CHAPTER 4: REGIONAL CONSERVATION ACTIONS

SWAP Element 4

Descriptions of conservation actions determined to be necessary to conserve the identified species and habitats and priorities for implementing such actions. Suggested components:

A. The Plan identifies how conservation actions address identified threats to species of greatest conservation need and their habitats.

B. The Plan describes conservation actions sufficiently to guide implementation of those actions through the development and execution of specific projects and programs.

C. The Plan links conservation actions to objectives and indicators that will facilitate monitoring and performance measurement of those conservation actions (outlined in Element #5).

D. The Plan describes conservation actions (where relevant to the State's species and habitats) that could be addressed by Federal agency or regional, national or international partners and shared with other States.

D1-The Plan describes regional conservation needs and actions.

E. If available information is insufficient to describe needed conservation actions, the Plan identifies research or survey needs for obtaining information to develop specific conservation actions.

F. The Plan identifies the relative priority of conservation actions.

CONTENTS

TABLES

FIGURES

HOW TO USE THIS CHAPTER

This Chapter provides:

1. An overview and background of key regional efforts to prioritize conservation actions
2. The top seven (7) priority regional actions with:
    - Need and action statements
    - Regional approach
    - 70+ new key regional projects addressing the top regional threats
    - Examples and opportunities for regional implementation
3. References and resources
4. Appendices for Chapter 4 provide:
    A. Regional Project Summary Table
    B. A matrix of priority actions from 2015 SWAPs
5. Supplementary Information 4: IUCN CMP Actions

New information and differences from the 2013 synthesis

The 2013 regional conservation synthesis summarized regional conservation actions implemented through the Regional Conservation Needs (RCN), Competitive State Wildlife Grants (CSWG) and Landscape Conservation Cooperative (LCC) programs (TCI and NEFWDTC 2013). Since that time, the regional State Wildlife Action Plan (SWAP) Synthesis provided a collective summary of the conservation actions identified in the 14 2015 Northeast SWAPs, highlighting regional themes and priorities (TCI and NEFWDTC 2017).

This 2023 Regional Conservation Synthesis updates the inventory of RCN projects supported by the Northeast Association of Fish and Wildlife Agencies' (NEAFWA's) Northeast Fish and Wildlife Diversity Technical Committee (NEFWDTC) and Competitive State Wildlife Grant (CSWG) projects undertaken in the Northeast region over the past decade. The synthesis of existing regional conservation actions is now updated to include regional efforts of the Science Applications At-Risk Species (SA ARS) program of the United States Fish and Wildlife Service (USFWS), which address Regional Species of Greatest Conservation Need (RSGCN) and/or Watchlist species also identified as At-Risk Species by the USFWS in 2021 (USFWS Regional At-Risk Species Coordination Team 2021).

Over the last decade, key tools and projects were developed to support NEAFWA's NEFWDTC and SWAPS:

- Northeast Habitat Status and Condition Assessments (Anderson et al. 2011, 2013a, 2016a, 2016b, 2023a)

- Northeast Lexicon (Crisfield and NEFWCTC 2013, 2022)
- Northeast Conservation Synthesis for SWAP Revisions (TCI and NEFWDTC 2013)
- 2013 Northeast RSGCN list update
- Northeast SWAP Database version 1.0 and 3.0 (TCI and NEFWDTC 2015, 2020b)
- 2018 Northeast RSGCN list update
- Northeast Climate Change Synthesis for SWAP Revisions (Staudinger et al. 2015, 2023)
- Northeast SWAP Synthesis, (TCI and NEFWDTC 2017)
- Limiting Factors Report (TCI and NEFWDTC 2020a)
- RSGCN Database version 1.0 (TCI and NEFWDTC 2023)
- 70+ new RCN, CSWG, SA projects completed on RSGCN and their habitats
- This Northeast Conservation Synthesis, including the 2023 RSGCN list (see *Chapter 1*)

The 2023 NEFWDTC website update (www.northeastwildlifediversity.org) allows for web-enabling this Regional Conservation Synthesis and all the relevant projects, databases, and associated communication tools and products. These tools and resources are searchable with filters to provide detailed information for conservation actions and projects, such as the inventory of RCN and CSWG projects. Resources described in Chapter 4 of this Regional Conservation Synthesis plus supplemental materials developed as part of the RCN 3.0 Technical Services project will be centralized on one user-friendly web platform.

4.1 OVERVIEW OF REGIONAL ACTIONS

Conservation actions are any activities that manage, protect, enhance, conserve, or restore fish and wildlife or their habitats. These may include habitat or species management, species or site protection, methods of controlling invasive species, species reintroduction and captive breeding, policy changes, and education programs.

The fourteen 2015 Northeast State Wildlife Action Plans (SWAPs) identified and prioritized conservation actions for each state in the region. Those actions served as a framework for the development of priority actions for addressing top regional threats to priority species and their key habitats at the landscape, watershed, and seascape level across the Northeast. These actions ranged from broad, overarching regional steps to be taken across state boundaries over large landscapes, watersheds, or seascapes and affecting multiple taxa (as recommended by the Landscape Conservation Report (AFWA 2021), to finer-scale actions that address individual species, habitats, or locations.

Information was compiled from the 2015 SWAPs, the Regional Conservation Needs (RCN) program, other key regional partners, and data sources that have become available since the 2015 SWAPs. The Northeast Fish and Wildlife Diversity Technical Committee (NEFWDTC) Technical Services project used the NE SWAP Database version 1.0 (TCI and NEFWDTC 2015) to analyze and synthesize this information in its 2017 SWAP Synthesis (TCI and NEFWDTC 2017). With additional input from its Taxonomic Teams, SWAP Coordinators, and Threat Working Groups, the NEFWDTC developed seven overarching regional conservation action themes. These broad regional actions call for developing and providing information on Northeast conservation priorities (Elements 1 and 2), addressing the top regional threats to these priority species and habitats (Elements 3 and 4), then evaluation of those actions to deliver the most effective regional conservation across the region (Elements 5, 6) with coordination and communication interwoven in all elements, but specifically addressed in Elements 7 and 8.

These priority regional actions are:

1. *Develop science-based information and tools to conserve RSGCN and key habitats in the Northeast.*
2. *Conserve Northeast RSGCN and their habitats from habitat loss and degradation by addressing development, natural systems modification, and biological resource use.*
3. *Protect native species and habitats from the introduction and spread of disease and invasive species in the Northeast.*
4. *Conserve aquatic habitats by addressing pollution and aquatic connectivity in Northeast waters.*
5. *Address climate change impacts to Northeast RSGCN and their habitats.*
6. *Coordinate inclusively across state boundaries to maximize efficiency and effectiveness of fish and wildlife diversity conservation in the Northeast.*
7. *Develop and implement effective regional scale monitoring to inform adaptive management of regional priorities and conservation in the Northeast.*

This Regional Conservation Synthesis focuses on the regional actions that were most frequently cited and shared by the states and links these specific actions to the top regional threats summarized in *Chapter 3*. This chapter includes examples of collaborative regional actions that have been implemented by the Northeast State Fish and Wildlife Agencies, NEFWDTC, and partners to address the most important regional threats to address RSGCN and their habitats.

More specific, finer-scale actions for Species of Greatest Conservation Need (SGCN) and their key habitats are described in the 14 Northeast SWAPs (see links to all 14 SWAPS in 4.2.4 of this chapter) and in the Northeast SWAP Database, which will be updated following the 2025 SWAP revisions. They are analyzed in more detail in the 2017 SWAP Synthesis and Limiting Factors reports (TCI and NEFWDTC 2017, 2020a) and in the RCN Grant Program reports[1]. The RSGCN Database will also be revised to include additional information and priority regional actions for the recently updated 2023 RSGCN list.

The 2017 SWAP Synthesis analyzed actions from 14 Northeast SWAPs using the TRACS action classification system (cross-walked to the International Union for the Conservation of Nature's (IUCN's) Conservation Actions Classification Scheme (www.IUCNredlist.org, *Supplemental Information 4*) as recommended by the 2013 lexicon (Crisfield and NEFWDTC 2013). In 2016, Conservation Measures Partnership (CMP)[2] released the Conservation Actions Classification, version 2.0, replacing the CMP and IUCN joint version 1.0 that was released in 2007 and its version 1.1 update of 2008. The classification system allows conservation actions to be classified and categorized in a three-level hierarchical system, organized into these categories: Target Restoration; Stress Reduction Actions, Behavioral Change; and Threat Reduction Actions, and Enabling Condition Actions (CMP 2020). The updated Northeast RSGCN Database is structured to incorporate species-based conservation actions for RSGCN and Watchlist species as information becomes available, consistent with the CMP Conservation Actions Classification system and as recommended by the 2022 Northeast Lexicon for the 2025 SWAPs (Crisfield and NEFWDTC 2022).

4.1.1 PRIORITIZATION OF REGIONAL ACTIONS

Since 2008, the RCN program framework has guided NEFWDTC to strategically develop high priority conservation actions and projects for fish and wildlife diversity across the Northeast (see *Appendix 4A*). While the RCN program provides guidance on conservation priorities, at the time of the last SWAP revisions no comprehensive regional assessment and priority-setting exercise had been conducted.

In 2017, the network of 14 Northeast State Fish and Wildlife Agencies (NEAFWA) addressed this through its NEFWDTC, SWAP Coordinators, Taxonomic Teams, and Threat Working Groups; and with its USFWS partners, worked together to prioritize the top actions identified in the 14 SWAPs. They relied on the SWAP Database and SWAP Synthesis (TCI and NEFWDTC 2015 and 2017) which had identified "top regional actions" as those most frequently cited by the 2015 SWAPs and addressing the largest number of RSGCN and their key habitats. Through a 2017 priority setting exercise, they refined these "Regional Priority Actions" that NEAFWA and their partners could take

together to conserve and restore northeast RSGCN and their habitats at the regional scale.

The original Northeast Conservation Synthesis (TCI and NEFWDTC 2013) provided an inventory of regional projects through 2012. Since 2013, almost 100 RCN, CSWG, and SA regional projects have been funded, targeting priority species and habitats, identifying threats and indicators, and developing conservation actions to address them in the form of a diverse toolbox of Best Management Practices (BMPs), protocols, and conservation planning data and tools. Projects developed collaboratively demonstrate NEAFWA's strategic approach in which each project builds on its predecessors to advance a unified, state-driven regional framework for developing and implementing priority regional fish and wildlife conservation. These can be customized to address local efforts to prevent or minimize threat impacts to RSGCN and their key habitats, both terrestrial and aquatic. The most current SWAP and RSGCN, RCN, and key partner information and tools facilitate prioritization of on-the-ground conservation work.

Ongoing prioritization occurs annually. The NEFWDTC, SWAP coordinators, and partners review current RSGCN and key habitat and threat information as updated by taxonomic experts across the region. From this information, new and emerging regional priorities are identified and updated. The NEFWDTC then implements these priorities through RCN, Competitive State Wildlife Grants, and other partners and funding sources on a regional scale. Over the past decade, multiple regional projects have been developed in response to these annual prioritization efforts and to strategic analyses of RSGCN and NEFWDTC efforts. Updating the RSGCN list and working with taxonomic experts across the region to provide up-to-date information on the key needs of these regional priority species helps identify priorities for conservation and funding. These priority needs are then implemented through the RCN program and other key regional funding sources including CSWG.

Regional Priority Actions can be taken at multiple levels or scales. The broad, regional scale, overarching actions are the focus of this chapter. These actions are coordinated across state boundaries at landscape and watershed levels. Tools and projects developed regionally provide the consistent framework to ensure effective implementation at the customized state or local level. Examples and opportunities for implementation at multiple scales are provided for each overarching action in the following sections.

These top seven overarching actions prioritized for the Northeast region address key goals and targets of many partner plans at multiple scales, including the most recent Global Diversity Framework from the Kunming-Montreal Convention on Biological Diversity[3], the National Fish, Wildlife and Plants Climate Change Adaptation Strategy

recommendations (National Fish, Wildlife, and Plants Climate Adaptation Network 2021). and reflect a diversity of other partner plans from the global to local scale.

4.1.2 KEY FISH AND WILDLFIE AGENCY PROGRAMS SUPPORTING RSGCN REGIONAL ACTIONS

There are many regional organizations and partners working in conservation across the region (see *Chapter 7* for a more complete list of partners). The key regulatory agency programs have supported significant work over the past decade (primarily RCN, CSWG, and SA that will be referenced throughout this chapter).

Tribal Nations. Twenty-five federally recognized Tribal Nations reside in the Northeast Region, along with the many others that have not received federal recognition. While each Tribal Nation is unique, they all contend with similar challenges, which include the need to protect their sovereignty and self-determination and keep their people safe. As important as Tribal conservation may be, Tribal Leaders must address a wide variety of concerns. Some Tribes have well-developed conservation programs, others may have only one Natural Resource contact, and some do not have any contact person in that position.

Like other federal agencies, the US Fish & Wildlife Service has a trust responsibility to the federally recognized Tribal Nations. The trust responsibility stems from the fact that all places in the United States were Indigenous homelands at one time. Tribal Nations received the government's promise that the Tribes' sovereignty and self-determination would be respected, the Tribes' interests would be protected, and the Tribes would be provided with a land base for their occupation and benefit. Honoring these promises is a perpetual obligation for the federal government. This is the basis of the trust responsibility. The Northeast Region of the U.S. Fish & Wildlife Service works to uphold the trust responsibility in a wide variety of ways. There are many things that the Service is called upon to do with Tribes, or for Tribes, as required by policy or regulation. For anything that the Service funds, permits, or does, the Service considers whether that proposed action has the potential to affect the interests of any federally recognized Tribal Nation. If it does, the Service informs the Tribe listens, to any concerns, and does what is feasible within the Service's authority to address those concerns. The Service's actions may warrant Tribal consultation under the Endangered Species Act, NEPA, National Historic Preservation Act (Sec. 106), and Bald and Golden Eagle Protection Act, among other laws.

In addition to the Service's obligatory relations with Tribal Nations, there are ways that the various programs within the Service can seek partnerships and the alignment of conservation priorities with Tribes. This may involve technical assistance or funding.

Service programs that work with Tribes in the Northeast include Ecological Services, Fisheries and Aquatic Conservation, and the National Wildlife Refuge System. For more than two decades, the Service's Tribal Wildlife Grants Program (TWG) has provided funding for Tribes' conservation projects and capacity-building. TWG is administered by the Service's Wildlife and Sport Fish Restoration program (Tim Binzen and Richard Zane, USFWS Tribal Liaison, pers. comm. 2023).

Federal Fish and Wildlife Agencies. At the federal level, the USFWS and National Maine Fisheries Service (NMFS) have important roles and responsibilities in conserving fish and wildlife, while the Department of Agriculture shares a regulatory role for plants and some invertebrates (mainly insects). The Endangered Species Act provides the framework for addressing the most critically imperiled species. In the Northeast, more than 100 fish, wildlife, and plant species are listed as Threatened or Endangered under the Act, with approximately 75 more scheduled for review. Hundreds of other species are at risk of becoming candidates as well, and for many of these species, prelisting conservation actions may be able to address threats and reverse declines. The many programs of the USFWS address its mission to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people[4].

The USFWS' Wildlife and Sportfish Restoration program administers grant programs that distribute millions of dollars annually to state agencies and Tribes to manage fish, wildlife, and habitats and evaluate and enhance SGCN throughout the region. Since 2008, a portion of the State Wildlife Grant Program funding has been used for competitive grants to encourage interstate collaboration, innovation, and species conservation at larger scales. The Competitive State Wildlife Grants (CSWG) funds can be used for research, fish and wildlife surveys, species restoration, habitat management, and monitoring (see *Appendix 4A*).

The Science Applications program, in coordination with other USFWS programs and state partners, generated a list of 76 Priority At-Risk Species (ARS) representing a diverse array of taxa and habitats from across the Northeast Region where coordinated conservation effort may preclude the need to list these species under the Endangered Species Act (USFW Regional At-Risk Species Coordination Team 2021). Eleven At-Risk teams recently formed to address species or multi-species groups. Each At-Risk Team works together with partners to carry out a variety of conservation actions, including habitat management, species and habitats surveys, development of conservation strategies, propagation, and research.

State Fish and Wildlife Agencies. At the state level, the 14 Northeast State Fish and Wildlife Agencies (NEAFWA) regulate and are charged with the conservation of fish and

wildlife. NEAFWA's Northeast Fish and Wildlife Diversity Technical Committee (NEFWDTC) is specifically charged with guiding regional efforts in fish and wildlife diversity. An important regional funding source to implement conservation is the Regional Conservation Needs Program. Since 2008, the thirteen NEAFWA states and the District of Columbia have contributed 4% of their annual federal State Wildlife Grants (SWG) Program funding to support projects of regional conservation interest. This funding is offered through an annual request for proposals administered by the NEAFWA[5] in collaboration with the WMI and USFWS. The funds are used to address conservation priorities that are shared across multiple jurisdictions.

Funding priorities for the Northeast RCN Grant Program continue to evolve, as many of the initial priorities have already been funded and are reported in this document. The RCN program practices adaptive management, refining priorities and selecting topics for funding that responds to urgent emerging wildlife needs, while at the same time continuing to address longstanding regional conservation concerns and keeping common species common. Details about the specific funding priorities addressed during each RCN grant cycle are available at the RCN website[1].

4.1.3 REGIONAL NEAFWA RCN AND USFWS CSWG AND SA PROJECTS FUNDED IN THE PAST DECADE

Projects completed over the past decade are listed in Table 4.1.1, with information on their funding source, the SWAP Elements/Chapters they address, and an active link to summaries in this chapter. The summary of each project is presented within one of the seven actions that it most directly addresses (as indicated in the Table 4.1.1). Many of these agency projects overlap to supplement each other and address more than one of the seven overarching actions and SWAP Elements. Therefore, they have been grouped or combined if supplemental or sequential. *Appendix 4A* provides a list of all RCN, CSWG, SA key regional projects and the SWAP elements that they address from 2007-2023. This Chapter provides summaries for projects implemented since the 2013 Synthesis. In section 4.2 they are organized by the kind of information or tool and SWAP element they address (see Table 4.1.1).

Table 4.1.1 Collaborative RCN, CSWG, and SA projects that address the regional conservation of RSGCN and key habitats. See *Appendix 4B* or www.northeastwildlifediversity.org for additional information on these projects. Click on the project name to go directly to the summary.

Project Name	**Funding Program**	**Species**	**Habitats**	**Threats**	**Info, Tools 1**	**Development 2**	**Disease & Invasive 3**	**H20 quality Connectivity 4**	**Climate 5**	**Coordinate 6**	**Monitor 7**	**Research**	**BMPs protocols**
Regional Project Title by Taxa and Topic	**X1**-indicates the primary action (1-7) addressed and the section located in this chapter). Note live links take you to the appropriate section by clicking on the project title. X indicates additional actions and SWAP elements addressed by each project.												
Northeast Regional Conservation Synthesis	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Northeast Lexicon for SWAP Revisions	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Northeast SWAP Comprehensive SGCN List	RCN	X			X1								
Northeast Regional Species of Greatest Conservation Need List	RCN	X			X1								
Northeast SWAP Database	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Modernizing the Northeast Wildlife Action Plan Database	CSWG	X	X	X	X	X	X	X	X1	X	X	X	X
RSGCN Database	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Northeast SWAP Synthesis	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Northeast RSGCN Key Limiting Factors Report	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Five-Factor Analysis	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Mammals													

Project Name	Funding Program	Species	Habitats	Threats	Info, Tools 1	Development 2	Disease & Invasive 3	H2o quality Connectivity 4	Climate 5	Coordinate 6	Monitor 7	Research	BMPs protocols
Allegheny Woodrat Recovery	RCN	X	X	X	X1		X		X	X	X	X	X
Bats and White-Nose Syndrome	CSWG, RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Gating Caves for Bat Conservation and Protection	RCN	X	X	X	X1	X	X	X	X	X	X		X
New England Cottontail Initiative and Conservation Strategy	CSWG, SA, RCN	X	X	X	X	X	X1	X	X	X	X	X	X
Bat Research in Maryland	CSWG	X	X	X	X1	X	X	X	X	X	X	X	X
Motus 1-3: Identifying Landscape-scale Habitat Use of Multiple SGCN in the Mid-Atlantic Region Using Nanotag Technology	CSWG	X	X	X	X1	X	X	X	X	X	X	X	X
Birds													
Eastern Black Rail projects	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Restore Eastern Black Rail habitat	CSWG, RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Bird Assessment and Monitoring Standard Operating Procedures	RCN	X	X		X	X	X	X	X	X	X1	X	X
The Conservation of Tidal Marsh Birds: Guiding action at the intersection of our changing land and seascapes	RCN, CSWG, ARS	X	X	X	X	X1	X	X	X	X	X	X	X

Project Name	Funding Program	Species	Habitats	Threats	Info, Tools 1	Development 2	Disease & Invasive 3	H20 quality Connectivity 4	Climate 5	Coordinate 6	Monitor 7	Research	BMPs protocols
Testing Salt Marsh Restoration Practices for Saltmarsh Sparrow Conservation	CSWG, ARS	X	X	X	X	X	X	X1	X	X	X	X	X
Distribution and demography of saltmarsh sparrows in the understudied, southern extent of the species' breeding range	CSWG	X	X	X	X	X	X	X	X1	X	X	X	X
Atlantic Coast Beach and Shorebirds (American Oystercatcher, Ruddy Turnstone, and Whimbrel)	CSWG, SA	X	X	X	X1	X	X	X	X	X	X	X	X
Forest Songbirds (Golden-winged Warbler, Cerulean Warbler, Wood Thrush)	SA	X	X	X	X1	X	X	X	X	X	X	X	X
CSWG Eastern Shore Initiative	CSWG		X	X		X1							
Best Management Practices for RSGCN In Northeast Forests	RCN	X	X	X	X	X1	X	X	X	X	X		X
Implementing Bird Action Plans for Shrubland Dependents in the Northeast	RCN	X	X	X	X	X1							

Project Name	Funding Program	Species	Habitats	Threats	Info, Tools 1	Development 2	Disease & Invasive 3	H20 quality Connectivity 4	Climate 5	Coordinate 6	Monitor 7	Research	BMPs protocols
Establishing a Regional Initiative for Biomass Energy Development for Early-Succession SGCN in the Northeast	RCN	X	X	X	X	X1							X
Reptiles and Amphibians													
Distribution and Conservation Status of Newly Described Leopard Frog Species	RCN	X	X		X1	X	X	X	X	X	X	X	
Northeast Regional Frog Monitoring	RCN	X	X		X	X	X	X	X	X	X1	X	
Conservation Plan for Blanding's Turtle and Associated Wetland-Dependent SGCNs projects	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Status Assessment and Conservation Plan for the Eastern Box Turtle	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Implementation of The Bog Turtle Conservation Plan for The Northern Population, With Benefits to Associated Headwater Wetland SGCN	RCN, CSWG, ARS	X	X	X	X1	X	X	X	X	X	X	X	X

Project Name	Funding Program	Species	Habitats	Threats	Info, Tools 1	Development 2	Disease & Invasive 3	H20 quality Connectivity 4	Climate 5	Coordinate 6	Monitor 7	Research	BMPs protocols
Creating a comprehensive conservation and management plan for the southern lineage of the Bog Turtle and its associated habitats	CSWG, RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Spotted Turtle Conservation	CSWG, RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Conserving Vermont's spotted turtles	CSWG	X	X	X	X1	X	X	X	X	X	X	X	X
Wood Turtle Conservation Plan	CSWG, RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Conservation Planning and Implementation for the Wood Turtle an Associated Riparian SGCN	RCN, CSWG	X	X	X	X1	X	X	X	X	X	X	X	X
Population Declines Due to Loss of Adult and Juvenile Turtles to Illegal Wildlife Trade	CSWG, ARS	X	X	X	X1	X	X	X	X	X	X	X	X
ARS Program efforts for the Northeast Turtles (Blanding's, Spotted, and Wood Turtle) Conservation	ARS	X	X	X	X1	X	X	X	X	X	X	X	X

Project Name	Funding Program	Species	Habitats	Threats	Info, Tools 1	Development 2	Disease & Invasive 3	H20 quality Connectivity 4	Climate 5	Coordinate 6	Monitor 7	Research	BMPs protocols
Hellbender Population Assessment and Protocols	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Conservation Strategy for the Northern Diamondback Terrapin	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Ranavirus in Amphibian Populations	RCN	X	X	X	X	X	X1	X	X	X	X	X	X
Timber Rattlesnake Population Assessment	RCN	X	X	X	X1	X	X	X	X	X	X	X	
Snake Fungal Dermatitis in New England Timber Rattlesnakes	RCN	X	X	X	X	X	X1	X	X	X	X	X	X
Conserving Snake Species of Greatest Conservation Need Threatened by an Emerging Fungal Skin Disease	CSWG	X	X	X	X1	X	X	X	X	X	X	X	X
Invertebrates													
Bee Pollinators in NJ	CSWG	X	X	X	X1	X	X	X	X	X	X	X	X
Pollinator Habitat in Xeric Grasslands, Barrens, and Woodlands	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Bee, Moth, and Vegetation Monitoring	RCN	X	X	X	X	X	X	X	X	X	X1	X	
Pine Barrens Species Conservation	SA	X	X	X	X1	X	X	X	X	X	X	X	X

Project Name	Funding Program	Species	Habitats	Threats	Info, Tools 1	Development 2	Disease & Invasive 3	H20 quality Connectivity 4	Climate 5	Coordinate 6	Monitor 7	Research	BMPs protocols
Farmland Pollinators (Monarch, American and Yellow-banded Bumblebee, Ashton's, Lemon, and Variable Cuckoo Bumble Bee)	SA	X	X	X	X	X	X	X1	X	X	X	X	X
Mountain Butterflies (White Mountain Arctic, White Mountain Fritillary)	SA	X	X	X	X	X	X	X1	X	X	X	X	X
Best Management Practices for Wetland Butterflies	RCN	X	X	X	X1	X	X	X	X	X	X	X	X
Status Assessment of Northeast Land Snails and Invertebrate Database	RCN	X	X		X1	X	X	X	X	X	X	X	
Conservation Assessment of Odonata in the Northeast	RCN	X	X	X	X1	X	X	X	X	X	X		
Other Terrestrial projects													
Regional Focal Areas for Species of Greatest Conservation Need Based on Site Adaptive Capacity, Network Resilience and Connectivity	RCN		X	X	X	X		X	X1	X	X		

Project Name	Funding Program	Species	Habitats	Threats	Info, Tools 1	Development 2	Disease & Invasive 3	H20 quality Connectivity 4	Climate 5	Coordinate 6	Monitor 7	Research	BMPs protocols
Staying Connected in the Northern Appalachians	CSWG	X	X	X	X1	X	X	X	X	X	X	X	X
Impact of Climate Change on SGCN	RCN	X	X	X	X			X	X1	X	X		
Integrating Vulnerability Science into a Strategic Conservation Plan for Maine's Species of Greatest Conservation Need	CSWG	X	X	X	X1	X	X	X	X	X	X	X	X
Updating Vermont's 2025 Action Plan with Vermont Conservation Design	CSWG	X	X	X	X	X	X	X	X1	X	X	X	X
Pennsylvania's SWAP Prioritization and Mapping Enhancements	CSWG	X	X	X	X	X	X1	X	X	X	X	X	X
Aquatic Projects													
Determining the Effects of Landlocked Alewives on Anadromous Alewife Restoration	RCN	X	X	X	X		X	X1	X	X	X	X	X
Chesapeake Logperch projects	CSWG, ARS	X	X	X	X	X	X	X	X	X	X1	X	X
Freshwater Mussels	RCN, CSWG	X	X	X	X1	X	X	X	X	X	X	X	X

Project Name	Funding Program	Species	Habitats	Threats	Info, Tools 1	Development 2	Disease & Invasive 3	H20 quality Connectivity 4	Climate 5	Coordinate 6	Monitor 7	Research	BMPs protocols
Freshwater Mussels (Brook Floater, Cumberland Moccasinshell, Pheasantshell, Tennessee Clubshell, Tidewater Mucket, Yellow Lampmussel)	RCN, CSWG, SA	X	X	X	X1	X	X	X	X	X	X	X	X
Diadromous Fishes Conservation (Alewife, Blueback Herring)	SA	X	X	X	X1	X	X	X	X	X	X	X	X
An Interactive, GIS-Based Application to Estimate Continuous, Unimpacted Daily Streamflow at Ungauged Locations in the Connecticut River Basin	RCN		X	X	X			X1	X		X		X
ELOHA Framework in the Great Lakes Drainage	RCN		X	X	X			X1	X		X		X
The Gulf of Maine Coastal Marine Ecosystem Survey	CSWG	X	X	X	X	X1	X	X	X	X	X	X	X
Terrestrial and Aquatic Habitat Classification Systems, Assessments and Guides	RCN	X	X	X	X	X	X	X1	X	X	X	X	X

4.2 DEVELOP SCIENCE-BASED INFORMATION AND TOOLS TO CONSERVE RSGCN AND THEIR HABITATS

4.2.1 REGIONAL NEED AND PRIORITY ACTIONS

Regional Need: The 2005 and 2015 Northeast SWAPs identified data deficiency as a limiting factor in the effective conservation of SGCN and their habitats in their states. They identified species and habitats of greatest conservation need, but differences in available data, capacity, and approaches to prioritization posed a further challenge to collaborative, regional conservation. Many of the SWAP SGCN and RSGCN/Watchlist species lack the current, consistent status, habitat, threat, and other information needed to inform effective conservation in the Northeast.

Priority Actions: Identify and develop regionally consistent information and priorities for species, key habitat, threats including climate vulnerability. Develop and apply targeted and inclusive communication of NEFWDTC priorities and products (from SWAPs, RCN, and key partners) to inform and guide regional conservation planning and incorporate into partner plans at all levels. Strategically focus "on-the-ground" conservation actions for regional habitat and species priorities by providing incentives, science-based best practices, techniques, tools, and information on land and water conservation to conserve RSGCN and their habitats.

See Priority Species in Chapter 1, Priority Habitats in Chapter 2, Priority Threats in Chapter 3, each with partner and program opportunities and examples. See Table 4.1.1 and Appendix 4A for priority projects completed and Appendix 4B, the SWAP Synthesis, and individual SWAPs for additional priority Conservation Actions.

Each Northeast State revises its plan every ten years and can be accessed through the respective **Northeast SWAP Website links:**

- Connecticut
- D.C.
- Delaware
- Maine
- Maryland
- Massachusetts
- New Hampshire
- New Jersey
- New York
- Pennsylvania - Fish
- Pennsylvania - Game
- Rhode Island
- Vermont
- Virginia
- West Virginia

4.2.2 APPROACH

The Northeast RSGCN list, first developed in 1999 and updated in 2013, 2018, and 2023 is maintained by the Northeast Association of Fish and Wildlife Agencies' Northeast Fish & Wildlife Diversity Technical Committee. As a non-regulatory regional list, its purpose is to provide focus, resources, and collaboration to secure species (and their habitats) of mutual conservation concern for current and future generations in the Northeast. Northeast RSGCN are species for which the region has stewardship responsibility due to their high conservation concern status and populations centered in the region. The 2023 list includes 20 taxonomic groups of vertebrate and invertebrate Species of Greatest Conservation Need derived from Wildlife Action Plans in the NEAFWA planning region. The list is updated every five years to support focused action on high priority Northeast species by the NEFWDTC, development of future SWAPS, and conservation planning and implementation by state fish and wildlife agencies and their partners.

The RSGCN list provides a framework and focus for consistent regional conservation of high priority fish and wildlife species and their habitats, and for identifying and addressing their key threats and vulnerabilities. It includes species that are globally or regionally imperiled and for which the Northeast Region has conservation responsibility. The process for selecting RSGCN is transparent and repeatable, relying on a broad set of well-accepted conservation assessments that cross taxonomic groups (TCI and NEFWDTC 2022). The RSGCN list is used by states and partners to facilitate coordinated conservation action across the region; see *Chapter 1* and the NEFWDTC website[1] for more information on the most current list and RSGCN Database version 1.0 (TCI and NEFWDTC 2023).

The SWAP Database version 3.0 (TCI and NEFWDTC 2020a) compiles specific status, habitat, threats and actions for SGCN and RSGCN from the 14 2015 Northeast SWAPs. It is a repository and a source of SGCN information that is searchable at the regional, subregional, or state level. As the RSGCN Database provides information on priority regional species, the SWAP Database provides broader information on SGCN for each state. The Northeast Fish and Wildlife Diversity website[1] highlights this and other information and tools developed for fish and wildlife diversity conservation over the past decade by the NEFWDTC and its partners.

These resources then inform regionally consistent information and approaches for implementation to effectively address the top regional threats in the Northeast. This Regional Conservation Synthesis applies the 14 SWAP conservation priorities at the regional scale. Additional partner information on regional priorities was referenced and considered in the identification of RSGCN, including USFWS Threatened, Endangered

and At-Risk species[6], ECOS website[7] or the ESA page[8], the US Forest Service Sensitive Species[9], NRCS lists of focal species[10], and NatureServe[11].

This state-based SWAP information on regional conservation priorities should be provided and incorporated into planning and regulatory efforts at the local, state, and regional scales. SWAPS/SGCN and RCN/RSGCN serve as valuable resources that can be incorporated into many planning efforts that are required or urged to consider information on fish and wildlife diversity. This includes the State Forest Action Plans, State Comprehensive Outdoor Recreation Plans, USFWS Comprehensive Conservation Plans for National Wildlife Refuges, US Forest Service National Forest Plans, Integrated Natural Resource Management Plans for Department of Defense lands, NRCS Farm Bill projects, and Tribal Wildlife Action Plans, among many others. Planning that occurs at the local level (e.g., county comprehensive plans), the planning district level, or for state-level infrastructure, energy, transportation, and other relevant planning efforts should also ensure that wildlife conservation has been considered in any activities that impact regional and state priority species or their habitats. Additional regulatory and planning efforts, including all federal regulatory departments and agencies, should utilize these data and tools in their standard operating procedures for planning and regulation.

Local, state, and regional partnerships and plans offer a holistic approach to conserving SGCN and RSGCN species and their habitats. In conjunction with restoration tools developed by regional partners, these efforts also support on-the-ground conservation of RSGCN and associated habitats in the region. Effective partnerships and actions include working with existing partners' programs and developing new programs, incentives, and tools relevant to SWAP/RSGCN priorities.

The NEFWDTC incorporates updated information on species, habitats, threats, and actions into its established communication process for internal prioritization. It also shares this information externally with partners to expand conservation efforts and develop the most effective means to address needs and threats. This reinforces the value of the NEFWDTC's RCN process, which seeks to identify and regularly update Northeastern fish and wildlife diversity conservation priorities and issues raised by states and their partners. The information can then be used to inform each iteration of the RCN project funding, identifying the best match of partner roles and capacity to maximize effectiveness, and cast a wider conservation footprint across the region.

4.2.3 PROJECTS PROVIDING INFORMATION AND TOOLS ON REGIONAL PRIORITIES

Appendix 4A provides a list of projects that have advanced the conservation of regional species and habitats through the RCN program and other key regional funding initiatives together with the SWAP elements that they address from 2007- 2023. This Chapter provides a list and summaries for those projects implemented since the 2013 Synthesis. In this section, projects are organized by the kind of tool or information and the SWAP element(s) they address (see Table 4.1.1 for list with links and *Appendix 4A* for all projects).

Partner use of these data and tools expands conservation effectiveness throughout the region, providing for more consistent implementation, monitoring, and evaluation of priority regional conservation targets identified by State Wildlife Action Plans[1].

REGIONAL INFORMATION ON PRIORITY SPECIES AND HABITATS

As part of the strategic development of sequential information and tools for states to work together at the regional landscape and watershed level, the following RCN projects specifically support SWAP revisions and NEFWDTC charges. The NEFWDTC Technical Services contractor (TCI) compiled, analyzed, and synthesized a vast amount of information on almost 20,000 species in the Northeast and conducted reviews of species, habitats, threats, and actions identified in the 14 State Wildlife Action Plans. This assisted state agencies in determining regional species and habitats of greatest conservation need; threats within the region; and actions that could be taken to limit the impact of these threats regionwide. Once these priorities were identified, the RCN program then funded a series of technical analyses, reports, and products, including the RSGCN list, Habitat Condition Assessment, Northeast Lexicon, Regional Synthesis, SWAP Synthesis, Northeast SWAP Database, RSGCN Database and website, and at least 70 additional projects providing information on these regional priorities. All are available on the NEFWDTC website and are summarized below.

Northeast Regional Conservation Synthesis (2013 and 2023) (RCN). To support the 2015 and 2025 SWAP revisions, syntheses of the most current and best available information on the Eight Essential SWAP Elements were produced. These documents provided current regional data and project summaries on species, habitat, threats, actions, monitoring, and partner/stakeholder information most relevant to fish and wildlife diversity, especially RSGCN across the Northeast (TCI and NEFWDTC 2013 and 2023). The documents were organized by SWAP Element to provide the regional context for individual state plans for each of those elements. The new 2013 RSGCN lists were presented along with summaries of the ongoing conservation work by states and their partners. These projects were funded through the RCN and CSWG programs to fill

critical data gaps and address conservation needs for the species given high priority by the NEFWDTC representing all 14 SWAPs.

Northeast Lexicon for SWAP Revisions (2013 and 2022) (RCN). Differences in the language used in the 2005 SWAPs spurred the NEFWDTC and SWAP Coordinators to work together to develop the Northeast Lexicon – a set of terminology conventions and a common data framework for SWAPs (Crisfield and NEFWDTC 2013 and 2022). The lexicon addressed the SWAP Elements- species, habitats, threats, actions, and monitoring and provided common classification systems and a common data framework based on the NE SWAP and RSGCN databases. The Northeast Lexicon improves inter-state communication, facilitating regional planning processes by helping states compare species, habitats, threats, actions, and monitoring for collaborative opportunities.

Northeast SWAP Comprehensive SGCN List 2015 (RCN). In 2015, NEAFWA's Northeast Fish and Wildlife Diversity Technical Committee consolidated all 14 SWAP SGCN lists, setting the stage for compilation of species, habitats, threats, and actions data into the Northeast Regional SWAP Database. This facilitated the RSGCN process as well as the NE SWAP and RSGCN Databases.

