found throughout 15 states in the central and eastern United States. Habitat destruction, modification, or curtailment of its habitat or range are the primary causes of the decline of the species. Anthropogenic disturbances also include cave flooding and commercial gates. However, white-nose syndrome, which is caused by the fungus *Pseudogymnoascus destructans* has greatly impacted populations in the Northeast United State and continues to be detected east of the Mississippi River.

Gray bat was listed as endangered under the ESA on May 4, 1976.

4.7.3 Indiana Bat and CH

The Indiana bat is a medium-sized species that has dull grayish chestnut fur; the basal portion of the hair on the back is a dull-lead color. The bat's underparts are pinkish to cinnamon, and its hind feet are small and delicate. The calcar (heel of the foot) is strongly keeled.

The Indiana bat is a migratory species that hibernates colonially in caves and abandoned mines in the winter, then migrates to wooded areas (roost sites) in the spring to bear and raise its young over the summer. While specific dates may vary by latitude or elevation, hibernation is typically from October through March or April. Indiana bats generally mate during fall before they enter caves to hibernate, but mating can also occur in winter. The non-hibernation season includes the rest of the year during which spring emergence, migration, maternity season (i.e., colony formation, pregnancy, pup-rearing), and fall swarming occur. In spring, reproductive females migrate and form maternity colonies in wooded areas where they bear and raise their young.

Indiana bats typically forage in semi-open to closed forested habitats (open understory), forest edges, and riparian areas. They are "selective opportunist" feeders, eating most flying insects, including beetles, flies, and moths, and caddisflies.

Suitable summer habitat for Indiana bats generally consists of a wide variety of forested/wooded habitats where they can roost, forage, and travel, including riparian zones, bottomland and floodplain areas, wooded wetlands, and upland communities. This includes forests and woodlots that contain potential roosts—live trees and/or snags greater than 5 inches diameter breast height that have exfoliating bark, cracks, crevices, and/or hollows—as well as linear features such as fencerows, riparian forests, and other wooded corridors. It also might include adjacent and interspersed non-forested areas such as emergent wetlands, adjacent edges of agricultural fields, old fields, and pastures. The wooded areas preferred by the Indiana bat can be dense or loose aggregates of trees with variable amounts of canopy closure. Please refer to the Rangewide Indiana bat survey guidelines for further description of suitable habitat.

Indiana bats hibernate during the winter in caves or mines. For hibernation, they require cool, humid caves or mines with stable temperatures under 50 degrees Fahrenheit but above freezing (USFWS 2007b).

Winter disturbance and habitat modification were the primary causes of the decline of the Indiana bat (USFWS 2007b). However, the disease white-nose syndrome, which is caused by the fungus *Pseudogymnoascus destructans*, is currently considered the most significant threat to many populations.

Indiana bat was listed as endangered under the ESA on March 11, 1967.

Critical Habitat

On September 24, 1976, the USFWS designated critical habitat for the Indiana bat (41 FR 41914). Eleven caves and two mines in six states were listed as critical habitat including Hellhole Cave, in Pendleton County, West Virginia. For additional information on Indiana bat critical habitat, see the USFWS species profile for the Indiana bat at https://ecos.fws.gov/ecp/species/5949.

4.7.4 Virginia Big-eared Bat and CH

The Virginia big-eared bat (*Corynorhinus* (=*Plecotus*) *townsendii virginianus*) a sub-species of the Townsend's big-eared bat, of which two sub-species are listed (Virginia and Ozark), as well as three non-listed sub-species. Townsend's big-eared bat is a medium-sized species with large ears (more than 1 inch long) connected across the forehead, mitten-shaped glandular masses on the muzzle, and elongate nostril openings. The adults weigh from 0.18 to 0.45 ounces (USFWS 1984).

Townsend's big-eared bat has tan underparts and brown dorsal fur. The Ozark big-eared bat (*Corynorhinus townsendii ingens*) is the largest and reddest of the five subspecies. The Virginia big-eared bat is sootier dorsally than the Ozark big-eared bat and averages slightly smaller in all dimensions. The first upper incisor rarely has a trace of a secondary cusp, and the rostrum is less heavy and inflated (USFWS 1984)

Mating occurs in the fall, with the peak of copulation between November and February, and often occurs at or near the site of the hibernaculum. Spermatozoa are store in the reproductive tracts of females until spring, when ovulation, fertilization, and gestation occur. Gestation varies from 56 to 100 days, depending on spring temperatures and the varying amounts of torpor experienced by different individuals. Parturition occurs in late spring and early summer. Adult females form maternity colonies in warmer sections of certain caves and abandoned mines and show a high degree of site attachment. Most males are solitary, some may live in or visit caves occupied by maternity colonies (USFWS 1984).

In late May or early June pregnant females give birth to a single pup that is capable of flight within 2.5 to 3 weeks and are fully weaned by 6 weeks (USFWS 1984). Newborn young weigh nearly 25 percent of their mother's weight. Females typically do not give birth until their second year of growth (USFWS 1984). The maximum life span of this species is approximately 16 years (USFWS 1984).

Virginia big-eared bats are foraging specialists with lepidopterans (moths) making up greater than 80 percent of the prey (Lacki and Dodd 2011). Foraging areas are generally located within a few miles of roost sites and consist of a mix of primarily forested habitats interspersed with open fields/hay fields, cliff lines, rock shelters or outcrops, riparian areas, and water sources such as streams, ponds, and wetlands (USFWS 2019f).

The Virginia big-eared bat is a colonial species that congregates in groups in caves or cave-like habitats (e.g., abandoned mine portals, rock crevices) for roosting and raising young in the summer, breeding in the fall, and hibernating during the winter. The species may use different sites during these different seasons and can migrate up to 40 miles when moving between sites (USFWS 1984). Overwintering and roosting habitats are primarily underground features such as caves or abandoned coal or hard rock mines (Piaggio et al. 2009). Virginia big-eared bats inhabit caves during both summer and winter. These caves are typically located in karst regions dominated by oak-hickory or beech-maple-hemlock associations (Barbour and Davis 1969 cited in USFWS 1984). Virginia big-eared bats in West Virginia hibernate in portions of caves where temperatures are 12 degrees Celsius or less but above freezing (USFWS 1984). Virginia big-eared bats require a narrow range of microclimatic conditions (e.g., temperatures, humidity) (USFWS 1984). This makes protecting and maintaining suitable sites highly important to the recovery of the species. The species is acutely sensitive to disturbance within sites, and can have increased mortality, have reduced reproductive success, or abandon sites completely because of disturbance or alteration of its habitats (USFWS 1984). Transportation projects that include bridges and culverts could be suitable roosting habitat.

Virginia big-eared bat can be found throughout 5 states in the mid-Atlantic and south-eastern United States. The Virginia big-eared bat is vulnerable to human disturbance in hibernacula. This sensitivity and the species' concentration in a limited number of sites make it highly vulnerable to threats. The species is also threatened by the degradation and fragmentation of foraging areas, activities that could damage or degrade surface or subsurface areas of caves, barriers to migration and activities that reduce connectivity between roosting and foraging areas, as well as sources of direct mortality such as predation, roads, wind farms, and oil and brine pits (USFWS 2019f).

Virginia big-eared bat was listed as endangered on December 31, 1979

Critical Habitat

On November 30, 1979, the USFWS designated critical habitat for the Virginia big-eared bat (44 FR 69208). Five caves in West Virginia and one cave in Kentucky were listed as critical habitat.

4.8 *PLANTS*

4.8.1 American Chaffseed

American chaffseed (*Schwalbea americana*) is a monotypic perennial member of the figwort family, Scrophulariaceae, in the tribe Euphrasieae. American chaffseed is an erect herb with unbranched stems or stems branched only at the base, growing to a height of 12 to 24 inches. The plant is densely albeit minutely hairy throughout, including the flowers. The leaves are alternate, lance-shaped to elliptic, stalkless, 0.8 to 2 inches long, and entire; the upper leaves are reduced to narrow bracts. The large, purplish-yellow, tubular flowers, 1.2 to 1.4 inches are borne singly on short stalks in the axils of the uppermost, reduced leaves (bracts) and form a many flowered, spike-like raceme. The showy flowers have a high degree of bilateral symmetry elaborated for pollination by bees (USFWS 1995a). The fruit is a narrow capsule approximately 0.4 to 0.5 inches long, with a septicidal dehiscence. The numerous seeds are pale greenish brown or yellowish-tan, narrowly linear, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting, sac-like structure that provides the basis for the common name, chaffseed (USFWS 1995a). Flowering occurs from April to June in the southern part of the species' range, and from June to mid-July in the northern part of its range. Fruits mature from early summer in the South to October in the North (USFWS 1995a).

American chaffseed is primarily a coastal plain species of the Atlantic and Gulf coasts. The range of American chaffseed once included all the coastal States from Massachusetts to Louisiana, and the inland States of Kentucky and Tennessee. Exceptions to its coastal distribution, all of which are historical records, include: an occurrence in the sandplains near Albany, New York, which Pennell (1935) considered a possible remnant population of glacial migration along the shores of the Hudson River; occurrences from Tennessee and Kentucky on sandstone knobs and ridges of the Cumberland Plateau and Highland Rim; an inland site on the Montague sandplain near the Connecticut River; and a sandplain in Hubbardston, Massachusetts (USFWS 1995a). Although the range was widespread, the historical record shows that the species was always relatively rare and local in distribution. American chaffseed was listed due to extirpation of the species from over half its historical range and a decline in known occurrences (USFWS 1995a).

American chaffseed occurs in sandy (sandy peat, sandy loam), acidic, seasonally moist to dry soils. The species is generally found in habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (USFWS 1995a). American chaffseed appears to be shade intolerant and, therefore, occurs in areas maintained in an open to partially open condition. In New Jersey, American chaffseed occurs in open areas that have been maintained by mowing within a pitch pine (*Pinus rigida*) community. In Massachusetts, one population of American chaffseed occurs in an open area managed by fall mowing (USFWS 2019g).

As of the writing of the recovery plan (USFWS 1995a), 72 occurrences of this species were known to be extant in New Jersey, North Carolina, South Carolina, Georgia, and Florida. As of 2018, there were 43 extant populations recorded, including 1 population in Massachusetts, and 2 populations in New Jersey, one natural and one reintroduced (USFWS 2019g). Threats to the species persist, primarily due to fire suppression resulting in vegetative succession of the ecosystem on which the species depends. Other threats include herbivory, succession, and roadside maintenance.

American Chaffseed was listed as endangered under the ESA on October 29, 1992.