Northeast Regional SWAP Database version 3.0 (2020b) (RCN). To support State Fish and Wildlife Agencies' efforts to identify regional priorities through access to data contained in the 14 Northeast SWAPs, NEFWDTC's compiled key information from the 14 Northeast SWAPs in a streamlined, searchable database which in turn provided state agencies and their partners with easy access to this information through simple queries and reports (TCI and NEFWDTC 2020b). This also helped in compiling the next RSGCN list while also identifying region-wide patterns and priorities that encouraged states to work together on the shared priorities identified in their SWAPS.

The current CSWG project includes updating and web enabling the database for improved accessibility and use. A CSWG project supported **Modernizing the Northeast Wildlife Action Plan Database beginning in 2023.** Building on prior achievements of the first version of the Northeast SWAP database, the NEAFWA states propose to upgrade this important regional tool to a web-based database to increase accessibility and analytical functionality to proactively address growing resource concerns and facilitate landscape-scale conservation. The database development will be completed in 2026. This work will be guided by a Steering Committee of the NEFWDTC SWAP Coordinators working with contractors and staff who will help ensure a fully functional, user friendly and accessible web platform and interactive product.

Northeast SWAP Synthesis (2017) (RCN). Once the SWAP Database was completed in 2016, NEFWDTC/TCI began an unprecedented compilation of all 14 State

Wildlife Action Plans (SWAPs) in the Northeast Region. TCI compiled and analyzed these data to find common threats to RSGCN and their habitats, determine common conservation actions, and identify actions that could be implemented through regional collaboration and coordination. Recently completed RCN projects set the stage for the compilation and analyses of species, landscapes, threats, and actions data into the Northeast Regional SWAP Database. The SWAP Synthesis report summarizes the database analysis of threats to SGCN and their habitats along with regional conservation priorities and recommendations for collaborative action (TCI and NEFWDTC 2017).

Northeast Regional Species of Greatest Conservation Need List (1999, updated 2013, 2018, and 2023) (RCN). NEFWDTC updates its RSGCN list every five years to identify current regional priority conservation targets. The RSGCN list was first developed in 1999 (Therres et al. 1999) and is maintained by NEFWDTC. It is a non-regulatory regional framework whose purpose is to provide focus, resources, and collaboration in securing species and their habitats for current and future generations in the Northeast. The 2023 list includes 20 taxonomic groups of vertebrate and invertebrate SGCN from SWAPs in the NEAFWA planning region. Northeast RSGCN are species for which the region has stewardship responsibility due to high conservation concern and/or populations that are centered in the Northeast Region. The list is updated every five years to support focused action on high priority Northeast species by the NEFWDTC, development of SWAPS, and conservation planning and implementation by state fish and wildlife agencies and their partners. (See *Chapter 1* and the NEFWDTC website for more information on the most current list).

Northeast RSGCN Key Limiting Factors Report (2020a) (RCN). The 2015 SWAPs identified threats to the state SGCN in the Northeast. The SWAP Database compiled these threats using the classification system outlined in the Lexicon in order to synthesize information at a regional level. However, linkages explaining why threats were responsible for the decline of species or degradation of habitats were not always clear. The Northeast Lexicon builds on the Conservation Measures Partnership threat classification system, which identifies direct threats to species and habitats, but does not capture indirect or amplifying threats (e.g., climate change, shifts in food availability, or predator-prey relationships). Additional data fields were added to the SWAP database to capture these indirect and amplifying threats, called limiting factors. The 2019 RSGCN limiting factors RCN project used these data to better explain how threats impact populations and habitat. The limiting factors were organized in four groups: 1) habitat use and condition factors; 2) migration and wintering strategies; 3) food needs; and 4) vulnerabilities due to reproduction or survivorship. For details see Northeast RSGCN Key Limiting Factor Themes Report (TCI and NEFWDTC 2020a) and *Chapter 3*.

RSGCN Database (2023 version 1.0) (RCN). The RSGCN database, previously part of the NE SWP Database, was created as a stand-alone database to more efficiently address the amount of information and focus of its contents. The information it includes is linked to the NE SWAP database by species ID, and includes state and partner data, RSGCN and conservation status, previous RSGCN lists, partner prioritization, habitat, threats, actions, limiting factors, etc. It is managed as a separate tool from the SWAP database because it encompasses all Northeast species (including non-SGCN), 5yr vs 10yr update, regional vs state lens). The database continues to be updated, as part of the RCN 3 project, and will be available on the NEFWDTC website.

RESEARCH, SURVEY, ASSESSMENT, OR MONITORING INFORMATION AND TOOLS

Five-Factor Analysis (RCN). An important RCN project was developed in 2015 to inform and expedite the federal workplan and listing process. Since 2010, the USFWS has received numerous listing petitions for potentially imperiled species. More than 25% of the species on the current Federal Listing Workplan occur in at least one state in the NEAFWA service region. Many of these species have been included as SGCN in one or more State Wildlife Action Plans developed by NEAFWA state members. A preliminary evaluation by state fish and wildlife agencies in the Northeast identified several species for which federal protection under the Endangered Species Act was potentially not warranted. Frequently, species of lower conservation concern can be precluded from listing if relevant data are compiled, and necessary conservation actions applied. The objective of this project was to facilitate state input and engagement in the USFWS listing process by synthesizing existing state and regional information. It uses the "five-factor analysis" approach of the USFWS applied to selected species for which substantial information is already available. The goals are to support ongoing conservation action and reduce the likelihood of federal listing (Klopfer 2016).

Five-factor status reviews were created for Little Brown Bat (*Myotis lucifugus*), Northern Red-bellied Cooter (*Pseudemys rubriventris*), Popeye Shiner (*Notropis ariommus*), and Chesapeake Logperch (*Percina bimaculata*). By providing this information in a form that can be readily used by the federal Endangered Species review team, the NEAFWA states can facilitate and/or potentially accelerate listing decisions for these four species of relatively low conservation concern and decrease the time needed for agency staff to respond to Service requests for information. Multiple benefits include the reduction of state and federal agency staff time needed for Section 7 compliance reviews for all WSFR funded grants.

Allegheny Woodrat Recovery (2013) (RCN). The objectives of this RCN project were to determine interactions between Allegheny Woodrat (*Neotoma magister*)

populations and forest dynamics, to determine incidence of raccoon roundworm (*Baylisascaris procyonis*) parasite load in raccoon feces; to conduct population analysis based on previous mark/recapture data; and to compare the relative efficacy of live trapping vs. remote cameras for detecting presence of Allegheny Woodrats. The study estimated populations at the six long-term monitoring sites. Results suggest that woodrat populations exist at low densities, are continuing to decline in western Maryland, and that certain sites represent critical habitat. These long-term monitoring sites are also considered to be some of the best strongholds for Allegheny Woodrat populations in western Maryland. Low population densities, continued declines in population, and the possible genetic consequences of interbreeding due to low populations put into question the species' long-term viability in the state (Duda et al. 2016, Pearce et al. 2016).

Motus 1-3: Identifying Landscape-scale Habitat Use of Multiple SGCN in the Mid-Atlantic Region Using Nanotag Technology (2018, 2019, 2022) (CSWG). This project provides: 1) geographic and temporal data on migration; 2) full life cycle data to inform habitat management and conservation action decisions for SGCN; 3) corroboration of recent modeling based on NEXRAD radar data identifying high-use migratory stopover sites; and 4) expansion of telemetry monitoring network by adding 46 automated telemetry receiving stations. In 2019, CSWG supported Motus II: Using Nanotag Technology to Identify Landscape-scale Habitat Use of Multiple SGCN in New England. The project will provide these data outputs with an additional focus on American Kestrel (*Falco sparverius*) and Monarch butterfly (*Danaus plexippus*), with full life cycle data to inform habitat management and conservation action decisions for SGCN, provide new data on detection distances to optimize tower construction and placement for species tracking, and expand the telemetry monitoring network by adding 50 automated telemetry receiving stations. The Motus project contributes significantly to landscape- scale monitoring of migratory species in the region. Motus III: PA and VT Portion of Identifying SGCN Habitat Use Across Multiple Scales Throughout the Eastern U.S. Using the Motus Wildlife Tracking System expanded and employed Motus receiving stations to detect animal movements and determine where stopover habitats are, where populations are breeding, and where they are migrating and wintering. Additionally, the Project expanded the telemetry monitoring network by adding 35 automated telemetry receiving stations across West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Connecticut, Delaware, Maine, Maryland, Massachusetts, Pennsylvania, New Hampshire, New Jersey, New York, Rhode Island.

Bat research in Maryland (2017) (CSWG). This project sought to further understand bat status and distribution in the region. Significant Results include

recovering tens of thousands of single-nucleotide polymorphisms (SNPs) reliably across each species and finding that the Genotype-by-sequencing (GBS) approach produces highly repeatable results without batch effects. Population structure results were generally consistent for all methods employed. Analyses more capable of detecting gradients showed east-west differentiation for Silver-haired Bats (*Lasionycteris noctivagans*), but such gradients were not apparent for Eastern Red Bats (*Lasiurus borealis*) and Hoary Bats (*L. cinereus*). Coalescent modeling of effective population size indicated historic population expansion. The current effective population is larger for Eastern Red Bats and Hoary Bats than for Silver-haired Bats. While other studies have performed genetic and genomic analyses on long-distance migratory bat species, this research was the first to do so across the species' ranges. Including dozens of sites across North America confirmed the panmictic nature of eastern red bats and hoary bats and detected an east/west split in silver-haired bat population structure. This study greatly increased the coverage across each species' range, though samples from some regions were sparse. Population estimates do not exclude the possibility—suggested by existing population models—that some of these species are at risk for extinction, causing concern about the long-term viability of tree-roosting bats. Genetics is a valuable tool to detect population structure and inform managers of potential subpopulations. Other methods, such as the standardized acoustic surveys conducted by the NABat program, may be better able to detect current population changes in these species.

Eastern Black Rail Assessment and Conservation Plan (2016) (RCN). The Eastern Black Rail (*Laterallus jamaicensis jamaicensis*) is considered one of the most endangered birds in the Northeast region of the U.S. and along the Atlantic Coast. Populations in the Northeast have declined by 85% since 1992, and this species now breeds in no more than a dozen locations per state within its breeding range (Watts 2016). RCN program funds partially supported the creation of a Status Assessment and Conservation Action Plan for the Black Rail across the Northeast planning region. Specifically, the funds supported collection of information from an established consortium of agencies, biologists, academic institutions, and land managers represented on the Eastern Black Rail Conservation and Management Working Group[12]; a value-added synthesis of this information; and development of action items needed for a successful conservation campaign. The final products include a Status Assessment report updated in 2016 which is available the NEFWDTC website.

A project to create and **Restore Eastern Black Rail Habitat (2020) (CSWG)** at six non-tidal freshwater wetlands on Maryland's Eastern Shore was funded through CSWG. Following recommendations from the conservation plan, this project aimed to shift the population to non-tidal habitats that are safe from the threat of sea level rise in order to help stabilize and grow the population. These efforts continue to create ideal conditions

to attract and retain Eastern Black Rails in two different settings, creating a complex of wetlands in an area that has historically supported Black Rails.

Testing Salt Marsh Restoration Practices for Saltmarsh Sparrow Conservation. (2020) (CSWG and SA). The Saltmarsh Sparrow (*Ammospica caudacuta*) has experienced dramatic population loss caused by nest and deteriorating conditions in tidal marshes throughout the North Atlantic coast. The purpose of this project is to test a variety of management techniques designed to protect and restore salt marsh habitat. This project will identify the best strategies to be employed in salt marsh habitat restoration, and advance efforts to conserve the imperiled saltmarsh sparrow and other salt marsh dependent birds.

Distribution and demography of Saltmarsh Sparrows in the understudied, southern extent of the species' breeding range (2022) (CSWG). Another C-SWG project will determine the breeding status and distribution of Saltmarsh Sparrows in Virginia for the purpose of developing and evaluating state-level management actions for this Tier IIIa Species of Greatest Conservation Need (SGCN). The species is under review for federal listing and the information gained from this project will help inform the development of recovery criteria and actions, especially for the southernmost extent of the species' breeding range. Distribution and demography of saltmarsh sparrows in this portion of the species' breeding range will be clarified.

Conservation of Tidal Marsh Birds: Guiding action at the intersection of our changing land and seascapes (2010) (CSWG). The goal of this initiative was to provide the information necessary for all states along the New England and Mid-Atlantic Coast (Bird Conservation Region (BCR) 30) to protect regionally important habitats for tidal marsh birds (including direct actions for 26 SGCN). The project's long-term goal is to provide a regionally consistent platform for tidal marsh monitoring in the face of anticipated sea-level rise and upland/watershed development. This Competitive State Wildlife Grant supports work done in Maryland and Virginia that contributes to the Regional Conservation Needs grant awarded in 2010.

Identification of Tidal Marsh Bird Focal Areas in BCR 30 (2013) (RCN). This project conducted bird surveys using both passive and broadcast point count methods along tidal marshes in Maryland and Virginia, recording all bird species detected by sight and sound. In 2011, 398 points were surveyed spanning the Delmarva coastline of Maryland and Virginia and a few sites on Virginia's western Chesapeake Bay coastline. A total of 143 bird species in Maryland and 151 species in Virginia were observed from 273 points surveyed in April to June 2011-2012. Spatial patterns of abundance among 14 marsh bird species were similar in both years. Vegetation data were collected at 261 sample points according to the standardized protocol for the associated RCN project in

2011 and at 256 sample points in 2012. Vegetation data collected at each point included cover classes for local plant communities, the presence of invasive species, percent cover of 1-4 dominant species, and percent cover of pannes/pools/creeks, open water, upland, and wrack. Dead snags were counted in each plot and the tide cycle during data collection was noted. All bird survey and vegetation plot data were submitted to the RCN grant partners for incorporation into the final regional analyses. Final regional maps, estimates of changes in distribution and abundance, and critical areas for long-term protection were determined (Shriver et al. 2012).

The Eastern Shore Initiative (2021) (CSWG). This project protected a total 4,561 acres including 3,885 acres of nationally declining wetland types, 2,435 acres of palustrine forested wetlands, 1,082 acres of palustrine shrub/scrub, 363 acres of palustrine emergent, and 5 acres of estuarine emergent and estuarine forested wetlands located in Accomack County, Virginia. Portions of this acreage will be added to the 5,574 acres currently in the Saxis Wildlife Management Area (WMA), contributing significant habitat to this important migratory bird staging area and preventing the encroachment of potentially damaging residential development. This important land acquisition project enhances the value of other nearby Wildlife Management Areas. Saxis WMA and other state-owned management areas on the Eastern Shore (Virginia and Maryland) are also premiere mid-Atlantic migration and wintering areas for wildlife, as well as destinations for outdoor recreation and viewing opportunities.

Bird Assessment and Monitoring Standard Operating Procedures (2009) (RCN). The RCN program funded the Development of Avian Indicators and Measures for Monitoring Threats and Effectiveness of Conservation Actions in the Northeast. Northeast regional monitoring procedures are now available for birds of grasslands, tidal marshes, and mountain forest habitats that span the northeastern landscape, contain a high percentage of vulnerable species, and encompass the region's major management issues. These coordinated bird monitoring programs can measure region-level threats and management impacts on target birds and habitats identified by SWAPs as being of greatest conservation need. Products of this work include peer-reviewed survey design, protocols, and standard operating procedures for each indicator group (grassland, tidal marsh, and mountain forest birds), along with a regional database for each of these groups. This project also resulted in the development and implementation of a regional coordinated bird monitoring framework (Northeast Coordinated Bird Monitoring Partnership 2007) and the Northeast Bird Monitoring Handbook (Lambert et al. 2009). The mountain bird survey data was gathered as part of the Vermont Center for Ecostudies' high-elevation bird monitoring program, Mountain Birdwatch.

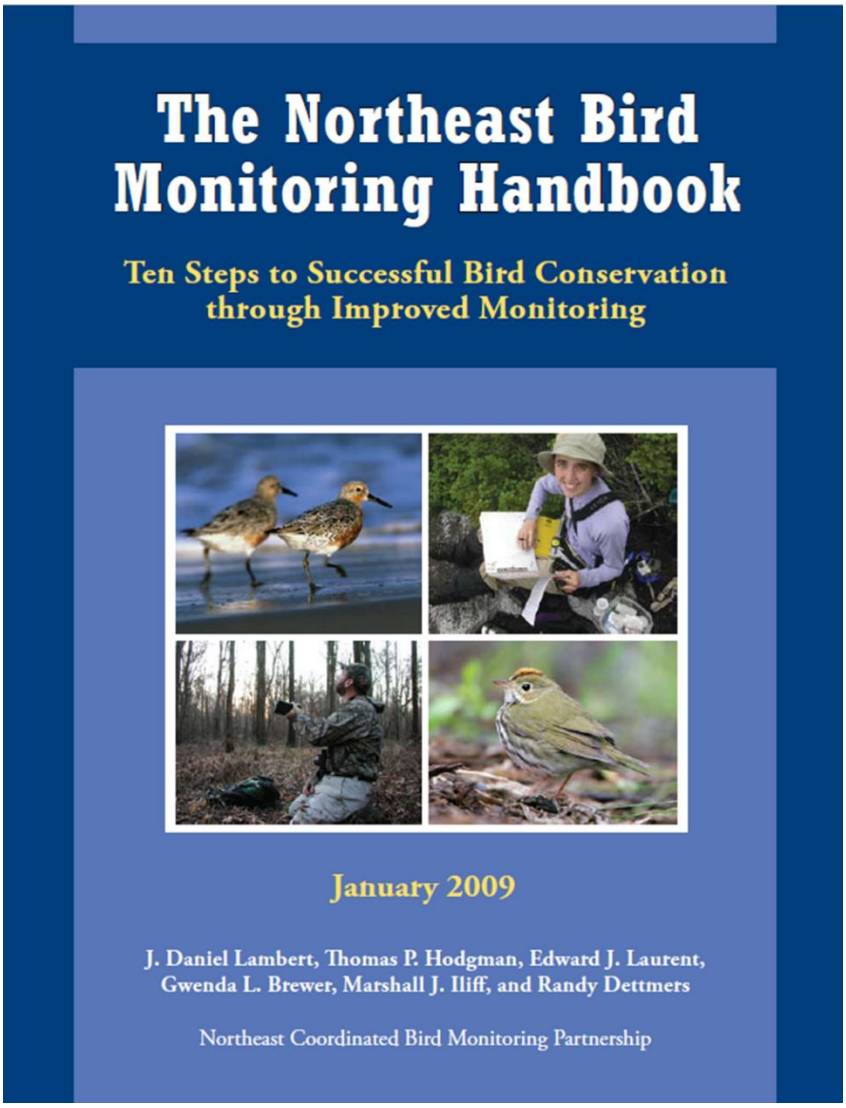


Figure 4.2.1 Northeast Bird Surveys, Protocols, and Monitoring RCN products for regional implementation.

Distribution and Conservation Status of Newly Described Leopard Frog Species (2016) (RCN). Objectives of this study were to: 1) determine which leopard frog species occur presently and occurred historically in ten eastern U.S. states; 2) refine the range of *Rana kauffeldi* relative to the two other leopard frog species; 3) map new, potentially reduced ranges for the two congeners; 4) assess the species' conservation status, particularly in areas where it is already known to be of concern; 5) contrast multi-level habitat associations among the three species; and 6) improve upon the separation of species using acoustic and morphological field characters to facilitate future inventory, monitoring, and status assessments. Significant changes in distribution of these three species were documented and *R. kauffeldi* was confirmed in eight eastern US states: Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina. Eighty-nine percent of these locations were

within 20 km of coastal waters. Differing habitat associations were also documented throughout its range. This multi-year, 10-state project demonstrated conclusively that *R. kauffeldi* is a habitat specialist with a small range centered in the most densely populated region of the United States. Making it more susceptible to stochastic events may exacerbate the impact of fungal pathogens and render it vulnerable to habitat fragmentation that in turn results in dispersal to less hospitable sites. Another concern for this species is the coastal proximity of many populations, making it vulnerable to rising sea levels and the increasing frequency and intensity of coastal storms associated with climate change. The study documented that *R. kauffeldi* has disappeared from a large part of its historical range in southern New York and Connecticut, including much of the Hudson Valley and all of Long Island. The study also reported disappearance of *R. pipiens* from much of the southern portion of its range, from Pennsylvania East through northwestern New Jersey, southeastern New York, southern Connecticut, southern Rhode Island, and coastal Massachusetts. A new northern range limit was identified for *R. sphenocephala* in central New Jersey (Schlesinger et al. 2017).

Hellbender Population Assessment and Protocols (2013) (RCN). The Hellbender (*Cryptobranchus allegheniensis*) is a RSGCN; the Common Mudpuppy (*Necturus maculosus*) shares a significant portion of its habitat with the Hellbender; and both have been identified as a Species of High Conservation Concern by the Northeast Partners in Amphibian and Reptile Conservation (NEPARC). Given the habitat overlap of these two species, efforts to detect Hellbenders concurrently generated data useful in monitoring Mudpuppy populations from 2014-2016. The objectives were: 1) to better document Hellbender distribution in the Northeast region; and 2) to develop standardized methodologies for monitoring Hellbender populations while collecting opportunistic information about Mudpuppy distribution. This was accomplished through stream surveys (including environmental DNA detection), improved communication among individuals working with Hellbenders or Mudpuppies, and the establishment of a regional stakeholder working group. Standardized protocols were developed to ensure the consistency and efficiency of Hellbender and Mudpuppy surveys while minimizing disturbance of stream boulder habitat. During the study, environmental DNA samples were collected from sites in New York, Pennsylvania, Maryland, West Virginia, and Virginia. Results of the project include: 1) a more comprehensive map of Hellbender distribution in the Northeast; 2) an eDNA archive (for detection of other stream-dwelling species); and 3) a protocol and communication framework to enable coordinated and efficient conservation of Hellbenders and Mudpuppies (Terrell et al. 2016).

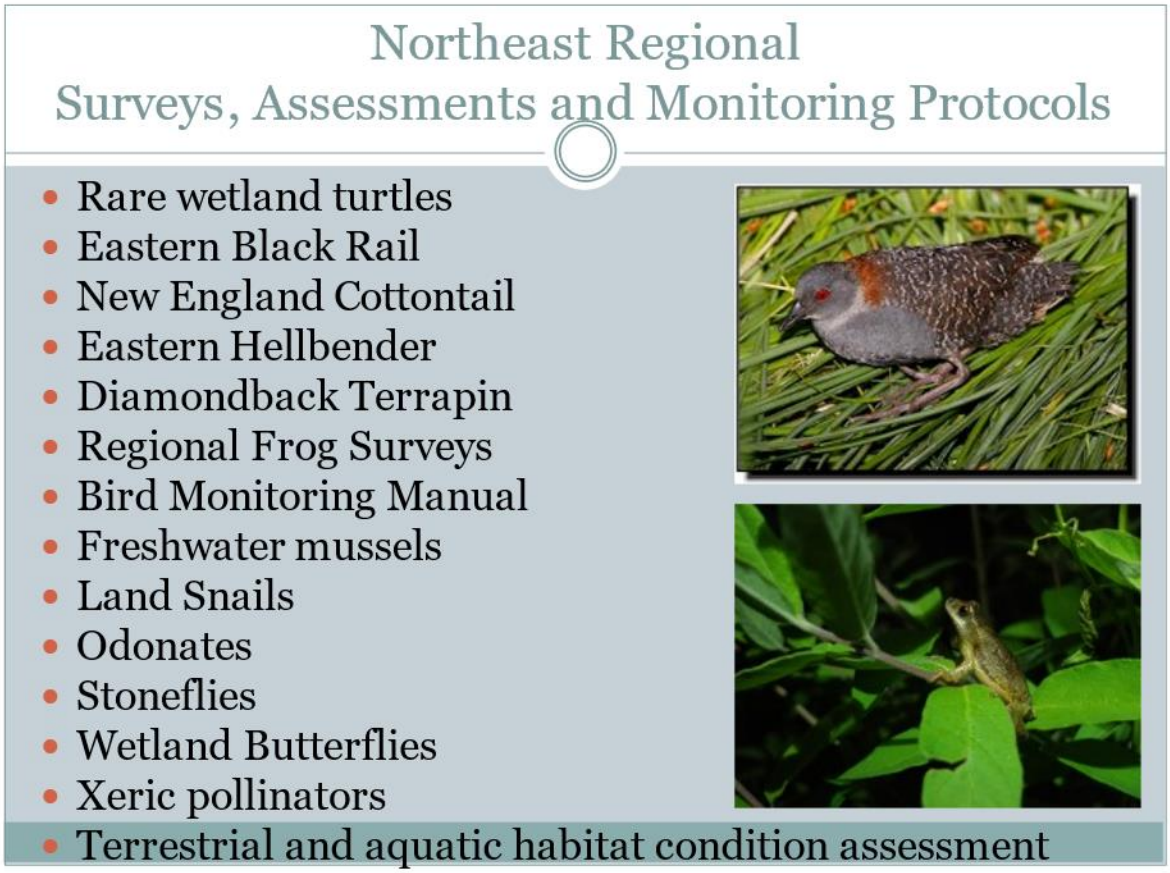


Figure 4.2.3. Example RCN projects providing information and tools on regional priority species and habitats.

Timber Rattlesnake Population Assessment (2016) (RCN). The Timber Rattlesnake (*Crotalus horridus*) was once widespread throughout eastern North America but in the four New England states that were the focus of this study, it now persists only in small, isolated populations. The goals of the study were to: 1) assess the viability of New England Timber Rattlesnake populations; 2), describe the population genetics structure of Timber Rattlesnakes in New England; 3) provide recommendations for genetic management and monitoring; and 4) develop a standardized protocol for monitoring Timber Rattlesnake populations informed by model-based estimates of occupancy and abundance. Model-based estimates of population growth and Population Viability Assessment results both suggest that populations in Vermont, New Hampshire, Eastern Massachusetts, and Connecticut may be declining while the Berkshire Mountains metapopulation does not appear to be declining under current conditions. Reducing anthropogenically-induced mortality is critically important. Available data strongly suggest that some Timber Rattlesnake populations in New England could benefit from genetic rescue. It was recommended that managers consider the ecology and conservation status of each population, available resources, and potential impacts,

and then assess the information provided by each method of monitoring in the development of any new project design (Bauder et al. 2018).

Status Assessment of Northeast Land Snails (2016) (RCN). A 2009 RCN project supported the Carnegie Museum's online invertebrate database which provides a wealth of information on invertebrate taxa status and distribution in the Northeast (Fetzner 2011). An additional RCN project sponsored a 2016 Land Snail Assessment of the status and distribution of land snails in the Northeast as a first step to their conservation (Hotepp et al. 2013). As a result, almost 30 species of land snails have been identified as RSGCN or Watchlist species. Land snails are an integral part of native habitats throughout the Northeast, playing important roles in cycling organic material and creating soil, moving energy and nutrients in food chains, and hosting major wildlife parasites. This project informed the important conservation needs and opportunities associated with 245 land snail species of the Northeastern United States, many of which are listed as SGCN or Data Deficient in the 14 State Fish and Wildlife Agencies. This project assisted states in proactive participation in the USFWS Federal Prelisting Process and may lead to preventing or minimizing additional listings under the Federal Endangered Species Act. The project also expanded and upgraded the existing land snail and slug website of the Carnegie Museum of Natural History, using data compiled from other museum collections to produce a more comprehensive resource. There are at least 317 species profiles for the region, 311 with specimen records, and another six that may be reported in the future. Fifty of the species are non-native. Regional maps are integrated into all species profiles (Hotepp et al. 2013).

Conservation Assessment of Odonata in the Northeast (2011) (RCN). A similar assessment of the dragonflies and damselflies of the Northeast serves as the foundation for RSGCN data for these species. Odonata are well represented on imperiled species lists for the Northeast due to narrow distributions, low population abundance, documented threats, and declines of many species. At present, nearly 200 different species are listed as SGCN by at least one Northeastern SWAP. The first Region-wide conservation assessment for the order Odonata (dragonflies and damselflies) was completed for more than 230 species that occupy a wide range of forested lentic and lotic habitats in the Northeast region. This assessment followed a procedure similar to those already conducted for certain vertebrate taxa in the Northeast (e.g., birds, reptiles, and amphibians). It included measures of regional responsibility, conservation concern, and vulnerability in a matrix format that can be used to prioritize species and conservation actions. Odonata were well suited to an assessment of this kind because their distributions and habitat affinities are relatively well known and the number of species is manageable, especially as compared to other insect groups. The project compiled available status and distribution information for all Odonate species in the thirteen states in USFWS Region 5. Regional responsibility was

evaluated for all states within the Northeast and updated at the regional scale, supporting conservation decisions that benefit Odonates and their habitats. The resulting prioritization scheme directs limited state and regional resources toward effective conservation actions that benefit Odonata and their habitats and thereby guide implementation of SWAPs (White et al. 2014).

Bee, Moth, and Vegetation Monitoring (2018-22) (RCN). A protocol was developed to track native bee communities at survey sites. Bee identification by regional experts was critical to the effort, and the collection is now with the Native Bee Inventory and Monitoring lab[13]. The **bee monitoring protocol** outlines 5 sampling windows, monthly, from May to September (Crisfield 2021a). Transects are laid out in the target habitat with 24 small bowls of soapy water placed five meters apart and left through the daylight hours or overnight if possible. Observers also net bees for 30 minutes while visiting the site. Samples are submitted with a standardized label to the USGS Native Bee Inventory and Monitoring Laboratory. The **moth monitoring protocol** outlines five sampling windows, monthly, from April to October, adjusted as necessary for latitude (Crisfield 2021b). The primary goals were to develop more complete species lists and document relative abundances for nocturnal moths in Xeric Habitats in the Northeastern US and to link these results with habitat condition data and management strategies which are also being tracked and analyzed. Three 15W UV bucket traps are set at each site. In 2021, 715 macro moths and 354 micro moths were identified across 16 sites, including nine RSGCN.

The Gulf of Maine Coastal Marine Ecosystem Survey: Mapping Biological Hotspots. (2013) (CSWG). The goal of this project was to fill critical knowledge gaps on the basic ecology, distribution, and abundance of 27 SGCN that inhabit the region's coastal marine ecosystem. Using distribution and abundance data, the partners calculated biological hotspot index values and developed digital maps based on habitat use model predictions. This critical information helps partners create effective conservation programs for these species within the Gulf of Maine and provide technical assistance for siting of offshore energy development projects to minimize effects on marine habitats.

Integrating Vulnerability Science into a Strategic Conservation Plan for Maine's Species of Greatest Conservation Need (2013) (CSWG). The Department of Inland Fisheries and Wildlife built upon the ongoing work of the North Atlantic Landscape Conservation Cooperative and other regional conservation partnerships to conduct a comprehensive review and update of the Maine Wildlife Action Plan. The outcome was a new Plan that utilized the best-available climate science to comprehensively address threats to the state's species and habitats. The revised Plan

provided better guidance at the scale of specific management regions, outlined a process for achieving measurable goals, and provided usable data to non-governmental conservation partners.

Pennsylvania's SWAP Prioritization and Mapping Enhancements (2013) (CSWG). The Pennsylvania Game Commission and the Fish and Boat Commission voluntarily implemented best practices for State Wildlife Action Plan revision, as recommended by the Association of Fish and Wildlife Agencies. The project included development of a tiered classification system for the state's SGCN, one that incorporates climate change vulnerability indices. Another key outcome was the development of a habitat prioritization matrix which helped the Commission delineate priorities for conservation action such as land acquisition, habitat management, and restoration. Pennsylvania continues to integrate a geospatial component into their revised State Wildlife Action Plan.

Updating Vermont's 2025 Action Plan with Vermont Conservation Design (2021) (CSWG). This project enabled VT to update Vermont Conservation Design data to 1) take advantage of new 0.5m LIDAR-derived land cover data, provide technical assistance by making action plan mapping and data available to all Vermonters; and 2) deliver outreach training to VFWD staff and communicate action plan vision and tools.

CONSERVATION PLANS AND BEST MANAGEMENT PRACTICES

Best Management Practices for RSGCN In Northeast Forests (2014) (RCN). Northeastern forests are considered key habitat for a large suite of wildlife, including several habitat specialists listed as SGCN in multiple states. Their vulnerability to various stressors has prompted the formation of several species--level conservation and research initiatives. This RCN project collaborated with several focused partnerships and with key forest stewards to integrate current ecological and biogeographic information into on-the-ground habitat enhancement. This collaboration produced spatially explicit management and conservation support for five regional SGCN: Bicknell's Thrush (*Catharus bicknelli*), Wood Thrush (*Hylocichla mustelina*), Canada Warbler (*Cardellina canadensis*), Rusty Blackbird (*Euphagus carolinus*), and American Marten (*Martes americana*). For each of these species, the report contains a species profile, conservation status, habitat landscape characteristics, desired habitat conditions, recommended practices and benefits with associated species, and ecosystem services and comprehensive planning. The project engaged both experts and end users to produce scientifically sound and practical guidelines for conserving these species and other SGCN in their guilds. Available occurrence data, distribution models, and stakeholder input delineated and prioritized areas with high management and

conservation potential. Working directly with habitat stewards ensured that the recommended practices are implemented in management and conservation opportunity areas. Results include field guides and guidelines to managing habitat for RSGCN in the Northeast and Mid-Atlantic Forests, a final report, and spatial prioritization for implementing these guidelines for RSGCN (Lambert and Reitsma 2017, Lambert et al. 2017).

Young Forest and New England Cottontail Conservation Initiative (2007, 2008, 2009, 2011, 2013, 2014) (CSWG, SA, RCN). As part of its young forest project, NEAFWA's Habitat Technical Committee developed a manual providing information and recommendations on managing and renewing young-forest habitats in the Northeast: Managing Grasslands, Shrublands and Young Forests for Wildlife (Oehler et al. 2006). Multiple resources, including articles, brochures, guidebooks and manuals (e.g., Fergus 2017), presentations, etc. are available online[14].

A Conservation Strategy for the New England Cottontail, a comprehensive plan for conserving the New England Cottontail (Fuller and Tur 2012), and a recent outreach plan (New England Cottontail Outreach Strategy 2018) are also available to help partners implement the conservation strategy for this species. In the short term, the goal of the initiative is to restore 1200 acres of New England Cottontail Rabbit (*Sylvilagus transitionalis)*, (NEC) habitat creating 50 new habitat patches across the species range, with an expected long-term population increase of 720 animals. The goal in the long-term is to avert federal listing by increasing the rate of colonization of habitat patches, thereby stabilizing metapopulation viability. Objectives were to: 1) convene a range-wide recovery steering committee comprised of partnering state wildlife agencies, NRCS, and USFWS; 2) evaluate target properties for habitat restoration and draft a spatially explicit habitat restoration plan; 3) disseminate restoration plans to local stakeholders and partnering agencies; 4) prescribe and implement habitat restoration activities in an adaptive management framework; 5) monitor performance to determine the relative efficacy of implemented actions; and 6) provide technical and administrative support to the states and partnering entities.

The range wide "Conservation Strategy for the New England Cottontail" was completed in 2012 by a multi-agency working group. State conservation summaries were completed for all six states and included in the regional conservation strategy that was peer reviewed in June 2012. A comprehensive landscape analysis was completed to design landscapes to support NEC populations, using models to analyze all parcels in the species range to identify target properties. Across 6 states, 12,439 parcels were ranked as the most likely to be suitable. The best ranked parcels have been adopted as targets for range wide NEC conservation. The formation of a private lands working group has increased the number of private parcels that are visited for evaluation and

generated contracts with NRCS, WMI and USFWS Partners for Fish and Wildlife. More than 950 acres have been treated on state lands across all six states since 2009, and the target of 1200 acres was met in May 2014. The **ARS Team supports the New England Cottontail Rabbit conservation (SA)** throughout the region. In 2012, state wildlife agencies from Connecticut, Maine, Massachusetts, New Hampshire, New York, and Rhode Island worked with USFWS and NRCS to finalize a conservation strategy to conserve the New England cottontail throughout its current range.

Atlantic Coast Beach and Shorebirds, Focusing on American Oystercatcher (*Haematopus palliatus*), Ruddy Turnstone (*Arenaria interpres*), Whimbrel (*Numenius phaeopus*) (2022) (SA). Shorebirds are among the most imperiled birds in North America, with population declines of 33% since 1980. Coastal areas of the Northeast Region host substantial populations of breeding, wintering, and migrating shorebirds, and some of the densest human populations in North America. Anthropogenic threats include habitat loss and degradation, human disturbance, predation, hunting, and sea level rise across their vast hemispheric ranges. The SA Beach and Shorebirds Team focuses on three species that represent a cross-section of shorebird life histories, seasonal habitat use, and management needs in the region. Each is listed as a USFWS Bird of Conservation Concern, and Species of Greatest Conservation Need in most coastal states in the region. To date, the team has focused on identifying its role in supporting existing conservation planning, such as the *American Oystercatcher Hemispheric Conservation Plan*, the *Whimbrel Conservation Plan*, and the *Atlantic Flyway Shorebird Initiative*. Increased engagement between USFWS staff from five programs and collaborative conservation entities such as the *American Oystercatcher Working Group* and groups of external partners with specific expertise in the three species (e.g., NGOs, state wildlife agencies, and universities) is a program priority. Efforts are underway to improve internal coordination across programs in the region. Priorities include:

- Initiating actions to address human disturbance at priority regional refuges
- Planning and pursuing opportunities for habitat acquisition, restoration, & enhancement
- Increasing efficacy and stability of predation management at locations experiencing poor outcomes
- Initiating research to identify priority stopovers (Ruddy Turnstone & Whimbrel) and understand importance of marsh habitat for breeding American Oystercatchers
- Helping initiate the first conservation plan for Ruddy Turnstone
- Engaging with partners to support priority conservation activities in other areas

Forest Songbirds (Golden-winged Warbler (*Vermivora chrysoptera*), Cerulean Warbler (*Setophaga cerulea*), Wood Thrush) (2022) (SA). More than 1 billion

breeding birds have been lost from forest habitats across North America over the past 50 years. Declines of birds associated with early successional, mature, and structurally diverse Eastern deciduous forest have contributed to these overall losses of forest birds, with golden-winged warbler, cerulean warblers, and wood thrush exhibiting some of the steepest declines. These three SGCN species represent those different forest ages and structures that are missing from many Northeastern deciduous forests today. The Forest Songbirds Team is partnering closely with the Appalachian Mountains Joint Venture (AMJV), whose geography overlaps with the core breeding areas of these three forest birds, to engage and support private and public forest landowners in implementing forest management practices that enhance the age and structural diversity of Eastern deciduous forests. A good example of this is a collaborative project, initiated in collaboration with the Service's Partners for Fish and Wildlife program, NRCS, and West Virginia DNR that is aiding private landowners in implementing the forest management activities identified as required practices under landowner incentive programs. The Team looks to collaborate on these kinds of activities within focal landscapes identified within the AMJV geography as well as additional focal areas outside of the AMJV that are important for these three at-risk forest songbirds. It plans to identify key audiences in each focal area for outreach regarding beneficial forest management practices for birds and available resources to assist in implementing them. The Team also seeks to collaborate with other agencies, especially state agencies and USDA, and NGOs with interests in forest bird conservation and creating healthy forest landscapes across the Northeast.