4.8.2 American Hart's-tongue Fern

American hart's-tongue fern (*Asplenium scolopendrium var. americanum*) is a perennial, evergreen fern, closely associated with cool, moist refugia on dolomitic limestone bedrock under intact, deciduous hardwood canopies with shallow soils and an open understory. American hart's-tongue fern is found in close association with outcrops of dolomitic limestone, in coulees, gorges and in cool limestone sinkholes in mature hardwood forests. It requires high humidity and deep shade provided by mature forest canopies or overhanging rock cliffs (Soper 1954). It prefers soils high in magnesium (USFWS 2019h).

The American hart's-tongue fern is distributed from central New York, through south central Ontario, and northern Michigan on glacially modified escarpments in areas of heavy lake-effect snowfall. Disjunct populations occur in sinkhole environments in Tennessee and Alabama (USFWS 2019h). Although American hart's-tongue is found over a very wide area, from Alabama to Canada, its populations tend to be very small and isolated due to its unique habitat. Because of its natural rarity, it is particularly vulnerable to disturbance. Many activities threaten the American hart's tongue fern.

The primary stressors influencing American hart's-tongue fern population viability are logging, development, quarrying, invasive species, impacts to snowpack and drought conditions, collection, recreation and observer impacts. Quarrying, recreation, and residential development have all destroyed these plants and their habitat (Stebbins 1935). Canadian populations are threatened by lumbering and the development of land for ski resorts and country estates, among other activities (USFWS 2019h). By removing shade trees, logging raises light levels and lowers humidity, decimating any American hart's-tongue ferns in that area.

American hart's-tongue fern was listed as threatened under the ESA on August 14, 1989.

4.8.3 Furbish's Lousewort

The Furbish's lousewort (*Pedicularis furbishiae*) is an herbaceous perennial plant that occurs on the intermittently flooded, ice-scoured banks of the Saint John River in northern Maine. It is endemic to Maine with a few, small subpopulations in northwestern New Brunswick, Canada and is found nowhere else in the world. The Furbish's lousewort was Maine's first officially listed endangered plant species, and it is listed as endangered in the province of New Brunswick.

The Furbish's lousewort is recognized early in the growing season by a basal rosette of deeply cleft or fern-like leaves. By mid-summer mature plants produce one or more flowering stems (scapes) that grow to about 20-30 inches in height. The stems have alternate, widely spaced, fernlike leaves along their length and are topped by a tight cluster (inflorescence) of small, yellow, tube-like flowers that bloom only a few at a time. The plant has two distinct growth stages; vegetative (immature, non-flowering) individuals that grow as a basal rosette of leaves and reproductive (flowering) plants.

The Furbish's lousewort does not spread clonally, and plants are established exclusively by sexual reproduction and seed (Stirrett 1980, Menges 1990). Flowering occurs at a minimum of three years (or possibly more) once plants reach a certain size (leaf area). Reproductive plants emerge in May as a rosette of leaves and then produce an average of 2 or 3, flowering stems, each stem having one or more spike-like inflorescences and each inflorescence having up to 25 flowers. Flowers bloom several at a time from about July 10 to August 30 (Stirrett 1980, Menges et al. 1986). The Furbish's lousewort is an obligate outcrosser (must be cross-pollinated by a nearby plant) (Macior 1978, Gawler 1983). It is pollinated by a single species of bumble bee, the half-black bumble bee (*Bombus vagans*), that has unique behaviors and tongue length to trigger the pollen mechanisms of the Furbish's lousewort (Macior 1978).

The Furbish's lousewort is an endemic with narrow ecological requirements found only on the mainstem of the St. John River. It is found in 20 small populations along portions of a 140-mile section of the St. John River extending from a short distance upstream from the confluence of the St. John and Big Black Rivers in northern Maine (Township T14R14; USFWS 1991c, Maine Natural Areas Program 2015) to the confluence of the Aroostook River, approximately 6.2 miles north of Perth-Andover, New Brunswick (Environment Canada 2010). In Canada, its range extends over the last 18.6 miles of this section, beginning at the international border (approximately 3.1 miles above the dam at Grand Falls) to approximately 6.2 miles, north of Perth-Andover, New Brunswick (Environment Canada 2010). The Furbish's lousewort is inextricably linked to the flood and ice dynamics of this single river, which flows north from its headwaters in northwestern Maine, then east, then south to the first dam at Grand Falls, New Brunswick. The river carves through the boreal forests of northern Maine before widening into rich farmland of the middle and lower valley. It forms the boundary between Maine and New Brunswick, Canada for part of its northern reaches. The St. John River watershed is among the largest on the Atlantic seaboard and the river above Grand Falls, New Brunswick is the longest stretch of free-flowing river in the eastern United States (USFWS 1991c).

The Furbish's lousewort habitat is generally confined to a narrow 6-foot band of ice-scoured, eroding riverbank below the forest edge and well above the rank herbs and grasses and cobble along the riverbed (Gawler et al. 1987). The Furbish's lousewort plants are shade tolerant but compete poorly with woody vegetation (alders (*Alnus* spp.)) and other dense vegetation. They are not found on the tributaries of the St. John River, including the Big Black, Allagash, and St. Francis Rivers, where low flows and reduced ice scour allow the development of dense vegetation to the water's edge. The Furbish's lousewort is mostly limited to the north- or west-facing riverbank shaded by the forest overstory. Some, generally small, isolated groups of plants are known to occur on the opposite riverbank under the shade of overhanging northern white cedar trees and in somewhat sunnier, south-facing sites in Canada. While reasons for this distribution are not completely known, cool, moist conditions and afternoon shade are believed to be important factors needed to support the Furbish's lousewort (USFWS 1991c). The amount of solar exposure may be critical for seedlings as they are in greatest abundance where competing vegetation is relatively sparse allowing filtered light to reach the soil surface.

The Furbish's lousewort typically grows on gravelly, calcareous soils and on lacustrine or glacial till deposits but almost always in the presence of groundwater seepage (Menges 1990). Most of the coarse glacial till soils along the river are low in nitrogen and organic matter and high in calcium (Macior 1978b). The Furbish's lousewort occurs only where periodic ice scour is not too frequent or too uncommon, and where the appropriate host plants, moist soils, and the half-black bumble bee pollinator are present. Ice scour frequency varies in amount and intensity throughout the range of the species.

In the most recent survey (2016-2017 in Maine and 2014 in New Brunswick, the total population in the United States and Canada numbered about 2,398 flowering stems. Most of the population currently exists at locations upriver of St. Francis, Maine (83 percent), and downriver subpopulations have dwindled in recent years (Maine Natural Areas Program 2015).

Furbish's lousewort was listed as endangered under the ESA on May 27, 1978.

4.8.4 Harperella

Harperella (*Ptilimnium nodosum*) is a small member of the carrot family (Apiaceae). Harperella is a perennial herb that grows to a height of 6 - 36 inches. The leaves are reduced to hollow, quill-like structures. The small, white flowers occur in heads, or umbels, reminiscent of a small Queen Anne's lace (*Daucus carota*) flower head. Flowers have five regular parts and are bisexual or unisexual, each umbel containing both perfect and male florets. Seeds are elliptical and laterally compressed, measuring 0.06 – 0.08 inches in length. In pond habitats, flowering begins in May, while riverine populations flower much later, beginning in late June or July and continuing until frost.

Harperella is a rare plant native to seasonally flooded rocky streams in Maryland, Virginia, and West Virginia. Harperella typically occurs in two habitat types: (1) rocky or gravel shoals or margins of clear, swift-flowing sections of rivers and streams; and (2) the edges of intermittent pineland ponds or low, wet savannah meadows in the coastal plain. In both habitat types, the species occurs in a narrow range of water depths; it is intolerant of deep water and of conditions that are too dry. However, the plants readily tolerate periodic, moderate flooding.

At riverine sites, short-duration spring floods annually scour the gravel bars or rock crevices where harperella grows, preventing substantial soil accumulations in which weedy competitors might gain a foothold. Sites where harperella grows simultaneously offer protection from severe erosion while receiving annual scouring during natural high flow events in the spring (Frye and Tessel 2012). Frye and Tessel (2012) found a positive correlation between harperella cover and cover of fine sediments, suggesting that harperella grows more successfully where a shallow layer of fine sediments settles between and around cobble and gravel substrates and accumulates in larger bedrock crevices and depressions. Harperella in Alabama, Arkansas, Maryland, North Carolina, Virginia and West Virginia typically occurs on rocky or gravel shoals and sandbars and along the margins of clear, swift-flowing stream sections.

Harperella depends on annual scouring during natural high flow events in the spring to maintain the sand and gravel bars that constitute much of the stream habitat. However, newly founded populations experience large temporal variation in habitat quality depending on the prevailing stream flow patterns. If stream flow remains low and flood events are few, then these patches may expand; however, during moderate to large flood events these patches over gravel and cobble are more likely to be extirpated. Low-flow periods appear to be a critical life-history phase for harperella when plants flower and fruit profusely (Frye and Tessel 2012).

The primary threats to harperella include changes in water flow and water quality. Because harperella occupies a narrow range of water depths, changes in flow can destroy suitable habitat by inundation or persistent desiccation. Dams, reservoirs, or other water impoundments or diversions would almost certainly threaten nearby harperella populations. Siltation caused by heavy construction, residential development, and agriculture has been cited as detrimental to the plant. Natural fluctuation in water flow causes significant yearly variation in subpopulation persistence. Small subpopulations are particularly susceptible to loss during normal high-water events.

Harperella is threatened by small population sizes and hydrological manipulations of the habitat, such as upstream water impoundments, declining water quality, and pond drainage.

Harperella was listed as endangered under the ESA on October 28, 1988.

4.8.5 Houghton’s Goldenrod

Houghton’s goldenrod (*Solidago houghtonii*) typically grows on moist sandy beaches and shallow depressions between low sand ridges along the shoreline, called interdunal wetlands. Fluctuating water levels of the Great Lakes play a role in maintaining this unique goldenrod. During high water years, colonies of Houghton's goldenrod may be submerged. When water levels recede, some plants survive the inundation, and new seedlings establish on the moist sand. Other plants that often grow with Houghton's goldenrod include Grass-of-Parnassus, Kalm's lobelia, shrubby cinquefoil, twig-rush, and other goldenrods.

Houghton's goldenrod occurs almost exclusively on Great Lakes shoreline, growing primarily along the northern shores of Lakes Michigan and Huron in the Straits region. In New York, Houghton's goldenrod is restricted to one site in the western part of the state (USFWS 2021f). The species is restricted to narrow bands of open, calcareous, lakeshore habitat.