Conservation Plan for Blanding's Turtle and Associated Wetland-Dependent SGCNs (2011, 2017) (RCN, CSWG). Over the past decade, significant advancements have been made, informing and addressing the conservation needs of RSGCN turtles. Multiple partners and grants (RCN and CSWG) have resulted in robust conservation plans, protocols, and best management practices to be implemented regionally for these important RSGCN. They are summarized below with additional information available on the Conservation Planning for Northeast Turtles website[15]. Blanding's Turtle (*Emydoidea blandingii*) is a wide-ranging, semiaquatic species found in discontinuous areas from Nebraska to Nova Scotia. In the eastern United States, Blanding's Turtles occur in discrete areas of Maine, New Hampshire, Massachusetts, New York, and Pennsylvania, with the largest areas of occurrence in New England and northern New York and the largest known population in Massachusetts. Eastern populations are of conservation concern because of habitat alterations, adult roadkill, elevated nest and hatchling depredation, and other factors. In 2004, the Northeast Blanding's Turtle Working Group was formed as a partnership including representatives from four state wildlife agencies (ME, NH, MA, NY), universities, land managers, and researchers. Between 2004 and 2010, the group expanded to involve other key partners and the state of Pennsylvania and published a status assessment summarizing the

causes of regional population decline and calling for strategic, proactive conservation measures (Compton 2007).

In June 2014, the Northeast Blanding's Turtle Working Group[16] completed the Conservation Plan for Blanding's Turtle and Associated Wetland-Dependent Species of Greatest Conservation Need in the Northeastern United States. This plan was updated in July 2021 after a second round of sampling and habitat management actions. Both efforts were multi-year collaborative projects funded by the U.S. Fish and Wildlife Service through its Competitive State Wildlife Grant program. Partners included the state wildlife agencies of Maine, New Hampshire, Massachusetts, New York, and Pennsylvania; public partners including the State University of New York at Potsdam, the University of Massachusetts at Amherst, the University of Maine at Orono; and private groups including Grassroots Wildlife Conservation, Inc., and Swamp walkers, Inc., funded by the U.S. Fish and Wildlife Service Competitive State Wildlife Grant (SWG) Program. The resulting website contains conservation and management plans for each of the four RSGCN species: Spotted (*Clemmys guttata*), Wood (*Glyptemys insculpta*), Blanding's, and Box (*Terrapene carolina*) Turtles. It provides survey forms/protocols including the pit tag protocol (NEPARC 2020).

Implementation of The Bog Turtle Conservation Plan for The Northern Population, With Benefits to Associated Headwater Wetland SGCN (2015, 2019) (RCN, CSWG). This project supplemented efforts to perform habitat management, engage in landowner outreach; continue application of a multi-state database; continue implementation of standardized population and habitat monitoring protocols; survey potential and historic wetlands; perform health assessments; draft best management practices; expand upon and refine the recently developed conservation plan; and perform a genetic assessment to determine conservation units for the northern population of Bog Turtle (*Glyptemys muhlenbergii*). Most recently, CSWG supported Creating a comprehensive conservation and management plan for the southern lineage of the Bog Turtle and its associated habitats. The objective of this project is to fill critical information gaps by beginning to address the two most pressing threats for the southern lineage of the bog turtle. This will be achieved by by 1) improving the understanding of the current distribution of the southern lineage of Bog Turtles; 2) determining the status and viability of populations within the southern lineage of Bog Turtles; 3) beginning a genetic study to identify metapopulations, management units, corridors, and current population genetic parameters, habitat management and nesting habitat creation for a subset of populations; 4) reaching out to landowners and law enforcement officials.

Spotted Turtle Conservation (2017, 2022) (CSWG, RCN). The Spotted Turtle Working Group, a team of state and federal biologists and university as well as NGO

partners, collaborated to quantify the Spotted Turtle (*Clemmys gutatta*) status and distribution from Maine to Virginia as well as the effects of climate change and habitat fragmentation on the species. As part of this project, the sponsors conducted standardized population assessments at multiple spatial scales, with centralized data analysis, to: (1) establish population baselines; (2) inform a comprehensive adaptive management strategy; and (3) identify priority habitat and population management actions at the regional, state, and local levels. Their website[17] provides a **Status Assessment and 2022 Conservation Plan**, the 2019 Monitoring Protocol, and field and data entry forms with instructions. **A CSWG Project Supported Conserving Vermont's Spotted Turtles: Using Novel Techniques to Detect a Cryptic Species and Identify Unknown Populations.** This project will identify suitable Spotted Turtle habitats and will determine if those habitats are occupied. It will support the development of eDNA sampling protocols in lentic systems, which will be transferrable to other states with Spotted Turtle information gaps and to other SGCN freshwater turtle species. It will use standardized methods and protocols developed for the ongoing CSWG/RCN Spotted Turtle project to evaluate the species' presence at 25 sites and improve priority nesting habitat.

Wood Turtle Conservation Plan (2011, 2014, 2016, 2021) (CSWG, RCN). Conservation Plan for the Wood Turtle in the Northeastern United States is the product of a multi-year, proactive effort among Northeastern State Wildlife Agencies and their partners to articulate a strategic action plan for the protection of regionally significant populations of Wood Turtles in the northeastern United States. The fundamental objective of this Plan is to protect the evolutionary potential of the Wood Turtle by ensuring the persistence of functional, ecologically viable, and regionally significant populations throughout the Northeast Region. To accomplish this objective, and to effectively triage conservation efforts, the sponsors developed a spatially explicit, stratified Wood Turtle Conservation Area Network based on the best available population, landscape, and genetic data. To achieve meaningful conservation of this species it will be necessary to stabilize and ultimately reverse population declines, both within this Conservation Area Network and elsewhere throughout the species' range. The plan includes a standardized survey protocol, field survey, turtle field forms, and a data entry template. Management guidelines, habitat management and poaching brochures, regulatory status, environmental review recommendations, and other helpful resources for Wood Turtles are available through the Northeast Wood Turtle working group website[18].

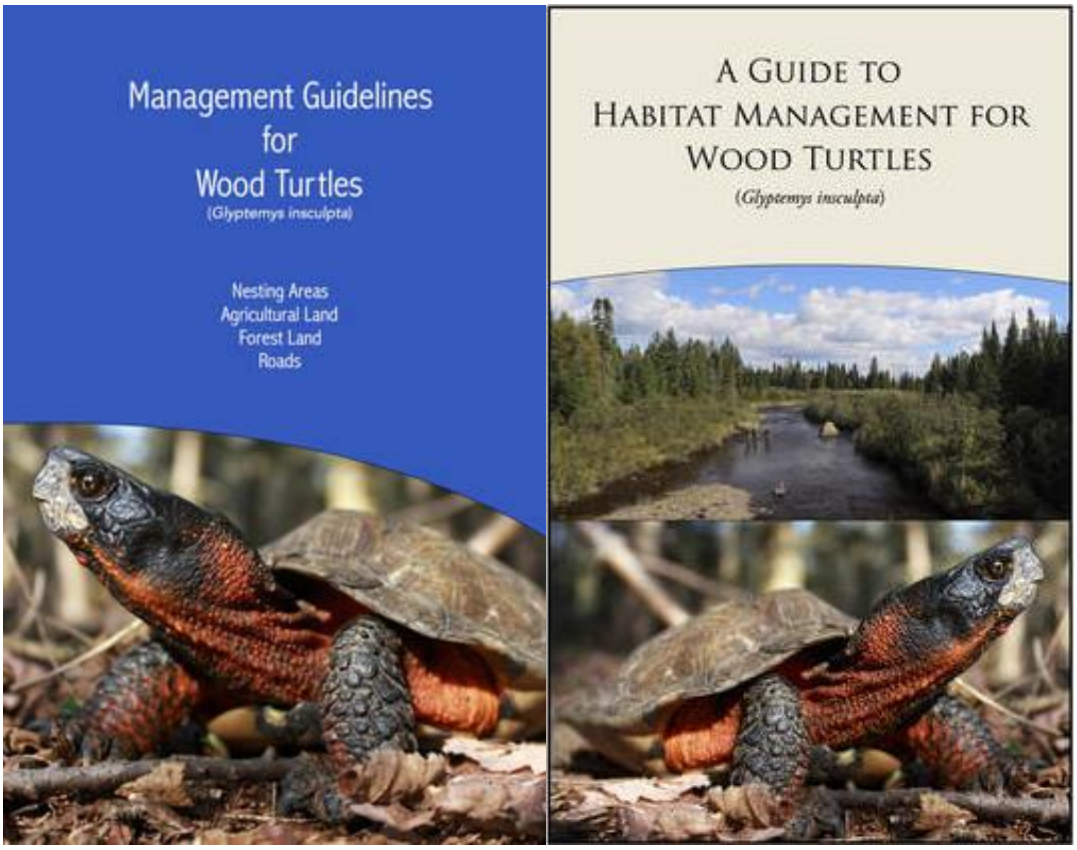


Figure 4.2.2 Management Guidelines for Wood Turtles in the Northeast.

Status Assessment and Conservation Plan for the Eastern Box Turtle (2018) (RCN). Although widespread and still relatively common throughout much of its range, the Eastern Box Turtle (*Terrapene carolina carolina*) has experienced dramatic declines in recent decades. This recent RCN project developed a status assessment and conservation plan for the Eastern Box Turtle in the Northeastern United States (West Virginia to Maine). Products include: 1) a standardized monitoring protocol; 2) a status assessment for the northeastern US; 3) a conservation area network representing conservation priorities for the species; and 4) a set of BMPs. Survey forms and multiple protocols, guides, partners, and other useful information for box turtle conservation are available at the Box Turtle working group website[19]. NEPARC has developed habitat management guidelines, land use planning resources, and references for conservation of this species in the Northeast. Both the regional group (NEPARC) and its national affiliate (PARC) are dedicated to the conservation of herpetofauna and their habitats and provide resource information on this and other reptile and amphibian species[20].

Population Declines Due to Loss of Adult and Juvenile Turtles to Illegal Wildlife Trade (2021) (CSWG, SA). The goals of this project were to 1) assess recently developed health and disease testing protocols and 2) determine the best method and use of genetic information to determine place of origin of confiscated

animals. These two actions are designed to slow the rates of decline in eastern, native SGCN turtle populations due to wildlife trafficking by providing states with the information needed to make informed decisions with regard to repatriation.

ARS program efforts for the Northeast Turtles (Blanding's, Spotted, and Wood Turtle) Conservation (2021) (SA). The At-Risk Turtle team is focused on working with the states to implement conservation plans that are informed by standardized monitoring and genetic analysis. All three species have conservation area networks that identify focal area sites also targeted for land protection; management opportunity sites targeted for restoration; and finally, sites in need of surveys. Due to data sensitivity, the Service does not have spatial information for the conservation area networks. The team is working with individual states on the following objectives: 1) securing viable populations through land conservation (using grant programs like LWCA, DE Bay, Chesapeake Wild, and America the Beautiful, and NRCS's Wetland Reserve Easement program); 2) enhancing populations through restoration of habitat (USFWS National Wildlife Refuge lands, DoD lands, and working with NRCS on private lands); 3) decreasing road mortality in areas with high mortality rates (work on refuges and with individual states using DOT funds); and 4) addressing illegal trade in turtles. Related objectives are to provide leadership on the Collaborative to Combat Illegal Trade in Turtles; support LE by: 1) identifying housing for confiscated turtles; 2) assisting states in returning turtles to the wild; 3) conducting genetic and disease screening; 4) developing outreach tools and a long-term strategy to address illegal trade in turtles; 5) assessing population status by continuing surveys on refuges, DoD lands, and through projects with NAFO; 6) continuing to support states in developing CSWGs; assess population status for Spotted, Wood, and Blanding's Turtles; and 7) raising public awareness by continuing to feature work promoting conservation and addressing threats..

Conservation Strategy for the Northern Diamondback Terrapin (2013) (RCN). The Northern Diamondback Terrapin (*Malaclemys terrapin*) is found in eight states of the Northeast Region and is considered Threatened in Massachusetts, Endangered in Rhode Island, and of Special Concern in Connecticut. The species has been identified by the Northeast Partners in Amphibian and Reptile Conservation as a species of regional conservation concern in the Northeast. It is identified in more than three-quarters of the region's SWAPs; and more than 50% of the species' distribution is within the Northeast Region (NEPARC 2010). Therres et al. (1999) also suggested that the Terrapin merited a federal listing assessment. This RCN project represented the first regional, comprehensive view of the status of the Terrapin in the Northeast. The resulting regional Conservation Strategy can guide and coordinate multiple-state laws and policies to protect the terrapin and its habitat and may reduce the need for a federal listing assessment. The strategy includes a status and distribution assessment

throughout the northeast; gathering life history information; and identifying threats and conservation actions along with additional resources and needs. This project also conducted a Threat Assessment outlined by the Northeast Lexicon. Populations have declined since the early 1990s due to multiple factors. Bycatch in commercial fishing, loss of habitat, drowning in commercial and recreational crab pots, increased nest failure due to predation from raccoons and other subsidized predators, and road mortality have been the primary causes of population decline. The project compiled state efforts and protocols to advance a Regional Coordinated Survey (terrestrial and aquatic) through the Maryland Coastal Bays Terrapin Project[21]. Using citizen scientists, the Maryland Coastal Bays Program created a database on local terrapin habitats to aid in conservation of the terrapin. The Program has also produced terrapin brochures, fact sheets, field guides, and other outreach information (Egger 2016).

Best Management Practices for Wetland Butterflies (2015) (RCN). This project addressed the uncertain status and distribution of many wetland butterfly species in several Mid-Atlantic States, including SGCN and RSGCN species in the Northeast. Some species declines may be due in part to threats impacting groundwater wetlands, including outright destruction, habitat degradation, and the succession of open wetland habitats to forest or dense shrubland. Climate change and habitat fragmentation may further impact these species and leave them vulnerable to local extirpations. The primary objective of this effort was to enhance and expand populations of wetland butterfly SGCN through developing a greater understanding of the distribution and habitat requirements for these species, and by implementing habitat enhancement projects where needed. Project goals were to: 1) update distribution data for 14 butterfly SGCN in the region; 2) model species distribution and climate conditions for each species; 3) identify and prioritize wetlands that support one or more of these 14 species; 4) implement wetland enhancement and improvement projects; and 5) develop BMPs for species distribution, climate modeling, and wetland enhancement projects. Results should guide targeted survey work for these species as well as prioritize wetlands for enhancement projects. In the long-term, results may serve to improve habitats for these species, offering the potential to increase populations of butterfly SGCN and promote connectivity between populations through increased habitat availability. Fourteen species of wetland-inhabiting butterflies with SGCN status were surveyed in 2016 and 2017 at multiple sites across four states – Maryland, New Jersey, Pennsylvania, and West Virginia. Survey data was used to evaluate the status of each species in all states where they occurred as well as refine the distribution data for each species across the region. All data points were mapped in ArcGIS and used to model species distribution in terms of both habitat and climate. BMPs were developed, and habitat enhancement projects were initiated in Maryland and Pennsylvania. The report includes Life History Guides to the 14 species, the Pennsylvania Habitat

Management Guide for Pollinators, Wetland Butterfly Habitat Enhancement BMPs, and additional resources including a model Wetland Restoration Report (Frye et al. 2018).

Pollinator Habitat in Xeric Grasslands, Barrens, and Woodlands (2018-22) (RCN)[22]. NEFWDTC prioritized another key regional habitat supporting multiple RSGCN taxa and focused on conservation of the fire-adapted xeric habitats that support a diverse fauna including pollinators. This RCN project developed a regional network of experimental adaptive management sites where coordinated management and monitoring leads to improvements in management over time. This includes ensuring adequate representation of forbs, bare soil, and other key pollinator habitat features; improving habitat for other RSGCN; and lowering management costs and treatment frequency to the greatest extent practical. It resulted in improved coordination and sharing of early successional habitat management expertise among states. Standardized regional vegetation and pollinator monitoring protocols were developed, enabling more effective pooling of data and providing a framework for informed, science-based management decisions. The project improved understanding of the abundance and distribution of select, vulnerable pollinator taxa (e.g., bees and butterflies), and of how these species respond to habitat management over time. Results both informed and improved on-the-ground management of at least 500 acres of habitat at regionally significant sites. The project served as a framework for longer-term monitoring and experimental adaptive management practices to improve overall management for these complex, fire-influenced systems (Milam 2018).

This Xerics Habitat for Pollinators Project focused on fire-adapted habitats (xeric grasslands, barrens, and woodlands) in the Northeast to improve the ability of Northeast states to implement cost-effective habitat management for the benefit of native pollinators and other RSGCN that depend upon these priority habitat types. Templates for data collection and reporting were developed along with the vegetation monitoring project protocol, which seeks to provide data consistent with the longstanding monitoring programs at some of the more established sites. A key variable, the percent of vegetative cover, is expected to respond to treatments and to indicate habitat suitability for ground-nesting bees.

Bee Pollinators in NJ (2015) (CSWG). This project enabled New Jersey to comprehensively evaluate the status of bee pollinators for its State Wildlife Action Plan. This project enabled New Jersey to comprehensively assess all species of rare bee pollinators so that Species of Greatest Conservation Need can be determined for its SWAP. Specifically, a state-of-the-art database held by project PI Winfree, along with targeted additional field data collection, helped to determine which bee species are rare in New Jersey and what their habitat and floral conservation needs are. A roadmap was

developed for how the State can be effective and efficient in managing for many rare and poorly known pollinator species.

Gating Caves for Bat Conservation and Protection (2016) (RCN). Bats in the Northeast have suffered steep population declines since 2006-07 due to White-Nose Syndrome (WNS). In 2016, the RCN Grants Program awarded funding to Connecticut, New Jersey, New Hampshire, Pennsylvania, and Rhode Island to increase the suitability of known bat hibernation sites by reducing human disturbance. Project funds supported construction or improvements of gates to the openings in caves and mines, structural enhancements to the sites to create better habitats, installation of a sign template for consistent messaging, and the placement of remote surveillance cameras as needed. These on-the-ground efforts involved many stakeholders and matching in-kind services. Even before the threats posed by WNS were known, human disturbance to hibernating bats was a well-documented threat in the Northeast. Many of the pre-WNS conservation efforts focused on better protection of critical winter habitat for bats, which can include caves, abandoned mines, sinkholes, aqueducts, and other locations, natural or man-made, where bats overwinter. Management actions can improve the structures for bats while preventing human disturbance. Protection of winter habitats for bats, even those infected with WNS, is an important component of long-term conservation actions for these species. Monitoring survival among WNS-infected bats in the Northeast has suggested increased resistance to fungal exposure. Therefore, reducing additional threats might allow rebounding populations to respond even more quickly, and ensure that sites receiving future fungal treatment or WNS management efforts will be secure and safe for hibernating bats. Another major step toward keeping these winter habitats safe involves raising awareness of conservation actions through consistent messaging. The combination of site protections, habitat enhancements, and improved messaging/signage should help enhance survivorship of bats at these over-wintering sites. A list of the projects and links to the individual reports are available through the NEFWDTC website.

Pine Barrens Species Conservation (2022) (SA). Pine barrens are a unique habitat type often characterized by sandy soils and fire-dependent plant communities dominated by pine species, though oaks are often also a major component of the ecosystem. Many rare species utilize pine barren habitats, but this project focused on two inhabitants, Frosted Elfin (*Callophrys irus*) and Eastern Whip-poor-will (*Antrostomus vociferus*). The Pine Barrens Team is analyzing data from Science Application's Rapid Response Team, eBird, and other sources to identify priority sites for co-management of the two species. Once sites are identified, the Team will work with Refuges, state conservation agencies, and other partners to enact on-the-ground management to improve conditions for both species. The team also intends to develop Best Management Practices for the two target species within pine barrens and to

develop a network of conservation practitioners for sharing research, management practices and needs, and information across the Northeast.

Diadromous Fishes Conservation (Alewife, Blueback Herring) (2022) (SA). Alewife (*Alosa pseudoharengus*) and Blueback herring (*Alosa aestivalis*), collectively known as River Herring, are categorized as SGCN in all New England states, New York, Pennsylvania, New Jersey, Delaware, and Virginia. Blueback herring are additionally categorized as SGCN in South Carolina and Florida. Within the past decade, River Herring Conservation Plans have been released by NOAA Fisheries and the Atlantic States Marine Fisheries Commission (ASMFC). Threats to River Herring populations include reduced access to historic freshwater spawning and nursery habitats, barriers with inadequate fish passage measures, freshwater and estuarine habitat/water quality degradation, climate change impacts, and indirect (bycatch) fishing pressure. In both the marine and freshwater environments, shifts in water temperature, related temporal/spatial shifts in environmental conditions, prey availability, and predation may be negatively influencing River Herring populations. Conservation goals for River Herring are aligned with those established in the ASMFC Amendment 2 to the Interstate Fishery Management Plan for American Shad and River Herring (River Herring Management) (ASMFC Shad and River Herring Plan Development Team 2009): *"Protect, enhance, and restore East Coast migratory spawning stocks of . . . alewife (Alosa pseudoharengus), and blueback herring (Alosa aestivalis) in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass."* Priority objectives include 1) preventing further declines in population abundance, 2) promoting improvements in degraded or historic habitat throughout the species range, 3) improving access to historic freshwater spawning and nursery habitat, and 4) increasing understanding of the influences of River Herring bycatch in commercial fisheries as well as updating the status of stock dynamics and health.

Farmland Pollinators (Monarch, American and Yellow-banded Bumblebee, Ashton's, Lemon, and Variable Cuckoo Bumble Bee) (2022) (SA). In the Northeast, native bumble bee species are experiencing habitat loss, climate related threats, and competition form non-native species. The USFWS has identified five bumble bee species (American bumble bee (*Bombus pensylvanicus*), yellow banded bumble bee (*Bombus terricola*), Ashton's cuckoo bumble bee (*Bombus ashtoni*), lemon cuckoo bumble bee (*Bombus citrinus*), and variable cuckoo bumble bee (*Bombus variabilis*) as well as Monarch butterfly as priority at-risk species in need of proactive conservation. These species, collectively referred to as "farmland pollinators," need region-wide habitat restoration and management. Additionally, little is known about the population status and distribution for many of these rare species. The USFWS provided funding to the Native Bee Inventory and Monitoring Lab for a multi-part project that includes surveys, floral resource research, public outreach, and developing a regional

conservation strategy for bumble bees. Additional projects supported by the farmland pollinator team include bumble bee surveys on National Wildlife Refuges across the Region, native thistle seed collection and propagation, and continued support for the New England Pollinator Partnership.

Mountain Butterflies (White Mountain Arctic, White Mountain Fritillary) (2022) (SA). The White Mountain arctic (*Oeneis melissa semidea*) and the White Mountain fritillary (*Boloria chariclea monitus*) are endemic butterflies that were left isolated at the summit of Mt. Washington after the last glaciation period approximately 13,000 years ago. Their distribution is limited to a 2,800-acre alpine zone of the Presidential Range at the White Mountain National Forest. Potential stressors include trampling of habitat by individuals or from off-trail recreational use; lack of redundancy due to the species' limited range; and potential negative effects to both species and their habitat from climate change. The project team is partnering with New Hampshire Fish and Game (NHFG), the White Mountain National Forest, the Mount Washington Observatory (WMO), and the Appalachian Mountain Club to develop and produce a public awareness and education campaign to inform the public of the presence and predicament of these species and develop signage to mark sensitive areas. There are ongoing research projects with NHFG, WMO, the University of New Hampshire, and the Northeast Adaptation Science Center to collect life history and abundance information on these two butterfly species. To date, these studies have successfully identified host species critical to complete the White Mountain Fritillary's reproductive cycle. Captive rearing protocols have been developed and implemented at the WMO and at the NHFG captive rearing facility. Studies that will continue into 2023 include DNA analysis to assess population structure, collection of demographic data, evaluation of impacts of climate change, species distribution modeling, and overwintering experiments.

Freshwater Mussels (Brook Floater (*Alasmidonta varicosa*), Cumberland Moccasinshell (*Medionidus conradicus*), Pheasantshell (*Phasianella ventricosa*), Tennessee Clubshell (*Pleurobema oviforme*), Tidewater Mucket (*Leptodea ochracea*), Yellow Lampmussel (*Lampsilis cariosa*)) (2022) (SA). Across the continent, freshwater mussels have experienced drastic declines. Over 74 % of the 298 freshwater mussel species found in North America are in some state of imperilment, with 93 species federally listed as endangered or threatened (Williams et al. 2017). Habitat degradation, which includes water pollution and impoundments, is by far the leading cause of these declines. Non-native species also have outcompeted some native species. Freshwater mussels provide ecological and economic benefits to people and aquatic ecosystems. Like oysters, they filter millions of gallons of water and act as ecosystem engineers. They're crucial to a multi-billion-dollar pearl jewelry industry, and harvest of mussels is a reserved treaty right for some Native

American tribes. Without intervention, freshwater mussels will continue to disappear within their range, with the risk of losing valuable ecosystem services.

Using adaptive management and working at landscape scales in partnership with states and Tribes, this project aims to restore and conserve these at-risk species of mussels and proactively address threats to avoid the need to list these species under the Endangered Species Act. With input from partners, the ARS program has been building a conservation plan called the *Northeast Region Conservation Strategy for Freshwater Mussels*. It provides a framework and strategies for conserving and restoring at-risk species of freshwater mussels and their habitats from Maine to Virginia and West Virginia. This will inform decisions on feasible, cost-effective actions that Service programs can take with partner support over the next five years to increase representation, redundancy, and resiliency (3 Rs) of each species, and ensure their long-term viability.

In 2022, biologists from 12 States, the Partnership for Delaware Estuary, USGS, and representatives from the Penobscot Nation were interviewed. A suite of questions aimed at identifying priority areas and management and science needs for conservation of mussels. This information is being synthesized into priority area maps and tables which will highlight areas for conducting surveys, habitat restoration, land protection, propagation and stocking, and science needs. Discussions held in 2021 with the Rappahannock, the Chickahominy, and the Upper Mattaponi Indian Tribes in Virginia are also informing priority areas for conservation of at-risk mussels and their host fish in the *Northeast Region Conservation Strategy for Freshwater Mussels*. Interviews with Tribal partners continue to further identify priority areas for conducting conservation for mussels. The strategy will be distributed to State and Tribal partners and other Service offices for review, to finalize the At-Risk Conservation Strategy. Continuing program efforts will work to build local action plans within target watershed and to implement projects. Priority science needs for mussels were also identified and included in the request for proposals through the USGS as well as priority projects for BIL funding that would benefit at-risk mussels.

4.2.4 REGIONAL EXAMPLES AND OPPORTUNITIES

The exceptional collaboration and coordination among state fish and wildlife agencies in the Northeast has driven and advanced collaborative identification, prioritization of needs, action steps to address them, and limiting factors for RSGCN and their habitats. Projects listed below represent key partner and collaborative regional projects and programs that inform SWAPs. Please see *Chapter 7* for a more complete list of Northeast partners.

FOREST MANAGEMENT PLANS

Forest and Woodlands are managed at the state level with a **State Forest Action Plan** (SFAP). These plans outline conservation strategies and priorities like those found in SWAPs, making the states eligible to receive federal funding as authorized by the Cooperative Forestry Assistance Act[23]. State Forest Action Plans are required to incorporate SWAP information, specifically in their habitat assessments, strategies, and shared priorities or goals. The State Forest Action Plans of the Northeast were updated in 2020. The US Forest Service and Northeast-Midwest State Foresters Alliance synthesized the 2020 State Forest Action Plans of the Northeast and Midwest and released a regional summary report in 2022 (USFS and Northeast-Midwest State Foresters Alliance 2022a). With State Forest Action Plans updated on a 10-year cycle that falls halfway between the 10-year cycle of SWAPs, the regional summary report identified "tremendous opportunities for further collaboration on wildlife habitat strategies with state and regional wildlife and forestry agencies, organizations, and other partners" (USFS and Northeast-Midwest State Foresters Alliance 2022a).

The regional summary report identifies 14 common themes across the 21 State Forest Action Plans, including wildlife habitat, adaptation to climate change, carbon management, forest health, clean water, wildfire and prescribed fire, sustainable forest management on public and private lands, and forest-based recreation, among others. Three regional themes address wildlife habitat (USFS and Northeast-Midwest State Foresters Alliance 2022a):

- Wildlife habitat protection: Use land conservation tools to provide forests for wildlife habitat and corridors for wildlife diversity and species of greatest conservation need as identified in the SWAP.
- Wildlife habitat enhancement and restoration: Proactively manage for wildlife diversity with techniques that increase age, class, and structural diversity. Support nurseries to provide native trees and shrubs important for wildlife. Use prescribed burns and other practices to restore natural disturbance regimes and provide diversity in forest age structure. Improve tools to identify where rare ecological features are located and help forest landowners manage for them.
- Collaborative engagement: Work with the state fish and wildlife agency and other partners to support strategies in the SWAP and SFAP for landscape-level habitat conservation and enhancement.

The US Forest Service and Northeast-Midwest State Foresters Alliance produced an accompanying Landscape-Scale Conservation Interactive Web Map that displays multi-state priorities identified in the 2020 State Forest Action Plans. There are 15 landscape-scale priority areas in the Northeast and 18 in the Mid-Atlantic, with five of

them shared across the subregions (USFS and Northeast-Midwest State Foresters Alliance 2022b). Individual State Forest Action Plans are available through the National Association of State Foresters[24].

The US Forest Service publication titled Forecasts of Climate-Associated Shifts in Tree Species (ForeCASTS) includes maps identifying future suitable Forest habitat ranges for 213 tree species across the US and globally[25]. Future Forest habitat suitability maps are available for 2050 and 2100 under multiple climate and emissions scenarios. The atlas of maps also quantifies the minimum acceptable distance between current habitat locations which may become unsuitable and the nearest habitat that will remain suitable in the future for a particular species (or group of species). ForeCASTS intends to assist conservation partners and managers in targeting priority tree species for monitoring, conservation, and adaptive management.

OUTDOOR RECREATION PLANS

State Comprehensive Outdoor Recreation Plans (SCORPs) are plans that describe a state's goals and priorities for outdoor recreation, updated every five years as required by the federal Land and Water Conservation Fund. Outdoor Recreation is an important activity that impacts Northeast fish, wildlife, and habitats, including RSGCN, and coordination to incorporate SWAP and regional priorities is encouraged. Individual SCORPs are not on the same revision cycle across the Northeast, with the current plans covering 2017-2022 for some states and others 2020-2025. There is extensive public engagement in the development of SCORPs, which often include polls, surveys and focus groups to determine the public's outdoor recreation needs and wants. Detailed information includes demographic and public participation data on outdoor recreation in the state. The priorities outlined in a SCORP may be implemented at the local level through state and federal grant programs for parks, trails, and a variety of outdoor recreation projects. The Society of Outdoor Recreational Professionals maintains a directory of SCORPs[26]. The 2020 update of the Pennsylvania SCORP, for example, includes the results of a project undertaken by The Trust for Public Land to map public access to the state's outdoor recreation areas, waterways, and trails with demographic data, spatially identifying areas of the greatest need for improved public access. Collaboration and coordination between SWAPs and SCORPs present an opportunity to address both the needs and potential threats of public access to wild spaces.

The Society of Outdoor Recreation Professionals is a national organization with the goal of protecting natural and cultural resources while providing sustainable public access to recreation[27]. The organization provides training, technical guidance, and networking. The 2021-2025 Strategic Plan for the Society of Outdoor Recreational Professionals outlines goals and objectives to provide justice, equity, diversity, and inclusion in sustainable outdoor recreation opportunities that contribute to the overall sustainability

of communities, ecosystems, and economies. A library collection of technical resources for topics from diversity, equity, inclusion, and accessibility to environmental education, responsible recreation, recreation conflict, heritage recreation, visitor use management, and access to public lands is available[28].

STATE EXAMPLES AND OPPORTUNITIES PROVIDING INFORMATION ON STATE AND REGIONAL PRIORITIES

State Fish and Wildlife Agencies have jurisdiction for and are repositories for state-level fish and wildlife conservation data. These data are used to inform many state, local, and federal planning, conservation, and regulatory entities as well as the public. State Wildlife Action Plans provide detailed science-based information on SGCN. Each Northeast State revises its plan every ten years and can be accessed through the respective **Northeast SWAP Website links:**

- Connecticut
- D.C.
- Delaware
- Maine
- Maryland
- Massachusetts
- New Hampshire
- New Jersey
- New York
- Pennsylvania - Fish
- Pennsylvania - Game
- Rhode Island
- Vermont
- Virginia
- West Virginia

The **NEAFWA** website[5] hosts the Northeast **SWAP Database** containing key data from all 14 Northeast SWAPs. This database was initiated by NEAFWA's Northeast Fish and Wildlife Diversity Technical Committee and developed by Terwilliger Consulting, Inc. This project was supported by State Wildlife Grant funding awarded through the Northeast Regional Conservation Needs Program which joins thirteen northeast states, the District of Columbia, and the U.S. Fish and Wildlife Service. It is administered by the Wildlife Management Institute in a partnership to address landscape-scale, regional wildlife conservation issues. Progress on these regional issues is achieved by combining resources, leveraging funds, and prioritizing conservation actions identified in the SWAPs. The RCN Program is an initiative of the Northeast Association of Fish and Wildlife Agencies.

State fish and wildlife agencies have developed more accessible data and web portals that depict the status and distribution of rare species and their habitats. State fish and wildlife agencies provide the most current data on fish and wildlife in their state that can be accessed by the public and used for environmental review and other uses. PA Wildlife Conservation Opportunity Area Tool; State Fish and Wildlife agencies/NHPs data; BioMap in Massachusetts; Beginning with Habitat in Maine; Taking Action for Wildlife in New Hampshire; and New Jersey's Landscape tool are just a few of these

state programs that provide information to planners and developers for strategic planning and to minimize the impacts of development. State examples are listed below:

Massachusetts BioMap3[29]. A short video[30] presents the basics of BioMap3. The Massachusetts SWAP used Key Sites, based on BioMap2, to identify and target the most important sites for biodiversity protection and habitat management. The clear selection criteria, strategic approach, and limited spatial extent of the project (key sites account for about 10% of Massachusetts) help focus conservation efforts for states and partners. Actions taken in key sites are typical land protection or restoration steps, and they tend to lessen the impact of threats like development, climate change, and vegetative succession.

Rhode Island SWAP Community Guide provides recommendations, examples, and resources for local planners, such as the use of compliant LEDs and fixtures to reduce the impact of artificial lights on nocturnal species (RI Department of Environmental Management 2015). **Rhode Island Woodland Partnership**[31]: information about this partnership can be found online through the Partnership's website.

Maine Land Trust Network[32]. The Southern Maine Regional Planning Commission[33] is likely the best example of a multi-jurisdictional entity. **Maine Beginning with Habitat[34]** is another. Both offer valuable service to local level planning boards, regional planning commissions.

Vermont's Community Wildlife. Works with realtors to make sure that habitat value is a consideration whenever properties are sold. This manual offers choices and opportunities to **Vermont** communities and others who engage in land use and conservation planning efforts (Austin et al. 2013).

Virginia Department of Wildlife Resources Fish and Wildlife Information System is a public portal information to search current information on any species and habitats in Virginia[35]. The **Virginia Natural Landscape Assessment** 2022 GIS layers map the statewide network of natural lands, ecological cores, and landscape corridors in the state[36].

New Jersey's Conservation Blueprint is a data-driven, interactive mapping tool made possible through a partnership between The Nature Conservancy, Rowan University, and the New Jersey Conservation Foundation, together with a collective of 21 conservation-focused government and non-profit groups[37]. **Time for CHANJ.** Connecting Habitat Across New Jersey (CHANJ) is an effort to make NJ landscapes and roadways more permeable for terrestrial wildlife by identifying key areas and actions

needed to achieve habitat connectivity across the state. CHANJ offers two main products – an interactive Mapping tool and a Guidance Document – to help prioritize land protection, inform habitat restoration and management, and guide mitigation of road barrier effects on wildlife and their habitats[38].

New Hampshire's Taking Action Together: Taking Action for Wildlife supports communities, conservation groups, and individuals with resources, tools, and training focused on conserving New Hampshire's wildlife and habitats[39].

PA Conservation Opportunity Area Tool: The 2015-2025 Pennsylvania Wildlife Action Plan is now available through a web-based map showing Species of Greatest Conservation Need within a user-defined area of interest[40]. Users can develop output reports that include actions to support the species and habitats in an area of interest. They can also generate lists of SGCN by county or watershed. See range maps for most Species of Greatest Conservation Need.

Maryland's Environmental Resources and Land Information Network
MERLIN Online is part of the Maryland iMAP mapping system was developed in the late 1990s to allow users to view spatial data and to use that information to make better informed decisions[41]. It allows users to produce a custom map of any location in Maryland, including their choice of base maps and data layers. For the advanced user, MERLIN Online data is available as Web Map Services (WMS) that can be incorporated into many desktop GIS applications and other online mapping tools. More information can be found at the Maryland iMAP Portal[42]. Maryland Department of Natural Resources website provide additional information on species in the state[43].

State Natural Heritage Programs are also a source for rare species and natural community information. In some states they are within the State Fish and Wildlife Agency. The **Massachusetts Natural Heritage Program of MA Fish and Wildlife** developed BioMap3. The Massachusetts SWAP used Key Sites, based on BioMap2, to identify and target the most important sites for biodiversity protection and habitat management. These included sites with a concentration of co-occurring rare species listed under the Massachusetts Endangered Species Act (MESA), those with the best-quality occurrences of high-priority species or natural communities (e.g., globally rare species), and those with multiple, co-occurring, landscape-level resources as identified by BioMap2. The clear selection criteria, strategic approach, and limited geographic scope (key sites account for about 10% of Massachusetts) help justify conservation efforts by states and partners. Actions taken in key sites are typical for other land protection or restoration strategies and are intended to limit the impact of threats like development, climate change, and vegetative succession. One approach to

prioritizing biodiversity hotspots that promise to be resilient under changing climates is to preserve geodiversity across landscapes. When these geologically diverse places are protected, the result acts to preserve nature's "stage" for continued but shifting biodiversity "actors" (e.g. Beier et al. 2015, Anderson et al. 2015, Anderson et al. 2023b).

KEY REGIONAL PARTNER EXAMPLES AND OPPORTUNITIES.

For additional information and partners, please see *Chapter 7*.

NE Climate Adaptation Science Center (UMass Amherst and USGS)[44]. NECASC's robust scientific contributions have produced valuable tools and information on addressing climate change in the Northeast. Collaboration with natural and cultural resource managers has provided the climate change science to help inform fish and wildlife management decision-making and produce actionable products and results including more than 160 research projects and tools to facilitate climate change adaptation strategies for the Northeast.

One of the most significant contributions was the 2015 Northeast Climate Change Synthesis to support the 2015 Northeast SWAP revisions (Staudinger et al. 2015). Staudinger et al. (2015) provided a wealth of information on the state of knowledge of impacts, vulnerabilities, and adaptive management of Northeast RSGCN and their key habitats for the 2015 SWAP revisions. NECASC has initiated a project to update the 2015 synthesis and assist the 2025 SWAP revision process (Staudinger et al. 2023). The 2023 Northeast Climate Change Synthesis revision provides additional, current data including more detailed climate change predictions across the region, information on the different assessments and indices, and multiple case studies on current and projected conditions for RSGCN and their habitats. NECASC established a Northeast Climate Change Working Group to share information on Northeast efforts among key partners as well as to solicit information leading to a better understanding of the climate change-related needs of state fish and wildlife agencies and their key partners, and then to develop and deliver science to meet those needs. Please see *Section 4.6* for additional information on specific projects, resources, and references on climate change.

JOINT VENTURES IN THE NORTHEAST

Atlantic Coast Joint Venture (ACJV)[45]. The Atlantic Coast Joint Venture (ACJV) is a regional partnership to restore and sustain native bird populations and habitats throughout the ACJV region. The ACJV is comprised of 16 state wildlife agencies from Maine to Florida and the territory of Puerto Rico; federal and regional habitat

conservation agencies; and other organizations. The partnership is currently focused on one of the most imperiled habitats in the ACJV region – coastal marshes and the suite of vulnerable birds that depend on them. The ACJV is leading a coordinated marsh restoration and protection effort across the flyway to ensure that the partnership can achieve its vision. ACJV approaches its coastal marsh conservation goals by focusing on three flagship species that represent this habitat: American Black Duck, Black Rail and Saltmarsh Sparrow. The partnership is working to develop species-specific population and habitat objectives, prioritize potential threats facing each species, and craft actions to remove or reduce those threats. ACJV works to protect, restore, and enhance critical habitats that sustain populations of these and other marsh-dependent fish and wildlife species. Its habitat work provides many strong and direct benefits to people by reducing flooding, improving water quality, and supporting tourism, recreation, hunting, and fishing.

ACJV's science-based tools help direct the most appropriate conservation actions to strategic places on the ground and include:

- Population and habitat objectives for our focal species and habitats.
- Decision-support tools and priority area maps to target conservation action.
- Conservation planning documents for focal species and coastal marsh habitat to guide work on the ground.

ACJV works through partnerships and through federal and other grant programs like the North American Wetland Conservation Act (NAWCA), National Coastal Wetlands Grants Program, National Fish & Wildlife Foundation, State Wildlife Grants, and Great Lakes Restoration Initiative grants to help partners obtain a five-year average of approximately $20 Million per year. This funding helps to conserve more than 46,500 acres per year and leverages an additional $47 Million annually for land protection and habitat restoration projects.

Appalachian Mountains Joint Venture (AMJV)'s mission is to restore and sustain viable populations of native birds and their habitats in the Appalachian Mountains Joint Venture[46] region through effective, collaborative partnerships. Its focus is on Bird Conservation, but this work also benefits the diversity of wildlife and habitats throughout the Appalachians. Much of AMJV's work revolves around improving the health, resilience, and structure of Appalachian Forests. AMJV works across the range of land ownerships, including federal lands (e.g., National Forests), state lands (state forests and wildlife management areas), industrially owned properties, and Private Lands. ACJV highlights a "working landscapes" approach that balances landowners' needs with conservation potential, one that typically results in win-win results for both birds and people.

Brook Trout Joint Venture (EBTJV)[47]. The Eastern Brook Trout Joint Venture (EBTJV) is a geographically focused, locally driven, and scientifically based effort to protect, restore and enhance aquatic habitat throughout the brook trout's Eastern US native range. Its mission is to secure resilient populations of wild Brook Trout by protecting, enhancing, and restoring aquatic habitat and increasing human connections to, and stewardship of, the natural environment. EBTJV fills a need for collaborative, coordinated management of brook trout habitat across jurisdictional lines, especially by providing science and data, collaboration and information sharing, funding results-oriented habitat projects, and promoting the story of native, wild brook trout.

Atlantic Coast Fish Habitat Partnership (ACFHP)[48]. Species-Habitat Matrix The Species-Habitat Matrix is an evaluation of the importance of benthic habitats as space for shelter, feeding, and breeding by coastal fishes and motile invertebrates in ACFHP's four subregions. ACFHP's analysis quantified the relationship between more than 100 different species across four life stages and 26 different habitats. To access the data and published results, visit the ACFHP website. **ACFHP's Assessment of Existing Information.** The Assessment of Existing Information was completed in 2009 with the primary purpose of informing and enabling conservation planning for ACFHP. It includes three components: 1) a representative bibliographic and assessment database; 2) a GIS spatial framework; and 3) a summary document with a description of methods, analyses of results, and recommendations for future work. The results supported development of priorities for ACFHP's conservation efforts within its boundaries.

Partners in Flight (PIF) databases[49] were developed through the voluntary collaboration of more than one hundred ornithological experts working to provide a standardized and transparent system for estimating the population size and conservation status of North American birds at multiple geographic scales. Additional data can be accessed from our partners via the Avian Knowledge Network (AKN)[50], a partnership of people, institutions and government agencies supporting the conservation of birds and their habitats based on current data, the adaptive management paradigm, and the best available science. AKN partners act to improve awareness, purpose, access to, and use of data and tools at scales ranging from individual locations to administrative regions (e.g., management areas, states, countries) and species ranges. The two distinct PIF databases are housed and managed by Bird Conservancy of the Rockies[51]. The **Population Estimates Database** (PED) provides breeding adult population size estimates for U.S. and Canadian land birds at continental, state/province, and Bird Conservation Region (BCR) scales. The **Avian Conservation Assessment Database** (ACAD) provides a wealth of information useful for assessing the conservation vulnerability and status of all bird taxa (waterfowl, waterbirds, shorebirds, and land birds) from Canada through Panama.

Xerces Society's Guidelines for Protecting Fireflies of the US and Canada provides conservation actions that address their key threats including habitat loss/degradation, pesticides, human disturbance, and light pollution(Fallon et al. 2019). They also provide habitat restoration and protection recommendations as well as protocols for surveying and monitoring, research needs, and outreach and advocacy recommendations. Xerces is a valuable resource for additional invertebrate species conservation expertise and information.

The Carnegie Museums' Online Invertebrate Database provides a wealth of information on these taxa (Fetzner 2011). NEAFWA's RCN program sponsored a 2016 Land Snail Project to assess the status and distribution of land snails in the Northeast as a first step in their conservation (Hotepp et al. 2013). Since then, almost 30 species of land snails have been identified as RSGCN or Watchlist species. A similar assessment of the dragonflies and damselflies of the Northeast serves as the foundation of RSGCN data for these species.

Shorebird Conservation Partners: At Virginia Tech, recent community-based social marketing research produced a guide to changing human behavior relative to shorebird disturbance (Mengak et al. 2019, Mengak and Dayer 2022). With the support of National Fish and Wildlife Foundation (NFWF), Community of Practice, various partner organizations, and some state offices/wildlife Refuges, campaigns to change behavior were developed and piloted at key sites. Analyses on the impacts of the Community of Practice's efforts are being evaluated using social and ecological science methods. This will result in an online toolkit to be published in spring of 2023, the final phase of a larger project on the Atlantic Flyway[52]. These efforts, in turn, will support development and implementation of even broader campaigns to change human behavior and protect shorebirds across the US and Canada.

The Wildlife Society (TWS) is comprised of national, regional, and state Chapters and Working Groups that serve multiple roles in wildlife conservation. Their publications, white papers, and position statements provide cutting edge scientific information and techniques across the region. The **Conservation Affairs Network** under TWS sets conservation priorities and actions geared toward outreach and support for conservation policy.

American Fisheries Society (AFS) is dedicated to strengthening the fisheries profession, advancing fisheries science, and conserving fisheries resources. Its publications include scientific articles, journals, and magazine. These include "**Common and Scientific Names of Fishes from the United States, Canada, and Mexico, 7th edition**" as well as the **Conservation Status of Imperiled**

North American Freshwater and Diadromous Fishes (Jelks et al. 2008). AFS is an active professional society producing a wide range of publications, white papers, and positions on many important issues facing fisheries today.

Eagle Hill Institute, sponsor of the Northeast Natural History Conference[53]. The Eagle Hill Institute (a 501(c)(3) scientific and literary nonprofit organization) is dedicated to contributing to a greater interest in scholarly and educational pursuits in the natural history sciences. The Institute has been providing natural history science summer seminars and fall workshops since1987 and has hosted the annual Northeast Natural History Science Conference since 2011. Its work has expanded over time to include the publication of a number of peer-reviewed scientific journals. It maintains a natural history and art history library, hosts occasional resident scholars, and offers chamber concerts, lectures, and discussion Forums.

The Northeastern Naturalist[54]. The *Northeastern Naturalist* covers all aspects of the natural history sciences focusing on terrestrial, freshwater, and marine organisms and the environments of the region from Virginia to Missouri, north to Minnesota and Nunavut, east to Newfoundland, and south back to Virginia. Manuscripts based on field studies outside of this region that provide information on species within this region may be considered at the Editor's discretion. The journal welcomes manuscripts based on observations and research focused on the biology of terrestrial, freshwater, and marine organisms and communities. Such studies may encompass measurements, surveys, and/or experiments in the field, under lab conditions, or utilizing museum and herbarium specimens. Subject areas include, but are not limited to, anatomy, behavior, biogeography, biology, conservation, evolution, ecology, genetics, parasitology, physiology, population biology, and taxonomy. Laboratory, modeling, and simulation studies on natural history of the region, without any field component, are considered for publication as long as the research has direct and clear significance to field naturalists and the manuscript discusses these implications.

These next four regional conservation actions specifically address the top regional threats identified in the 2005 and 2015 SWAPS and 2023 RSGCN and their habitats in the Northeast. Detailed information on these top threats, the RSGCN species they impact, and additional tools and resources are provided in *Chapter 3*.

These overarching actions prioritized in the Northeast region address key goals and targets of partner plans at multiple scales, including the most recent Global Diversity Framework from the "Kunming-Montreal" Convention on Biological Diversity3, the National Fish, Wildlife and Plants Climate Change Adaptation Strategy recommendations (National Fish, Wildlife, and Plants Climate Adaptation Network. 2021) and reflect a diversity of other partner plans from the global to local scale.

4.3 CONSERVE NORTHEAST RSGCN AND THEIR HABITATS BY ADDRESSING HABITAT LOSS AND DEGRADATION (FROM DEVELOPMENT, NATURAL SYSTEM MODIFICATION AND BIOLOGICAL RESOURCE USE)

4.3.1 REGIONAL NEED AND PRIORITY ACTIONS

Regional Need: The 2005 and 2015 SWAPs, the 2017 SWAP Synthesis, and the 2023 RSGCN process consistently identified that habitat loss and degradation from development, natural systems modification, and biological resource use as top threats facing Northeast RSGCN and their habitats. The Northeast region is among the most developed and modified areas in the United States, impacting RSGCN species and their associated habitats. A coordinated, regional approach and set of tools and guidelines to address land and resource use on Northeast landscapes and waters are needed, especially in the face of increasing impacts from climate change.

Priority Actions: Provide and encourage incorporation of SWAP and regional priorities into land, water and natural resource use plans, decisions, and management programs across the Northeast. Provide information and guidance with best practices and consistent protocols for RSGCN and their key habitats. Work with agencies and entities that regulate impacts to fish and wildlife habitats to develop and implement holistic, effective, consistent policies and approaches that incorporate climate projections into risk assessments across Northeast lands and waters to conserve and restore RSGCN and their habitats.

See Priority Species in Chapter 1, Priority Habitats in Chapter 2, Priority Threats in Chapter 3, each with partner and program opportunities and examples. See Table 4.1.1 and Appendix 4A for priority projects completed and Appendix 4B, the SWAP Synthesis, and individual SWAPs for additional priority Conservation Actions that address habitat loss and degradation across the Northeast.

4.3.2 APPROACH

From the global perspective, habitat destruction and over-exploitation are at the top of the list of global threats to biodiversity, although the relative ranking of these threats often depends on local context and the metrics used (Bellard et al. 2022). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

(IPBES), International Union for Conservation of Nature (IUCN), and World Wide Fund for Nature (WWF) recently ranked these global threat categories in terms of their estimated contribution to biodiversity loss. The IPBES ranking of these threats identified habitat change as the most important, followed by overexploitation, climate change, pollution, and biological invasions. See Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services[55]; and the United Nations Convention on Biological Diversity[56]. A synthesis of recent driver impacts indicated that land/sea use change has been the dominant direct driver of recent biodiversity loss worldwide. Direct exploitation of natural resources ranks second and pollution ranks third, followed by climate change and invasive alien species (Jaureguiberry et al. 2022). Although the ranking of threats at the global scale varies depending on the system used, the same threats consistently rise to the top. Addressing global biodiversity loss requires tackling all these major drivers as well as their many interactions.

The December 2022 Convention on Biological Diversity set targets for land and water conservation that aim to reverse the unprecedented losses caused by development at the national and global scales. One of the agreement's twenty-three targets aims to protect at least 30 percent of the planet's land and water by 2030. Thirty-by-thirty (30×30) refers to efforts by the global community to conserve 30% of terrestrial and marine habitat by 2030. This became official policy in the U.S. in 2021. See the **IUCN Green List of Protected and Conserved Areas[57]** and **Protected Areas Database of the US (PAD-US)[58]**. TNC is augmenting the PAD-US dataset as part of the RCN Northeast Habitat Condition Analysis project by reaching out to its state chapters in the Northeast for the best available information (Anderson et al. 2023a).

EPA's Report on the Environment[59], The National Climate Assessment[60], the Socioeconomic Data and Applications Center (SEDAC), CIESIN-The Earth Institute at Columbia University[61], and NASA's Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Centers[62] provide detailed information on the status of environmental health and biodiversity nationwide. Again, the same threats rise to the top, and are all anthropogenic in their origin. The first iteration of the SWAP Synthesis (TCI 2007) listed the same top threats as did the 2015 SWAPs and the 2023 RSGCN analysis (see Chapter 3 for detailed threat descriptions, impacts and examples in the Northeast).

Biological resource use of animals and plants continues to impact RSGCN and their key habitats in the Northeast in multiple ways (see Chapters 1 and 2). See Chapter 3 for detailed threat descriptions, RSGCN impacts, and additional resources for responding to this threat. Reducing it requires working closely with regulatory agencies and divisions that regulate harvest of animals or plants. In some states the jurisdiction of some animals and plants is shared with other agencies. Some state fish and wildlife

agencies may not have authority for all invertebrates or plants. Close coordination with all regulatory authorities is critical (e.g., state Department of Agriculture) and states often develop cooperative agreements between agencies for this purpose.

State marine programs usually have jurisdiction over marine plants and animals, though diadromous fish are often shared responsibilities. For conservation of marine RSGCN, agency counterparts include NOAA's National Marine Fisheries Service (NMFS), as well as regional fisheries Councils and Commissions. NOAA's current Strategic plan for New England and the Mid-Atlantic region outlines approaches to managing fisheries and marine resources (NMFS 2022). The plan states that effective science-based management is essential to reaching optimum yield while preventing overfishing. Close collaboration with the New England and Mid-Atlantic Fishery Management Councils, Atlantic States Marine Fisheries Commission, state and fishing industry partners, the Northwest Atlantic Fisheries Organization, and local organizations and stakeholders should continue to address impacts on RSGCN and their habitats. Halpern et al. (2019) describes the status and recent changes to ocean environments. The current NOAA National Strategy can be accessed through the NOAA Fisheries website (NMFW 2022).

Development, natural systems modifications, and biological resource use have long been identified as top regional threats to RSGCN and their habitats in the Northeast, beginning with the original SWAPS in 2005 (TCI 2007). See *Chapter 3* for detailed threat descriptions, RSGCN impacts, and additional resources for each threat. It is important to note that most actions are ultimately taken at the local and state levels, even though they are identified as important at regional or broader scales. Regional implementation can include the development of consistent tools and data to inform customized state-level implementation. A coordinated approach between and among the states to share their advancements in the development of broader, regional tools and guidelines is more efficient and effective than 14 states working independently toward the same goal.

Together, the fourteen 2015 Northeast SWAPs cited more than 800 unique actions to address the severe, irreversible threat posed by development. More than 75% of the recommendations pertained specifically to residential development, but some of the recommended actions were more broadly focused.

The most commonly shared and frequently cited action categories to address habitat loss and degradation listed by SWAPS are (in descending order):

1) **direct management of natural resources;**
2) **data collection and analysis;**
3) **land and water acquisition and protection;**

4) **outreach, planning, species management/reintroduction, coordination and administration; and**
5) **partnerships, technical assistance, and law enforcement.**

All were identified as critical to strategically addressing the threat of development (TCI and NEFWDTC 2017) (see *Appendix 4B*, the 2017 SWAP Synthesis and individual SWAPS for additional actions in each category.

Numerous efforts have been undertaken to **inform local and state land use planning and development**. Each state's Fish and Wildlife agency and Natural Heritage Program provides detailed information on the status, occurrence, and distribution of rare and endangered species, their habitats and associated natural communities. Ensuring that local, state, and regional planning and development are informed by SWAP SGCN and RSGCN species and habitat information is the critical first step toward ensuring that they are considered in each local and regional plan and project. Along with the environmental review process for each state and locality, providing SWAP and regional key habitat and COA information that identifies important areas and considerations allows local planning boards and commissions to be more strategic in their design and placement of projects.

This includes **identifying important lands and waters to be protected as cores with corridors** that allow healthy movement of fish and wildlife populations and enough conserved habitat on public and private lands to make this movement possible. The restoration of functioning ecosystems in targeted areas to connect and enhance the matrix of conserved habitat is a key conservation priority. Environmental review and restoration should not only consider the historical impacts on a species and system, but also incorporate climate change projections to help determine whether future conditions will support the species or system and to prioritize areas that offer climate refugia and suitable habitat.

A common thread in SWAPs was the need to inform land use decision-makers in both the public and private sectors about the importance of incorporating SWAP priorities (RSGCN, SGCN, COAs and key habitats) into their plans and programs.

State fish and wildlife agencies and their partners with direct knowledge of SGCN and their habitats can **provide technical assistance to landowners, land managers, and decision-makers** on the most appropriate strategies and best practices for incorporating wildlife diversity into land use planning at the local, state, and regional levels. State agencies can engage partners for effective conservation and to inform stakeholders and the public about the importance of SGCN

and their role as sentinel species for functioning ecosystems, as well as in protecting clean air and water and quality of life for human communities. Proactive conservation is also a more ecologically, socially, and economically beneficial approach to resource management. Smart growth planning can avoid significant costs, such as the destruction along developed coasts caused by hurricanes and other coastal storms. Additional actions and resources can be found in the 2017 SWAP Synthesis and action matrix in *Appendix 4B, Chapter 2* (by habitat) and *Chapter 3* (by threat).

As development, natural system modification, and biological resource use continue to impact Northeast wildlife and its habitats, **providing access to SWAP and regional data** and encouraging its use in strategic growth planning, transportation, and green infrastructure initiatives is key. New tools are being developed at the regional, state, and local levels to facilitate incorporation of regional data and priorities into resource management and planning (see Table 4.1.1 and Appendix 4A and Chapter 2 for habitat management information and examples). Development for commercial, industrial, recreational, and residential purposes is a longstanding threat to many wildlife species. It fragments habitats and reduces wildlife populations, either directly through events like construction and road mortality, or indirectly via the introduction of invasive species or diseases. As climates changes in coastal areas, human populations will expand into other areas, displacing or adversely impacting native wildlife in the process. See *Chapter 3* for detailed threat descriptions, RSGCN impacts, and additional resources for these threats.

Planning should prioritize landscape connectivity and include actions that support migration corridors and facilitate movement of multiple species in terrestrial, aquatic, and coastal habitats. In terrestrial systems, The Nature Conservancy's resilient and permeable landscapes tools can be used to identify climate-resilient sites and corridors (Anderson et al. 2016a, 2016b). Designing Sustainable Landscapes[63] and Nature's Network[64] can be used to evaluate development scenarios with information and RSGCN data, prioritizing areas for conservation, restoration, and land acquisition as a way to increase connectivity and preserve refugia. The U.S. Geological Survey's Coastal Response data layers[65] and TNC's Resilient Coastal Sites[66] can be used to identify locations that support and protect coastal resiliency and to prioritize areas for land acquisition and restoration that allow upslope and inland migration (Anderson et al. 2016b).

Many states and partners identified the need to **determine priority areas for protection and conservation**. Many SWAPs identified Conservation Opportunity Areas and Nature's Network/Database by NALCC and its partners addressed this at the regional scale. Planning, outreach, and technical assistance encourage the use of incentives and improvement of land use practices by working with both public and

private sector partners. SWAPS identified specific habitats where voluntary incentives could be used. These include wetland and riparian buffers, vernal pools, northern and south-central forest and swamps, pine barrens, wetlands, and coastal dune and marsh habitats. A key objective is to improve connectivity of the human/built landscape to mitigate the effects of sprawl and limit additional habitat fragmentation. Several RCN projects developed BMPs to specifically address development, natural systems modification, and biological resource use (see Table 4.1.1 and Appendix 4A).

Education and Outreach actions included development and dissemination of a variety of wildlife-friendly tools and information for localities, homeowner associations, etc. Providing technical assistance to landowners, planners, developers, and other land users was cited by the SWAPS as crucial to protecting SGCN and their habitats.

Law and Policy recommendations focused on the need to improve buffers around important wetlands; wildlife friendly zoning; and incentives for public and private sector conservation and stewardship. These include green infrastructure, land tax programs, long term easement incentives, and policy as well as private sector standards and incentives for wildlife-friendly lawn care and better water management through the reduction of semi-impervious surfaces. See *Chapter 7* for additional information on Northeast partners and *Chapter 3* for more detailed threat information.

4.3.3 REGIONAL PROJECTS ADDRESSING HABITAT LOSS AND DEGRADATION FROM DEVELOPMENT, NATURAL SYSTEMS MODIFICATION AND BIOLOGICAL RESOURCE USE

The NEFWDTC and SWAP Synthesis identified Development, Natural Systems Modification and Biological Resource Use as top regional threats in the 2005 and 2015 SWAPs. To address them, NEAFWA's RCN and key partner programs prioritized and funded multiple projects to provide management guidelines and Best Management Practices (BMPs) that will help restore and improve habitat quality, function, and connectivity for RSGCN in the region. For a complete list of these projects, see Table 4.1.1 and *Appendix 4A*; for additional partner information see *Chapter 7*.

See Priority Species in Chapter 1, Priority Habitats in Chapter 2, Priority Threats in Chapter 3, each with partner and program opportunities and examples. See Table 4.1.1 and Appendix 4A for priority projects completed and Appendix 4B, the SWAP Synthesis, and individual SWAPs for additional priority Conservation Actions.

Appendix 4A provides a list of projects that have advanced the conservation of these regional species and habitats through the RCN, CSWG, SA programs from 2007 to 2023. This Chapter provides a list (Table 4.1.1) and summaries of those projects implemented since the 2013 Synthesis, organized by the predominant information or tool and SWAP element they address. The key RCN and CSWG projects addressing Development, Natural Systems Modification, and Biological Resource Use are summarized below.

Development of Model Guidelines for Assisting Local Planning Boards with Conservation of Species of Greatest Conservation Need and their Key Habitats through Local Land Use Planning (2008) (RCN). This project focused on integrating conservation information on SGCN and their habitats with land use planning decisions. The intended audience was decision-makers, particularly those at a local scale, and volunteers needing access to information. The goal in many instances was to answer their questions with a few simple keystrokes. The project developed an initial toolkit for planners that provides a) easy access to SGCN and habitat information; b) access to funding sources that support wildlife conservation planning; c) legal frameworks in each state that address SGCN; d) BMPs; and e) mechanisms that can deliver this information efficiently and effectively. A regional and state-by-state overview of wildlife conservation practices in the Northeast helps to identify priorities for future studies, reveals gaps in information, and highlights successful programs. The study also builds on a wealth of information previously compiled by each partner and offers an inventory of existing delivery mechanisms, legal requirements, BMPs, funding sources, and key networking and dissemination opportunities available in the Northeast region. Through in-depth interviews with representatives of state wildlife agencies, selected land trusts, and municipalities, the study identifies gaps in the existing delivery system that may be filled through an expanded toolkit. This project includes a) an overview of wildlife and conservation information available from a national / regional and state- level sources, as well as detailed information in an Excel spreadsheet format ; b) case studies showing how biodiversity conservation was incorporated into planning in Virginia and Pennsylvania; c) legal conservation frameworks for each state ; d) funding sources for conservation by state; and e) links to a demonstration toolkit for three states (Virginia, Pennsylvania, and New Hampshire). This toolkit is available on NatureServe's LandScope America. It brings together maps, data, and stories about natural places and presents them in dynamic and accessible formats (Sneddon et al. 2012).

Staying Connected in the Northern Appalachians (2008) (CSWG). This project implemented top priority actions from the Maine, New Hampshire, New York and Vermont Wildlife Action Plans to restore, maintain and enhance the six most important habitat linkages in the Northern Appalachian Ecoregion, benefitting at least

41 wide-ranging and forest-dwelling SGCN. Benefits to SGCN will accrue through protecting the ability of species to move regionally in response to changing climate and by protecting and/or restoring opportunities for regional genetic interchange. States will integrate conservation planning at the ecoregional, state and local scales with land protection (at least 18,250 acres) and technical assistance activities targeted to municipalities where most land use decisions in the Northeast are made. The work of this partnership of eight state agencies in four states and 13 non-profit organizations will be complimented by similar conservation activities in the neighboring four Canadian provinces. International coordination will be provided by Two Countries, One Forest.

The Staying Connected in the Northern Appalachians Initiative, also referred to as the "Staying Connected Initiative" or SCI[67], was supported by a Competitive State Wildlife Grant awarded in 2009 and by other funding sources. Staying Connected advanced landscape-scale conservation across the Northern Appalachian Ecoregion by maintaining, enhancing, and restoring habitat connectivity for a variety of SGCN. The SCI partnership concentrated its work in eight key areas, focusing on connectivity and the blending of conservation science, land protection, technical assistance for land use planning and community action, and road barrier mitigation.
The final report includes separate reports on each of twelve component projects supported by SCI's Competitive State Wildlife Grant (CSWG). The other essential piece of this report is the extensive body of supplemental materials provided in the attachments.

Best Management Practices for RSGCN In Northeast Forests (RCN). This project provides BMPs for the biological resource use of forested habitats. Northeastern forests are considered key habitat for a large suite of wildlife, including several habitat specialists listed as SGCN in multiple states. Their vulnerability to various stressors has prompted the formation of several species--level conservation and research initiatives. This RCN project collaborated with key forest stewards to integrate current ecological and biogeographic information into on-the-ground habitat enhancement. This collaboration produced spatially explicit management and conservation support for five regional SGCN: Bicknell's Thrush, Wood Thrush, Canada Warbler, Rusty Blackbird, and American Marten. For each of these species, the report contains a species profile, conservation status, habitat landscape characteristics, desired habitat conditions, recommended management/conservation practices, and ecosystem services and comprehensive planning. The project engaged both experts and end users to produce scientifically sound and practical guidelines for conserving these species and other SGCN in their guilds. Available occurrence data, distribution models, and stakeholder input delineated and prioritized areas with high management and conservation potential. Working directly with habitat stewards ensured that the

recommended practices are implemented in management and conservation opportunity areas. Results include field guides and guidelines for managing habitat for RSGCN in the Northeast and Mid-Atlantic Forests, a final report, and spatial prioritization for implementing these guidelines for RSGCN (Lambert and Reitsma 2017, Lambert et al. 2017).

Implementing Bird Action Plans for Shrubland Dependents in the Northeast (2007-2012) (RCN). This project enhanced the conservation status and increased awareness of shrubland habitat-dependent SGCN in the Northeast, with a focus on the Appalachian Mountains. SWAPs in VA, MD, WV, PA and NY collectively identify 87 SGCN that are dependent upon shrubland habitats in Bird Conservation Region 28 – Appalachian Mountains. Among the 87 shrubland- dependent SGCN, there are 40 birds, 16 mammals, 16 amphibians/reptiles, and 15 invertebrates. Shrubland habitats in BCR 28 have declined due to loss of land to development, maturation of successional habitats, suppression of natural disturbance, and lack of active management. To address the decline in shrubland habitat-dependent SGCN, this project was designed to increase the conservation status of shrubland habitats on public and private lands through the development of Best Management Practices (BMPs), establishment of BMP demonstration areas, monitoring the response of selected shrubland species to habitat management, and outreach to public land managers and private landowners. Restoration of shrubland habitats depends on private landowner awareness, knowledge, and engagement in providing conservation benefits to the suite of species. Short-term conservation benefits included an increase in shrubland habitats. Long-term benefits will accrue from a growing awareness among private landowners that current and future actions taken on their land will determine if this suite of species remains imperiled. Final products include a report *Implementing Bird Action Plans for Shrubland Dependents in the Northeast* as well as the following publications: *Implementing the American Woodcock Conservation Plan, American Woodcock Habitat: Best Management Practices for the Central Appalachian Mountains Region* and *Under Cover: Wildlife of Shrublands and Young Forest*. A web site[68] was developed and populated with documentation of BMPs, demonstration areas, and opportunities for technical assistance (McDowell 2011, Gilbart 2012).

Establishing a Regional Initiative for Biomass Energy Development for Early-Succession SGCN in the Northeast (RCN). This project outlined the costs and benefits that biomass energy systems pose for SGCN in the Northeast. This information can be used to identify opportunities that certain biomass energy applications present for managing SGCN. It can also provide an impetus to work with biomass developers for mutual benefit. For example, some biomass energy systems have the potential to provide habitat favorable to early successional SGCN. In nearly all 13 states, early successional species are included in the list of SGCN but the tools

available to wildlife managers for creating and maintaining these habitats are dwindling. Biomass energy systems provide a clear opportunity for early successional species habitat management. Public demand for green energy alternatives is increasing and the amount of land needed to supply these facilities is substantial. There are many types of biomass systems, either in-place or proposed, for the region. The project team investigated only those systems that utilize native species and assigned each of the SGCN to a general habitat class based on life history information. Potential interaction responses of positive, negative, no effect, or not applicable were assigned to each combination of biomass system and SGCN; and the net potential impacts of specific biomass system implementation on SGCN were summarized.

Overall, the results of this project show that biomass energy development will impact SGCN at the state and regional levels. Results, in general, indicated that biomass systems that utilize wood from existing mature forests will result in a net negative impact to SGCN as these forests are converted to a younger state. Biomass systems sited on existing agricultural land would have a larger potential net positive for SGCN regardless of which biomass system was implemented. Some of the biomass systems presently under discussion have structural or floristic components similar to those provided in these species' natural habitats. This is particularly true for "early successional species" that utilize habitats maintained through frequent disturbance. Ultimately, the interest in biomass energy development may supply the only real landscape-level alternative for addressing the shortage of shrub and grassland habitat in the region. The study recommends that wildlife resource management agencies become active participants in the planning and implementation phases of biomass energy project development, to mitigate potential negatives and maximize potential benefits (Klopfer 2011).

Best Management Practices for Wetland Butterflies (RCN). This project provided BMPs for the management of wetland habitats. It also addressed the uncertain status and distribution of many wetland butterfly species in several Mid-Atlantic States, including SGCN and RSGCN species in the Northeast. Some species declines may be due in part to threats impacting groundwater wetlands, including outright destruction, habitat degradation, and the succession of open wetland habitats to forest or dense shrubland. Climate change and habitat fragmentation may further impact these species and leave them vulnerable to local extirpations. The primary objective of this effort was to enhance and expand populations of wetland butterfly SGCN through developing a greater understanding of the distribution and habitat requirements for these species, and by implementing habitat enhancement projects where needed. Project goals were to: 1) update distribution data for 14 butterfly SGCN in the region; 2) model species distribution and climate conditions for each species; 3) identify and prioritize wetlands that support one or more of these 14 species; 4)

implement wetland enhancement and improvement projects; and 5) develop BMPs for species distribution and climate modeling and for wetland enhancement projects. Results should guide targeted survey work for these species and prioritize wetlands for enhancement projects. In the long-term, results may also improve habitats for these species, increase populations of butterfly SGCN, and promote connectivity between populations through increased habitat availability. Fourteen species of wetland-inhabiting butterflies with SGCN status were surveyed at multiple sites across four states – Maryland, New Jersey, Pennsylvania, and West Virginia—in 2016-17. Survey data was used to evaluate the status of each species in all states where they occurred, as well as to refine the distribution data for each species across the region. All data points were mapped in ArcGIS and used to model species distribution in terms of both habitat and climate. BMPs were developed, and habitat enhancement projects were initiated in Maryland and Pennsylvania. The report includes Life History Guides to the 14 species, the Pennsylvania Habitat Management Guide for Pollinators, Wetland Butterfly Habitat Enhancement BMPs, and additional resources including a model Wetland Restoration Report (Frye et al. 2018).

Conservation Plans for Blanding's, Bog, Wood, Spotted, and Box Turtles and Associated Wetland-Dependent SGCNs (RCN, CSWG). Over the past decade, significant advancements have been made in addressing the information and conservation needs of RSGCN turtles through the RCN and CSWG grants. Multiple partners and grants (RCN and CSWG) have resulted in robust conservation plans, protocols, and best management practices to be implemented regionally for these important RSGCN. See *Appendix 4A* and summaries presented in *section 4.2.3*. For additional information on the BMPS, protocols and conservation actions that address development and biological resource use see the Conservation Planning for Northeast Turtles website[15].

The SA ARS program 2022 efforts for the Northeast Turtles (Blanding's, Spotted, and Wood Turtle) Conservation. The At-Risk Turtle team worked with the states to implement conservation plans that are informed by standardized monitoring and genetic analysis. Specifically, this work has focused on: 1) securing viable populations through land conservation (using grant programs like LWCA, DE Bay, Chesapeake Wild, and America the Beautiful, and NRCS's Wetland Reserve Easement program); 2) enhancing populations through restoration of habitat (work on refuge lands, DoD lands, and working with NRCS on private lands); 3) decreasing road mortality in areas with high mortality rates (work on refuges and with individual states using DOT funds); 4) addressing illegal trade in turtles. The team continues to provide leadership on the Collaborative to Combat Illegal Trade in Turtles, to support Law Enforcement by identifying housing for confiscated turtles, and to help states get turtles back to the wild through genetic and disease screening. Development of outreach tools is

part of a long-term strategy to address illegal trade in turtles continues. The ARS program assesses population status on refuges and DoD lands, and through projects with NAFO, and is the lead for spotted and wood SSA and assists on the Blanding's SSA.

Figure 4.3.1. Management guidelines for RSGCN Turtles (see northeastturtles.org).

Population Declines Due to Loss of Adult and Juvenile Turtles to Illegal Wildlife Trade in 2021 (CSWG). The goals of this project were to: 1) assess recently developed health and disease testing protocols and 2) determine the best method and use of genetic information to determine the place of origin of confiscated animals. These two actions are designed to slow the rates of decline in eastern, native SGCN turtle populations due to wildlife trafficking by providing states with the information needed to make an informed decisions regarding repatriation.

Young Forest and England Cottontail Conservation Initiative (2007-14) (CSWG, SA, RCN). As part of its young forest project, NEAFWA's Habitat Technical Committee developed a manual providing information and recommendations on managing and renewing young-forest habitats in the Northeast: Managing Grasslands, Shrublands and Young Forests for Wildlife (Oehler et al. 2006). Multiple resources, including articles, brochures, guidebooks and manuals, presentations, etc. are available on this site. A Conservation Strategy (Fuller and Tur 2012), and a recent outreach plan for the New England Cottontail (New England Cottontail Outreach Strategy 2018) are also available to help partners implement the conservation strategy for New England cottontail rabbit (*Sylvilagus transitionalis*).