High lake levels are a potential threat to some populations that occur along Great Lakes shorelines, particularly in recent years. Residential development and the overuse of shoreline areas for recreational activities continue to be a threat. Invasive species, including *Phragmites australis* (common reed) and *Typha spp.* (cattails) threaten some populations (USFWS 2021f).

Houghton's goldenrod was listed as threatened under the ESA on August 17, 1988.

4.8.6 Jesup's Milk-vetch

Jesup's milk-vetch (*Astragalus robbinsii var. jesupii*) is a perennial, herbaceous plant of the Fabaceae family. A narrow endemic, it is known from only three populations along the Connecticut River in New Hampshire and Vermont. Jesup's milk-vetch inhabits bedrock outcrops of chlorite or phyllite schist that are periodically scoured by flooding and ice-rafting along the Connecticut River. These riparian ledges are sparsely vegetated; however, they support a globally rare natural community type and several rare plant species in addition to Jesup's milk-vetch. Plants at each site occupy a narrow band between a lower bound determined by typical water levels during the growing season and an upper bound defined by the deep shade of long-lived woody vegetation that is at a high enough elevation to survive the occasional severe scouring by ice. Seed dispersal appears to be very local in general, and gene flow among the populations appears to be minimal. The three populations of Jesup's milk-vetch in New Hampshire and Vermont comprised 736 plants in 2018 (not including introduced plants at one site). Population sizes are highly variable among years; in the years between 1997 and 2018, the global population has ranged from 260 plants to over 2,000 plants (USFWS 2019i).

Immediate threats to the populations include encroachment of competing native and nonnative invasive vegetation, problems intrinsic to small populations subject to extreme demographic and environmental stochasticity, hydrological alterations as a result of hydropower management, and the potential effects of climate change on the natural river dynamics and the species' life history. Herbivory and trampling (at one location) by recreational users of the Connecticut River are deemed to be lesser threats to the species (USFWS 2019i).

Jesup's milk-vetch was listed as endangered under the ESA on July 6, 1987.

4.8.7 Knieskern's Beaked-rush

Knieskern's beaked-rush (*Rhynchospora knieskernii*) is a plant of the sedge family (Cyperaceae) endemic to the Pinelands region of New Jersey. Knieskern's beaked-rush is thought to be a perennial species, although in areas of high disturbance, the species most likely acts as an annual, germinating yearly from a seed bank. Although not all plants produce the culm (hollow stem that bears the flower each year), flowering and seed production have been observed in very young plants. Typically, spikelets begin to form on culms in June and flower in early August. Achenes begin to form in late August and are dispersed from mid-September to late December (UWFS 2024c). During the dispersal period, leaves senesce, and winter buds develop; buds remain photosynthetic until March. Seed dispersal mechanisms are not documented; however, bristles on the achene (small, thin-walled one-seeded dry indehiscent fruit) could assist in animal dispersal (USFWS 1993c).

Knieskern's beaked-rush is found on continually moist to wet, and are described as various combinations of sand, clay, bog ore, gravel, and peat. An early successional species and colonizer, this species is intolerant of competition, especially from woody species. It is generally found on relatively bare substrates with sparse vegetation and limited duff. Periodic disturbance, either natural or human-induced, which maintains a damp-to-wet site in an early seral stage may be necessary for the successful colonization, establishment, recruitment, and maintenance of Knieskern's beaked-rush. Knieskern's beaked-rush is also found on human-disturbed wet sites that exhibit similar early successional stages due to water fluctuation or periodic disturbance from vehicles, fire or mowing (USFWS 1993c).

The habitat originally thought to be required for this species is associated with bog-iron deposits. These areas are generally found adjacent to slow-moving streams in the New Jersey Pinelands region. These bog-iron deposits are subject to the erosional forces of the stream system, which, combined with the durability of the bog-iron, allows the habitat to remain essentially unchanged and in an early seral state. Bog-iron sites are therefore considered to be a naturally maintained and long-lasting habitat for the species.

In addition to these habitats, later records for Knieskern's beaked-rush document that the species occurs in human-created early-successional wet habitats created by human disturbances to the landscape. Sites with human disturbance occur along the edges of abandoned clay, sand, and gravel pits; borrow pits that are functioning as vernal ponds; ditches; road grading on unimproved roads; and railroad and powerline rights-of-way. Knieskern's beaked-rush has also been documented colonizing areas where white-tailed deer (*Odocoileus virginianus*) have reduced plan competition by repeatedly bedding down in one areas before moving on (USFWS 2024c). Although these human-disturbed sites are not associated with bog-iron deposits, they do exhibit some of the same characteristics as bog-iron sites, including a high water table, temporary inundation, and open, early-successional habitat with relatively bare substrate (USFWS 1993c).

As of the 2022 rangewide survey, there are an estimated 57 extant populations of Knieskern's beaked-rush, including 6 previously unidentified populations discovered in New Jersey. Potential threats to this species include habitat alteration due to vegetative succession, loss of habitat through development activities such as residential construction, loss of fire-maintained habitat, and possible excessive off-road vehicle use.

Knieskern's beaked-rush was listed as threatened under the ESA on August 19, 1991.

4.8.8 Leedy's Roseroot

Leedy's roseroot (*Rhodiola integrifolia spp. leedyi*) have an elongate stem with smooth, waxy, closely packed leaves. Flowering occurs in early June, appearing as a four to five petaled, dark red, orange, or yellow flower clustered on dense heads. Seeds are winged and adapted for wind dispersal. Seeds produced by plants at Glenora Cliff, New York, sometimes germinate in their follicles and produce seedlings on the parent plant. Leedy's roseroot inhabit a unique cliff environment in Minnesota called a maderate cliff. This rare cliff type is characterized by the presence of cracks in the rocks that connect to cold, underground caves. Moisture and cool air come to the surface through the cracks from the caves below.

Leedy's roseroot occur in three states: New York, Minnesota, and South Dakota. In New York, Leedy's roseroot occurs at two sites, a large population on the shores of Seneca Lake and a single plant at Watkins Glen.

Threats to this listed plant include small and isolated populations; development and construction; cliff erosion due to logging, heavy rains, poor soil conservation practices above occupied cliff faces, inherent cliff instability, and stochastic events. Dumping and filling of sinkholes, groundwater contamination, use of pesticides, and hydrological changes due to climate change are also identified as a threat to Leedy's roseroot.

Leedy's roseroot was listed as threatened under the ESA on May 22, 1992.

4.8.9 Northeastern Bulrush

The northeastern bulrush (*Scirpus ancistrochaetus*) is a member of the sedge family (Cyperaceae) native to the northeastern United States. It is one of eighteen species in North America of a natural group of leafy bulrushes within the genus *Scirpus*. The northeastern bulrush is a tall (80 to 120 centimeter), leafy, perennial herb that produces stems and leaves from short, thick underground rhizomes. It is distinguished from other *Scirpus* species by its drooping, clustered fruiting heads; dark, chocolate-brown florets; achene bristles that are barbed to the base, and broad bracts (Schuyler 1962). Flowering occurs from mid-June to July, and fruit sets between July and September.

The life history and reproductive biology of the northeastern bulrush are not fully understood, in part because the species is difficult to study—it is not easily identifiable when it is not fruiting or in flower; it occurs in widely scattered, isolated wetlands; and its presence or observability may be unpredictable from year to year.

The northeastern bulrush can reproduce both sexually and vegetatively. Sexual reproduction occurs in the form of flowering and/or fruiting stems. However, the primary means of recruitment appears to be vegetative reproduction by new plants developing from nodal and basal shoots. This appears to be supported by the observed clumping of stems (evidence of cloning). The parental stem dies by autumn, leaving the nodal shoots to root themselves as independent plants (USFWS 1993d). Genetic information indicates frequent clonal reproduction and low success of sexual reproduction (Cipollini et al. 2013; 2017), likely contributing to the species' low genetic interconnectedness and apparent difficulty dispersing.

Light availability and changes in hydrology can have substantial effects on the northeastern bulrush, and individuals likely respond to shifts in these habitat factors by altering reproductive strategy from sexual to asexual or vice versa. Lower water levels seem to promote sexual reproduction, but asexual reproduction also occurs under this condition (USFWS 1993d; 2009c).

Survey data from throughout the northeastern bulrush's range indicate there can be variable fluctuations in population size from year to year. In some cases, plants are absent above ground for several years before re-emerging. This is likely due to changes in environmental conditions, although the exact causal mechanisms are not well understood. When water levels and/or light availability are not favorable, the population becomes stressed, dwindles in size, and sometimes becomes completely absent above ground. When favorable habitat conditions return, the population may re-emerge.

The northeastern bulrush is a wetland obligate plant occurring in acidic to almost neutral wetlands including sinkhole ponds, wet depressions, vernal pools (collectively, seasonal or ephemeral wetlands), beaver flowages, and other riparian areas found in hilly country (Schuyler 1962). Optimal habitat includes abundant sunlight, higher organic matter (Lentz and Dunson 1999), and seasonally and/or annually fluctuating water levels, although prolonged periods with too much or too little water may be detrimental. The northeastern bulrush may be found in a wide range of water depths from deep water to several feet away from the water's edge, depending on seasonal fluctuations in water levels (Thompson 1991). Plants typically grow in open areas surrounded by forest. Light availability is known to influence plant growth, reproduction, and distribution (Boardman 1977; Lentz and Cipollini 1998). Shaded plants are often taller, but at the expense of the roots and other organs (Lentz and Cipollini 1998), and the species usually is absent from the highly shaded perimeter of wetlands.

Wetland characteristics at occupied sites vary geographically—in the northern part of its range, the majority of known northeastern bulrush populations are in beaver flowages, whereas in the southern part of its range, known populations are almost exclusively found in ephemeral wetlands. Wetlands occupied by the species in the northern part of its range do not appear to have any obvious, unique habitat characteristics, and the species is absent from many seemingly suitable wetlands. Both wetland types supporting the northeastern bulrush are fed by surface water, although some wetlands also receive ground water inputs, which likely increase the stability of those wetlands (Lentz-Cipollini and Dunson 2006). Populations in wetlands that fill solely from surface water may be more be sensitive to low rainfall years. The available information for most northeastern bulrush populations does not include whether groundwater influences water level.

The northeastern bulrush occurs in eight states: Vermont, New Hampshire, Massachusetts, New York, Pennsylvania, Maryland, Virginia, and West Virginia; and four physiographic provinces (New England, Blue Ridge, Valley and Ridge, and the Appalachian Plateaus. The Service's final rule to list the northeastern bulrush as endangered documented 13 populations in 6 states (USFWS 1991d); however, the species is now known from 148 extant populations in 8 states, including all states occupied in 1990. Increased survey effort since listing is likely the primary reason for the increase in the number of known populations. Recent survey results have been mixed. For example, 100 sites with seemingly suitable habitat in New Jersey were surveyed in 2016, with negative results (Gilbert 2017). On the other hand, in 2017, thousands of plants were found in what could be the largest population in New Hampshire; and in July 2019, a new population was discovered in Pennsylvania.

Fluctuating water levels, light availability and disturbance are factors influencing northeastern bulrush viability. A common characteristic of all wetlands where the northeastern bulrush is found is water levels that fluctuate seasonally and/or annually, providing adequate surface water to fill wetlands and then allow a gradual drawdown of water levels. Ephemeral wetlands typically experience inundation in late winter and spring and falling water levels in summer and fall to the point that surface water may be absent, but the soil is still saturated (USFWS 1993d). Fluctuations can vary greatly within a given season due to variable temperature and precipitation patterns acting on surface water along with increased evapotranspiration rates from surrounding vegetation. There is evidence that water level differences as small as 2 inches can trigger changes in initial growth pattern, leaf life span, and root-to-shoot ratio (Lentz and Dunson 1998). Water levels in beaver wetlands can fluctuate on seasonal timescales but also shift on longer-term cycles of beaver occupation, disuse, and reoccupation of an area. The species' adaptation for dormancy above ground is beneficial as it allows for survival during unfavorable habitat conditions; however, too much or too little water is detrimental. Although the northeastern bulrush has adapted to fluctuating water levels, populations may decline if hydrology is altered to the point that water remains too high or low.

The northeastern bulrush is typically found in wetland openings surrounded by forests. The species performs well under higher light conditions and is generally found in the sunniest portions of a wetland. Increased canopy shading over time can reduce light quality at a site, which in turn can have a negative effect on individual plant health, population size, and population persistence at a site. Lentz and Cipollini (1998) found that light levels strongly affected growth and biomass allocation of the northeastern bulrush. Shaded plants were often taller to maximize light exposure but at the expense of shoot and root mass. These results indicate that increases in shading, which can result from forest canopy closure, can contribute to the reduction or loss of northeastern bulrush populations at a site. Northeastern bulrush population decline has been attributed to increased canopy shading for some sites in Pennsylvania (Cipollini and Cipollini 2011).

Anthropogenic disturbance can affect northeastern bulrush populations directly by damaging or killing individuals or indirectly by destroying vernal pools or wetlands, introducing pollutants and sediment, and altering the hydrology of a site. The Service's listing rule indicated development was a direct and indirect threat to the northeastern bulrush and described known habitat loss, habitat degradation, and loss of populations from development and modification of wetland hydrology. Development activities that have affected the species include residential and commercial development, road construction/maintenance, pipeline and power line construction/maintenance (USFWS 1993d), and agriculture. The listing rule documented populations in Virginia, West Virginia, and Pennsylvania that had been disturbed/destroyed, or were threatened, by development. Although development was an important threat at the time of listing, the threat largely seems to have abated, with only one population lost to development since listing. The development activities listed above are still possible future threats to northeastern bulrush populations. At this time, oil and gas development in Pennsylvania is perhaps the most likely arena for this threat to manifest; however, no available information indicates any populations are under imminent threat from development. Therefore, while anthropogenic activities can adversely affect the northeastern bulrush, extirpation of a population due to development is unlikely.

Northeastern bulrush was listed as endangered under the ESA on June 6, 1991.

4.8.10 Northern Wild Monkshood

Northern wild monkshood (*Aconitum noveboracense*) has very distinctive, blue hood-shaped flowers. The flowers are about 1 inch in length, and a single stem may have many flowers. Stems range from about 1 to 4 feet in length. The leaves are broad with coarse, toothed lobes.

Northern wild monkshood has only been found in Iowa, Wisconsin, Ohio, and New York. Northern wild monkshood is typically found on shaded to partially shaded cliffs, algific talus slopes, or on cool, streamside sites. These areas have cool soil conditions, cold air drainage, or cold groundwater flowage. On algific talus slopes, these conditions are caused by the outflow of cool air and water from ice contained in underground fissures. These fissures are connected to sinkholes and are a conduit for the air flows.

In New York, northern wild monkshood occurs along streams (or in one case, a cliffside seep), shaded by Beech, sugar maple, yellow birch, or eastern hemlock. All existing occurrences have been found on sandstone-derived rocky or sandy soils, at elevations ranging between 400 and 1000 meters. In New York, this species is only known from Delaware, Ulster and Sullivan counties, and historically from Chenango County.

Northern wild monkshood is a perennial and reproduces from both seed and small tubers. The flowers bloom in July or August and are pollinated when bumblebees pry open the blossom to collect nectar and pollen.

Threats to northern wild monkshood are predominately related to habitat loss or degradation. Possible threats include contamination and filling of sinkholes, grazing and trampling by livestock, human foot traffic, logging, maintenance of highways and powerlines, misapplication of pesticides, quarrying, and road building.

Northern monkshood was listed as threatened under the ESA on May 27, 1978.

4.8.11 Sandplain Gerardia

Sandplain gerardia (*Agalinis acuta*), a plant of the snapdragon family, is an annual light green herb from 4 to 8 inches tall and occasionally up to 16 inches. The stem is weakly angular and has few branches. The leaves are opposite, linear, and up to 1 inch long. The pink-purple, bell-shaped flowers appear from late August through September, are 0.4-0.5 inches long, and have two yellow lines and red or purple spots in the corolla throat. The corolla lobes are slightly notched at the tip (USFWS 1988a).

Sandplain gerardia grows in dry, sandy, open areas. The plant has a very restricted distribution due to its dependence on the periodic disturbance of its specialized and limited habitat. It grows in sandplain, serpentine or maritime grassland or shrubland habitats.

Sandplain gerardia is known to occur on Cape Cod, MA, Long Island, NY, Baltimore County, MD, and Washington County, RI (USFWS 1989). Efforts of our recovery partners have resulted in an increase from 1, 218 plants at 10 sites in 1988 (USFWS 1989) to 41, 382 plants at 13 sites surveyed in 2017 (the last year for which complete survey data are available), not including over 100,000 plants discovered at a Barnstable, MA site in 2018 (USFWS 2019j).

The most significant threat to the species has been the continuing loss of grassland habitat along the coastal plain of southern New England, western Long Island, and the offshore islands of Nantucket and Martha's Vineyard. The continuing threats to the species include habitat loss and degradation from development, change in land use, vegetation succession, and the loss of the natural processes that maintain suitable habitat (USFWS 2019j).

There is currently work being conducted to further understand the taxonomic relationship between *A. acuta* and *A. decemloba.* In the most recent 5-year review, the Service's position was that the taxonomic entity known as A. acuta is not a distinct species (USFWS 2019j). The Service therefore concurs with the taxonomic revision recommended by Pettengill and Neel (2011) and the FNA synonymizing *A. acuta* under *A. decemloba*. The Service's recommended classification is to delist *A. acuta* since, as described above, it no longer meets the statutory definition of a species, however, until a Final Rule is published delisting A. acuta, consultation under Section 7(a)2 of the ESA is still required.

Sandplain gerardia was listed as endangered under the ESA on October 7, 1988.

4.8.12 Seabeach Amaranth

Seabeach amaranth (*Amaranthus pumilus*) is an annual plant of the Amaranth family (Amaranthaceae) that exhibits low sprawling growth and small spinach-like leaves and is restricted to open sandy portions of ocean beaches between the high tide line and the toe of the primary dune. The species often grows in the same areas selected for nesting by shorebirds such as plovers, terns, and skimmers (USFWS 1996c). Habitat destruction and alteration, incompatible beach grooming practices and recreational activities have all contributed to the decline of this species. Threats include beach stabilization efforts (particularly the use of beach armoring (e.g., sea walls and riprap) and the construction of dunes that prevent over wash and result in growth of vegetation that can compete with seabeach amaranth), intensive recreational use, mechanical beach raking, and herbivory by webworms (USFWS 1996c).

Seabeach amaranth has reddish stems and small, rounded, notched, spinach-green leaves. In the Northeast, these low-growing plants typically reach about 4 inches in length by late summer but can occasionally reach over 3 feet in diameter. The small white flowers and dark seeds are located in inconspicuous clusters along the stems. Germination begins in May and continues through the summer. Flowering begins as soon as plants reach sufficient size (June or July) and continues until senescence in early winter. Plants are monoecious (having male and female flowers on the same plant). The flowers are borne in the leaf axils and are wind pollinated. The species is a prolific seed producer, and the waxy seeds are relatively large (0.08-0.1 inches) and are believed to be viable for many years. Seed dispersal may occur by wind, water and possibly birds, and whole plants and seed are temporarily buoyant. The life history of this plant, combined with the dynamic coastal habitat within which it evolved, give this species the ability to move within the coastal landscape as a fugitive species, colonizing habitat as it becomes available in both space and time.

Seabeach amaranth is native (endemic) to Atlantic Coast beaches and barrier islands. The primary habitat of seabeach amaranth consists of over wash flats at accreting ends of islands, lower foredunes, and upper strands of non-eroding beaches (landward of the wrack line), although the species occasionally establishes small temporary populations in other habitats, including sound-side beaches, blowouts in foredunes, inter-dunal areas, and on sand and shell material deposited for beach replenishment or as dredge spoil. The species usually grows on a nearly pure sand substrate, occasionally with shell fragments mixed in.

Seabeach amaranth occupies elevations from 8 inches to 5 feet above mean high tide. The plant grows in the upper beach zone above the high tide line and is intolerant of even occasional flooding during its growing season. The habitat of seabeach amaranth is sparsely vegetated with annual herbs and, less commonly, perennial herbs (mostly grasses) and scattered shrubs. Vegetative associates of seabeach amaranth include sea rocket (*Cakile edentula*), seabeach spurge (*Chamaesyce polygonifolia*), and other species that require open, sandy beach habitats. However, this species is intolerant of competition and does not occur on well-vegetated sites. Seabeach amaranth is often associated with beaches managed for the protection of beach nesting birds such as the piping plover (*Charadrius melodus*) and least tern (*Sterna antillarum*).

Seabeach amaranth was listed as threatened under the ESA on May 7, 1993.