The goal of the initiative in the short-term is to restore 1200 acres of New England cottontail habitat, creating 50 new habitat patches across the species range, with an expected long-term population increase of 720 animals. The goal in the long-term is to avert federal listing by increasing the rate of colonization of habitat patches, thereby stabilizing metapopulation viability. Objectives included: 1) convene a range-wide recovery steering committee comprised of partnering state wildlife agencies, NRCS, and USFWS; 2) evaluate target properties for habitat restoration and draft a spatially explicit habitat restoration plan; 3) disseminate restoration plans to local stakeholders and partnering agencies; 4) prescribe and implement habitat restoration activities in an adaptive management framework; 5) monitor performance to determine the relative efficacy of implemented actions; and 6) provide technical and administrative support to the states and partnering entities.

The range wide "Conservation Strategy for the New England Cottontail" was completed in 2012 by a multi-agency working group. State conservation summaries were completed for all six states and included in the regional conservation strategy that was peer reviewed in June 2012. A comprehensive landscape analysis of all parcels in the species range supported the design of landscapes to support NEC populations and the identification of target sites. Across 6 states, 12,439 parcels were ranked as the most likely to be suitable. The best ranked parcels have been adopted as targets for range-wide NEC conservation. The formation of a private lands working group has increased

the number of private parcels that are visited for evaluation, and resulted in contracts with NRCS, WMI, and USFWS Partners for Fish and Wildlife. More than 950 acres have been treated on state lands across all six states since 2009, and the target of 1,200 acres was met by May 2014. The **ARS Team supports the New England Cottontail rabbit conservation (SA)** throughout the region. In 2012, state wildlife agencies from Connecticut, Maine, Massachusetts, New Hampshire, New York, and Rhode Island worked with U.S Fish and Wildlife Service and the Natural Resources Conservation Service to finalize a conservation strategy to conserve the New England cottontail throughout its current range.

Pollinator Habitat in Xeric Grasslands, Barrens, and Woodlands (2018-22) (RCN) [22]**.** NEFWDTC prioritized another key regional habitat supporting multiple RSGCN taxa and focused on conservation of the fire-adapted xeric habitats that support a diverse fauna including pollinators. This RCN project developed a regional network of experimental adaptive management sites where coordinated management and monitoring leads to improvements in management over time. This includes ensuring adequate representation of forbs, bare soil, and other key pollinator habitat features; improving habitat for other RSGCN; and lowering management costs and treatment frequency to the greatest extent practical. The project also resulted in improved coordination and sharing of early successional habitat management expertise among states. Standardized, regional vegetation and pollinator monitoring protocols were developed, enabling more effective pooling of data and providing a framework for informed, science-based management decisions. The project improved understanding of the abundance and distribution of select, vulnerable pollinator taxa (e.g., bees and butterflies), and of how these species respond to habitat management over time. Results informed and improved on-the-ground management of at least 500 acres of habitat at regionally significant sites. The project served as a framework for longer-term monitoring and experimental adaptive management practices to improve overall management for these complex, fire-influenced systems (Milam 2018).

This Xeric Habitat for Pollinators Project focused on fire-adapted habitats (xeric grasslands, barrens, and woodlands) as a way to improve the ability of Northeast states to implement cost-effective habitat management for the benefit of native pollinators and other RSGCN that depend upon these priority habitat types. Templates for data collection and reporting were developed along with the vegetation monitoring project protocol, which seeks to provide data consistent with the longstanding monitoring programs at some of the more established sites. A key variable, the percent of vegetative cover, is expected to respond to treatments and to indicate habitat suitability for ground-nesting bees.

4.3.4 REGIONAL EXAMPLES AND OPPORTUNITIES TO ADDRESS DEVELOPMENT, NATURAL SYSTEMS MODIFICATION, AND BIOLOGICAL RESOURCE USE

Please see *Chapter 3* for detailed threat descriptions, impacts to RSGCN, and additional resources, tools and examples for each threat.

Habitat Management Guidelines and Best Practices for Reptiles and Amphibians. The RCN, CSWG and SA projects listed in Table 4.1.1 and summarized above on rare wetland turtles in the Northeast provide robust conservation plans, guidelines and resources. Additional Habitat Management Guidelines for Northeast Amphibians and Reptiles are available from PARC/NEPARC since habitat alteration, fragmentation and loss are collectively considered to be the primary challenge in the region. With herpetofauna populations declining and human populations expanding across more land, PARC developed a series of regionally specific best management practices, or Habitat Management Guidelines, to provide proactive guidance for improving the compatibility of land management practices with the conservation needs of these animals. These guidelines are not regulations and should be regarded instead as recommendations helping landowners and managers to consider the needs of amphibians and reptiles during their management activities. They are directed toward resource managers and private landowners who have a desire to help protect amphibians and reptiles. These are regionally specific guidelines for managing habitats with the goals of keeping common species common, stemming the decline of imperiled species, and reducing the likelihood that these species will become listed as threatened or endangered. More specific conservation and management plans containing more specific recommendations for turtle species, including the spotted, wood, box, and Blanding turtles, can be found on the Conservation Planning for Northeast Turtles website[15]. Mitchell et al. (2006) describe habitat management guidelines for herptiles in the Northeast. MacNeil et al. (2013) provides forest management guidelines for the Midwest.

Working with Urban areas and Infrastructure has provided a diversity of conservation and education opportunities. Sparks et al. (2019) attempt to "bridge the gap" between **Bats and Transportation Projects** in their Manual of Best Management Practices for Bridges, Artificial Roosts, and Other Mitigation Approaches for North American Bats. McCance et al. (2017) describe the importance of urban wildlife management in the U.S. and Canada. Many partners efforts seek to promote wildlife conservation and education in urban environments and have found opportunities to work with diverse development partners across the region (see *Chapters 2 and 7* for more details).

Wildlife Habitat Council (WHC)[69] empowers companies to advance biodiversity, sustainability, employee engagement and community relations goals. Its mission is to recognize, inspire, engage and support businesses to achieve wins for nature and vision is a world in which nature is fully integrated into all aspects of business (operations, corporate citizenship and management). WHC programs translate corporate sustainability goals and objectives into tangible and measurable on-the-ground actions. Through a focus on building collaboration for conservation with corporate employees, other conservation organizations, government agencies and community members, WHC programs focus on healthy ecosystems and connected communities.

Designing Sustainable Landscapes (DSL)[63]**.** Multiple tools to Design Sustainable, Permeable, Resilient Landscapes have been developed in the Northeast. Designing Sustainable Landscapes (DSL) is a landscape conservation project focusing on the Northeast region. Its purpose is to offer guidance for strategic habitat conservation by assessing ecological integrity and landscape capability for a suite of focal species across the landscape. Assessments are done for both the current landscape and potential future landscapes, as modified by models of urban growth, climate change, and sea level rise. Indices of ecological integrity were used as part of the modelling (McGarigal 2018a, 2018b).

For global and national context, The December **2022 Convention on Biological Diversity** set targets for land and water conservation that aim to reverse the unprecedented loss of nature to development. One of the agreement's twenty-three targets aims to protect at least 30 percent of the planet's land and water by 2030. Thirty-by-thirty (30×30) refers to efforts by the global community to conserve 30% of terrestrial and marine habitat by 2030. This became official policy in the U.S. in 2021. The IUCN Green List of Protected and Conserved Areas[57]and Protected Areas Database of the US (PAD-US)[58] are spatial resources available at the global and national scales. TNC is augmenting the PAD-US dataset as part of the RCN Northeast Habitat Condition Analysis project by reaching out to NE state TNC chapters for the best available information. See Anderson et al. (2023a).

The 30x30 Initiative is an inclusive model of conservation that is science-based, locally driven, and engages all stakeholders, from tribal and Indigenous communities to farmers, ranchers, and outdoors enthusiasts. The first annual progress report on the America the Beautiful initiative[70] highlights steps the Administration has taken over the past year to support locally-led and voluntary efforts to conserve, connect, and restore lands and waters across the nation that sustain the health of our communities, power local economies, and help combat climate change (America the Beautiful Interagency Working Group 2021). The report outlines the collective work to pursue the national conservation goal by the US Departments of the Interior,

Agriculture and Commerce, and the White House Council on Environmental Quality. The federal actions described in the progress report align with the America the Beautiful initiative's guiding principles and build upon the existing investments made through the Great American Outdoors Act[71] to support the creation of more parks and increased access to the outdoors and nature-based recreation in historically underrepresented communities while creating jobs that support restoration and resilience. The initiative also prioritizes supporting Tribally led conservation and restoration priorities, as well as expanding collaborative conservation of fish and wildlife habitats and corridors.

Wildlife Corridors. The Wildlife Corridors Conservation Act of 2019 establishes a National Wildlife Corridors System to designate wildlife corridors on federal public lands. It also provides funding for states, tribes, and other entities to protect wildlife corridors on nonfederal lands. The new grant program would provide up to $100 million a year over the next five years through competitive grants to states, Tribes, and/or other land managers to construct wildlife crossings over or under their highways. This will ensure that fish, wildlife, and plants can migrate between habitats for genetic exchange and climate adaptation. The bill directs federal land and water management agencies to collaborate with each other, as well as with states, tribes, local governments, and private landowners, to manage national wildlife corridors according to the habitat connectivity needs of native species. The bill also creates a publicly available National Wildlife Corridors Database[72] to inform corridor protection. Establishing this program is a critical step forward in protecting and restoring fish, wildlife, and plant species populations across our nation's lands and waters. Collisions between vehicles and animals result in more than 200 human deaths and 26,000 injuries, as well as the deaths of more than 1 million large animals each year. Currently, VA and NH are the Northeast states that have passed enabling state laws to address this problem.

Habitat Connectivity. Similar collaborative RCN projects undertaken by TNC evaluate and map the relative landscape permeability or "habitat connectivity," resilience, and site capacity across the Northeast region. These projects determine how permeability and resilience coincide with the locations and habitat of species of greatest conservation concern to identify where the most important regional conservation areas are, as well as movement concentrations, particularly those areas where movements may be funneled due to constriction in the landscape (Anderson et al. 2016a, 2016b, DeLuca2021). Using this information, TNC measured the amount of flow, permeability, and resistance present in the region's roads and in its secured-lands network. The projects are guided by a thirteen-state steering committee.

The DSL project provides much of the basis for the conservation planning tools used by **Nature's Network**[64] and **Connect the Connecticut**[73]. DSL is a project of the Landscape Ecology Lab at the University of Massachusetts and is supported primarily

by the U.S. Fish and Wildlife Service North Atlantic-Appalachian Region, with additional support from the Northeast Climate Adaptation Science Center and the University of Massachusetts, Amherst. The most recent updates include revised 2020 data for species models and an Index of Ecological Integrity (IEI) to recreate the Nature's Network terrestrial cores and connectors. This phase also includes a new species model for Spotted Turtle. The new Spotted turtle Landscape Capability Model supported the development of Spotted Turtle conservation cores, showing connectivity among cores, and road vulnerability. Additional updates provide transportation and infrastructure data on culverts, dams, and beaches for improved habitat connectivity analyses.

North Atlantic Aquatic Connectivity Collaborative. New decision-making tools that consider climate change and other stressors (including barriers, pollution and land use change) have also been developed to aid managers in planning conservation actions for aquatic connectivity and flows in stream[74], river and lake[75] systems, including the USGS FishTail indices[76]. Other resources, like the US Climate Resilience Toolkit[77] and the Massachusetts Wildlife Climate Action Tool[78], allow managers to explore information, tools, and case studies for a growing number of species, habitats, and sectors.

Development has reduced the quantity and suitability of fish and wildlife habitat across the region. This has put additional pressure on conserved or protected habitat, including management activities in those dwindling managed conservation areas. Many localities and states have adopted the most current Global Diversity Framework[3] target of conserving 30% of their lands and waters.

Northeast Climate Adaptation and Science Center (NECASC)[44]. NECASC has conducted multiple projects informing land and water planning and use, including refugia and connectivity projects. See Staudinger et al. (2023) for a synthesis of climate change information and tools. Their website profiles 165 projects addressing multiple aspects of fish and wildlife conservation in relation to climate change.

Atlantic Coast Fish Habitat Partnership[48] The Assessment of Existing Information was completed in 2009 with the primary purpose of informing and enabling conservation planning for ACFHP. It includes three components: 1) a representative bibliographic and assessment database; 2) a GIS spatial framework; and 3) a summary document with a description of methods, analyses of results, and recommendations for future work. The results supported development of priorities for ACFHP's conservation efforts within its boundaries. The Species-Habitat Matrix is an evaluation of the importance of benthic habitats as space for shelter, feeding, and breeding by coastal fishes and motile invertebrates in ACFHP's four subregions. The

analysis quantified the relationship between more than 100 different species across four life stages and 26 different habitats.

The NOAA Marine Protected Area (MPA) Inventory identified protected areas of Estuaries, Marine Nearshore, Marine Offshore, and Oceanic habitats in the US that in 2020 met the IUCN definition for international protected areas. An interactive map of the MPA Inventory is available online[79]. Protected waters include National Estuarine Research Reserves (NERRs), National Marine Sanctuaries, and waters within the boundaries of state and federal parks, wildlife management areas, refuges, and preserves. In the Northeast, 218,388 acres of Estuaries and connected Marine Nearshore waters were protected as of 2020, including the nine NERRs (Table 2.19.1). There are two MPAs in the Marine Offshore and Oceanic habitat of the Northeast. The Northeast Canyons and Seamounts Marine National Monument includes 12,699 square miles of Marine Offshore and Oceanic habitat located approximately 130 miles east-southeast of Cape Cod in federal waters off New York and New Jersey. The Marine National Monument is approximately the size of the state of Connecticut in two disjunct but adjacent areas, one protecting three submarine canyons and one protecting four seamounts. The Gerry E. Studds / Stellwagen Bank National Marine Sanctuary protects approximately 847 square miles of Marine Offshore and Oceanic habitat and is located east of Boston between Cape Ann and Cape Cod, Massachusetts. Both MPAs are managed by NOAA.

Other protection measures for Marine Offshore and Oceanic habitats are regulatory in nature. These include the designation of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) by NOAA Fisheries and the protection of coral areas from fisheries impacts by the regional Fishery Management Councils. Virtually the entire Marine Offshore and Oceanic areas of the Northeast have been designated EFH for at least one species at one life stage or another, including Atlantic HMS and multiple other managed species[80].

NOAA's current Strategic plan for New England and the Mid-Atlantic. The plan states that effective science-based management is essential to reaching optimum yield while preventing overfishing (National Marine Fisheries Service 2020). Annual commercial landings revenues total nearly $2 billion, and recreational fisheries generate more than $5.8 billion in trip expenditures. Close collaboration with the New England and Mid-Atlantic Fishery Management Councils, Atlantic States Marine Fisheries Commission, state and fishing industry partners, the Northwest Atlantic Fisheries Organization, and local organizations and stakeholders will continue.

Forest and Woodlands are managed at the state level with a State Forest Action Plan (SFAP). State Forest Action Plans present Sustainable Forest

Management as one of the issues in their Regional Summary of the 2020 State Forest Action Plans in the Northeast and Midwest Forests (USDA Forest Service and Northeast-Midwest State Foresters Alliance 2022a).
These plans outline conservation strategies and priorities like those found in SWAPs, making the states eligible to receive federal funding as authorized by the Cooperative Forestry Assistance Act[81] . State Forest Action Plans are required to incorporate SWAP information, including their habitat assessments, strategies, and shared priorities or goals. The State Forest Action Plans of the Northeast were updated in 2020. The US Forest Service and Northeast-Midwest State Foresters Alliance synthesized the 2020 State Forest Action Plans of the Northeast and Midwest and released a regional summary report in 2022 (USFS and Northeast-Midwest State Foresters Alliance 2022a).

State Forest Action Plans are updated on a 10-year cycle that falls halfway between the 10-year cycle of SWAP; and, the regional summary report identified "tremendous opportunities for further collaboration on wildlife habitat strategies with state and regional wildlife and forestry agencies, organizations, and other partners" (USFS and Northeast-Midwest State Foresters Alliance 2022a). The regional summary report identifies 14 common themes across the 21 State Forest Action Plans, including wildlife habitat, adaptation to climate change, carbon management, forest health, clean water, wildfire and prescribed fire, sustainable forest management on public and private lands, and forest-based recreation, among others. The US Forest Service and Northeast-Midwest State Foresters Alliance produced an accompanying Landscape-Scale Conservation Interactive Web Map that displays multi-state priorities identified in the 2020 State Forest Action Plans. There are 15 landscape-scale priority areas in the Northeast and 18 in the Mid-Atlantic, with five of them shared across the subregions (USFS and Northeast-Midwest State Foresters Alliance 2022b). Individual State Forest Action Plans are available through the National Association of State Foresters[24].

State Comprehensive Outdoor Recreation Plans (SCORPs) are plans that describe a state's goals and priorities for outdoor recreation. They are updated every five years as required by the federal Land and Water Conservation Fund. Outdoor Recreation is an important activity that impacts Northeast fish, wildlife, and habitats, including RSGCN, and coordination to incorporate SWAP and regional priorities is encouraged. Individual SCORPs are not updated on the same revision cycle across the Northeast: the current plans cover 2017-2022 for some states and 2020-2025 for others. There is extensive public engagement in the development of SCORPs often with polls, surveys and focus groups used to determine the public's outdoor recreation needs and wants. Detailed information includes demographic and public participation data on outdoor recreation in the state. The priorities outlined in a SCORP may be implemented at the local level through state and federal grant programs for parks, trails, and a variety of outdoor recreation related projects. The Society of Outdoor Recreational

Professionals maintains a directory of SCORPs[26]. The 2020 update of the Pennsylvania SCORP, for example, includes the results of a project undertaken by The Trust for Public Land to map public access to the state's outdoor recreation areas, waterways, and trails with demographic data, spatially identifying areas of the greatest need for improved public access. Collaboration and coordination between SWAPs and SCORPs present an opportunity to address both the needs and the potential threats of public access to wild spaces.

Landowner Incentive Programs. There is both a need and an opportunity to encourage land/water/resource conservation through voluntary incentives, landowner and partner agreements, and easements. Federal and state conservation agencies, including the Departments of Agriculture and the Interior, have a diversity of programs with technical and financial assistance available across the Northeast. Examples of habitat management action that attempt to mitigate development impacts include providing for wildlife movement (notably turtles and other reptiles and amphibians) across habitat types. Several RCN projects described above provide BMPs and conservation recommendations, specifically to prevent road mortality and habitat loss; develop more cost-effective and green infrastructure designs; install road crossing structures and fencing; protect nesting areas; and improve buffers. Multiple federal, state, and local programs support key habitat conservation across the Northeast. Coordination with these partner agencies---including USFWS, NOAA, Department of Transportation, Federal Emergency Management Agency (FEMA), Environmental Protection Agency (EPA), Federal Energy Regulatory Commission (FERC), Department of Agriculture and Consumer Services (DOA), Natural resources Conservation Service (NRCS), and their implementing agency counterparts at the state and local levels---to incorporate regional species and habitat priorities into their programs and projects is essential. NRCS implements on- the-ground conservation through its Working Lands for Wildlife Program[10]; USFWS offers landowner assistance programs[82]; and state fish and wildlife agencies and forestry agencies also provide landowner assistance for conservation. Natural processes and flow could be restored to impacted aquatic systems by working with localities and regulatory as well as non-regulatory partners to restore land connections, water quality and quantity, and reconnect aquatic networks for fish and wildlife movement (see *Appendix 4A*).

Additional actions to address or mitigate development include providing pollinator habitat (information and land/yard management techniques) at rural, suburban, and urban sites. Because some RSGCN have been able to adapt to developed areas (chimney swifts, swallows, night hawks, eagles, osprey, falcons, and a range of pollinators, for example), there is both a need and an opportunity to manage these urban species and their habitat through green infrastructure and artificial nesting structures.

Nongovernmental organizations (NGOs) and land trusts[83] are also important partners in local land conservation, assisting and acquiring voluntary conservation easements donated by landowners. There are hundreds of land trusts and conservation groups across the Northeast, and in many places, these local, state, and regional groups are leading the way forward in the protection of habitat and wildlife corridors, contributing 70% of the growth in land protected since 2015.

Numerous techniques and programs are available to improve the condition of Developed Areas for wildlife. Urban wildlife management is of increasing importance and takes many forms (McCance et al. 2017). Multiple partner organizations offer guidance and certification of developed spaces as improved habitats for birds and pollinators. Others offer programs for urban forestry and canopy trees. Some address specific hazards such as light pollution; collisions with glass, aircraft, or vehicles; and the use of transportation infrastructure by bats.

The National Wildlife Federation (NWF) Certify Wildlife Habitat program offers guidance for improving suburban and urban yards, gardens, schoolyards, commercial spaces, and roadside greenspaces for wildlife[84]. Certification requirements including providing wildlife food, water, cover, places to raise young, and the use of sustainable maintenance practices (i.e., soil and water conservation, controlling exotic species, organic practices). The program offers signage to be installed at certified spaces as education and outreach tools to the public.

The North American Butterfly Association offers a public Butterfly Garden Certification program to improve garden habitats for butterflies[85]. To be certified as a North American Butterfly Association Butterfly Garden, the garden must contain at least three species of caterpillar food plants, at least three species of nectar plants, and avoid of the use of pesticides. Multiple types of educational signs are available for installation in certified gardens.

The Xerces Society has developed a Pollinator Protection Pledge that outlines four steps for improving pollinator habitat in Developed Areas and agricultural areas[86]. The four recommended steps include growing pollinator-friendly flowers, providing nest sites, avoiding the use of pesticides, and spreading the word to others about the need to improve pollinator habitat. Pollinator Habitat signs are available as well as recommendations for sharing on social media.

Developed spaces can be certified as **Monarch Waystations by Monarch Watch** through a program to create, conserve and protect habitat for the RSGCN Monarch Butterfly[87]. Guidance is available for the public to create waystations or to certify existing spaces that meet the requirements for certification. Waystations must be at

least 100 square feet in size, receive at least six hours of sun a day; have soil types and drainage suitable for growing milkweed and nectar plants; provide shelter from predators and the elements; have at least 10 milkweed plants of at least two species; provide a mix of nectar plants across multiple seasons; and include a plan for conducting regular maintenance of the space with activities like watering, removing invasive plants, and eliminating the use of insecticides. Monarch Waystation signs are available to increase education and outreach to the public.

The National Audubon Society manages Plants for Birds[88] and Bird-Friendly Building[89] programs, which together can create Bird-friendly Communities[90]. The Plants for Birds program encourages the public to improve developed spaces as bird habitat by creating native plant gardens. The Bird-Friendly Building program addresses the threats of light pollution and collisions with glass through a Lights Out network of cities and states.

The USFS Urban and Community Forestry Program provides technical, financial and educational assistance to developed communities with the goal of improving the tree canopy in Developed Areas in the Northeast and beyond[91]. The program is overseen by the National Urban and Community Forestry Advisory Council and guided by a Ten-Year Urban Forestry Action Plan with the current version spanning the decade from 2016 to 2026. Educational and scientific resources are provided on the Vibrant Cities Lab website[92], which includes an Urban Forestry Toolkit, and through a National Webinar Series. The NEAFWA region falls within the Eastern administrative region of the USFS. The exception is Virginia, which is within the Southern region.

Staying Connected Initiative (SCI). The Staying Connected Initiative[67] is a regional partnership between public agencies and non-profit organizations working to protect functional habitat linkages that mitigate the impacts of habitat fragmentation and climate change for many SGCN across the Northern Forest (Maine, New Hampshire, New York and Vermont and Canada). Wildlife in this region stay connected thanks to an extensive network of forest, wetland, and riverine habitats that enables far-ranging mammals to reach suitable habitat and helps maintain the genetic diversity as well as the overall health and vitality of wildlife populations.

Since 2009, SCI partners have completed permanent land protection projects that enhance connectivity in the linkage areas covering more than 50,000 acres. Approximately 40,000 additional acres of important connectivity lands are in various stages of development. SCI has provided direct assistance to dozens of localities, helping to secure or initiate meaningful improvements in the land use plans and/or policies of nearly 20 communities and at least three regional planning commissions. SCI has also identified road segments important for landscape connectivity and is collaborating with

state departments of transportation (DOTs) to improve connectivity during road maintenance/upgrade projects. Within the SCI region, 13 towns have added connectivity provisions to their local plans; more towns are considering them; and another town has created a new Conservation Fund. In Vermont, one RPC has incorporated connectivity provisions into its regional plan, which covers 19 linkage-area towns and eight others outside the linkage boundary. Three additional RPCs are now working on similar provisions. Six towns have revised their zoning and subdivision bylaws/regulations to address habitat and connectivity priorities; and two towns have established new Conservation Commissions.

Adirondacks Program for Residential Development. The Wildlife Conservation Society's Adirondacks Program identified best practices and case studies for implementing conservation design ordinances that govern residential development, thereby helping communities and planning boards to adopt and implement land use practices that protect wildlife connectivity.

SCI focuses on the top priority actions identified in partner states' Wildlife Action Plans, providing land protection and technical assistance targeted to the places where most land use decisions in the Northeast are made. Primary objectives are:

1. To develop conservation science information and analyses on ecological features, wildlife movement zones, community conservation values, and wildlife road crossing locations, using these to inform land protection, land-use and transportation planning, barrier mitigation, and technical assistance for local groups and decision makers.
2. To protect important habitat connectivity "steppingstones" at key road crossings and other high priority areas through technical and financial support to land trusts.
3. To support local land-use planning through technical assistance that municipalities can incorporate into their town plans, land use planning, and zoning ordinances.
4. To provide local organizations with technical assistance designed to enhance the knowledge and skills of local groups so they can more effectively implement wildlife and connectivity conservation activities.
5. To increase the permeability of roads and highways by offering technical assistance to state transportation agencies as part of planned road maintenance/upgrades on priority wildlife linkage segments.

IUCN Green List of Protected and Conserved Areas[57] and

Protected Areas Database of the US (PAD-US)[58]. TNC is augmenting this dataset as part of the Northeast Habitat Condition Analysis project by reaching out to NE state TNC chapters for the best available information. See Anderson et al (2023a).

Other resources displaying regional conservation partnerships are available through **the RCP Network**[93] **and the ALPINE Network**[94].

The National Wildlife Federation encourages wildlife habitat on private lands through an assortment of programs, including the wildlife Habitat Certification Program[84].

Rapid and large-scale changes to lands and waters mean that wildlife are losing the habitats they once knew. Every habitat garden is a step toward replenishing resources for wildlife such as bees, butterflies, birds, and amphibians—both locally and along migratory corridors. By adding pollinator-friendly and monarch-friendly plants, gardens also count toward the Million Pollinator Garden Challenge[95].

See *Chapter 2* (for habitat development or resource use) and *Chapters 3* and *7* for additional partners and projects addressing development, natural systems modification and biological resource use.

STATE OPPORTUNITIES FOR IMPLEMENTATION

State fish and wildlife agencies have developed more accessible data and web portals that depict the status and distribution of rare species and their habitats. PA Wildlife Conservation Opportunity Area Tool; State fish and wildlife agencies/NHPs data; BioMap in Massachusetts; Beginning with Habitat in Maine; Taking Action for Wildlife in New Hampshire; and New Jersey's Landscape tool are just a few of these state programs that provide information to planners and developers for strategic planning and to minimize the impacts of development. State examples are listed below:

Massachusetts BioMap3[33]. The Massachusetts SWAP used Key Sites, based on BioMap2, to identify and target the most important sites for biodiversity protection and habitat management. The clear selection criteria, strategic approach, and limited spatial extent of the project (key sites account for about 10% of Massachusetts) help focus conservation efforts for states and partners. Actions taken in key sites are typical land protection or restoration steps, and they tend to lessen the impact of threats like development, climate change, and vegetative succession.

Rhode Island SWAP Community Guide provides recommendations, examples, and resources for local planners, such as the use of compliant LEDs and fixtures to

reduce the impact of artificial lights on nocturnal species (RI Department of Environmental Management 2015). **Rhode Island Woodland Partnership**[96]: information about this partnership can be found online through the Partnership's website.

Maine Land Trust Network[32]. The Southern Maine Regional Planning Commission[33] is a good example of a multi-jurisdictional entity. **Maine Beginning with Habitat**[34] is another. Both offer valuable service to local level planning boards, regional planning commissions.

Vermont's Community Wildlife. Works with realtors to make sure that habitat value is considered whenever properties are sold. This manual offers choices and opportunities to Vermont communities and others who engage in land use and conservation planning efforts (Austin et al. 2013).

Virginia Natural Landscape Assessment[36]. 2022 — GIS layers map the statewide network of natural lands, ecological cores, and landscape corridors.

New Jersey's Conservation Blueprint[37] is a data-driven, interactive mapping tool made possible through a partnership between The Nature Conservancy, Rowan University, and the New Jersey Conservation Foundation, working with a collective of 21 conservation-focused government and non-profit groups. **Time for CHANJ.** Connecting Habitat Across New Jersey (CHANJ)[38] is an effort to make NJ landscapes and roadways more permeable for terrestrial wildlife by identifying key areas and actions needed to achieve habitat connectivity across the state. CHANJ offers two main products – an interactive Mapping tool and a Guidance Document – to help prioritize land protection, inform habitat restoration and management, and guide mitigation of road barrier effects on wildlife and their habitats.

New Hampshire's Taking Action Together[39]: Taking Action for Wildlife supports communities, conservation groups, and individuals with resources, tools, and training focused on conserving New Hampshire's wildlife and habitats.

PA Conservation Opportunity Area Tool[40]: The 2015-2025 Pennsylvania Wildlife Action Plan is now available through a web-based map showing SGCN within a user-defined area of interest. Users can develop output reports that include actions to support the species and habitats in an area of interest. They can also generate lists of SGCN by county or watershed. See range maps for most Species of Greatest Conservation Need.

4.4 PROTECT NATIVE NORTHEAST SPECIES AND THEIR HABITATS FROM THE INTRODUCTION AND SPREAD OF INVASIVE SPECIES AND DISEASE

4.4.1 REGIONAL NEED AND PRIORITY ACTIONS

Regional Need: The 14 Northeast 2005 and 2015 SWAPS, the 2017 SWAP Synthesis, and the 2023 RSGCN process identified Invasives and Disease as top regional threats to fish and wildlife diversity in the Northeast. imperiled species and habitats can be severely impacted or lost due to invasive species or disease, even if all other conservation objectives are met. Invasive species may be less negatively impacted by climate change than native species; or may even benefit from these changes. To effectively prevent or address these impacts, an effective, collaborative regional scale effort is required.

Priority Actions: Develop regionally coordinated and targeted early detection and rapid response strategies for the control and management of invasive, non-native species that pose threats to native wildlife or communities. Work with and through Northeast partners and networks for effective, inclusive, regional conservation. Use climate projections to estimate timelines and locations most vulnerable to invasive species spread and establishment. Coordinate with agencies and entities that regulate impacts to fish and wildlife habitats to develop and implement effective, consistent policies, incentives, and approaches to address invasives and disease across Northeast lands and waters.

See Priority Species in Chapter 1, Priority Habitats in Chapter 2, Priority Threats in Chapter 3, each with partner and program opportunities and examples. See Table 4.1.1 and Appendix 4A for priority projects completed and Appendix 4B, the SWAP Synthesis, and individual SWAPs for additional priority Conservation Actions that address invasive species and disease.

4.4.2 APPROACH

Prevention and documentation are critical to addressing the pervasive threat of invasive species and diseases. Once invasive species and diseases are established, whether through introduction or extension of their former range, control measures can be difficult to implement, and eradication may be impractical or prohibitively expensive. For more information on the impacts of invasive species and disease, see Chapter 3. Targeted outreach (e.g., to anglers, boaters, hunters, landscapers, outdoor

recreationists) that provides information about the impact of invasive species and diseases and how to identify these emerging threats in the field is critically important. Working closely with the Wildlife Disease Cooperatives, state and regional Invasive Species Council, and other partners ensures up-to-date information and regional coordination.

In general, when prioritizing threats and actions, the cost, likelihood of success, severity of impacts, and urgency are all factors that need to be considered. In the case of invasive species, treatment is expensive and successful eradication can be difficult to achieve. Therefore, many of the proposed actions focus on prevention and monitoring. Addressing pollution and aquatic connectivity can help increase resilience to climate change and increase the adaptive capacity of native species and populations to future risk. Priority actions identified in 2015 SWAPS, presented in the 2017 SWAP Synthesis, and prioritized by the NEFWDTC and their Threat Working Groups include:

- **Develop regionally coordinated and targeted mechanisms for early detection and rapid response**, deploying control/management strategies and response plans that reduce the impacts and/or limit the distribution of invasive, non-native species (wildlife and plants) and disease.
- **Customize the existing National Invasive Species Strategy** based on - 1) prevention 2) early detection and rapid response 3) control and management, and 4) rehabilitation and restoration.
- **Develop and implement regional tools, incentives and BMPs** to maximize the effectiveness of these strategies while avoiding excessive harm to non-target species.
- **Identify Priority Areas**: Work with RISCC and other key partners to identify targeted locations for research, survey, management, eradication, and monitoring in the Northeast.
- **Develop effective and coordinated messaging and communication** about the threat, and actions to address this threat of disease and invasive species in the Northeast.
- **Develop and improve consistent protocols and policies**, incentives, and regulations in Northeastern states to prevent introduction and spread of disease and invasives.

The NEFWDTC and SWAP Synthesis identified Invasive Species and Disease as top regional threats in the 2005 and 2015 SWAPs. NEAFWA's RCN and key partner programs prioritized and funded multiple projects to provide information, management guidelines, and Best Management Practices (BMPs) and protocols to address the impacts of these threats on RSGCN and their habitats in the region. Some of the key projects are listed below as resources. For a complete list, see Table 4.1.1 and *Appendix*

4A; and for additional partner information see *Chapter 7*. For more detailed information on RSGCN and habitats, see *Chapters 1 and 2* respectively. *Chapter 2* provides information on Northeast habitat status and condition as well as RSGCN supported by each habitat. It also provides examples of management and conservation plans and efforts that address these threats in the region. ***Chapter 3* provides detailed threat descriptions, impacts on RSGCN, and additional resources and examples that may help in addressing this threat in the Northeast.**

4.4.3 INVASIVE SPECIES

Key state and regional partners have been monitoring invasive plants over the past decade (Bradley et al. 2022a, Allen et al. 2022). Invasive plants are a common focus of habitat management. A recent survey of natural resource managers in the Northeast found that 70% of the more than 200 respondents focused much of their time on invasive plants (Beaury et al. 2020). Chapter 3 provides more detailed threat descriptions, impacts on RSGCN, and additional resources and examples for this threat in the Northeast.

Invasive plant management is most successful during the early stages of invasion, when eradication is still feasible (Rejmánek & Pitcairn 2002). Proactive management at the early stages of invasion involves preventing species from being introduced through policy mechanisms such as state noxious weed lists. Proactive management also involves monitoring for new invasions and quickly eradicating the invaders before they spread – a practice known as early detection and rapid response (Westbrooks 2004). Preventing or detecting and then eradicating invasions early are much more cost effective than controlling invasions after the species has become established (Leung et al. 2002, Keller et al. 2007). Moreover, preventing plants from invading and reaching high abundance reduces environmental impacts (Tekiela & Barney 2017, Bradley et al. 2019).

Although proactive prevention, early detection and rapid response are the most effective tools for invasive plant management, controlling populations at any stage can benefit wildlife habitat. In a meta-analysis of studies from more than 200 papers, Bradley et al. (2019) showed that there is a significant negative, linear relationship between invasive plant abundance (e.g., percent cover, stem count, biomass) and native species diversity. From a management standpoint, this suggests that environmental harm continues to accrue linearly as plant invasions progress. Therefore, reducing invasive plant abundance at any stage of invasion reduces corresponding ecological harm.

Focusing on the current population of invasive plants in the Northeast, the first key management need is to reduce the continued introduction of known invasive species. Most invasive plants are introduced as ornamentals (Lehan et al. 2013) and lag times

between introduction and invasion (Aikio et al. 2010) leads to the persistent sale of known invasive plants across the U.S. (Beaury et al. 2021a). The ongoing sale of invasive plants both perpetuates and expands current invasions (Beaury et al. 2021a). It also has the potential to seed new plant invasions as climate change makes conditions more suitable for novel species to invade (Allen et al. 2022; Bradley et al. 2022a).

One of the primary tools states can use to reduce the number of invasive plants introduced as ornamentals is the development and use of incentives and "green light" alternatives. Encouraging the use of native species by local nurseries and seed banks provides industry incentives and important outreach and messaging, as does the use of "green lists" of native species alternatives. Dumroese (2009) provides a manual of native plants to nurseries (see examples in the next section).

Another tool available to states is the regulation of the species as noxious weeds, and thus prohibiting their sale. States can provide incentives for the use of native seed banks, and "Green lists" for native species. They can also improve coordination and consistency of regulation across state borders (Lakoba et al. 2020, Beaury et al. 2021b). In a survey of the lower 48 states, Beaury et al. (2021b) found only a 17% overlap in regulated plants between adjacent states. Focusing on six northeastern states (CT, MA, ME, NH, NY, VT), Bradley et al. (2022b) showed that such inconsistencies are largely due to differences between the pools of species evaluated by each state rather than to different outcomes among state risk assessment protocols. Regulatory inconsistencies across state borders are likely due to the lack of state capacity to evaluate and recommend invasive plants for regulation. To increase consistency, northeastern states should first evaluate risk from plants already regulated by adjacent states. A taxonomically standardized list of regulated plants (as of April 2021) is available as supplementary material in Beaury et al. (2021b) and updated lists are posted through the National Plant Board[97]. Increasing coordination and sharing risk assessment resources across state borders could improve consistency and reduce the ongoing sale of known invasive plants (Bradley et al. 2022a, 2022b). The Northeast Regional Invasive Species & Climate Change network (NE RISCC)[98] hosts a biannual working group of invasive plant council representatives spanning states from Pennsylvania to Maine to improve information exchange. However, a second key challenge for most states is the lack of resources to conduct regulatory assessments. The lack of funding and capacity for risk assessment impedes consistent regulation and leads to the continued introduction and spread of known invasive plants.

Managing for the combined threats of invasive species and climate change is daunting. AFWA surveys of threats to climate adaptation consistently point to range-shifting invasive species as the top threat (Ernest Johnson 2020). Proactively preventing the introduction (by regulated sales through noxious weed laws) and expanding monitoring

and EDRR for range-shifting invasive plants are critical tools for climate-smart invasive species management.