4.8.13 Sensitive Joint-vetch

Sensitive joint-vetch (*Aeschynomene virginica*) is an annual plant that typically reaches a height of 3 to 6.5 ft in a single growing season, although they can grow as tall as 8 ft. Stems are single and sometimes branch near the top, with stiff or bristly hairs (USFWS 1995b). The leaves are even-pinnate, 1 to 5 inches long, and consist of 30 to 56 leaflets. The flowers are yellow with streaks of red and grow in racemes (elongated inflorescence with stalked flowers). The fruit is a 1 – 1.5 inch-long green pod with 4 to 10 segments that turns dark brown when ripe. Plants flower from July through September and occasionally into October (USFWS 1995b). In autumn, senescence may be triggered by the drop in water temperature or by salinity intrusion due to a decrease in freshwater flow. Bumblebees have been observed pollinating the flowers. Fruits form shortly after the first signs of flowering in July. Although flowering continues until late fall, production of vigorous fruits appears to decline significantly by mid-October. Seed maturation begins in August and continues through October. Germination takes place from late May to early June. Seedlings grow quickly, approximately doubling in size every 2 weeks during the first 6 weeks.

This species has been confused with other members of the genus, especially *A. indica* and *A. rudis*. These two species, not native to the United States, have spread northward into North Carolina in recent years, where their ranges now overlap with that of this threatened species. *A. indica* is common in wet agricultural areas from Virginia to Florida, and west to Texas and north to Missouri. *A. rudis* has a scattered distribution from Pennsylvania to Florida to California.

The sensitive joint-vetch occurs in tidal river systems, typically in areas where sediments accumulate, and extensive marshes are formed. These marshes are influenced by tidal fluctuations because they are flooded twice daily and consist of fresh or slightly brackish water. The species seems to prefer the marsh edge at an elevation near the upper limit of tidal fluctuation, where soils may be mucky, sandy, peaty or gravelly (USFWS 1995b). It is usually found in areas where plant diversity is high (50 species per acre) and annual species predominate. Bare to sparsely vegetated substrates appear to be of critical importance to this plant. As an annual, it requires such microhabitats to establish and grow. Such areas may include areas along rivers with new deposits of soil that have not yet been colonized by perennial species, low swales within extensive marshes, or areas where muskrats have eaten most of the vegetation. An important habitat feature for the sensitive joint-vetch appears to be sparsely vegetated areas for germination and growth because it thrives in an environment where there is little competition from other plants. It appears to remain at a particular site for a relatively short period of time, and maintains itself by colonizing new, recently disturbed habitats where it may compete successfully among other early-successional species. Species known to occur with sensitive joint-vetch are: Northern wild rice (*Zizania aquatica*), arrow arum (*Peltandra virginica*), pickerelweed (*Pontederia cordata*), smooth beggartick (*Bidens laevis*), halberdleaf tearthumb (*Polygonum arifolium*), arrowleaf tearthumb (*Polygonum sagittatum*), and rice cutgrass (*Leersia oryzoides*).

Sensitive joint-vetch is a member of the bean family (Fabaceae) and is native to the eastern United States. It is found in brackish and freshwater tidal wetlands in Maryland, New Jersey, North Carolina, and Virginia. Habitat destruction, modification, or curtailment of its habitat or range are the primary causes of the decline of the species.

Sensitive joint-vetch was listed as threatened under the ESA on June 19, 1992.

4.8.14 Shale Barren Rock Cress

Shale barren rock cress (*Boechera serotina*) is a biennial plant in the mustard family. This species has two age classes: non-reproductive and reproductive individuals. Young, non-reproductive individuals have leaves in a basal rosette. Average rosette size ranges from 0.6 – 1.4 inches. Potentially reproductive individuals are present in the form of erect, flowering plants lacking a basal rosette. The flowering stem is composed of 3 to 41 branches. The flowers are small with white or creamy petals. Seeds are yellowish brown and have a narrowly elliptic body, 1.5 to 2 times longer than broad with a narrow wing.

Shale barren rock cress is an endemic species restricted to mid-Appalachian shale barrens. Mid-Appalachian shale barrens are characterized by an open, scrubby growth of pine, oak, red cedar, and other woody species adapted to the xeric conditions. Shale barren vegetation occurs on eroding shale formations, which are generally steeper than 20 degrees and have southern aspects (Keener 1983). Shale barrens are most frequently found on eroding slopes undercut by a stream flowing directly below the shale barren. In some barrens, the fairly open canopy seems to be maintained by drought, and steep unstable substrates. Finer particles of soil are fairly constantly washed away, resulting in a thin layer of soil (Keener 1983). Shale barren soils are generally shallow, severely leached, and low in nutrients; easily displaced by forces of heat and cold, rain, snow, hail and frost; and subject to desert-like temperatures and moisture conditions.

Keener (1983) proposed that shale barren endemics such as shale barren rock cress are heliophytes, and so obligate upon high light intensity and low competition. Plant species endemic to the shale barrens appear to depend on low competition from surrounding woodland species, ensured by the habitat's extreme temperatures, shallow soils, and disturbance from erosion and rain, snow and ice storms. Fire, too, may be important for clearing out fire-intolerant competitors such as red maple, though more research needs to be done on the role of fire and fire suppression in the shale barrens. These stochastic disturbance events may be critical for regularly exposing soils in which the rock cress can germinate and establish. Shale barren rock cress appears to be limited to exposed shale scree and bordering xeric woods.

Shale barren rock cress is found in Virginia and West Virginia. Habitat destruction, modification, or curtailment of its habitat or range are the primary causes of the decline of the species. Commercial and residential development have encroached upon populations and eliminated what once was productive habitat.

Shale barren rock cress was listed as endangered under the ESA on August 14, 1989.

4.8.15 Small Whorled Pogonia

Small whorled pogonia (*Isotria medeoloides*) has a greenish-white stem that grows to between 3 and 13 inches tall. It gets its common name from the five or six grayish-green leaves that are displayed in a single whorl around the stem. When the leaves are well developed, a single flower or sometimes a pair rises from the center of the circle of leaves. The flowers are yellowish green with a greenish-white lip. Each flower has three sepals of equal length that spread outward. The flowers are scentless, lack nectar, and are primarily self-pollinating.

Small whorled pogonia produces fruit that ripens in the fall. The seeds contain very little food reserves and therefore need to fall on soil containing with mycorrhizal fungi in order for the seed to germinate and seedlings to become established. An over-wintering vegetative bud may form in late August or September. Occasionally small whorled pogonia will reproduce vegetatively, without the use of seeds.

Small whorled pogonia occurs on upland sites in mixed-deciduous or mixed-deciduous/coniferous forests that are generally in second- or third-growth successional stages. Small whorled pogonia occurs both in fairly young forests and in maturing stands (USFWS 1992a). Various second-growth forest types in which small whorled pogonia occurs in its primary range include: mixed deciduous/white pine or hemlock forests in New England, mixed deciduous forests in Virginia, and white pine/mixed deciduous or white pine/oak/hickory forests in Georgia (USFWS 1992a). Understory trees and shrubs in the northern part of the range include witch-hazel (*Hamamelis virginiana*), striped maple (*Acer pensylvanica*), American hazelnut (*Corylus americana*), and serviceberry (*Amelanchier arborea*) (Mehrhoff 1980). In the southern part of the range flowering dogwood (*Cornus florida*), sourwood (*Oxydendron arboreum*), mountain laurel (*Kalmia latifolia*), American chestnut (*Castanea dentata*), witch-hazel, and, in the mountains, flame azalea (*Rhododendron calendulaceum*) are the more common understory tree and shrub associates (USFWS 1992a).

Characteristics common to most small whorled pogonia sites include sparse to moderate ground cover in the species' microhabitat, a relatively open understory canopy, and proximity to features that create long persisting breaks in the forest canopy. Soils at most sites are highly acidic and nutrient poor, with moderately high soil moisture values.

Orchid seeds, unlike seeds of other angiosperms, contain either very small quantities of food reserves or none at all (USFWS 1992a). They will not germinate and/or establish seedlings unless they fall on a substrate containing a suitable mycorrhizal fungus (Jackson and Mason 1984). The strands of the fungus penetrate the cells of the orchid and form a symbiotic root/fungus association. Mycorrhizae serve as conduits through which the young, non-photosynthetic orchid seedling receives water and nutrients (Mallock et al. 1980). In return, the orchid provides the fungus with carbohydrates at a later stage of its life cycle (Sanders et al. 1975).

Small whorled pogonia can be limited by shade. The species seems to require small light gaps, or canopy breaks, and generally grows in areas with sparse to moderate ground cover. Too many other plants in an area can be harmful to this plant. This orchid typically grows under canopies that are relatively open or near features that create long-persisting breaks in the forest canopy such as a road or a stream.

Although sparse, small whorled pogonia is widely distributed, with a primary range extending from southern Maine and New Hampshire through the Atlantic Seaboard states to northern Georgia and southeastern Tennessee. Outlying colonies have been found in the western half of Pennsylvania, Ohio, Michigan, Illinois, and Ontario, Canada (USFWS 1992a). Habitat destruction, modification, or curtailment of its habitat or range are the primary causes of the decline of the species. Commercial and residential development have encroached upon populations and eliminated what once was productive habitat.

Small whorled pogonia was listed as endangered under the ESA on October 12, 1982, and reclassified to threatened on November 7, 1994.

4.8.16 Swamp Pink

Swamp pink (*Helonias bullata*) is a distinctive perennial plant in the Liliaceae (Lily) family (USFWS 1991e). This plant is a smooth perennial herb with thick, stocky rhizomes. Its leaves, which form a basal rosette, are evergreen, oblong-spatulate or oblaceolate, parallel-veined, acute, and attenuated at the base. A stout hollow stem arises from the rosette and may grow to a height of 5 feet at the time of seed maturation. The inflorescence consists of 30 -50 fragrant flowers. The fruit capsule is 3-lobed, papery, with an inverted heart shape and consisting of many ovules. During the winter months, the leaves of swamp pink lie flat or slightly raised from the ground and are often hidden by fallen leaf litter. The flowerhead of the next season is visible, appearing like a large button in the center of the rosette. Leaves often turn a reddish-brown color over the winter; new, bright green leaves appear in spring. Plants bloom as early as March and often last until May, while seed production occurs in June (USFWS 1991e).