To **develop consistent and proactive invasive species management**, states can:

- Share information across borders (what's coming and how to manage it)
- Increase capacity for multi-state working groups of invasive species officials.
- Provide information, incentives, and alternatives to all sectors involved
- Develop consistent protocols, policies, incentives, and regulations for invasives sold/traded, especially those already regulated by neighboring states.
- Increase capacity for risk assessment with state invasive species networks.
- Increase the development and use of incentives and "green light" alternatives
- Use the resources provided by research from NE RISCC to identify high impact range-shifting species
- Monitor and manage new infestations of invasive species.
- Fund rapid response teams

The same well-established, coordinated efforts to address invasive plants in the region are also being applied to animals, specifically in aquatic environments. Introduction of non-native species, which may result in hybridization, competition, and predation, has also impacted many native species including RSGCN. Examples include the Northern snakehead (now established in the Potomac River), the rusty crayfish, fishhook water flea, and diatoms such as didymo. These and other non-native species can alter freshwater aquatic environments, which in turn effects all species in the system including RSGCN. Parasitism and diseases such as whirling disease (introduced from Europe) have affected many wild and hatchery populations of trout and salmon species in the United States and Canada.

Some species, such as the Northern Snakehead, Zebra Mussel, Spongy Moth and Emerald Ash Borer, are the focus of significant ongoing management efforts, whereas others remain an unmet challenge. Species that are used in recreational activities including fishing (such as crayfish, salamanders, and other "bait") have conservation efforts underway to prevent the spread of invasives or exploitation of native species. Maryland, Pennsylvania, and Virginia have active outreach campaigns to prevent the spread of invasive crayfish and other "bait" species. The release of live, unused bait into Maryland waters is a common practice among Maryland anglers. The use and release of live crayfishes as bait by anglers has resulted in the introduction of five non-native crayfish in Maryland waters. Three of these – Rusty Crayfish, Virile Crayfish, and Red Swamp Crawfish – are considered invasive due to their adverse effects on aquatic ecosystem function and native biodiversity. The rapid spread of this species is the result

of bait bucket introductions – the transfer of live crayfish from one watershed to another and their release by anglers. The introduction of invasive crayfish is thought to be one of the most pressing threats to native crayfish diversity worldwide.

In the Mid-Atlantic region, the spread of invasive crayfishes through their use as bait has been followed by declines of native crayfishes in Maryland, Pennsylvania, and West Virginia. Due to their ability to achieve high densities and their importance as both prey and predator, invasive crayfishes have the capacity to affect more than just native crayfish diversity. They are known to adversely affect stream insects, mussels, snails, amphibians, reptiles, fishes, and sport fisheries. In recognition of the threats posed by invasive crayfish, several U.S. states and Canadian provinces have banned the use of live crayfishes as bait and many others have restricted their use in some way. In response to the discovery of Rusty Crayfish in 2008, Maryland prohibited the catch, use, or possession of crayfish in the Upper Potomac, Middle Potomac, and Lower Susquehanna River basins unless the head is removed immediately upon capture. This regulation aimed to prevent the catch and transfer of Rusty Crayfish from these basins into other Maryland waters. MDNR is considering expanding this regulation to include all river basins. A statewide ban on the catch, use, or possession of live crayfish would be more enforceable, more easily interpreted by anglers, and would protect all Maryland waters against the spread of invasive crayfishes (MD DNR, unpublished 2014).

The impacts of multiple insect invaders on Northeast habitats have been well documented (Staudinger et al 2023). NE CASC climate change synthesis provides current information on the impacts and vulnerabilities of many Northeast RSGCN and their habitats. A list of top 100 aquatic invaders was developed by NECASC and will help focus and coordinate consistent efforts to minimize their impacts (Allen et al. 2022).

Over the past decade, NEAFWA NEFWDTC has prioritized and addressed the problem of invasive species through a strategic approach, collaborating with its partners in the Northeast. Exotic invasive species pose significant threats to SGCN throughout the region. SWAPs have identified wildlife species within each state that warrant some level of management concern. Most of the RCN projects listed in Table 4.1.1 also mention or address invasive species and disease as issues in their conservation of specific species or habitats.

The goal of an early RCN project, **Identifying Relationships of Invasives Species with SGCN,** was to produce a list of invasive species that posed the most significant threats to SGCNs in the Northeast Region. However, during the project it became evident that the true value in this effort lay in the data assembled and the ability of future users to customize it for their specific needs. The goal of the project was therefore amended to focus on the provision of these data tables and on developing a process that

would allow users to modify them and generate lists reflecting their own importance criteria. Since there are different ways to evaluate the impacts of invasive species, several metrics were compiled to give users a way to create ranked lists that can be used individually or together (e.g., sum of ranks). Users can understand how each metric is calculated, what information is included, and which metric is the most appropriate one to use. The metrics can be easily modified in MS Excel to produce custom values keyed to specific needs. The final report provides background information on how the SGCN data tables of SGCN were developed and how they should be interpreted for prioritizing and ranking invasive species threats. Also provided is an example of how this information can be used to generate specific ranked lists of invasive terrestrial species in Pennsylvania.

4.4.4 REGIONAL EXAMPLES AND OPPORTUNITIES THAT ADDRESS INVASIVE SPECIES

Many partners and networks have formed to address this pressing threat across the Northeast. Key examples are provided below.

Northeast RISCC Management Network[98]**.** The Northeast Regional Invasive Species & Climate Change (RISCC) Management Network aims to reduce the compounding effects of invasive species and climate change by synthesizing relevant science, sharing the needs and knowledge of managers, building stronger scientist-manager communities, and conducting priority research. The network includes invasion scientists, climate scientists, natural resource managers, policymakers, and stakeholders from the broader public. The website provides a listserv and multiple resources including "Management challenges"—a series of two-page documents that synthesize the current state of knowledge about a topic related to invasive species and climate change. These management challenges are designed to help share knowledge about these topics to managers and stakeholders.

Many watersheds have active efforts that include the monitoring and management of Invasive species. The Chesapeake Bay Watershed is one example of an active partnership to assess and address aquatic invasive species. The U.S. Geological Survey (USGS) revised the Chesapeake Bay-based science plan and reported that all 13 agencies and organizations in the Bay region identified Aquatic Invasive Species (AIS) as being of general concern, with most stakeholder groups reporting AIS-related issues to be of high priority (Densmore 2020). Species in this category include fishes, invertebrates, invasive plants, and microbes including aquatic animal pathogens.

The **USGS** maintains records of Nonindigenous Aquatic Species that can be queried by species, location, and other key data fields[99]. Figure 4.4.3 depicts the locations of the

Zebra mussel (*Dreissena polymorpha*) in the US. Most states have active programs to prevent the introduction and spared of this formidable invasive mussel, and these active management and outreach efforts can be used for other aquatics as well.

EDDMapS hosts the invasive range expanders listing tool[100] based on spatial models of climate-change-driven range shifts for 896 non-native, invasive plants (Allen and Bradley 2016). This tool allows users to generate a list of invasive plants that are not currently found in their state (or county) but that could expand into the region as a result of climate change (models are based on distribution data compiled in 2015). Hundreds of new invasive plants are projected to expand into Northeast states by mid-century. However, some of these species are likely to cause greater ecological impacts than others.

Using the **invasive range expanders listing tool,** Rockwell-Postel et al. (2020) and Coville et al. (2021) evaluated the ecological and socioeconomic impacts of invasive plants likely to expand into southern and northern New England, respectively. Both studies used the IUCN Environmental Impacts Assessment of Alien Taxa protocol (EICAT; Hawkins et al. 2015). The EICAT protocol involves compiling all scientific literature describing ecological impacts of the target taxon and scoring those impacts on a scale of 1-4, where negative impacts on native species populations are scored as a 3 (moderate impacts) and negative impact on native species diversity or on the populations of multiple native species are scored as a 4 (major impacts).

Rockwell-Postel et al. (2020) evaluated 100 range-shifting invasive plants that are not currently present but are deemed likely to expand in Connecticut, Massachusetts, New York, and/or Rhode Island. They identified 20 species with major impacts on native communities. Bradley et al. (2020) later narrowed this list to five species most likely to affect northeastern ecosystems: *Anthriscus caucalis, Arundo donax, Avena barbata, Ludwigia grandiflora,* and *Rubus ulmifolius*. Similarly, Coville et al. (2021) evaluated 87 range-shifting invasive plants not currently present but likely to expand in Maine, New Hampshire, and/or Vermont and identified 24 species with major impacts on native communities (see Table 1 from Coville et al. 2021). Combining these high-impact, range shifting species for New York and the New England states, Allen et al. (2022) created a list of 24 species that are also commonly offered for sale as ornamental plants. This 'Do Not Sell' list (Allen et al. 2022) comprises priority species that could quickly invade the mid-Atlantic and New England due to the combination of climate change and horticulture introduction. These species are priorities for proactive coordination and regulation.

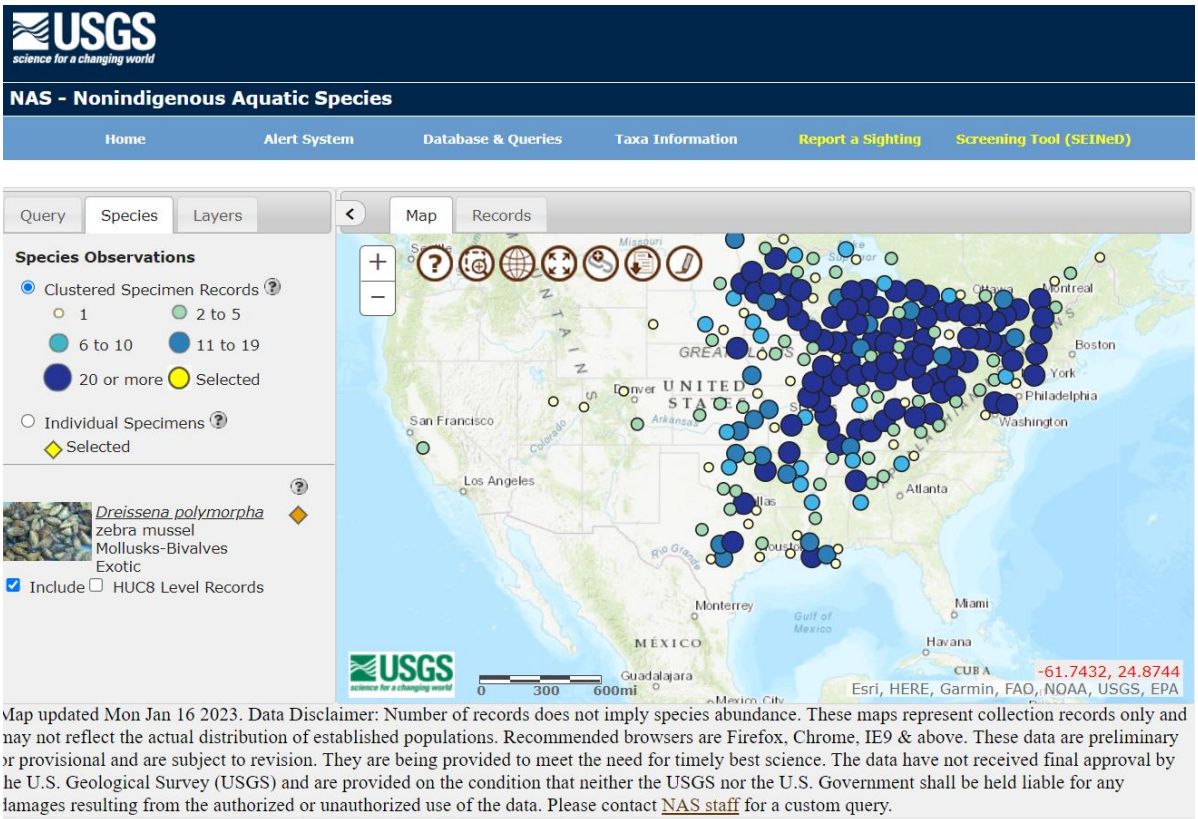
Following the same methods as Rockwell-Postel et al. (2020) and Coville et al. (2021), Salva and Bradley (*in prep*.) have completed EICAT assessments for species projected to

expand into Delaware, Kentucky, Maryland, Ohio, New Jersey, Pennsylvania, Virginia, and West Virginia. Salva and Bradley (*in prep*.) have evaluated 108 range-shifting species and identified 32 species with major impacts. These species have not yet been further evaluated for vulnerability of northeastern habitats or for their likely introduction as ornamental plants. However, this list, together with the synthesis by Allen et al. (2022) provides a starting point for proactive invasive plant regulation across the Northeast.

Great Lakes and Lake Champlain Invasive Species Program. EPA's Great Lakes National Program[101] is a synthesis of readily available information from many partners, including federal, state, and tribal entities, to "inventory" the degree to which the eight stated purposes of the Program are currently being met (Great Lakes National Program Office 2019). This inventory was done in collaboration with Great Lakes states and tribes, EPA Regions 1 and 2, and the Lake Champlain Basin Program[102].

To help inform recreational fishers, the general public, and students about the dangers of invasive species, **Delaware Sea Grant (DESG)** developed a three-pronged informational approach on how to identify and what to do when encountering invasive species. The project was funded by the Mid-Atlantic panel on Aquatic Invasive Species and involved DESG's Marine Advisory Service. Members of a local recreational fishing club were given waterproof rack cards with information on invasive fish and how to report them to local management agencies. The rack cards highlight three invasive fish—northern snakehead, flathead catfish and blue catfish—and their similar looking counterparts, bowfin and channel catfish. The card a QR code, email, and phone contact information where users can report invasive species to the Delaware Department of Natural Resources and Environmental Control (DNREC). A similar program focuses on the European Green Crab, the Asian Shore Crab and the Chinese Mitten Crab[103].

The invasive mussel collaborative connects people, science, and management to advance technology for invasive mussel control. The collaborative maintains a directory, a library, and a wide variety of resources for mangers, property owners, recreational users, etc. Control methods, management and research projects are compiled[104].



Map updated Mon Jan 16 2023. Data Disclaimer: Number of records does not imply species abundance. These maps represent collection records only and may not reflect the actual distribution of established populations. Recommended browsers are Firefox, Chrome, IE9 & above. These data are preliminary or provisional and are subject to revision. They are being provided to meet the need for timely best science. The data have not received final approval by the U.S. Geological Survey (USGS) and are provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the data. Please contact NAS staff for a custom query.

Figure 4.4.1 USGS Mapped Query Results for Zebra Mussel (USGS 2023).

The USDA Natural Resources Conservation Service's multiple programs assist landowners in addressing invasive species and pests and provide services, technical support, and financial assistance, as well as many resources[105].

Terrestrial Invaders. The Northeast U.S. has been identified as a hotspot for future invasion risk because of climate change (Allen and Bradley 2016). Up to 100 invasive plant species are projected to expand into the region, threatening native ecosystems, agricultural systems, and economies. Because the identity of these range-shifting species is known (Allen and Bradley 2017), there is currently a unique and perhaps fleeting opportunity to prevent the introduction and spread of high-impact species into this increasingly vulnerable region. The large number of range-shifting invasive plants, coupled with limited resources, makes early detection and a rapid *comprehensive* response for all 100 species a challenge. Therefore, prioritizing range-shifting invasive plants is a critical step in developing informed and effective prevention strategies. Getting a step ahead of the expected invasions by targeting high-impact species will not only allow states to use resources most effectively, but also increase the likelihood of success. This study illustrates how the combination of watch lists and impact assessments creates an effective tool for proactive management of invasive plants in the context of climate change. From a list of 100 species, five were identified as high priority due to reported impacts in ecological communities and invading ecosystems like those

found in New York and southern New England. Aside from reported impacts, these five species are deemed likely to invade the Northeast, either due to recent establishment in this region or to the existence of known introduction pathways that could lead to quick establishment and rapid spread (Bradley et al. 2019).

Landscape-scale Changes to Plant Communities. Invasive species establish outside of their native range, spread, and negatively impact ecosystems and economies. As temperatures rise, many invasive plants can spread into regions that were previously too cold for their survival. The Northeast Climate Adaptation Science Center and University of Massachusetts continue to model landscape-scale changes to Northeastern plant communities under climate change scenarios, providing natural resource managers with site-specific lists of native plant species likely to be resilient to novel future climates. A recent survey of 200 natural resource managers in the Northeast indicated that the top research priority was specific information to support the management of climate-resilient native communities. But less than 10% of respondents reported that planting species adapted to climate change in restoration or adaptation projects was part of their management portfolio (Beaury et al. 2020). Scientific outcomes will be translated into action through collaboration with the Northeast RISCC Management Network (co-founded by co-PI Bradley) and RISCC-supported Invasive Plant Councils working group (state officials from CT, MA, ME, NH, NJ, NY, PA, RI, and VT) as well as managers from the US Fish & Wildlife Service and the National Park Service. The project will generate spatially explicit, joint predictions of plant communities at any location within the Northeast region under published climate scenarios (Abatzoglou et al. 2018). It will also provide natural resource managers with site-specific lists of climate-adapted species to inform the creation of climate-smart vegetative communities across the Northeast CASC region[106].

Aquatic Invaders of the Northeast[107]. Currently, hundreds of invasive aquatic species occur in the Southeast and the Western U.S. and have the potential to move into the Northeast region. This project will help guide future monitoring efforts and bring attention to high-risk areas that could be invaded by southern and western aquatic species. In 2022, NECASC developed a list of the top 100 aquatic species that naturally occur in the southeast and the western U.S. and have the potential to invade the Northeast. The research team selected these species based on input from a regional stakeholder workshop to ensure that priority management species are considered. Early detection and rapid response are essential to minimize the impact of invasive species, and this research is a critical first step to ensure that these responses are informed and based on the best available science.

Regulations to Reduce Spread of Invasive Plants. Consistent and proactive regulation to prevent the introduction and spread of new invasive plants is most

effective when applied consistently across jurisdictional boundaries and proactively, either to prohibit non-native species from arriving in the first place or to sequester and, if possible, eradicate them in the earliest stages of invasion. Recent analyses of state regulated plant lists in the Northeast show that regulations are neither consistent nor proactive. A NECASC project that focused on invasive plant regulation across six northeastern states (Connecticut, Maine, Massachusetts, New Hampshire, New York, and Vermont) confirms previous findings that invasive plant regulations are inconsistent and reactive, and driven by different sets of information and variations in the lists of species being evaluated. Risk assessment protocols varied considerably across states, but they consistently included criteria related to ecological impact, potential to establish, dispersal mechanisms, and life history traits. While none of the assessments explicitly considers climate change, they also did not contain language that would preclude regulating species that have not yet arrived in the state. To increase consistency and proactivity, the project recommends a two-pronged approach in which states would: 1) focus on high-risk, range-shifting invasive species identified in neighboring states; and 2) explicitly consider climate change when assessing "potential distribution" or "potential impact" of target species. Lists of these high-risk, range-shifting invasive species are compiled by Bradley et al. (2022a).

The Native Plant Trust[108]. The Native Plant Trust (the nation's first plant conservation organization) focuses on New England's native plants with the mission to conserve and promote these species in order to ensure healthy, biologically diverse landscapes. They save native plants in the wild, grow them for gardens and restorations, educate others on their value and use, create cutting-edge tools, and foster collaborations that advance plant conservation. Based in Massachusetts at Garden in the Woods, the Trust operates a native plant nursery at Nasami Farm as well as six rare plant sanctuaries in Maine, New Hampshire, and Vermont. Native Plant Trust has paid staff and 1,500 trained volunteers who work throughout New England to monitor, protect, and restore rare and endangered plants; collect and bank seeds for biological diversity; detect and control invasive species; conduct botanical and horticultural research; and educate the public, from home gardeners to professional land managers. Native Plant Trust is leading the Northeast region's conservation community in its effort to save native plants. It is the largest organization in New England dedicated solely to protecting and restoring rare plant species, and to keeping common plant species common. The Native Plant Trust also provides resources and technical assistance on their website.

Mid-Atlantic Early Detection Network. The Mid-Atlantic Early Detection Network (MAEDN) powered by EDDMapS (Early Detection & Distribution Mapping System) tracks more than 400 species of invasive plants[109]. High priority invasive insects and pathogens are also included. Invasive species observations can be reported using the

Early Detection and Distribution Mapping System (EDDMapS) developed by the University of Georgia's Center for Invasive Species and Ecosystem Health. Reporting can be done on a laptop or desktop computer or via smartphone. Because of the extent of invasion in Washington, D.C., National Capitol Region PRISM[110] and Invasive Species provide information on early detection and rapid response. Habitats that are otherwise high quality are a high priority for treatment. Small patches of invasive species are also targeted to prevent their spread into otherwise untouched habitat. Partnerships with the National Park Service are important because the region has so much edge habitat where invasions begin at the boundary of land management[111].

U.S. Forest Service and Intertribal Nursery Council[112]. Multiple programs, projects, and initiatives of the US Forest Service offer partnership opportunities to conserve forests and woodlands in the Northeast. The federal agency manages the tribally guided Intertribal Nursery Council to advance the interests of Indigenous peoples involved with plant production in nurseries. The goals of the Intertribal Nursery Council are to share information and technology transfer, preserve ecological knowledge, provide nursery training, conduct conservation education, and contribute to reforestation and habitat restoration projects by propagating native plants. The *Nursery Manual for Native Plants: A Guide for Tribal Nurseries* handbook contains detailed information on native plant propagation from seed collection to holistic pest management (Dumroese et al. 2009).

The US Forest Service maintains a National Seed Laboratory that propagates seeds of native plants for conservation and restoration projects and conducts research on restoring and sustaining native plant communities[113]. The Laboratory has developed a Native Plant Protocol for handling, germinating, and storing seeds. It also provides training materials to transfer technology and conserves seeds for genetic diversity. The Reforestation, Nurseries and Genetic Resources Program is a collaborative partnership sponsored by the US Forest Service to share technical information with land managers and nurseries related to the production and planting of trees and other native plant species for reforestation, restoration and conservation of forests and woodlands[114]. Numerous guidelines and resources have been developed by the Program and its partners, including a Propagation Protocol Database and the Native Plant Network.

The US Forest Service Landscape Scale Restoration Grant Program is a competitive grant program to address landscape-level issues affecting state, tribal, and private Forests and Woodlands such as watershed protection and restoration, the spread of invasive species, disease, insect infestation, and wildfire risk reduction. Conservation strategies of State Forest Action Plans are prioritized, and projects are evaluated and grants awarded regionally. A Landscape Scale Restoration Manual and Landscape Scale

Restoration Project Planning Tool are available to guide conservation projects. An inventory of landscape-scale restoration projects is available[115].

The Northeast-Midwest State Foresters Alliance is a partnership of state forestry agencies across 20 states in the Northeast, Midwest, and the District of Columbia[116]. The mission of the organization is to collaboratively protect, conserve, and manage the Forests and Woodlands of the region. Forestry-related BMPs have been developed to protect water quality in adjacent aquatic habitats and are available through the National Association of State Foresters[117].

Invasive Plant Atlas of New England. The mission of the Invasive Plant Atlas of New England (IPANE)[118] is to provide a comprehensive web-accessible database of invasive plants to facilitate education and research that will be continually updated by a network of professionals and trained volunteers. The database will facilitate education and research that will in turn lead to a greater understanding of invasive plant ecology and support informed conservation management. An important focus of the project is the early detection of, and rapid response to, new invasions.

New England examples of incentives and projects to increase the supply of wild, native plant seeds and promote their use include a ReSeeding Rhode Island project, Connecticut's NOFA's EcoType Project[119], and the New England Transportation Consortium's seed project[120].

Garden for Wildlife. National Wildlife Federation (NWF)'s Garden for Wildlife[121] promotes and sources local, native plant species at the National level. Their website provides information on the threats to wildlife, including invasive species, and provides a wealth of educational resources. The National Wildlife Federation, one of America's largest and most trusted conservation organization, works across the country to unite Americans in giving wildlife a voice. NWF has been on the front lines for wildlife since 1936, fighting for the conservation values that are woven into the fabric of the nation's collective heritage[122].

Aquatic Invasive Species in the Chesapeake Bay Drainage—Research-Based Needs and Priorities of U.S. Geological Survey Partners and Collaborators. The U.S. Geological Survey (USGS) revised the Chesapeake Bay science plan and reported that all 13 agencies and organizations located in the Bay region identified Aquatic Invasive Species (AIS) as being of general concern, with most stakeholder groups reporting AIS-related issues to be of high priority (Densmore 2020). Species in this category include fishes, invertebrates, invasive plants, and microbes including aquatic animal pathogens.

Education and Outreach

Effective regional conservation depends on clear and consistent Information about state and regional conservation targets, specifically SGCN in SWAP and COAs, RSGCN, and Regional Conservation Opportunity Area (RCOA) habitats. When engaging partners, stakeholders, and the public, one important role for the state fish and wildlife agencies will be to clearly state how top threats impair populations of SGCN and explain how conservation actions can address those impacts.

Education and Outreach actions should include current regionally consistent messaging of SWAP SGCN/RSGCN priorities and conservation needs. The RSGCN list has recently been updated and offers current opportunities for these regional messages to be shared. Improved communication and technical assistance approaches should target key audiences that include land use decision-makers, stakeholders, and the public to address this important threat to SGCN and key habitats. Communication and messaging efforts should include benefits and risks to species and humans (i.e., why should people care?). These outreach and education messages and actions should be distributed/communicated to target audiences through accurate, clear definitions, lists, and best practices (including lists and benefits of using locally adapted native species).

Multiple state/regional/subregional invasive species expert groups, councils, and networks exist in each state and across the Northeast; and coordination among these groups is critical. This coordination should communicate current SWAP/RSGCN species and habitat priorities and encourage the development of best practices for these targets. Many of these invasive species' groups are listed below as examples of partnership efforts within the RISCC Management Networks. These networks reduce the joint effects of climate change and invasive species by synthesizing relevant science, sharing the needs and knowledge of managers, building stronger scientist-manager communities, and conducting priority research. The Northeast Region RISCC[98] website contains research and tool summaries, management challenges, guiding principles, and current news and events. Tools include:

- Climate Voyager Map-with climate projections and visualizations,
- Resilient Land Mapping Tool for planning and decision-making considering resiliency and range shifts,
- Don't Move Firewood – outreach and education for preventing the spread of invasive species,
- Invasive Range Expanders Listing Tool for stakeholder engagement in range-shift and climate change impacts,
- New England landscape Future Explorer for land use projections and decision-making,

- Nonindigenous Aquatic Species (NAS) a database for mapping and alerts for aquatic species,
- Xerces partnership with Bee City/Bee Campus USA[123] uses regionally specific native plant guides,
- Homegrown National Park[124] additional plant guides, and
- Pollinator Pathways[125] is another project that promotes the idea of corridors through entire neighborhoods, encouraging broad participation.

Theodore Roosevelt Conservation Partnership (TRCP)[126]. Members of the $689-billion outdoor recreation industry have established a blue-ribbon commission to stop and reverse the spread of aquatic invasive species in the U.S. The commission will convene leading biologists, environmentalists, policymakers, and resource managers to assess existing mitigation efforts and identify more effective eradication solutions. Findings from the analysis will be presented to Congress and the Administration in 2023, with the goal of passing comprehensive legislation to better manage and eliminate aquatic invasive species.

STATE EXAMPLES AND OPPORTUNITIES

- **Maryland** DNR promotes a citizen science program called "Statewide Eyes" to identify and report invasive species using a free mobile application called the Mid-Atlantic Early Detection Network (MAEDN). Use of the MAEDN increased fourfold between 2015 and 2016, and Maryland users have submitted more records than any other state in the region, with Virginia a close second. Invasive plants new to the area have been found and reported by MAEDN users (e.g., *Cardamine impatiens* and *Corydalis incisa*). In 2016, Maryland banned the sale of three ornamental invasive plants: Shining Canesbill, Yellow Flag Iris, and Fig Buttercup. Warnings are also required to be posted on Burning Bush, Border Privet, and three invasive vines that are non-native members of the wisteria family. Atlases, BioBlitz, other surveys, and citizen science all provide significant contributions to public knowledge about status and distribution of multiple taxa, both native and non-native.
- Partnerships for Regional Invasive Species Management (PRISM) in **New York** is a program to coordinate treatment and prevention of invasive species outbreaks. NY's Adirondack Park Invasive Plant Project, Cornell Invasive Plants, and iMapInvasives[127] are online tools for reporting invasive species and data management. New York State's Department of Environmental Conservation (NYS DEC) lists regulated species and provided guidelines with their education and outreach initiatives:

    - Nuisance & Invasive Species List[128]
    - Prohibited and Regulated Invasive Plants (NYS DEC and NYS DAA 2014)
    - Long Island Sound Study to restore and protect the Sound[129]
- In 2020 the **Maine** Forest Service and Maine Natural Areas Program were awarded Landscape Scale Restoration Grant funding for the Mapping, Prioritizing, and Controlling Invasive Plants in Maine Woodlands project. This project will develop an invasive plant landscape plan; publish a manual of science-based strategies detailing how to survey, map, prioritize, and control invasive plants; and conduct in-depth training. Financial incentives for private landowners to prepare Invasive Plant Control Practice Plans will be competitively funded, with follow-up monitoring of treatment efficacy.
- **Maryland Crayfish regulations.** The release of live, unused bait into Maryland waters is a common practice among Maryland anglers. Based on a survey of Maryland's freshwater anglers conducted in 2008: 1) approximately 20% of freshwater anglers use live crayfish as bait; and 2) 69% reported releasing unused crayfish alive into streams and lakes at the end of their fishing trips. Most anglers (72%) reported that they caught their own crayfish while 26% reported that they purchased crayfish from bait shops. The use and release of live crayfishes as bait by anglers has resulted in the introduction of five non-native crayfish in Maryland waters. Three of these – Rusty Crayfish, Virile Crayfish, and Red Swamp Crawfish – are considered invasive due to their adverse effects on aquatic ecosystem function and native biodiversity. Virile Crayfish, first introduced in the Patapsco River in the late 1950s, is now the most widespread invasive crayfish – currently found in 11 river basins in Central and Western Maryland. MD DNR is considering expanding its regulations to address this.
- **Delaware**: **Homegrown National Park**[124] is a grassroots call-to-action to regenerate biodiversity and ecosystem function by planting native plants and creating new ecological networks cofounded in Delaware.
- **Rhode Island's Wild Plant Society**[130] works at the state scale, providing education and propagation of native plants for sale and partnering with farmers and land trusts statwide. ReSeeding RI is a new project of the RI Wild Plant Society, building on lessons learned from RhodyNative and the EcoType Project/Eco59 retail counterpart model to create a sustainable approach to promoting wild, native plants[131].

4.4.5 WILDLIFE DISEASE

Chapter 3 provides more detailed descriptions, impacts on RSGCN, and additional resources and examples for this threat in the Northeast. Wildlife diseases have the potential to imperil a broad range of both terrestrial and aquatic wildlife and have been

identified as one of the top regional threats. The SWAP Synthesis and Limiting Factors reports (TCI and NEFWDTC 2017, 2020a) summarized additional information and actions needed to address the threat of disease in the Northeast as prioritized by NEFWDTC and SWAP coordinators. Actions to address data gaps and concerns about the introduction and spread of disease in fish and other aquatic taxa includes employing the experience and techniques learned from WNS, CWD, Rana Virus, Avian Flu, Bsal and other challenging efforts to combat wildlife diseases over the past decade.

Priority planning actions included the development of regionally coordinated Response Plans as well as targeted early detection and ways to implement rapid control/management strategies that will reduce the impacts to native wildlife or communities. Customizing the National Invasive Species Strategy with regional tools and BMPs to maximize the effectiveness of these strategies while avoiding excessive harm to non-target species was recommended. Additional recommended actions include developing treatment, containment, and mitigation options and protocols; and improving prevention through quarantine, risk assessments, and improved, consistent regulation.

Little is known about invertebrate pollinators compared to other taxonomic groups, but as implementation of SWAPs and focused RCN projects fill critical data gaps, knowledge about the importance of these species and their vulnerabilities has grown. Significantly more invertebrates have been listed as SGCN in the fourteen 2015 Northeast SWAPS; they now represent 71% of all SGCN listed in the region. Proactive work is needed to assess the status of these taxa and the threats facing them. Better understanding of the impact of disease on declining populations and of the loss of habitat for these regionally important species is crucial to avoid the potential for listing. While there are still many unknowns in pollinator conservation, coordinated monitoring of the effects of disease will help identify effective best practices that can be implemented for these species in all Northeast states.

Appendix 4A provides a list of projects that have advanced the conservation of these regional species and habitats through the RCN, CSWG, SA programs from 2007- 2023. This Chapter provides a list (Table 4.1.1) and summaries for those projects implemented since the 2013 Synthesis, organized by the predominant information or tool and SWAP element they address. The key RCN and CSWG projects to address Disease are summarized below.

Bats and White-Nose Syndrome (2007, 2008) (RCN, CSWG). The RCN Grant Program supported two projects to address the ongoing WNS crisis in Northeast bat populations (WNS; Reeder et al. 2011). The first studied the effects of the fungus that causes WNS on hibernating bats and demonstrated that bats infected by the fungus were aroused to normal body temperatures more frequently than uninfected bats

(Reeder et al. 2011). These arousals depleted the bats' fat stores and likely contributed to their subsequent mortality. The number of arousal events significantly predicted the bats' date of death; and the severity of fungal infection correlated with the number of arousal events.

The second project developed methodologies to combat WNS. Specific goals included: 1) testing potential treatments for efficacy against cultures of the fungal pathogen associated with WNS under laboratory conditions' 2) testing potential treatments for safety in healthy bats; and 3) testing potential treatments for efficacy against fungal infection in hibernating bats. The project tested formulations of terbinafine and other anti-fungal compounds. Research on WNS has also received support through the competitive SWG program.

A CSWG project supported this regional effort to address White Nose Syndrome through a Multi-state Coordination, investigation, and Rapid Response grant project. At the start of the 2008 grant, WNS was only known to be present in New York, Connecticut, Massachusetts, and Vermont. The hope was for the spread of the fungus to be limited to adjacent states the following year. Unfortunately, by the spring of 2009, it had swept south all the way to western Virginia. Although the sudden magnitude of the problem was unexpected, this grant was critical to preventing state agencies from being completely overwhelmed by the crisis. Eleven states participated in this grant: Pennsylvania, New Hampshire, Vermont, Connecticut, New Jersey, Delaware, Maryland, West Virginia, Virginia, Wisconsin, and New York. All of these states except, Wisconsin, felt the impact of WNS on their bat populations during the grant period. Common goals of developing a public reporting system, improving public outreach, coordinating sample requests, and improving ability to monitor and track bat populations were developed and shared. The group cooperated in identifying and selecting research priorities that were most important to states already experiencing heavy bat mortalities associated with WNS.

The **New England Cottontail Conservation Strategy (2007-14) (CSWG, SA, RCN)** and initiative addresses the potential impact of disease (including Rabbit Hemorrhagic Disease) on this important Northeast species**.** To help avoid and minimize the spread of the rabbit hemorrhagic disease, USFWS (CSWG, SA) and its partners have developed a conservation strategy and noninvasive monitoring tools focusing on New England Cottontail populations. The CSWG grants and At-Risk Species Team have worked through the New England Cottontail Conservation Initiative for decades, and their Conservation Strategy and extensive efforts include preventing and addressing disease (Tur and Fuller 2012).

Ranavirus in Amphibian Populations (2014) (RCN). In 2014, NEAFWA RCN funded a project investigating Ranavirus in amphibian populations. NEFWDTC

developed an initial set of priority actions that respond to this disease in the Northeast. In 2017 SWAP Synthesis and NEFWDTC also identified Ranavirus and related diseases in herpetofauna as a regional priority. The Committee sponsored several regional projects to address this threat and identified both an action framework and partnerships for implementation. Protection efforts targeted native SGCN and RSGCN by preventing the introduction and spread of Ranavirus, Bsal and other diseases of reptiles and amphibians. In the Northeast, some actions focused on working with the pet industry advisory council and Disease Cooperatives to prevent introduction of diseases through the pet trade. This included early detection at ports of entry, development of a rapid assessment tool, and species health profiles. Additional RCN projects were prioritized to address this serious threat and are summarized below.

In order to better understand the extent to which Ranavirus is impacting amphibian and reptile populations in the Northeast, and to develop a sampling protocol for the region, this RCN project led by MD DNR staff with EFWDTC and NEPARC participation conducted a survey of amphibian larvae at randomly selected wood frog breeding ponds. The study area encompassed parts of Delaware, Maryland, New Jersey, Pennsylvania, and Virginia. In 2013 and 2014, a total of 4,306 individual wood frog larvae were collected for quantitative PCR analysis by Montclair State University in New Jersey. Individuals representing seven amphibian species that are subject to active die-offs were collected for analysis by the USGS National Wildlife Health Center (NWHC), representing both the largest geographic area and the greatest sample size ever screened for Ranavirus. A regional survey, diagnostic lab reports, and published scientific literature indicated that Ranavirus has been lab-confirmed in 33 herpetofauna species in at least 64 counties in the Northeast region. It was found most frequently in Wood Frog larvae, Eastern Box Turtles, and the larvae of Spotted Salamanders, Green Frogs, and American Bullfrogs (Smith et al. 2016).

Scientists and conservation groups in the Northeast continue to address the challenge of how to best respond to the threat posed by Ranavirus, as the study indicated that state response capacity varied across the region. Most states (11 of the 14) make use of the diagnostic services of the NWHC. The study developed and applied field protocols and recommended that disinfection protocols become standard operating procedure for all land management agencies as they work with groups like PARC to develop strategies to address the threat of emerging diseases.