Swamp pink is an obligate wetland species occurring along streams and seepage areas in freshwater swamps and other wetland habitats (USFWS 1991e). Swamp pink occurs in a variety of wetland habitats, including swampy forested wetlands bordering meandering streams; headwater wetlands; sphagnous, hummocky, dense, Atlantic white cedar swamps; Blue Ridge swamps; meadows; bogs; and spring seepage areas (USFWS 1991e). Specific hydrologic requirements of swamp pink limit its occurrence within these wetlands to areas that are perennially saturated, but not inundated, by floodwater (Rawinski and Cassin 1986). The water table must be at or near the surface year-round, fluctuating only slightly during spring and summer months (Sutter 1982). Groundwater seepage with lateral groundwater movement are common hydrologic characteristics of swamp pink habitat (USFWS 1991e). Swamp pink is a shade-tolerant plant and has been found in wetlands with canopy closure varying between 20-100% (Sutter 1982). Sites with minimal canopy closure are less vigorous due in part to competition from other species (Sutter 1982). Swamp pink is often found growing on the hummocks formed by trees, shrubs, and sphagnum mosses, and these micro-topographic conditions may be an important component of swamp pink habitat (USFWS 1991e). The major threat to the species is loss and degradation of its wetland habitat due to encroaching development, sedimentation, pollution, succession, and wetland drainage. In addition, the species exhibits extremely low seedling establishment, which appears to be a significant limitation to the colonization of new sites (USFWS 1991e).

Swamp pink is currently found in 7 states in the eastern United States (USFWS 1988b). Habitat destruction, modification, or curtailment of its habitat or range are the primary causes of the decline of the species.

Swamp pink was listed as threatened under the ESA on October 11, 1988.

4.8.17 Virginia Spiraea

Virginia spiraea (*Spiraea virginiana*) is a perennial shrub that has a modular growth form with many branches. The species is clonal, with a root system and vegetative characteristics that allow it to thrive under appropriate disturbance regimes. Mature plants grow 3 to 10 feet tall. Its alternate leaves are single tooth serrated; 1 to 6 inches long and 1 to 2 inches wide; occasionally curved; and have a narrow, moderately tapered base. The leaves are also darker green above than below. The plant produces flowers that are yellowish green to pale white, with stamens twice the length of the sepal. Young stems are greenish yellow to dark brown and mature stems are dark gray. The roots form a complex system. The creamy white flowers are in tightly packed bunches. The species blooms from late May to late July, but flower production is sparse and does not begin until after the first year of establishment. Virginia spiraea has a clonal root system that can fragment and produce more plants. This form of vegetative reproduction is more common than flower pollination and seed dispersal in this species.

Virginia spiraea occurs along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often near the stream mouth; USFWS 1992b). The species relies on periodic disturbances, such as high velocity scouring floods, which eliminate competition from trees and other woody vegetation. However, if the frequency and intensity of these floods are too great, the plant may become dislodged and wash downstream into less suitable habitat. There is a single exception to this species' preferred riverine habitat, which is a West Virginia population (Raleigh County) that occurs in a wet meadow near disturbance (USFWS 1992b).

Virginia spiraea is found in the Appalachian Plateaus or the southern Blue Ridge Mountains in Alabama, Ohio, West Virginia, Virginia, Tennessee, North Carolina, Kentucky, and Georgia. It no longer occurs in Pennsylvania. Human activities have inadvertently maintained the species in several sites through periodic clearing, yet human activities are the only documented cause of extirpation.

Virginia Spiraea was listed as threatened under the ESA on July 18, 1990.

4.9 *REPTILES*

4.9.1 Bog Turtle

The bog turtle (*Glyptemys muhlenbergii*) is the smallest emydid turtle, and one of the smallest turtles in the world. Adult carapace length is 7.9 to 11.4 cm (3.1 to 4.5 inches). The dark brown or black carapace may be marked with radiating light lines or a light blotch on the vertebral and pleural scutes. Scute annuli are usually prominent in juvenile and young adult specimens, but the carapace may be nearly smooth in old adults. The head, neck, and limbs are typically dark brown with variable reddish to yellow spots and streaks. A large reddish orange to yellow blotch is visible behind and above each tympanum, sometimes merging into a continuous band on the neck. The upper jaw is weakly notched. (Ernst et al. 1994). The plastron is also brown or black, but often with lighter yellow blotches towards the medial and anterior scute edges. Hatchlings are similar in appearance to adults. Their tails are proportionately longer than those of adults. Sexual dimorphism is marked in adult animals. Males are characterized by a proportionately flatter carapace, concave plastron, and long, thick tail with the vent beyond the posterior carapace margin. Females are more highly domed and have a wider carapace for their size, have flat or slightly convex plastrons, relatively short and thinner tails, with the vent located beneath the posterior margin of the carapace (USFWS 2001).

Bog turtles have been found at elevations ranging from near sea level in the north to 1500 meters in the south (Herman and George 1986). They usually occur in small, discrete populations occupying suitable wetland habitat dispersed along a watershed. These wetlands are a mosaic of micro-habitats that include dry pockets, saturated areas, and areas that are periodically flooded. The turtles depend upon this diversity of micro-habitats for foraging, nesting, basking, hibernation, shelter, and other needs. Unless disrupted by fire, beaver activity, grazing, or periodic wet years, open-canopy wetlands are slowly invaded by woody vegetation and undergo a transition into closed-canopy, wooded swamp lands that are unsuitable for habitation by bog turtles (Tryon and Herman 1990, Klemens 1993). Historically, bog turtles probably moved from one open-canopy wetland patch to another, as succession closed wetland canopies in some areas and natural processes (e.g., beaver activity or fire) opened canopies in other areas (Klemens 1989). Bog turtles inhabit a variety of wetland types throughout their range, but generally these are small, open-canopy, herbaceous sedge meadows and fens bordered by more thickly vegetated and wooded areas Throughout the bog turtle's northern range, seepage or spring-fed emergent wetlands associated with streams are the primary habitat (USFWS 2001). These are often at or near the headwaters of streams or small tributaries. The habitats are often elongate or strip-like transitional zones between drier upland areas and more thickly vegetated, wetter, wooded swamp or marsh. Although bog turtles are dependent upon suitable open-canopy sedge meadows and fens for many of their ecological requirements such as foraging, reproduction, and thermoregulation, they also utilize more densely vegetated areas for hibernation and may be incidentally found in a wide variety of habitats when making relatively long-distance movements (Buhlmann et al. 1997; Carter et al. 1999, 2000; Morrow et al. 2001). The continued existence of these habitat mosaics, as well as the ecological connections between these areas, is required to maintain bog turtle populations. Bog turtles inhabit sub-climax seral wetland stages and are dependent on riparian systems that are unfragmented and sufficiently dynamic to allow the natural creation of meadows and open habitat to compensate for the closing-over of habitats caused by ecological succession.

Bog turtles generally hibernate in densely vegetated areas. In Massachusetts, Klemens (1993) reported that early season captures of bog turtles were concentrated on and near tubby hummocks that served as hibernacula at the interface zone between open fen habitats and shrub and wooded swamp. These hummocks were covered with small trees and shrubs (primarily alder, gray birch, red maple, and tamarack) with springs percolating up around them. Narrow, tunnel-like cavities were angled downward through these hummocks, passing in between the tangled tree roots, and then down into the water. Bog turtles were observed basking at the mouths of these tunnels in early May, but by mid-May most turtles had moved from the sheltered hummock areas out into the open fen, although a few turtles remained around a spring-fed alder clump throughout the spring and summer activity season.

Bog turtles can be found throughout the northeastern United States, including Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, and Pennsylvania. The southern population of bog turtle was also listed as threatened due to similarity of appearance. Habitat destruction, modification, or curtailment of its habitat or range are the primary causes of the decline of the species.

Bog turtle was listed as threatened under the ESA on November 4, 1997.

4.9.2 Eastern Massasauga

The eastern massasauga (*Sistrurus catenatus*) is a small rattlesnake with a thick body, heart-shaped head and vertical pupils. The average length of an adult is about 2 feet. Adult massasaugas are gray or light brown with large, light-edged chocolate brown blotches on the back and smaller blotches on the sides. Eastern massasaugas are highly secretive and cryptic in nature, and can persist in low densities, which makes them difficult to detect. Eastern massasauga habitat includes non-forested wetlands across its range (Wright 1941, Reinert and Kodrich 1982, Seigal 1986, Weatherland and Prior 1982, Johnson and Leopold 1998) and will use fen and transitional peatlands, especially in the eastern part of its range (Wright 1941, Johnson and Leopold 1998). Open-canopy areas are critical for feeding and reproduction, which require active thermoregulation (Reinert and Kodrich 1982, Johnson 1995).

Massasaugas live in wet areas including wet prairies, marshes, fens, sedge meadows, peatlands, and low areas along rivers and lakes. Massasaugas also use adjacent uplands (shrublands, open woodlands, prairie) during part of the year. The active season generally begins in March or April, when massasaugas emerge from their winter hibernacula and move to their summer habitat where mating and parturition occurs in later summer (USFWS 2016c). Generally, males and non-gravid females move into upland and structurally complex vegetation communities for foraging during the active season. The type of habitat used during the active season generally consists of high, dry habitats, open canopy wetlands and adjacent upland areas. Active season habitat use varies regionally. Individual snakes can be found in a wide variety of habitats including: old fields (Reinart and Kodrich 1982), bogs, fens (Kingsbury et al. 2003, Marshall et al. 2006), shrub swamps, wet meadows, marshes (Wright 1941), moist grasslands, wet prairies (Seigel 1986), sedge meadows, peatlands (Johnson and Leopold 1998), forest edge, scrub shrub forest (DeGregorio et al. 2011) floodplain forests (Moore and Gillingham 2006) and coniferous forests (Harvey and Weatherhead 2006). In New York and southern Ontario, eastern massasauga prefer peatland community types (Johnson 1995). In Pennsylvania, the snakes use some woodlands, wetter grasslands, and upland grasslands, with all areas having a shrub component (Reinert and Kodrich 1982).

Females generally breed every other year (Johnson 1995). During the active season, gravid females thermoregulate to obtain optimal body temperatures for young development. Moving between basking sites and retreat sites depending on the conditions needed. Basking sites are generally open, sunny areas in higher and drier habitats than used in fall or winter. Basking area vegetation is usually short, but it is adjacent to taller vegetation. Shorter vegetation may be more desirable for thermoregulation, white tall vegetation may provide better cover (Marshall et al. 2006). Gravid females do not require foraging sites because they do not feed until after parturition. After birth, they may feed ravenously to replenish energy reserves before hibernating (Harvey and Weatherhead 2010).

Retreat sites may be used at all times of year. Retreat sites are generally used by the snake to hide from potential predators but are also important to gain shelter from extreme temperatures because these sites are more thermally stable than surface habitat (Shoemaker 2007). Retreat sites can be hibernacula, rock crevices, hummocks, live or dead tree root systems, mammal holes, crayfish burrows, shrubs, boards, burn piles before burning, or any structure that a snake can crawl into or under (USFWS 2016c).