Preventing Bsal in Amphibian Populations (2016) (RCN, CSWG, SA). The SWAP Synthesis also prioritized prevention and spread of Disease: *Batrachochytrium salamandrivorans* (Bsal). In 2016, the NEFWDTC and NEPARC reached out through the Northeast and Southeast Wildlife Disease Cooperatives to help protect wild populations of amphibians by preventing the introduction of *B. salamandrivorans* from imported amphibians. Collaborators, working with the Disease Cooperatives, developed

methods for early detection that require swabbing individual animals and then testing the samples. Practical approaches to implementing these diagnostic tests are still to be developed. Ideally, animals should be tested before leaving the country of origin. If imported, individuals would need to be held for a few days until results were returned or tracked and retrieved if testing positive. NEPARC's Website provides information and resources and multiple protocols on preventing the introduction and spread of this disease in the Northeast. A North American Bsal Task Force has been established and a North American Strategic Plan to Prevent and Control Invasions of the Lethal Salamander Pathogen *Batrachochytrium salamandrivorans* has been developed (North American Bsal Task Force 2022).

Snake Fungal Dermatitis in New England Timber Rattlesnakes (2014) (RCN, CSWG). In 2014, NEAFWA RCN also funded a project investigating snake fungal dermatitis in New England Timber Rattlesnakes. The NEFWDTC identified this as a priority and specifically identified actions to address disease response in the Northeast. The Timber Rattlesnake is a RSGCN, a species of 'Severe Concern' by NEPARC (2010) and is listed as a Species of Greatest Conservation Need in 12 Northeast states. It is believed to be extant in only 10 of those states. In 2009, Timber Rattlesnakes were found to have a significant fungal dermatitis, which has been shown to cause mortality in Viperidae snakes. Due to the low population numbers of the Timber Rattlesnake in New England, the study was prioritized for RCN funding and led by the Roger Williams Park Zoo. It provides a baseline health assessment of multiple New England populations of the Timber Rattlesnakes in 2014. Ninety-eight individuals from nine Timber Rattlesnake populations in New England were captured (and released) for the study across four seasons. Data gathered on the snakes included morphological measurements, gender, and estimated age. Individuals were visually examined for dermatitis lesions or external abnormalities; blood was drawn for hematology, serum biochemistry, and heavy metal analysis; and two cloacal swabs were obtained for paramyxovirus testing. The study provides an initial prevalence rate of fungal dermatitis in these nine populations that can be used for comparison in future years to determine if the prevalence of the disease is increasing. The overall prevalence among snakes studied was 33% and found to be higher in the spring than summer. The analyses showed no evidence that the disease is an opportunistic infection in snakes with suppressed immunity, and in fact the sampled snakes appeared to be in overall good health (McBride et al. 2015).

A CSWG Project **Conserving Snake Species of Greatest Conservation Need Threatened by an Emerging Fungal Skin Disease supplemented this project throughout the region.** Using data obtained from the regional snake species assessment, state partners used an adaptive management framework for development of long-term conservation strategies for up to 40 snake species potentially impacted by the

disease. Other conservation actions include evaluation of treatment options, experimental treatment with antifungal agents, captive rearing, and monitoring.

4.4.6 REGIONAL EXAMPLES AND OPPORTUNITIES THAT ADDRESS WILDLIFE DISEASE

Much can be learned from recent challenges of and responses to WNS, Bsal, CWD and other prominent wildlife diseases over the past decade. Working closely with the Wildlife Disease Cooperatives ensures up-to-date information and regional coordination. The Northeast region worked quickly to respond to the discovery of White Nose Syndrome and learned a lot about how to respond to disease outbreaks through research, rapid response, and coordination. The RCN program funded several projects related to wildlife diseases that provided valuable protocols, standard operating procedures, and BMPs that were then employed across the region to minimize the introduction and spread of White Nose Syndrome in bats, Ranavirus in amphibians, and Fungal Dermatitis in Timber Rattlesnakes. See Table 4.1.1 and *Appendix 4B* for examples of RCN projects that developed handling protocols to contain, avoid, treat, and mitigate these diseases in RSGCN. See Chapter 7 for additional information on partners. Chapter 3 provides detailed threat descriptions, impacts on RSGCN, and additional resources and examples for this threat in the Northeast.

The **North American Bsal Strategic Plan** includes background information on Bsal and the ecological significance of salamanders in ecosystems, as well as a brief review of policy options aimed at preventing Bsal introduction in North America (North American Bsal Task Force 2022). The Task Force and its strategic goals are described, as are the roles of the Technical Advisory Committee and other working groups. These include goals for: Response & Control; Diagnostics; Research; Decision Science; Surveillance & Monitoring; Data Management; Outreach & Communication; and Clean Trade. **The Rapid Response Plan Template**, which provides guidance for field or captive activities, and the Bsal Implementation Plan, which outlines more specific goals and priorities of the Technical Advisory Committee and working groups, are provided as appendices. Both appendices are expected to evolve over time to include new information and updates posted on relevant websites (e.g., North American Bsal Task Force[132] and PARC's disease resources[133] websites).

Portal for Reporting Diseases in Herpetofauna. PARC has developed a national disease reporting portal[134]. The PARC Disease Task Team[135] has also created an amphibian and reptile disease alert email where people in the USA and Canada can report or learn about an incident of sick, dying, or multiple dead amphibians or reptiles. The PARC DTT maintains a current list of appropriate individuals to contact in both

countries. PARC's website also has a resource page with recent publications and contacts.

Northeast Partners in Amphibian and Reptile Conservation. NEPARC has a Working Group that addresses Reptile and Amphibian Diseases[136]. NEPARC's working group published a scientific article in Herpetological Review describing best practices for decontaminating construction equipment (Julian et al. 2020). They developed a Three-Step Guide (NEPARC 2022) for a general audience and equipment operators as well as a short video on how to reduce the spread of disease in this taxon. The NEPARC website on emerging diseases has numerous other resources related to various herptile diseases, including Bd, Bsal, and ranavirus, including best practices, factsheets, and links to other resources.

USGS Wildlife Health Center. The National Wildlife Health Center (NWHC)[137] was established in 1975 as a biomedical laboratory dedicated to assessing the impact of disease on wildlife and identifying the role of various pathogens in contributing to wildlife losses. It provides information, technical assistance, and research on national and international wildlife health issues. The Center monitors and assesses the impact of disease on wildlife populations; defines ecological relationships leading to the occurrence of disease; transfers technology for disease prevention and control; and provides guidance, training, and on-site assistance for reducing wildlife losses. It provides multiple resources and tools, including WHISPers, a partner-driven, web-based repository for sharing basic information about historic and ongoing wildlife mortality (death) and morbidity (illness) events in North America[138].

Wildlife Disease Cooperatives and Support.

The **Southeast Wildlife Disease Cooperative**[139] conducts research on ecology of avian influenza virus in waterfowl and shorebirds; assessing and reducing the health risks posed by translocating wild animals; the ecology of tick-borne zoonoses; West Nile Virus infections in wild birds, and more.

The **Northeast Wildlife Disease Cooperative** (NEWDC) was affiliated with Tufts University from 2013 to 2020. This consortium of veterinary diagnostic laboratories provided educational opportunities, wildlife diagnostics, cutting-edge research, and collaboration with wildlife agencies in the region. It also disseminated current information regarding wildlife diseases to wildlife agencies and organizations in the Northeast United States. The cooperative entered a dormant phase when the Director of NEWDC transitioned to a new position. Henceforth, disease threats will be managed through a coordinator hired by the Northeast Association of Fish and Wildlife Agencies with additional funding from the US Fish and Wildlife Service and support from USGS. The **Northeast Regional Fish and Wildlife Health Coordinator** will support the

work of fish and wildlife health practitioners to address zoonotic and other wildlife diseases. This position will work with Coordinators from other regions, encouraging nationwide collaboration, and will help develop regional strategies for the prevention, detection, control, and eradication of wildlife diseases.

Cornell Wildlife Health Lab[140]. The Cornell Wildlife Health Lab works to promote the health and long-term sustainability of wildlife populations through integration of the fields of wildlife ecology and veterinary medicine. The Lab conducts disease surveillance and collaborative research; develops diagnostic tools; and communicates findings through training, teaching and public outreach. The lab is based at the Cornell University College of Veterinary Medicine Animal Health Diagnostic Center (AHDC).

Penn State and the Wildlife Futures Program[141]. Penn State's Department of Veterinary and Biomedical Sciences' mission is to protect animal health, human health, and food safety through diagnostic laboratory services and professional expertise. Priorities include early detection and monitoring of animal diseases and providing support for animal owners and industries, veterinarians, animal research scientists and educators as well as state and federal animal health programs. The Animal Diagnostic Laboratory (ADL)[142] fulfills its mission by providing in-depth, rapid diagnostic information to support disease control, health management, and performance of livestock, poultry, wildlife, fish, and companion animals; and by ensuring the safety of foods of animal origin. Furthermore, ADL provides active surveillance of animal diseases and identification of emerging diseases through the development and application of new diagnostic methods, training, and education for new diagnosticians, veterinarians, and graduate students. These proactive measures are designed to ensure the viability of Pennsylvania's animal industries. Wild animals are frequently submitted for evaluation at ADL and wildlife submissions must be arranged through the PA Game Commission. It is a science-based, wildlife health program to increase disease surveillance, management, and research supporting the protection of wildlife across the Commonwealth of Pennsylvania and beyond. It is a partnership with the Pennsylvania Game Commission which provides information, resources and guidance on current wildlife disease issues including:

- **Threat Assessments**
- **Wildlife COVID-19 Resources**
- **Wildlife Disease Fact Sheets –** A compendium of fact sheets on various wildlife diseases, organized into the following groups: mammals, birds, reptiles & amphibians, and multiple species groups.
- **Additional Resources include Avian Flu and Rabbit Hemorrhagic Disease**

Reporting Bat Sightings film-outreach example. Outdoor enthusiasts including climbers and hikers can play and important role by reporting their bat sightings. A new film by **Ravenswood Media**[143], ***Explorers for Bats***[144], explains how climbers and hikers can help document their sightings while at the same time avoiding harm to the bats, including introducing disease. In the film, wildlife managers, bat experts and climbers are interviewed, each providing information about bat behavior, habitat use, populations in established climbing areas, and how those who want to conserve outdoor recreation are invested in bat conservation. Climbers are provided with guidelines for encountering bats, focusing in particular on how to climb in areas without contributing to the spread of the WNS fungus. The interviews take place in spectacular settings on Federal lands in Maine and Utah. Ravenswood Media produced ***Explorers for Bats*** in collaboration with the Colorado Natural Heritage Program, Climbers for Bat Conservation, the National Park Service, and Idaho Department of Fish and Game. The film was funded by a grant from the US Fish & Wildlife Service, administered by the Wildlife Management Institute.

4.5 CONSERVE AQUATIC HABITATS AND RSGCN BY ADDRESSING POLLUTION AND AQUATIC CONNECTIVITY IN NORTHEAST WATERS

4.5.1 REGIONAL NEED AND PRIORITY ACTIONS

Regional Need: The 2015 SWAPS, 2017 SWAP Synthesis, and NEFWDTC identified pollution and the loss of aquatic connectivity as top threats facing aquatic RSGCN and their habitats across the Northeast. Many RSGCNs are associated with aquatic habitats in the Northeast, but these habitats continue to be affected by pollution, water quantity and quality management challenges, and aquatic connectivity issues that can benefit from watershed-focused regional approaches. Climate change will exacerbate water quality issues, requiring environmental assessments and restoration actions to evaluate past management in light of these additional challenges to effectively address present and future conservation goals.

Priority Actions: Provide regional SWAP priorities for incorporation into local, state, and regional water management and watershed planning efforts, highlighting RSGCN and key habitats. Work with partners to improve aquatic connectivity, water management, and water quality for RSGCN and their habitats. Work with agencies and entities that regulate impacts to fish and wildlife habitats to develop and implement effective, consistent policies and approaches across Northeast lands and waters.

See Priority Species in Chapter 1, Priority Habitats in Chapter 2, Priority Threats in Chapter 3, each with partner and program opportunities and examples. See Table 4.1.1 and Appendix 4A for priority projects completed and Appendix 4B, the SWAP Synthesis, and individual SWAPs for additional priority Conservation Actions that address aquatic RSGCN habitat quality.

4.5.2 APPROACH

Chapter 3 provides detailed threat descriptions, impacts on RSGCN, and additional resources and examples for this threat in the Northeast. Continued development along the eastern seaboard is increasing the demand for freshwater, with upland resources being tapped to meet this demand. There is increasing awareness of the need to protect water rights for natural habitats and species. State fish and wildlife agencies have limited authority or capacity to prevent the creation of aquatic barriers or pollution resulting in degraded habitats downstream. This emphasizes the need to work with partners and regulatory agencies at the local, state, regional, and national levels to incorporate current information on SGCN and RSGCN as well as the impacts and benefits of pollution reduction and aquatic connectivity programs.

SWAPs identified dams and water management structures as a priority threat to aquatic fish and wildlife diversity regionally. Specific SWAP actions can be found in the NE SWAP Database and the 14 2015 SWAPs. The 2017 SWAP Synthesis compiled priority SWAP actions and information to address this threat[1]. These action priorities include direct management activities, data collection, partnership development, communications, focused planning, and coordination.

Actions to address these key water management threats are frequently confounded by problems in identifying responsibility for repairs, upgrading, or removal of dams and related structures. Even when ownership is known, repair or removal of these structures may be voluntary, or contingent on the consent of willing owners. Assessing species impacts and monitoring population responses are needed in order to provide informed guidance on conservation work in partnership with state Departments of Transportation and other entities. Restoring watershed buffers and guiding vegetation management and land use activities to restore natural ecosystem communities and functions for RSGCN wildlife and their habitats will help minimize pollution and the impact of extreme weather events. Important communication actions identified were those that effectively message aquatic connectivity and its benefits to SGCN; the costs and risks of degrading

dams; best practices for dam/culvert upgrading or removal; and the importance of maintaining minimum flows or levels.

Direct management actions that improve aquatic connectivity by upgrading or removing barriers to restore passage and flow as well as improving buffer condition were identified as high priorities across the region. Applying SWAP, RCN, RSGCN, and key partner tools enhanced with state and local data provides a framework and critical guidance for prioritizing on-the-ground conservation in the Northeast. SWAP priorities need to be incorporated into standards of practice for residential and commercial development, service, and transportation to reduce the impacts of pollution (e.g., the lawn care, road salting).

Aquatic connectivity and pollution reduction are best accomplished with active support and engagement of public and private partners including Departments of Transportation, key Non-Governmental Organizations (NGO), and watershed groups. There is a continuing need to inventory and monitor barriers and water quality conditions and to document RSGCN vulnerabilities and responses to implemented actions. Likewise, there is a continuing need to implement effective, consistent BMPs that engage partners and landowners. Some relevant BMPs already exist; others need to be developed. Offering standardized buffer guidance that incorporates regional SWAP and partner priorities into local, state, and regional water and watershed planning efforts is also important in protecting RSGCN and their key habitats.

Outreach to large landowners such as military bases and corporate/industrial parks is also a priority, along with US Department of Agriculture programs to restore important grassland and early successional habitats and minimize pollution. Planning actions included those that consider SGCN requirements when regulating wells and dams, especially regarding flow release schedules and protocols and creating dam/water management regulations and policies that support biodiversity in or around RSGCN habitats. Measuring and monitoring species and habitat responses to water quality and quantity were likewise considered priority actions by Northeast SWAPs.

An important first and continuing step in aquatic conservation is **working with and informing watershed stakeholders,** providing them with current information on state and regional species and habitat conservation priorities and clearly explaining what is important and why. SWAPs are critical resources for this state-scale information. Regional priorities provided in the RSGCN and SWAP Databases can be found on the NEFWDTC website. **These priorities should be incorporated into local, state, and regional water quality and watershed planning efforts highlighting RSGCN and key habitats.** This includes working with private and NGO partners and stakeholders to incorporate these important conservation targets into

their programs and planning processes. The 2017 SWAP Synthesis and Northeast SWAP Database contain detailed actions and information gathered from analysis of the 14 2015 Northeast SWAPs—information on the impacts of this top regional threat to SGCN and RSGCN and their habitats as well as strategies to improve aquatic connectivity and reduce pollution. Key actions identified to address these threats at the regional scale also include incorporating connectivity into transportation and infrastructure design and implementation (culverts, bridges, road crossings, water control structures, and fencing to protect key areas and habitats).

There is a need to **incorporate SWAP and RSGCN information and conservation into transportation, infrastructure, and other sources of pollution and barriers.** Some state and regional efforts (involving North Atlantic Aquatic Connectivity Collaborative[74], TNC, and other key partners) have mapped stream barriers while others have performed cursory condition assessments. These inventories and assessments help determine priorities for upgrades and removal, but additional criteria for assessing ecological conditions are needed. A related need is to develop and test cost-effective approaches to modifying and upgrading barriers that can still provide significant benefits to RSGCN and SGCN in streams. A wide range of improvements and replacement designs, including the use of "slip-line" culverts, are already available to minimize the impact of stream crossings on SGCN; but others can and should be developed.

There is a continuing need to **develop and disseminate consistent, regional BMPs and incentives for barrier removal, repair, and replacement that support conservation of RSGCN and SGCN**. Additional considerations in dam removal planning include invasive species and water temperature. Assessing the condition of the region's 80,000 culverts and road crossings posed a difficult challenge. In a triage effort, 15,000 were identified as high priority, although it should be noted that this ranking does not include sufficient ecological assessment criteria. Not all dams can be removed, so other strategies must be developed to minimize impacts on SGCN. There is continued need for research leading to the development of improved fish passage structures. Where dams are large enough to require flow release schedules, ecologically appropriate practices should be used. The Federal Energy Regulatory Commission and state regulatory agency policies should be updated to include the conservation needs of SGCN. Classification and regulation of dams varies among states, with some states focusing only on larger dams, and others requiring annual inspection of much smaller dams. These differing regulations will need to be considered in any regional aquatic connectivity initiatives.

Improving the condition of stream and riparian buffers remains a priority in the Northeast. Degraded buffers along adjacent transportation corridors (e.g., roads and

railroads), or where power and pipelines traverse rivers and streams, cause similar negative impacts. With consideration for other wildlife needs, careful selection of buffer plants can not only improve stream health and aquatic habitat; they can also provide suitable habitat for pollinators, help stabilize stream temperatures, and reduce pollutant run-off. BMPs for buffers are available, but more consistency in recommendations should specifically include the conservation needs of SGCN.

Significant aquatic connectivity and stream quality improvements can be achieved by **working with partners**. More coordination with State Departments of Transportation is recommended. USDA-NRCS and other partners have multiple wetland and riparian buffer programs (e.g., Wetland Reserve Program, Conservation Reserve Program) that can lead to improved water management practices, and RSGCN and SGCN conservation needs should be included in these, as well. Working with regional partners such as Trout Unlimited, Eastern Brook Trout Joint Venture, and National Fish Habitat Partnerships initiatives can also help incorporate scientific assessments and RSGCN priorities into a wide range of activities.

An emerging area of conservation action relates to **protecting groundwater for RSGCN and their key habitats**. This is especially important in late summer when risk of severe drought is greatest. The effect of water withdrawals on SGCN may increase with climate change because: 1) sea level rise is expected to result in saltwater intrusion near coasts where aquifer water is withdrawn; 2) warmer air temperatures will expose species in low-flow streams to much higher water temperatures; and 3) higher frequency and increased severity of drought in late summer could cause and/or exacerbate conflicts between the many demands for freshwater, including the need to maintain natural habitats for SGCN. Requirements to address RSGCN life-history for wells in proximity to their habitats should be considered. As sea level rise introduces salt water into shallow aquifers, coastal states need to consider and communicate the needs of RSGCN in local and state water management planning.

Over the past decade, it has become clear that Climate Change exacerbates water quality and quantity issues in the Northeast. NECASC has provided valuable research,

information, and tools for better understanding and adaptation strategies[49] (Staudinger et al. 2023).

Multiple RCN, CSWG, and SA efforts address aquatic connectivity and water quality and quantity within species and habitat conservation strategies and plans, including the following RCN, CSWG and SA projects listed in Table 4.1.1and *Appendix 4B*: SWAP Database, RSGCN Database and List Development, 2017 SWAP Synthesis, 2020 Limiting Factors Report, Great Lakes ELOHA, Landlocked Alewives, Aquatic Connectivity Dam Assessment, Flow Models, Brook Floater, Chesapeake Logperch, Diadromous Fishes, Rare Wetland Turtles, Hellbender, Diamondback Terrapin Wetland Bird, Odonate Assessment, and Wetland Butterfly projects. See Table 4.1.1and *Appendix 4B*.

4.5.3 REGIONAL PROJECTS ADDRESSING AQUATIC HABITAT CONSERVATION

The 14 Northeast 2005 and 2015 SWAPS, the 2017 SWAP Synthesis, and the 2023 RSGCN process identified Pollution and Water Management as top regional threats to fish and wildlife diversity conservation in the Northeast. To address them, NEAFWA's RCN and key partner programs prioritized and funded multiple projects to assess and remove aquatic barriers and improve connectivity and water quantity and quality in the region. Some of the key projects are listed below as resources. For a complete list of these projects please see Table 4.1.1 and *Appendix 4*, for additional partner information see *Chapter 7*. For more detailed information on aquatic species and habitats, see *Chapters 1 and 2* respectively. *Chapter 2* provides information on Northeast aquatic habitat status and condition as well as RSGCN supported and provides examples of management and conservation plans and efforts in the region. *Chapter 3* provides detailed threat descriptions, impacts on RSGCN, and additional resources and examples for this threat in the Northeast.

An Interactive, GIS-Based Application to Estimate Continuous, Unimpacted Daily Streamflow at Ungauged Locations in the Connecticut River Basin (2007) (RCN). This project developed an interactive map-based decision-support tool to estimate continuous unimpacted daily streamflow at ungagged locations in the Connecticut River basin (Archfield et al. 2013). Work from this project allows users to identify a stream reach of interest in the Connecticut River basin and obtain estimated continuous daily, unregulated, or "natural" streamflow at the selected location. The

Connecticut River UnImpacted Streamflow Estimator (CRUISE) tool spans the entire Connecticut River basin, including the states of Connecticut, Massachusetts, New Hampshire, and Vermont. This work expands on a method developed for Massachusetts to estimate daily streamflow at ungagged locations. The CRUISE software tool and user manual are available through the USGS[145].

ELOHA Framework in the Great Lakes Drainage. (2008) (RCN). This RCN project applied the Ecological Limits of Hydrologic Alteration (ELOHA) framework in the Great Lakes drainage of New York and Pennsylvania to develop an objective, spatially explicit process for evaluating the ecological impacts of new withdrawals of water from the tributaries of Lakes Erie, Ontario, and the upper St. Lawrence River (Taylor et al. 2013). This provided the information necessary to develop and implement instream flow standards for managing the Great Lakes surface and ground-waters of New York and Pennsylvania under the terms of the **Great Lakes Compact** (see *Chapter 7*). Additional multi-state benefits include transferability of the holistic, ELOHA-based technique being developed from the Susquehanna Basin to the Great Lakes Basin; guiding implementation of the Great Lakes Compact in at least two states, with useful information for other states and provinces in the region (e.g., Vermont, Ontario, Quebec, Ohio); and assessing and documenting the transferability of the project methods and models to other NEAFWA states or watersheds. The project engaged technical advisors from agencies, universities, and other stakeholders in combining testable models of ecological responses to flow alterations with an assessment of current alterations in different types of streams. This combination enabled New York and Pennsylvania to determine the flows necessary to sustain aquatic life and to implement instream flow policies that balance human and ecosystem needs.

Determining the Effects of Landlocked Alewives on Anadromous Alewife Restoration. (2015) (RCN) Another RCN project funded dam removal and fish passage efforts that are critical components of anadromous Alewife restoration, reconnecting runs to prime spawning habitat in coastal lakes. Landlocked Alewife populations have become established in many coastal New England lakes, and the effects of landlocked Alewives on anadromous Alewife restoration were unknown. Specifically, this RCN project investigated the effects of landlocked Alewife presence on anadromous Alewife restoration in Rogers Lake, which once hosted one of the largest anadromous Alewife runs in Connecticut (Palkovacs et al. 2018). From 2015-2017, spawning anadromous adults were stocked and sampled. A novel set of microhaplotype genetic markers were developed to identify anadromous, landlocked, and hybrid juveniles. Estimates of spawning time showed that anadromous Alewives spawn earlier in the spring than landlocked Alewives, but that there is a period of overlap in spawning time, creating the potential for hybridization. Results of genetic monitoring indicate that anadromous Alewives are successfully spawning in Rogers Lake. The identification of

anadromous juveniles indicates that anadromous Alewife are able to successfully spawn and juveniles to rear in a lake containing a landlocked population. The identification of hybrids indicates that the two life history forms can successfully spawn together and produce viable and competitive offspring. Estimates suggest that anadromous production is high enough to initiate anadromous Alewife restoration. They also show that landlocked Alewives are still substantially more common in the lake compared to anadromous or hybrids. Hybrids are less common than anadromous juveniles, but they are present at ecologically and evolutionarily relevant abundances. Future work continues to track the abundance of each life history form to better understand how anadromous production and hybridization are proceeding as the restoration project continues. A PowerPoint summary and the full report on the Restoration of Anadromous Alewife of Lakes of Connecticut can be found through the NEFWDTC website.

Chesapeake Logperch (Percina bimaculata) projects (2018) (CSWG, SA). The Chesapeake Logperch (*Percina bimaculata*) is listed as threatened in Pennsylvania and Maryland. Historically, this species was found in the Chesapeake Bay watershed in the District of Columbia, Maryland, Pennsylvania, and Virginia. It was limited to the lower sections of the Potomac and Susquehanna rivers and their tributaries, and a few direct tributaries to the Chesapeake Bay. It was thought to have been extirpated from the Potomac River drainage due to pollution and sedimentation. Threats to the Chesapeake Logperch are many: nutrient loading/sediment loading; Polychlorinated Biphenyls (PCBs) and Chlordane; pollution; habitat loss/modification of natural systems (*i.e.*, dams fragmenting riverine habitat, development, conversion to agricultural use); impingement (Peach Bottom Nuclear Facility intake structures); stranding in shallow pools (mid-summer months); and the introduction of hybrid aquatic species nd invasive aquatic species, such as the Northern Snakehead (*Channa argus)*, the Flathead Catfish (*Pylodictis olivaris*), and Zebra Mussels (*Dreissena polymorpha*).

The objectives of this CSWG project were to: 1) determine the extant distribution of the Chesapeake Logperch and identify any significant phenotypic variation among sub-populations occupying the mainstem river and tributary streams; 2) determine habitat characteristics, life history and behavioral aspects of the Chesapeake Logperch; 3) reintroduce Chesapeake Logperches; 4) develop a conservation action plan for Chesapeake Logperch in Maryland; and 5) ensure that progress on grant activities is tracked and communicated to all partners.

The ARS program efforts contributing to the conservation goals and actions include: 1) protect, conserve, and enhance viable extant populations in Maryland and Pennsylvania; 2) reintroduce this species to historical range (including the Potomac

drainage), and augment existing populations; 3) monitor the species; 4) protect streams and habitat from agricultural and urban run-off; and 5) genetic characterization.

The ARS team is working with state and federal partners to implement a captive rearing operation (multiple facilities). State partners are working to complete the last year of a 5-year Comp-SWG study on the Logperch including determining life history, behavior, and habitat characteristics; identifying suitable release sites; releasing wild and propagated Logperch stocks; and developing a Conservation Action Plan for logperch in Maryland. Federal partners have initiated genetic analysis to determine the genetic diversity implications for propagation efforts. The Team also works with academia on behavior, predator avoidance, and other studies.

Aquatic Habitat Classification System and Map Guide. (2007, 2011)
Important foundational RCN projects established classification and mapping of aquatic habitats in the Northeast. A classification system was developed for aquatic habitats with an accompanying guide to the Northeast Aquatic Habitat Map. These serve as a companion to the terrestrial and aquatic habitat maps. The goal of this project was to ensure the understanding and widespread use of the **Northeast Aquatic Habitat classification system** by creating a printable web-based guide to the Northeast Aquatic Habitat Classification and GIS database (Olivero and Anderson 2008, Olivero Sheldon et al. 2015). The guide includes descriptions of the habitat types, sample photographs, statistics and distribution patterns, guidance for using crosswalks to other (state) classification schemes, and, when available, wildlife associations for Northeast fish and mussels. A steering committee developed a classification scheme that simplifies the full classification into logical stream types. Most recent classification systems for lakes and ponds and marine systems have also been updated and completed (Olivero and Anderson 2008, Olivero at al. 2015, Olivero Sheldon and Anderson 2016).

Diadromous Fishes (Alewife, Blueback Herring) (2022) (SA). Alewife (*Alosa pseudoharengus*) and Blueback herring (*Alosa aestivalis*), collectively known as River Herring, are categorized as SGCN in all New England states, New York, Pennsylvania, New Jersey, Delaware, and Virginia. Blueback herring are additionally categorized as SGCN in South Carolina and Florida. River Herring Conservation Plans have been released by NOAA Fisheries and the Atlantic States Marine Fisheries Commission (ASMFC) within the last decade. Threats to River Herring populations include exclusion from or reduced access to historic freshwater spawning and nursery habitats; barriers with inadequate fish passage measures; freshwater and estuarine habitat/water quality degradation; climate change impacts; and indirect (bycatch) fishing pressure. In both the marine and freshwater environments, shifts in water temperature, related temporal/spatial shifts in environmental conditions, prey availability, and predators may be negatively influencing River Herring populations. Conservation goals for River

Herring are aligned with those established in the ASMFC Amendment 2 to the Interstate Fishery Management Plan for American Shad and River Herring (River Herring Management) (ASMFC Shad and River Herring Plan Development Team 2009): *"Protect, enhance, and restore East Coast migratory spawning stocks of . . . alewife (*Alosa pseudoharengus*), and blueback herring (Alosa aestivalis) in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass."* Priority objectives include: 1) preventing further declines in population abundance; 2) promoting improvements in degraded or historic habitat throughout the species range; 3) improving access to historic freshwater spawning and nursery habitat; and 4) increasing understanding of the influences of River Herring bycatch in commercial fisheries as well as updating the status of stock dynamics and health.

Freshwater Mussels (Brook Floater, Cumberland Moccasinshell, Pheasantshell, Tennessee Clubshell, Tidewater Mucket, Yellow Lampmussel) (2012, 2016, 2022) (RCN, CSWG, SA). Across the continent, freshwater mussels have experienced drastic declines. More than 74 % of the 298 species found in North America are in some state of imperilment, with 93 species federally listed as endangered or threatened (Williams et al. 2017). Habitat degradation, which includes water pollution and impoundments, is by far the leading cause of these declines. Non-native species also have outcompeted some native species. Freshwater mussels also provide ecological and economic benefits to people and aquatic ecosystems. Like oysters, they filter millions of gallons of water and act as ecosystem engineers. They're crucial to a multi-billion-dollar pearl jewelry industry, and harvest of mussels is a reserved treaty right for some Native American tribes. Without intervention, freshwater mussels will continue to disappear within their range, with the risk of also losing the valuable ecosystem services they provide.

An RCN project assessed the conservation status of the brook floater mussel, *Alasmidonta varicosa,* in the United States and established the trends in distribution, occurrence, and condition of populations (Wicklow et al. 2017). They reported on: 1) its biology and life history; 2) the distribution and condition of all known populations from Maine to Georgia; (3) the human impacts on populations; 4) the results of models using environmental factors at both the HUC 12 level and stream level as predictors of population condition; and 5) the results of a survey concerning threats to this species that was sent to mussel biologists from Maine to Georgia.

Using adaptive management and working at landscape scales in partnership with states and Tribes, partners work together to restore and conserve these at-risk species of mussels and proactively address threats in an effort to avoid the need to list these species under the Endangered Species Act. With input from partners, the ARS program has been building a conservation plan called the **Northeast Region Conservation**

Strategy for Freshwater Mussels. It provides a framework and strategies for conserving and restoring at-risk species of freshwater mussels and their habitats from Maine to Virginia and West Virginia. This will inform decisions on feasible, cost-effective actions that Service programs can take with partner support over the next five years to increase representation, redundancy, and resiliency (3 Rs) of each species, and ensure their long-term viability.

In 2022, biologists from 12 States, the Partnership for Delaware Estuary, USGS, and representatives from the Penobscot Nation were interviewed. A suite of questions aimed at identifying priority areas and management and science needs for conservation of mussels. This information is being synthesized into maps and tables which will highlight priority areas for conducting surveys, habitat restoration, land protection, propagation and stocking, and science needs. Discussions held in 2021 with the Rappahannock, Chickahominy, and Upper Mattaponi Indian Tribes in Virginia are also informing priority areas for conservation of at-risk mussels and their host fish, as described in the *Northeast Region Conservation Strategy for Freshwater Mussels*. Interviews with Tribal partners continue to further identify priority areas for mussel conservation efforts. The strategy will be distributed to State and Tribal partners and to other Service offices for review and comment, and the result will be a comprehensive At-Risk Conservation Strategy. Continuing program efforts will work to build local action plans within target watershed and implement projects. Priority science needs for mussels were also identified and included in the request for proposals through the USGS as well as priority projects for BIL funding.

Brook Floater Rangewide Conservation and Restoration Initiative (CSWG). This project developed protocols to estimate the occupancy and detection rates of Brook Floater within the watershed; estimate how environmental and observational covariates influence these rates; and standardize methods for capture-mark and recapture of Brook floater at high-priority conservation sites.

The Gulf of Maine Coastal Marine Ecosystem Survey: Mapping Biological Hotspots (2013) (CSWG). The goal of this project was to fill critical knowledge gaps on the basic ecology, distribution, and abundance of 27 SGCN that inhabit the region's coastal marine ecosystem. Using distribution and abundance data, the partners calculate biological hotspot index values and develop digital maps based on habitat use model predictions. This critical information helps the partners develop effective conservation programs for these species within the Gulf of Maine and provide technical assistance for siting of offshore energy development projects in ways that minimize their impacts on marine habitats.

4.5.4 REGIONAL EXAMPLES AND OPPORTUNITIES

Chapter 3 provides detailed threat descriptions, impacts on RSGCN, and additional resources and examples for this threat in the Northeast. Many estuary and watershed programs in the Northeast are working to reduce non-point source pollutants. For example, the Chesapeake Bay Program's Total Maximum Daily Load limits on nutrients and sediment set in 2010 by US Environmental Protection Agency (EPA) were written into Watershed Implementation Plans that detail how and when each of the Bay jurisdictions will meet the goals[146]. Other such programs across the Northeast include the Hudson River Estuary Program, Delaware Bay Program, Lake Champlain Basin Program, Great Lakes Restoration Initiative, Long Island Sound Program, and Riverkeeper Programs, etc. (see *Chapter 2* and *7* for additional partners' programs).

North Atlantic Connectivity Collaborative. The aquatic connectivity portal maintained by the North Atlantic Aquatic Connectivity Collaborative is a one-stop source for tools and regional collaboratives focused on aquatic organism passage ("fish passage") and the fragmentation of river and stream ecosystems. It is a starting place for stakeholders, users, and tool developers looking to keep track of the latest initiatives and identify opportunities for collaboration and action[84]. Examples of this site's contents include:

- **TNC HUC12 Prioritization Tool**[147], spanning the 13 North Atlantic states from Maine to West Virginia helps identify sub-watersheds that may have priority for field survey and crossing assessments.
- **TNC Aquatic Barriers Prioritization Tool**[148], for the 13 North Atlantic states from Maine to West Virginia explores barriers to aquatic connectivity — dams and road stream crossings, using GIS.
- **Fishwerks**[149], is a Web-based GIS platform that uses sophisticated optimization tools to help maximize the efficiency of habitat improvement projects for migratory fish in the Great Lakes basin.
- **Freshwater Network – Chesapeake Region**[150], allows users to explore barriers to aquatic connectivity — dams – and identify high priorities for removal or improved fish passage. It also supports custom analyses in the Chesapeake Bay watershed states of Virginia, Maryland, and Pennsylvania.
- **Coastal Resilience Maine**[151]**,** allows users to explore barriers to aquatic connectivity — dams and road-stream crossings– in the Penobscot River Watershed and identify high priorities for removal and/or improved fish passage. It also supports a range of custom analyses.
- **Southeast Aquatic Barrier Prioritization Tool**[152], Atlantic Drainages from the Roanoke River in VA to Mobile Bay allows users to explore barriers to aquatic connectivity — dams – and identify likely high priorities for removal or improved fish passage. It also supports a range of custom analyses.

NRCS Wetland Reserve Easements Program. The Natural Resources Conservation Service (NRCS) Wetland Reserve Easements Program (one part of the Agricultural Conservation Easement Program) provides funds to purchase development rights in connected riparian areas. Land eligible for Wetland Reserve Easements includes farmed or converted wetland that can be successfully and cost-effectively restored. NRCS prioritizes applications based the easement's potential for protecting and enhancing habitat for migratory birds and other wildlife. In many cases NRCS has included the SWAP SGCN species in their priority ranking system. An example is its use in habitat protection of saltmarshes to support Saltmarsh Sparrow. Working with experienced partners, NRCS funds the enlargement of stream buffers, an example of conservation stewardship design[153].

Environmental Protection Agency's Report on the Environment[154] includes five indicators of ecological condition that address the state of the nation's ecological systems, providing insight into the degree to which the natural environment is being protected:

- **Extent and Distribution.** This indicator examines trends in the overall extent (area and location) of different kinds of ecological systems. It also examines spatial patterns in the distribution of ecological systems that affect interactions of nutrients, energy, and organisms, considering Ecological Connectivity, Forest Extent and Type, Forest Fragmentation, Land Cover, Land Use, Urbanization and Population Change, and Wetlands
- **Diversity and Biological Balance.** These indicators identify trends in the types and numbers of species that live within ecological systems and how they interact with each other. Examples include: Benthic Macroinvertebrates in Wadeable Streams, Bird Populations, Coastal Benthic Communities, Cyanobacteria in Lakes, Fish Faunal Intactness, Non-Indigenous Estuarine Species in Pacific Northwest, Submerged Aquatic Vegetation in Chesapeake Bay
- **Ecological Processes.** These indicators focus on trends in the critical processes that sustain ecological systems, such as primary and secondary productivity, nutrient cycling, decomposition, and reproduction: Carbon Storage in Forests, for example
- **Physical and Chemical Attributes.** *Physical attributes* can include temperature, hydrology, and physical habitat, as well as major physical events that reshape ecological systems, such as fires, floods, and windstorms. *Chemical attributes* can include pH, dissolved oxygen concentrations, and nutrients (e.g., nitrogen and phosphorus). These indicators include: Acidity in Lakes and Streams, Hypoxia in Gulf of Mexico and Long Island Sound, Nitrogen and Phosphorus in Agricultural Streams, Nitrogen and Phosphorus in Large Rivers, Nitrogen and Phosphorus in Wadeable Streams, Sea Level, Sea Surface

Temperature, Stream Flows, Streambed Stability, and Temperature and Precipitation

- **Ecological Exposure to Contaminants.** This indicator set provides information on biomarkers of exposure to contaminants that are particularly important with respect to the health of plants and animals, as well as to humans who might consume them: Coastal Fish Tissue and Lake Fish Tissue, for example.