Foraging habitat can be floodplain, riparian, lowland, and upland forest or any area that provides an abundance of suitable prey. Foraging habitat usually has an open canopy and a sedge or grass ground cover (Johnson et al. 2000). The diet of eastern massasauga varies across the species range, but may consist primarily of small mammals (Microtus, Peromyscus, and Blarina). Juvenile eastern massasauga occasionally feed on snake species (USFWS 2016c).

After the active season, eastern massasauga rattlesnakes move to low wet areas for overwintering or hibernation (Reinert and Kodrich 1982, Johnson et al. 2000, Harvey and Weatherhead 2006). During colder months (generally October through April), they often hibernate below the frostline in sites that provide insulated and moist subterranean spaces where individuals can avoid freezing or dehydration. Hibernating snakes must spend most of the winter fully submerged in water (USFWS 2016c). Across its range, eastern massasaugas have been reported to hibernate for up to six months of the year and have used crayfish burrows, mammal burrows, rocky crevices, rodent holes, hummocks, old stumps, rotten logs, and tree and shrub root systems (Wright 1941, Johnson 1995, Dreslik 2005, Harvey and Weatherhead 2006, Johnson and Leopold 1998) or any excavation that reaches the water table (Reinert and Kodrich 1982). Hibernacula are typically near wetland edges, or slightly inland (typically within 500 meters of regulated wetlands)(Reinert and Kodrich 1982, Seigal 1986, Weatherhead and Prior 1992, Johnson 1995). The snakes hibernate either singly or in small groups or clusters, aggregating where favorable microhabitats occur (USFWS 2016c). The habitat needs while hibernating may be determined by features below ground, including water table depth, water table dissolved oxygen, temperature and pH (USFWS 2016c). Massasaugas rattlesnakes stay in the area around their hibernacula until overnight temperatures warm up enough for them to move to their active season range. Most eastern massasauga will either return to the same hibernacula each year (Johnson et al. 2000) or to an area within roughly 300 ft of their previous hibernation site (Harvey and Weatherhead 2006).

The range of eastern massasauga in the northeast includes sections of western New York, western Pennsylvania, and southeastern Ontario. In New York, the massasauga is known from only two sites (Johnson and Leopold 1998, Johnson 2000). Once common across its range, eastern massasauga has declined dramatically since the mid-1970s as result of habitat loss and fragmentation, a lack of proper habitat management, and eradication by humans. The most prominent threats include habitat loss and fragmentation through development and vegetative succession, mortality of individuals on roads, hydrologic alteration resulting in drought or flooding, persecution, collection, and post-emergent prescribed fire, mowing, and disking. Disease is a relatively recent threat with still unknown consequences.

The eastern massasauga was listed as threatened under the ESA on October 31, 2016.

4.10 *SNAILS*

4.10.1 Chittenango Ovate Amber Snail

Chittenango ovate amber snail (*Novisuccinea chittenangoensis*) is a terrestrial species with a shell that is ovate, slender, acute and of moderate thickness. The spire is long, slightly less than half the shell length, and the aperture is very oblique. The shell color is translucent, calcareous pale yellow to white. Adult specimens averaged 20.9 millimeters (mm) in shell length.

Chittenango ovate amber snail is known from only one site, located in the Chittenango Falls State Park in Madison County, NY. Chittenango ovate amber snail survives in and presumably prefers cool, partially sunlit areas of lush herbaceous growth within the spray zone of the Falls. The snails mate from May through July, ovipositing from June through July. Egg clusters are deposited at the base of plants, under matted vegetation, or in loose, wet soil. The young snails hatch in 2 to 3 weeks, measuring barely 2 mm. Snails are believed to reach maturity in five to eight months, or the spring following hatching. Life span for Chittenango ovate amber snails is approximately 2.5 years (USFWS 2006).

Chittenango ovate amber snails apparently feed on microflora and must obtain high levels of calcium carbonate from their environment for proper shell formation. Snails are generally found on green vegetation.

The habitat of Chittenango ovate amber snails lies within the ravine at the base of the 167-foot-tall waterfall formed by Chittenango Creek as it flows north from Cazenovia Lake toward Oneida Lake. This north-south oriented ravine forms a deep gorge that is shaded or partially shaded throughout most of the growing season, resulting in a microclimate that stays relatively cool during the summer, and because of the creek flow and ice formations, is relatively warm in the winter compared to the surrounding area. Spring thaws and periodic major rainfall events tend to remove vegetation from significant portions of the primary habitat for these snails. Five parameters appear to have significance in habitat considerations: humidity, substrate, temperature, vegetation and water quality (USFWS 2006). The primary habitat of Chittenango ovate amber snail is protected by the Chittenango Falls State Park, which reduces the likelihood of impacts to habitat through changes to substrate and vegetation, as well as providing protection from direct threats as a result of human access to habitat.

The primary threats to the snail in its existing habitat are considered to be the small population size and limited distribution of the species and the negative interaction with an introduced snail, *Succinea* sp. B. Additionally, habitat changes and inadvertent human disturbance present potential threats.

Chittenango ovate amber snail was listed as threatened under the ESA on August 2, 1978.

4.10.2 Flat-Spired Three-Toothed Snail

The flat-spired three-toothed land snail (*Triodopsis platysayoides*) is endemic to the Cheat River gorge of northern West Virginia. Little is known of the life history of this secretive animal. The flat-spired three-toothed land snail likely forms two genetically distinct populations, but has low overall diversity, occupies a very specific ecological niche, and has limited dispersal potential to occupy new habitat.

Flat-spired three-toothed land snails are typically observed within 3 feet of a rock feature. They can be found in cool, moist, deep fissures in shale, sandstone and limestone outcrops and in talus. This snail occurs in outcrops from the river bottoms to the ridgetops. Rock outcrops 3 feet or more in height are considered potential habitat if there are cracks and crevices at least 3 feet deep. The snail appears to prefer rock talus but also is found in cliff line areas that contain deep, dark crevices. When the two habitats coincide (rock talus and cliff line), the flat-spired three-toothed land snail is more often found in the talus.

Rock formations where the snail is found are usually Pottsville Sandstone, a relatively resistant rock which forms steep cliffs (mainly along the canyon rim), boulder fields, and talus slopes. The snail also occurs upon the Greenbrier Limestone formation at cave entrances (exposed in the lower levels of the Gorge). The forest that makes up its habitat is primarily second growth and oak dominated. It supports a large diversity of plants.

While plant associations and ages of trees occurring at known sites vary greatly, several plant species are commonly found at flat-spired three-toothed land snail sites: sweet birch, rhododendron, and red maple (Caldwell et al. 2006; Hotopp 2000). Dourson (2007) concluded that rock structure is more important than the age of trees or vegetative composition growing on rocks. Slope aspect is also a factor. North and northeast slopes in the Cheat Gorge provide naturally cooler and moister habitats than south and southwest facing slope aspects (USFWS 2007c).

The flat-spired three-toothed land snail is primarily active at night. Most snail activity is observed during spring to early summer during cool, moist weather conditions when air temperatures are between 60 – 65 degrees Fahrenheit with relative humidity greater than 85 percent (Dourson 2007). During daytime, the snail primarily has been found on the ceiling, wall, or floor of rock structures. During the night, snails have been found equally on both rock and the leaf litter near rock features. The species has been observed foraging and resting under wet leaves (next to rock structure) and moving across the littler to a rock feature (Dourson 2007). It is unknown whether the snail hibernates during winter. Its diet consists of a variety of leaves, rat feces, mushrooms, and other plant matter found in the leaf litter. It is believed that the tree cover provides essential cooling that contributes to the preferred microclimate for the snail (Dourson 2007).

Little is known about population sizes or trends because the snail is so difficult to survey (USFWS 2007c). Presence/absence surveys have been conducted at spotty locations throughout the gorge. The failure to detect a snail during a presence/absence survey does not prove absence, especially if surveys are conducted during suboptimal conditions (e.g., dry and hot). Dourson (2007) notes that the flat-spired three-toothed land snail appears to be a relatively common species where it is found. Although many other species of snails have been documented coexisting with the flat-spired three-toothed land snail, they generally do not exceed flat-spired three-toothed land snail numbers (Dourson 2007). In many cases, the flat-spired three-toothed land snail was the most common snail, sometimes exceeding all other snail species combined.

At the time of listing, in 1978, the flat-spired three-toothed land snail was thought to be restricted to an area of less than 160 acres on the summit of Cooper's Rock, at the downstream end of Cheat Gorge, in Monogalia County, West Virginia. In 1981, the known range of the species was extended approximately

0.9 miles upstream (east) of Cooper's Rock. The first population on the south side of the gorge was discovered in 1982. When the Recovery Plan was written in 1983, the known range included seven locations, all in close proximity to Cooper's Rock. During surveys conducted from 1981 to 1991, 11 new localities were found, located south of Interstate-68 in Monogalia and Preston counties, West Virginia. The present known range of the species includes 99 element occurrences. The snail occurs on both sides of the gorge within an approximately 14-mile stretch, including portions of the major tributary raves. The range of the species begins near the mouth of Muddy Run near Ruthbelle in Preston County and extends to the lower reaches of Cheat Lake near Tyrone in Monogalia County (USFWS 2007b). Although the range of the species has expanded since listing, it is still considered to be a narrowly ranging species endemic to scattered rock features within the Cheat Gorge.

At the time of listing, recreational use of Coopers Rock State Forest was identified as the primary threat. Visitors could reduce leaf litter, crush snails, or toss away cigarettes, which could be a serious fire hazard (USFWS 1978). Fires pose a potential threat to the species. Fires could kill individuals as well as significantly reduce leaf litter for foraging. Decline in tree cover poses a moderate threat to *T. platysayoides*. Tree cover provides shade that can influence the microclimate of the snail's habitat which is important given the specie' preference for cooler areas especially during the summer

Flat-spired Three-toothed land snail was listed as threatened under the ESA on August 2, 1978.

5 Effects of Covered Activities

This section covers the effects of the anticipated activities covered in this standing analysis to the covered species and critical habitat (above). Where appropriate in our analysis, we make note of which activities are expected to have no effect on a species and critical habitat. This information is provided as helpful technical assistance to those agencies and project proponents who may be unfamiliar with the species and activities and can be incorporated by reference by action agencies when they make a NE determination.

The effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02).

A project's action area must include all areas affected (i.e., modifications to land, air, or water) by the proposed action, and not merely the immediate area involved in the action. If the activities satisfy the two-part test for causation ("but for" and "reasonably certain to occur"), they should be considered as part of the action. To qualify for use of this standing analysis, a project's action area must be wholly encompassed by the coverage area for this standing analysis as described above and all activities within the proposed action must fit within the scope of the standing analysis.

Qualifying actions typically involve one or more of the stressors addressed below.

5.1 *General Effects Analysis*

A project that meets all the following criteria can get to a "no effect" determination for a species if it

1. Occurs entirely within an area that does not provide habitat for listed species.
2. Does not have any potential for indirect effects to listed species or the habitats they depend on (e.g., water discharge into adjacent habitat or waterbody, changes in hydrology [e.g., surface flows, discharges, groundwater elevation], sound, and introduction of an exotic plant species).
3. Will not impact structures that may serve as roosts for listed bats.

For the most part, the species-specific conservation measures ensure projects are not occurring in suitable (occupied) habitat and will not have direct or indirect effects, as described above. For projects where listed species may be present, activities may involve some or all of the stressors considered below.

5.1.1 Direct Impacts

Direct impacts to federally listed species must be avoided for projects to qualify for the use of this Dkey. Projects can avoid direct impacts to listed species through avoidance of suitable habitat, application of time-of-year restrictions to conduct activities when listed species are not present, avoidance of particular project activities that will result in direct impacts within suitable habitat, or conducting surveys to demonstrate probable absence of species, or mark locations of listed species to ensure that project activities avoid those locations. Adherence to the specific conservation measures will ensure that any direct impacts to species will be avoided.

Conservation measures that avoid direct impacts to listed species through complete avoidance of suitable habitat are provided for Cheat salamander, Chittenango ovate amber snail, and flat-spired three-toothed snail.

Conservation measures that apply time-of-year restrictions to conduct activities within suitable habitat when listed species are not present are provided for bog turtle and eastern massasauga rattlesnake (e.g., conduct activities in upland areas while species are hibernating in wetlands), piping plover, roseate tern and rufa red knot (e.g., conduct activities in beach habitat when birds are not present),

Conservation measures that include avoidance of project activities that will result in direct impacts if conducted within suitable habitat are provided for black rail (e.g., vegetation treatments), bog turtle and eastern massasauga rattlesnake (e.g., activities within 300 feet of wetlands), crayfish, fish and freshwater mussels (e.g., instream activities), gray bat and Virginia big-eared bat (e.g., activities in caves), Indiana bat (e.g., prescribed fire, tree cutting, activities in caves), Madison Cave isopod (e.g., changes to hydrology), northeastern beach tiger beetle and puritan tiger beetle (e.g., activities on beaches, application of pesticide), plants (e.g., application of herbicide, ground disturbance, or vegetation removal), roseate tern (e.g., aquaculture with equipment that could trap birds).

Conservation measures that allow project proponents to mark locations of listed species in order to avoid locations within suitable habitat where listed species may be present are provided for listed plants ((e.g., vegetation removal, ground disturbance).

For a subset of species, surveys can be conducted to demonstrate that the species meets the survey criteria to support probable absence within the action area, and as a result direct impacts will not occur. These species or guilds include, northeastern beach tiger beetle, freshwater mussels, plants, Indiana bat, and bog turtle. In addition, projects can avoid direct impacts to plants by conducting surveys to determine the location of listed plants and employing conservation measures to avoid project activities within those locations.

For other species, survey criteria were not included because surveys are either potentially detrimental to the species (e.g., electroshock surveys for listed fish), difficult to conduct to the level of effort required to support the probable absence of the species (e.g., black rail, Madison Cave Isopod) or survey results are not adequate to ensure that the species has not moved into the project's action area since the survey was conducted (e.g., piping plover, red knot, roseate tern).

5.1.2 Insignificant Habitat Loss/Degradation

Some projects that qualify for use of this DKey may result in minor loss/fragmentation or temporary degradation of available habitat for one or more federally listed species. However, we believe that adherence to the specific conservation measures will ensure that any reduction or modification of available habitat will result in only insignificant effects to listed species and critical habitats. Conservation measures that control for significant loss/degradation of habitat include restrictions on the extent and timing of certain activities (e.g., outside of breeding, nesting, or migration periods of migratory birds), restrictions on stream/hydrology-impacting activities for several species (e.g., black rail, bog turtle, eastern massasauga, crayfish, fish, freshwater mussels, listed plants) restrictions on vegetation or ground-disturbing activities within the range or buffered habitat of several species (e.g. black rail, bog turtle, eastern massasauga, Indiana bat, Karner blue butterfly, listed plants, northeastern beach tiger beetle, Puritan tiger beetle, rusty patched bumble bee), and restrictions on actions that may fragment habitat or create barriers to movement/dispersal within the range of fish and freshwater mussels (e.g., improperly placed culverts/dammed or blocked streams).

For coastal species, including piping plover, red knot, roseate tern, northeastern beach tiger beetle, puritan tiger beetle, projects that include activity in beach habitats may impact the species if projects will permanently alter suitable habitat, or temporarily alter habitat in such a way that habitat is not available for feeding, breeding or sheltering. Beach restoration projects may include the long-term addition of suitable habitat but may alter the foraging resources available to nesting or migratory shorebirds (e.g., piping plover, rufa red knot), cover larvae burrows and alter food sources for northeastern beach tiger beetle or Puritan tiger beetle, or cover seed bank or growing season habitat for seabeach amaranth. Shoreline stabilization and/or beach renourishment may result in changes to beach profiles and/or altered natural beach dynamics resulting in loss or degradation of beach habitat used for breeding, feeding, and sheltering by northeastern beach tiger beetle, piping plover, Puritan tiger beetle, roseate tern, rufa red knot, and seabeach amaranth.

For bats, projects that include activity that could alter the suitability of caves for hibernation have been excluded from the key.

5.1.3 Insignificant or Discountable Levels of Disturbance

5.1.3.1 Noise and Vibration

Noise and/or vibration resulting from some projects are typically produced temporarily during the construction phase (e.g., construction vehicles and equipment, blasting) and may be permanently produced during the operation phase (e.g., roads/trails/bridges, commercial/recreational facilities, military operations). However, we believe that adherence to the specific conservation measures will ensure that any disturbance related to an increase in noise and/or vibration will result in only insignificant effects to listed species and critical habitats.

Conservation measures that limit exposure to noise and vibration and control for significant disturbance include restrictions on the timing of certain activities when species are present are provided for bats (e.g., tree cutting, drilling, blasting), bog turtle and eastern massasauga (e.g., upland activities), piping plover, roseate tern, and rufa red knot (e.g., activities conducted on beaches, activities that increase the presence of humans, presence of aircraft below 500 feet), roseate tern (e.g., number of boat trips for aquaculture projects)

Restrictions on instream activities allows projects to avoid impacts of noise or vibration which may cause permanent or temporary displacement of listed fish, crayfish, and listed mussels.

5.1.3.2 Smoke, Dust, Chemicals, and Odor

Smoke, dust, chemicals, and/or odor resulting from some project activities are typically produced temporarily during the construction phase (e.g., construction vehicles and equipment, blasting, invasive plant treatment/pesticide application, prescribed burning) and may be permanently produced during the operation phase (e.g., mines/quarries, commercial/residential developments, military operations). However, we believe that adherence to the specific conservation measures will ensure that any disturbance related to an increase in smoke, dust, chemicals, and/or odor will result in only insignificant effects to listed species and critical habitats. Conservation measures that limit exposure to these stressors and control for significant disturbance include restrictions on the timing of certain activities (e.g., prescribed burning and pesticide use in potential habitat during bat active seasons), restrictions on chemical use and vegetation-disturbing activities (e.g. within the SLA of listed insects), restrictions on direct and indirect river/stream impacts (e.g. within mussel habitat), and disturbance buffers around sensitive areas (e.g. piping plover and roseate tern nesting sites).

5.1.3.3 Night Lighting

Night lighting produced by some projects may occur temporarily during the construction phase (e.g., equipment lighting) and/or permanently during the operation phase (e.g., road/trail and facility lighting). However, we believe that application of the specific conservation measures will ensure that any disturbance related to night lighting will result in only insignificant effects to listed species and critical habitats. Most federally listed species are not expected to be affected by night lighting; however, certain species that are active at night (e.g., bats, piping plover, roseate tern, rufa red knot) may be sensitive to an increase in lighting at night. Conservation measures that limit exposure to this stressor and control for significant disturbance include the general exclusion for wind turbines (which require night lighting for safety), exclusion of activities that could result in increased bird collisions, the timing of certain activities (e.g., artificial lighting while bats are not present), exclusions of actions that may increase light as a result of an increase in human activity in potential habitat during the red knot migration windows or piping plover nesting season), and disturbance buffers around sensitive areas.

5.1.4 Changes to Hydrology

Several Northeast species are dependent on river and/or wetland habitats and stable water levels. Major alteration of habitat through change to hydrology could change habitat conditions such that they are no longer suitable, either through drying or inundation. For species that overwinter or shelter in wetlands (black rail, bog turtle, eastern massasauga rattlesnake), stable hydrology is necessary for successful overwintering. Aquatic species (e.g., crayfish, fish, freshwater mussels, Madison Cave isopod) depend on water sources that provide consistent quality, quantity and timing of water. Examples of projects that may significantly alter hydrology include those with large amounts of fill, large water withdrawals, and changes to structure (culverts or dams) within rivers and streams. Projects that include in-stream activities may alter water quality, quantity or timing temporarily or permanently. Conservation measures that address potential changes to hydrology include limits on in-stream activities, wetland activities, and activities that would introduce or expand sources of potential sediment or chemical contamination of water bodies.

6 SUMMARY AND CONCLUSION

After considering the relevant information pertaining to the species and critical habitat, reviewing the covered activities and associated required conservation measures, and evaluating their anticipated effects), we conclude that the actions subject to this standing analysis will support a federal action agency determination of "No Effect" or support a section 7(a)(2) determination pursuant to the Act of "may affect, not likely to adversely affect," as appropriate, for the subject species and critical habitat as described above. This standing analysis is based on the consultation provisions of section 7(a)(2) of the Act and the information cited and will undergo review and revision, as needed, if any of the following conditions have been met: 1) If new information reveals the effects of the covered action(s) to the covered species or critical habitat are occurring in a manner or to an extent not considered in this standing analysis based on applied use; or 2) If the species or critical habitat covered by the standing analysis has a change in status.

This standing analysis will be provided through IPaC via a link on the DKey summary page.

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