The New England District of the U S Army Corps of Engineers developed **Stream Crossing Best Management Practices** (USACE 2015).

DAMS AND WATER MANAGEMENT

Most states' experience with this threat involves dam removal or culvert replacement. Efforts have focused on priority structures for which removal can significantly lengthen connected stream segments and restore RSGCN/ SGCN habitats and populations by facilitating aquatic organism passage.

Nationwide, the USFWS has been involved in the removal of 1600 barriers to fish passage over the past two decades. USDA-NRCS and the National Fish Passage Program are other national partners. In each state, environmental protection agencies, power utility companies, departments of transportation, and Watershed protection NGO's (including Trout Unlimited, American Rivers, etc.) are potential partners, as well. American Rivers summarizes the state of dam removal throughout the US on its website[155].

States reported that the ability to cite economic benefits of dam removal or fish passage is important in justifying this conservation work. A 2010 USFWS report estimated the annual economic contributions attributable to the focus areas detailed in the National Fisheries Program Strategic Plan (Charbonneau & Caudill 2010). Aquatic Habitat & Species Conservation and Public Use were focus areas of the report and included case studies of dam removal and improvements.

Most watersheds in the Northeast address invasives and disease in their plans and programs. The Connecticut River is one example of the many active watershed partnerships in the region.

Connecticut River Watershed Council[156]. The Connecticut River Watershed Council works to protect the watershed from source to sea, The Connecticut River watershed unites a diversity of habitats, communities, and resources from Alpine forests to tidal estuaries, rural farmlands to urban riverfronts, salamanders to bald eagles, and mussels to salmon.

Economic Impacts of Habitat Improvements. Gentner Consulting Group developed a tool allowing users of the National Fish Habitat Action Plan to calculate economic impacts of fresh and saltwater habitat improvements (Gentner 2013). The **Atlantic Coastal Fish Habitat Partnership (ACFHP) Plans** incorporate water quality and connectivity in their Conservation Strategic Plan which is updated every five years and used as a guidance document by the ACFHP Steering Committee, the Partnership-At-Large, state and federal agencies, and restoration practitioners (ACFHP 2017). The Plan is designed to address goals, objectives, and strategies that the Atlantic Coast Fish Habitat Partnership will focus on to improve the condition of Atlantic coastal fish habitat. A more specific set of priority actions is presented in the 2020-21 Action Plan (ACFHP 2020). The current NOAA National Strategy can be accessed through the NOAA Fisheries website (NMFW 2022).

Northeast Climate Adaptation and Science Center. NECASC provides a wealth of information and tools on how climate change exacerbates the issues of water quality and quantity in the Northeast. Their website[50] includes a list of projects, publications, and examples, several of which are presented below:

- **Determining the Skill and Value of Incorporating Streamflow Forecasts into an Early Drought Detection System -** This research investigates success in forecasting or predicting the onset and severity of drought. One of the unique features of NECASC's research agenda is the active engagement of water supply utilities. Another is the evaluation of how climate informs short-term stream flow forecasts.
- **Science to Inform the Reconnection of Floodplains and Restoration of Green Space to Minimize Risk in the Future -** This project identifies opportunities to manage flows, connections, and landscapes in ways that increase the resilience of human communities and ecosystems. This research identifies dynamic and adaptive solutions to managing river flows that support continuation of valuable infrastructure services.
- **An Assessment of Midwestern Lake and Stream Temperatures under Climate Change -** Water temperatures are warming in lakes and streams, resulting in the loss of many native fish. Given clear passage, cold water stream fishes can take refuge upstream when larger streams become too warm. Likewise, many Midwestern lakes "thermally stratify," with warmer waters closer to the surface.
- **Small dam removal as a tool for climate change resilience -** Across the United States, millions of small dams fragment the landscape and alter stream ecosystems. Removal of obsolete dams and related structures is a way to eliminate or reverse the negative impacts on humans and ecosystems.

- **Science to Inform Management of Floodplain Conservation Lands in a Changing World -** Recent extreme floods on the Mississippi and Missouri Rivers have motivated decision-makers and resource managers to expand the inventory of floodplain conservation lands. Within Missouri, there are currently more than 85,000 acres of public conservation lands in large-river floodplains.
- **Framework for Protecting Aquatic Biodiversity in the Northeast Under Changing Climates -** This project uses an analytical, iterative process to evaluate aquatic biodiversity protection and management scenarios across four Northeastern states (Connecticut, Massachusetts, New Hampshire, and Vermont). It integrates climate change and management to identify land protection and restoration actions that optimize aquatic biodiversity protection into the future. Ultimately, the results will help managers to promote aquatic ecosystem health and prioritize climate adaptations.
- **Rethinking Lake Management for Invasive Plants Under Future Climate: Sensitivity of Lake Ecosystems to Winter Water Level Drawdowns -** Small lakes are important to local economies as sources of water and places of recreation. Commonly, lakes are considered more desirable for recreation if they are free of the thick weedy vegetation, often comprised of invasive species, that grows around the lake edge.
- **Mapping Salt Marsh Response to Sea Level Rise and Evaluating 'Runneling' as an Adaptation Technique to Inform Wildlife Habitat Management in New England -** Loss of saltmarsh habitat is one of the greatest threats to coastal sustainability in the Northeast. Salt marsh has been identified as an essential fish and wildlife habitat, and loss of saltmarsh corresponds with precipitous declines in marsh-dependent wildlife.
- **Mapping Connections Across Ecosystems in the Northeast to Inform Climate Refugia Networks**. As the climate continues to change, vulnerable wildlife species will need specific management strategies to help them adapt to these changes. One such strategy is based on the idea that some locations a species inhabits today will remain suitable over time and should be protected.
- **Mapping Connections across Ecosystems in the Northeast to Inform Climate Refugia Networks**

The New England District of the U S Army Corps of Engineers developed Stream Crossing Best Management Practices (USACE 2015).

STATE EXAMPLES AND OPPORTUNITIES

Connecticut: Connecticut has imposed a fine of up to $1000/day for dams that are not maintained or that are deemed unsafe. Keeping dams free of tree growth and maintaining structural integrity are high priorities. While many dams have been

removed, the impact of coincident threats like rising water temperatures, inadequate buffer vegetation, and pollution may have limited species responses. In one example, the Zemko Dam was removed from the Eightmile River system in Salem, CT. Fish populations responded positively to the dam's removal; however a complete shift from lentic to lotic fishes did not occur within a 3 year sampling period (Poulos et al. 2014; Poulos & Chernoff 2017).

Maine: The Penobscot River Restoration Project[157] is a collaboration between the Penobscot Indian Nation, seven conservation groups, hydropower companies PPL Corporation and Black Bear Hydro LLC, and state and federal agencies. Its purpose is to restore 11 species of sea-run fish to the Penobscot River while maintaining energy production. This was accomplished by removing dams, installing fish lifts and bypasses, and replacing water intakes.

- **Penobscot River-** Penobscot River Restoration Project (Natural Resources Council of Maine)[184] and Restoring the Penobscot River (The Nature Conservancy)[158]
- The Penobscot Nation[159] provides information on water management, mud gates and invasive species affecting their lands and waters.
- Maine has been surveying stream crossings for 11 years and has nearly completed its inventory. The Maine Stream Habitat Viewer was made available in 2012 and is a powerful tool to access habitat and barrier data. In 2014, TNC, Maine Audubon, and the Maine State Chamber of Commerce lobbied for, and voters approved, a bond to fund improvements to stream crossings that would protect public safety, improve aquatic habitat connectivity, and allow for resiliency in the face of more frequent and intense storms. Priority projects begin with a full Aquatic Organism Passage study. There is still a need to improve the cost-effectiveness of these road crossing improvement projects.
- **Kennebec River (Edwards Dam) removal is documented here:**
    - Twenty years of dam removal successes – and what's up next[160] (American Rivers)
    - How Removing One Maine Dam 20 Years Ago Changed Everything[161] (The Revelator)
    - River Rebirth: Removing Edwards Dam on Maine's Kennebec River[162] (National Geographic)
    - Edwards Dam and Kennebec River Restoration[163] (Natural Resources Council of Maine)

Maryland: A 2014 publication reported links between chloride concentration in streams, mayfly abundance, the benthic macroinvertebrate index of biotic integrity, brook trout density, and salamander and mussel populations (Ashton et al. 2014). In all

cases, streams with high chloride concentrations had low measured populations and were more likely to be listed as "impaired" streams in Maryland. This report also provides an extensive bibliography including measurements of chloride impacts on other species. For example, amphibians are particularly sensitive to road salt run-off due to their permeable skin. Spotted Salamanders (*Ambystoma maculatum*) were especially sensitive; Anurans in the genera of *Bufo, Rana, and Xenopus* were more tolerant; and salamanders in the genera *Aneides* and *Batrachoseps* were the most tolerant of all the species surveyed (Karraker et al. 2008).

Maryland is working with the State Highway Administration to monitor impacts of road salt application in a study that began in 2016.

Massachusetts:

- **Nissitisit River, Rattlesnake Brook, Shawsheen River, Cotley River, Housatonic River West Branch, Ipswich River**
  River Run – A Story of Dam Removal in Massachusetts[164] (MA Division of Ecological Restoration [MA DER] film series)
- **Removal** of the dilapidated **dam** and reconnecting 40 upstream river miles on a beautiful trout stream in **northeastern** Massachusetts
- **Stream Crossing Explorer - Deerfield River Watershed[165]**, Massachusetts and Vermont. Provides a data visualization and decision support tool that was developed to assist with locating and prioritizing stream crossings that meet user-defined criteria.
- **MA DER Restoration Potential Model Tool[166]**, An RPM Tool displays information that can be used to evaluate the relative ecological benefits of removing any known dam in Massachusetts.

New Hampshire:

- **NH Aquatic Restoration Mapper[167]** provides an Interactive tool allowing users to explore stream crossing, flood hazards, and aquatic habitat data to identify restoration opportunities in New Hampshire Communities.
- **Mill Pond Dam in Durham, NH[168].** Restoring Our Water and Food Ways of N'dakinna (Our Homelands) (2021 video by Ellen Ervin, Indigenous New Hampshire Collaborative Collective)[169]
- **Exeter River (Great Dam, Exeter NH), -** Great Dam Removal Project (Town of Exeter)[170], Documentary on the Exeter Dam (Exeter Historical Society)[171], Dam Removal and Habitat Restoration on the Exeter/Squamscott River, New Hampshire (Atlantic Coastal Fish Habitat Partnership)[172]

- **Bellamy River (Sawyer Mills Dams, Dover NH)-**A River's Freedom (The Nature Conservancy)[173] and Sawyer Mills dams being removed from Bellamy River (Foster's Daily Democrat)[174]
- New Hampshire River Restoration Task Force[175]
- **Gale River (White Mountains NH)-**Partners celebrate restoration of New Hampshire's Gale River (American Rivers)[176]

New York: Since the 1980s, the Adirondack Lakes Survey Corporation has worked to monitor acid deposition and its related ecological impacts in the Adirondack Mountains of New York. As the effects of acid deposition on aquatic and forest ecosystems have become well documented, environmental groups have successfully advocated for regulation of air-borne pollution to prevent acid rain and/or mitigate its impacts on Northeastern lakes and forests. The regulatory and monitoring work has reduced airborne acid pollutant loading and documented the ecological response.

- There are many examples of attempts to reduce road-salt use to benefit surface waters in New York. Specifically, there are documented increases in chloride in Lake Champlain[177]. NYSDOT is implementing salt reduction projects in the Adirondacks. Several ongoing studies explore the impact in the Lake George area. Vermont is also exploring road salt reduction.

Rhode Island: The White Rock Dam on the Pawcatuck is an example of interstate collaboration in dam removal (between Rhode Island and Vermont in this case)[178]. Other removals are underway, including a second one on the Pawcatucket River. Currently, there are anadromous fish passage projects on the Ten Mile, Blackstone, Wood/Pawcatuck, and Woonasquatucket River systems. They include full or partial dam removals and the installation of fishways/eel ramps. Some of these efforts provoked resistance to removal where the dams are considered cultural/historic landmarks. Horseshoe Falls, also on the Pawcatuck, is an example of this. Improving fish passage in RI is probably one of the best examples of collaborative partnering and urban restoration in the state (both of which were highlighted on p. 25 of the RI WAP Companion Guide[35]).

Vermont: In 2012, six farms in the Lake Champlain watershed participated in a study comparing edge-of-field treatments (Braun et al. 2016). The farms were enrolled in NRCS pollution reduction programs. Practices included cover cropping; manure injection and conservation tillage; soil aeration prior to manure application; adding waste and sediment control basins; and creating grassed waterways. Parameters that were monitored in the study include total phosphorus, total dissolved phosphorus, total nitrogen, total dissolved nitrogen, chloride, total suspended solid, soluble reactive phosphorus, and total event discharge. Precipitation, air temperature, runoff-specific conductance, and runoff temperature were also monitored.

Virginia and West Virginia: During the summer of 2016, three dams were removed in the West Fork River watershed in West Virginia[179]. The dams were between 85 and 105 years old. They were originally built for water supply purposes and were deemed to be both obsolete and safety liabilities. Removal of the dams reconnected 491 miles of streams and tributaries upstream of the Hartland Dam and benefited Clubshell and Snuffbox freshwater mussels. The National Park Service approved a Water Trail on the river. Plans are in place to extend the connected stream distance by installing passage for fish and non-motorized boaters at the Hartland Dam.

- As water levels dropped upstream of the dams, there was some sloughing of riverbanks and collapse of roads beside the banks. (West Virginia Division of Highways worked to stabilize these situations.) Volunteers and contractors relocated 1430 stranded mussels (representing 9 different species) into newly established riffle/run habitat. The declining water levels exposed a large amount of trash that had been submerged and had to be removed. At the same time, the local water utility realized between $40,000-and $50,000 in savings, in part because the incoming water was much cleaner and fewer treatment chemicals were needed.
- In Virginia, dams are being removed on the Upper Tennessee River Basin to benefit Yellowfin Madtom, Slender Chub, Spotfin Chub, Tan Riffleshell, Fluted Kidneyshell, Shiny Pigtoe, and dozens of other SGCN. Communities are supporting these efforts and have expressed interest in creating blueways or organized boating paths, enhancing local recreation and tourism opportunities once flow is restored.

OTHER RESOURCES

- **Connecticut River project:** Reconnecting Habitat for Fish (Connecticut River Conservancy)[180]
- **National Oceanic and Atmospheric Administration**: "Dam Removals in New Hampshire Benefit Public Safety, Fish Migration"[181]
- **New England Sustainability Consortium**: The Future of Dams Project[182]
- **The Nature Conservancy**
  "Unleashing Rivers": feature article[183] on dam removal in New England and "Removing Barriers to River Health and Fisheries", Provides overview of the Nature Conservancy's work restoring river ecosystems through dam removal[184]
- "The river is us; the river is in our veins": re-defining river restoration in three Indigenous communities (Fox et al. 2017).
  This resource uses three case studies in the US, New Zealand, and Canada, to

explore how Indigenous knowledge is expressed through Native participation in river restoration and how these practices affect restoration outcomes. It shows why cultural approaches to restoration are important, and the kinds of opportunities they create.

"Dam Removal: Case Studies on the Fiscal, Economic, Social, and Environmental Benefits of Dam Removal" (Headwaters Economics 2016). Report compiled by an independent, nonprofit research group summarizing fiscal, economic, social, and environmental benefits of dam removal. Formatted by case studies, including dam removals in Massachusetts, Maine, Connecticut, and Rhode Island.

- "Centuries of Anadromous Forage Fish Loss: Consequences for Ecosystem Connectivity and Productivity" (Hall et al. 2012). Analyzes dam records of Maine rivers to find where fish populations were prevented from accessing their native habitat by dams built between 1600 and 1900. Concludes that successful restoration of ecologically important fish species can occur in places where dams are removed.
- "Effects of Dam Removal on Fish Community Interactions and Stability in the Eightmile River System, Connecticut, USA" (Poulos and Chernoff 2017). Tracks the temporal effects of dam removal on fish community interactions in the Eightmile River system of Connecticut. Suggests that, following dam removals, it may take decades or even centuries for restored sites to approximate the eco-community structure of nearby undisturbed sites.
- "Shortnose Sturgeon in the Gulf of Maine: Use of Spawning Habitat in the Kennebec System and Response to Dam Removal" (Wippelhauser et al. 2015). Provides the first evidence that Shortnose Sturgeon began to spawn in the restored Kennebec River after the Edwards Dam was removed in 1999. Highlights the importance of the Kennebec system to Shortnose Sturgeon throughout the Gulf of Maine and the role of dam removal in river ecosystem restoration.
- "Opening the tap: Increased riverine connectivity strengthens marine food web pathways" (Dias et al. 2019)
  Models the increases in energy flow and population productivity resulting from improved ecosystem connectivity following dam removal. Suggests potential for biomass increase of several species with high economic value and a major increase for species of conservation concern. Emphasizes the benefits of increased connectivity between freshwater and ocean ecosystems.
- "Dam Removal Effects on Benthic Macroinvertebrate Dynamics: A New England Stream Case Study (Connecticut, USA)" (Poulos et al. 2019)
  Examines the effects of dam removal on the structure, function, and composition of benthic macroinvertebrate communities in a temperate New England stream. Indicates that the effects of stream restoration on benthic macroinvertebrate communities are site-specific and that interactions among benthic

macroinvertebrate taxa are important determinants of the post-dam removal community.

4.6 ADDRESS CLIMATE CHANGE IMPACTS TO NORTHEAST RSGCN AND THEIR HABITATS

4.6.1 REGIONAL NEED AND PRIORITY ACTIONS

Regional Need: The 2015 SWAPS, 2017 SWAP Synthesis, and NEFWDTC identified climate change as one of the top five threats facing Northeast RSGCN and their habitats. One of the largest current challenges related to climate change is uncertainty. As information related to climate change and its effects becomes more available, it is increasingly important to incorporate climate-change scenarios into conservation decisions for priority regional species and habitats and to develop climate-smart actions.

Priority Actions: Collaborate with key climate change partners to provide the best available scientific data for RSGCN and climate-related conservation issues to inform existing and new actions developed to address climate change as both a threat and threat amplifier. Incorporate climate projections and information to assess future scenarios of risk and use this information to develop climate-smart actions. Use existing climate vulnerability data when possible and conduct Climate Change Vulnerability Assessments to assess risk. Develop a regional Climate Adaptation Strategy guided by the 2021 national plan, NE CASC, and other key partners expertise and resources.

See Priority Species in Chapter 1, Priority Habitats in Chapter 2, Priority Threats in Chapter 3, each with partner and program opportunities and examples. See Table 4.1.1 and Appendix 4A for priority projects completed and Appendix 4B, the SWAP Synthesis, and individual SWAPs for additional priority Conservation Actions.

4.6.2 APPROACH

Since the 2013 Northeast Conservation Synthesis, additional information and resources have significantly advanced the state of knowledge and informed actions addressing the impacts of climate change on Northeast RSGCN and their habitats. One key advancement was the establishment of the Northeast Climate Adaptation Science Center in 2012. **The Climate Adaptation Science Centers** are US Geological Survey

collaborations with academic institutions, bringing together climatologists, biologists, ecologists, and hydrologists with cutting-edge approaches to address major challenges posed by climate change[49]. **NECASC**'s robust scientific contributions have produced valuable tools and information on addressing climate change in the Northeast. Collaboration with natural and cultural resource managers has provided the climate change science to help inform fish and wildlife management decision-making and produce actionable products and results including more than 160 research projects and tools to facilitate climate change adaptation strategies for the Northeast[50]. **One of the most significant contributions was the 2015 Northeast Climate Change Synthesis to support the 2015 Northeast SWAP revisions (Staudinger et al. 2015). NECASC has initiated a project to update the 2015 synthesis and assist the 2025 SWAP revision process which will be available in late 2023 (Staudinger et al. 2023)**. NECASC established a Northeast Climate Change Working Group to solicit information leading to a better understanding of the climate change-related needs of state fish and wildlife agencies and their key partners; and then to develop and deliver science to meet those needs.

Resources, tools, information, and efforts that did not exist a decade ago are now available to inform and address climate change in the Northeast. Many climate change plans and assessments have been developed at the national, regional, subregional, landscape, and watershed levels. An important advancement has been the work of NEAFWA's NEFWDTC to document the climate change needs of RSGCN and their habitats in reports and databases. The following sections summarize these regional priority SWAP actions and advancements. See Staudinger et al. (2023) for more detailed information. In the revised 2023 NECASC Climate Change Synthesis. Chapter 3 provides detailed threat descriptions, impacts on RSGCN, and additional resources and examples for this threat in the Northeast.

The **Northern Institute of Applied Climate Science[185]** provides multiple resources for project planning and on the ground use and application (Janowiak et al. 2016). **The Adaptation Workbook was created for landowners and managers** unsure of how climate change might apply at the scales that are relevant to their work. Forest Adaptation Resources: Climate change tools and approaches for land managers, 2nd Edition (Swanston et al. 2016). The Workbook is also available for agriculture, which is described in Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast (Janowiak et al. 2014). The Workbook provides users with a flexible, logical process to consider climate change information and design customized management actions that can help achieve their management objectives. It is a structured process to consider the potential effects of climate change and design land management and conservation actions that can help prepare for changing conditions. The process is flexible to accommodate a wide variety

of geographic locations, ownership types, ecosystems and land uses, management goals, and project sizes[186]. The Workbook consists of 5 basic steps:

1. **Define** goals and objectives
2. **Assess** climate impacts and vulnerabilities
3. **Evaluate** objectives considering climate impacts
4. **Identify** adaptation approaches and tactics for implementation
5. **Monitor** effectiveness of implemented actions

Oakes et al. (2021) provides a **rapid-assessment approach** to facilitate climate-informed conservation and nature-based solutions by using the 5Ws to help define project goals, consider climate risks, and brainstorm climate-informed actions and prescribes the following steps.

Step 1—Gather and examine the best-available information on current and projected climate change and its effects on nature and/or people that are the focus of the local planning effort (see Staudinger et al. 2023 for the most current Northeast climate projections).
Step 2—Consider how changes in climate could impact the effectiveness of traditional actions in meeting goals, as well as any ways in which those actions and goals may need to be modified to be more effective in a changing climate. Walk through the full suite of questions with respect to what, where, when, why, and who (the 5Ws) to make actions climate- informed:

- WHAT (modifying tactics)—Are there ways that traditional actions need to be modified to be effective at achieving goals under a changing climate? Are there new actions that will be needed to achieve goals, or address new or exacerbated challenges caused by climate change?
- WHERE (working in strategic locations)—Are there strategic places or sites to be prioritized in implementation, given potential climate change impacts (e.g., work in places that are more or less likely to be impacted, or places where the chances of successful outcomes may be greatest)?
- WHEN (shifting the timing and urgency)—Do the anticipated effects of changing climate increase the urgency of actions that are already being implemented? Would such climate-informed actions need to occur at different times of the year to be effective?
- WHY (embracing forward-looking goals)—Even with modifications in actions, is there a need to adjust the project goals to be more realistic or feasible as the climate changes (e.g., focus on different targets, or strive for different objectives)?
- WHO (reshaping project leadership, values, and stakeholder involvement)—Who leads design and implementation, and who needs to be involved for actions to be accepted, effective, enduring, and reflective of the needs and diverse values of

people and communities? Does climate change affect who benefits or should benefit from actions? Who might be harmed by actions or bear the costs?

Step 3—Document any changes to project goals and design. If after asking the above questions you do not feel that modifications to current goals and actions are needed, document the logic on how current actions will be adequate to achieve goals even as the climate changes.

REGIONAL SWAPS AND RSGCN CLIMATE CHANGE THEMES

Climate change differs from other direct threats identified in SWAPs because fish and wildlife agencies and their partners have little ability to prevent or reverse the impacts, and instead need to focus on understanding and responding to the resultant ecological changes. Securing species vulnerable to climate change threats requires a well-developed understanding of non-climate related stressors which are in turn recognized and addressed in SWAPs, as well as the potential effect of climatic changes on those species and their habitats. The added threat of climate change presents new challenges for fish and wildlife diversity. It also compounds the persistent problems posed by deficiencies in the resources needed to address other long-term challenges.

Compared to other threats, the full impacts of climate change, as well as its interactive and amplifying effects on other threats are uncertain. However, for some groups of species there are known vulnerabilities that have been documented through the NEFWDTC RSGCN process. In fact, taxa experts indicated that the majority of RSGCN are likely to be impacted by climate change across all taxa reviewed. Across all habitat types, life history requirements, and taxonomic groups, the following climate change themes emerged from the RSGCN process in the Northeast.

Coastal habitat resilience. In general, coastal RSGCN species are threatened by sea level rise and coastal storms, with impacts to habitat that affect shelter, nesting, and foraging – habitat uses across all life phases. Beaches and other coastal habitats remain a high priority for research and conservation action. Decades before the threats posed by climate change were known, loss or degradation of coastal habitat was responsible for population declines among birds, marine mammals, fishes, invertebrates, and sea turtles. Climate change exacerbates other threats in these coastal habitats, with impacts on RSGCN.

Over-wintering. Warming winters present unique challenges for different RSGCN taxa groups. Snake and other reptile brumation activity is interrupted on warm winter days, with potential health impacts and vulnerabilities to collection, disturbance, or killing at den sites. Bats and other species may also have temperature-dependent wintering strategies, and males and females may have different wintering behaviors or

timing. Cave bats including the Tri-colored, Indiana, Northern Long-eared, Little brown, and Virginia Big-Eared bats are vulnerable to White Nose Syndrome, with growing evidence that cave temperature and humidity may influence fungal growth. Burrowing species, including small mammals, crayfish, mussels, and many reptiles and amphibians that rely on constant, undisturbed winter substrates and conditions are also becoming more vulnerable with the advent of increasingly severe weather events. In general, less is known about vulnerabilities and requirements during winter when species are less active and often harder to observe. Some species rely on winter snowpack to hide from predators or for protection from the cold (e.g., lynx, snowshoe hare and others). In the Northeast, winter temperatures may change more significantly than summer temperatures, so it is critical to understand winter vulnerabilities and climate change impacts.

Hydrologic conditions. More intense precipitation events and higher flood stages are predicted for the Northeast. Concerns for RSGCN freshwater mussels, stoneflies (and other EPT), and crayfish are primarily associated with the potential for scouring floods which have historically decimated populations in Northeast rivers, as have drought conditions which expose mussels or prevent crayfish from burrowing. These extreme river and stream conditions would also affect freshwater and diadromous fishes, Hellbenders, and Tiger Beetles which do not survive long periods of inundation. Other amphibians will also be affected by changes in hydrologic conditions, particularly if higher temperatures increase evapotranspiration, because of their reliance on vernal pools, wetlands, and high elevation habitats. Talus and other rocky habitats are important for snakes and amphibians, and soil moisture and humidity within the rocky spaces is important for these species and their invertebrate food sources. High elevation wetlands and hydrologic conditions below ground are likewise threatened by warming temperatures and drying. Burrowing crayfish, reptiles, amphibians, and small mammals require specific moisture and substrate conditions that will be impacted by storm events or intensified drought. Changes to temperature of headwaters and small streams.

Food resources. For most RSGCN taxa groups, the impacts of climate change on food resources are uncertain. We can surmise that climate change will impact food abundance through changes in temperature (e.g., insects or floral resources) and hydrology (e.g., aquatic insects and fish). Phenology mismatch is a concern in both terrestrial and aquatic species if prey populations and food supplies are not available during critical times of high energy demands. Red Knots (*Calidris canutus rufa*), Roseate Terns (*Sterna dougalii dougalii*), and North Atlantic Right Whales (*Eubalaena glacialis*) are among the coastal and marine species most likely to be affected, while bats and neotropical songbirds highlight this threat in relation to the hatch timing of forest insects. Offshore, initial research shows that the Gulf of Maine is one of the fastest warming bodies of water in the world (Seidov et al. 2021). In combination with the

longstanding negative impacts of over-harvesting and the weakening influence of the Labrador Current, system-level climate changes are likely to induce corresponding changes in species distribution, prey availability, and disease risks. A reduction in zooplankton caused by warming ocean waters would have widespread impacts on all aspects of marine food webs.

Climate Change Information Needs Identified by RSGCN Taxonomic Teams

In 2019-2020, the 20 NEFWDTC taxonomic teams provided information on vulnerabilities and limiting factors for RSGCN. This information is summarized below, by taxa. Generally, additional RSGCN need climate vulnerability assessments that could be accomplished efficiently for taxonomic groups such as freshwater mussels, hibernating bats, and amphibians relying on vernal pools. Specific research topics are provided in the Limiting Factors report (TCI and NEFWDTC 2020a).

Birds. If birds' life cycles are regulated by daylight hours (unaffected by climate change) but prey lifecycles, particularly those of invertebrates, are regulated by water or air temperature (now warming earlier each year), many bird species may experience food scarcity in the years to come. Such phenology shifts have been noted for a number of migratory species. The Red Knot migration is triggered by daylight hours, but nesting and egg availability of Horseshoe Crab, an important food source for Red Knot, are primarily triggered by ocean temperature. For coastal birds, sea level rise and storm surge threaten nesting success and forage habitat suitability. Inland birds can respond to warming temperatures by shifting ranges northward and to higher elevations, but boreal species in the Northeast have little opportunity to seek refugia, and birds with higher site fidelity may also adapt more slowly. While birds are currently less affected by disease than other taxa, there is evidence that warmer, wetter conditions are increasing the threat of West Nile Virus for some species.

Mammals. The wintering, hydrologic concerns, and food uncertainties described above also apply to mammals. Some mammalian species may be adapting to climate change through range shifts, but increased survey efforts at the northern and southern edges of their ranges will be necessary to fully understand these shifts. Like other taxa found only at high elevations, coastal and lowlands species will also experience loss of suitable habitat with climate change. The North Atlantic Right Whale, one of the most endangered marine mammals, urgently requires research to understand the impacts of ocean warming and acidification on its food resources, shifts in migratory patterns, and how these interact with other issues that affect its survival such as entanglement and ship strikes.

Reptiles. Warming winter temperatures are affecting brumation in reptiles with unknown impacts for individuals or populations. Warming temperatures during nesting

will cause shifting sex ratios for almost all RSGCN turtles. Northern Diamondback Terrapins in Maryland, for example, now have a sex ratio of 9 females per 1 male. (Higher proportions of males as bycatch in crab traps also partially explains these numbers.) Sea turtles and Northern Diamondback Terrapins have vulnerabilities during nesting due to sea level rise or storm surge as do freshwater turtles from flooding events. Reptiles may also be affected by changes in hydrologic regimes, particularly moisture in high elevation rocky habitats.

Amphibians. Most RSGCN salamanders have specific hydrologic requirements for vernal pools including soil moisture conditions and late summer refuges with high humidity. Traditional habitats for the high elevation *Plethodon* species are now at risk of warming or drying in late summer, and these species have little opportunity to seek alternative habitats. Coastal RSGCN (e.g., Eastern Mud Salamander and Atlantic Coast Leopard Frog) may also experience habitat degradation due to sea level rise.

Fish are affected by changes in water temperature, ocean acidification, extreme precipitation, or drought. All of these have the potential to affect mortality, health and fitness, food resources, and reproductive success. Climate vulnerability assessments are needed for most fish.

Aquatic invertebrates. Aquatic invertebrates are particularly vulnerable to flood scour and droughts. Temperature shifts may also affect aquatic invertebrates directly. If warming water temperatures affect host fish, mussel reproduction may be limited, and species ranges may retract from the southern edge. Dispersal upstream to cooler waters in response to rising temperatures may be more difficult for mussels and other less mobile aquatic invertebrates. For headwaters species, there is no more habitat further upstream to disperse to. Warming water temperatures can cause algal blooms and associated degradation of water quality which may in turn impact aquatic invertebrates. Near coasts, saltwater intrusion may make habitats unsuitable. Increased storm frequency and intensity will also increase sediment, nutrient and pollutant loads in runoff.

Butterflies. While the effects of climate on butterflies are still largely unknown, the high elevation butterflies of New Hampshire, Vermont, and Maine are vulnerable due to the absence of suitable alternative habitats into which they can disperse or migrate. Rising temperatures may lead to increased forest pest outbreaks, and the management of these pests via spraying will have negative impacts on many lepidopterans.

MANAGEMENT-RELATED INFORMATION NEEDS ACROSS TAXA

The Limiting Factors effort also showed that a common thread across taxa was the need for adequate research, surveys, and monitoring to determine baseline status and detect changes in populations before and after climate adaptation strategies are applied. Multiple taxa recommendations included the need for monitoring protocols that are consistent range-wide. A consistent, unified approach would improve status assessments and interventions as well as provide additional opportunities for conservation, thus avoiding the need to list these species at the federal level. A better understanding of the interaction between climate change and the top five regional direct threats and actions taken to address them would greatly inform management decisions across the region. These specific needs were expressed across the region and for all RSGCN taxa:

Invertebrate biomass. Because of the high number of vertebrate RSGCN relying on invertebrate food sources, there is a need to understand declines in invertebrate biomass within the context of climate change. This includes insects in terrestrial systems and plankton and krill in aquatic ones.

Wintering. Wintering vulnerabilities are an area of uncertainty across many taxonomic groups. Species may adapt to warming winters by changing the timing of wintering or the wintering strategies, but little is known currently about triggers for hibernation or migration, temperature-dependent activity states, or changes in energy demands associated with these changes in activity levels. The increase in installation of wind farms along common migration routes adds urgency to these questions, pointing specifically to the need to understand timing and other aspects of migration for birds and tree bats as well as impacts of the new infrastructure.

Changes in hydrologic regimes. Because of the large number of RSGCN associated with hydrologically defined habitats, anticipated changes in precipitation regimes and evapotranspiration will affect many RSGCN. Sedimentation, which has already changed substrate conditions in many streams, will need to be mitigated during extreme weather events. Some RSGCN are impacted by water management structures, which may also need to be redesigned as extreme precipitation events become more frequent.

Coastal habitats. These habitats have been degraded or reduced in size by intensive development along the coast and are now further threatened by sea level rise and storm surge. All RSGCN along the coast are affected by loss of habitat and intensified beach management. Some are affected by changing phenology of predator-prey relationships, ocean acidification, and warming temperatures, with uncertainty about their ability to shift inland or withstand flooding. Continued efforts are needed to improve habitat

management and resiliency, to promote living shorelines as an adaptation, and monitor RSGCN.

Disease. There is an ongoing need to track the impacts of disease in reptiles and amphibians. There is also a need to learn if diseases of freshwater mussels or crayfish are responsible for population declines. Finally, West Nile Virus and Bird Flu are known to impact some birds but their effects on RSGCN birds in particular are unknown.

High-elevation species conservation. The Shenandoah Salamander illustrates the management challenges climate change presents for this high elevation species. During the past few decades, climatic changes have restricted the Shenandoah Salamander to a few isolated habitats at the tops of three mountains within Shenandoah National Park. Managers have struggled to assess the relative merits of monitoring a likely extinction event vs. putting those human resources to a different and perhaps better use elsewhere. Similar conditions exist for other endemic RSGCN species across the region, and management scenarios and decisions, including novel actions like assisted migration, need to be informed by sound climate change and adaptation science. It is important that these investments are made in places where species will also benefit over the long-term, and climate projections and scenario planning can help managers make informed decisions that have the highest likelihood of success under high levels of uncertainty.

Several NECASC projects aimed to identify and prioritize landscapes for conservation investment that benefits species and habitat long-term. These efforts can focus on single species or on multiple species conservation. Another focus for prioritization can be areas that are buffered from climate change and thus enable the persistence of biodiversity (Morelli et al. 2016). When these "climate change refugia" are mapped based on known habitat requirements and predicted climate and vegetation shifts, non-climate threats can be managed to conserve species. Such mapping is already being done for cold lakes and stream fishes in the Midwest and Massachusetts (e.g., ECOSHEDS for the Northeast[187], Hansen et al. 2017, Daniel et al. 2017). Other efforts focused on vernal pool salamanders[188] and on conifer forest mammals and birds. Mapping for coastal sand plains specialists is being coordinated by the Northeast Climate Adaptation Science Center.

Climate refugia. Landscape resiliency, connectivity, and the presence of habitat refugia are important geospatial considerations for climate planning. By developing this information, states can make other SWAP implementation actions more strategic and long-standing. For example, if good Blanding's Turtle habitat were filtered to identify those habitats that would be most suitable under future conditions, current restoration and protection efforts could be focused where a species (or suite of species) is most likely to persist over the long term.

Please see Staudinger et al. (2023) for a comprehensive synthesis of climate change and its impacts on RSGCN and their habitats in the Northeast.

4.6.3 REGIONAL EXAMPLES AND OPPORTUNITIES

By its nature, global climate change is a large-scale threat, and the Northeast states can benefit by coordinating to develop, share, and implement tools for adaptation and by planning together and with the many regional Northeast partners. The NECASC 2023 Northeast Climate Change Synthesis (Staudinger et al. 2023) contains more detailed information, analyses, and climate adaptation tools and strategies to reduce uncertainty and inform climate-smart guidance and actions to protect Northeast fish and wildlife and their habitats, including RSGCN.

The NEFWDTC and SWAP Synthesis identified Climate Change as a top regional threat in the 2005 and 2015 SWAPs. To address this threat, NEAFWA's RCN and key partner programs prioritized and funded multiple projects designed to provide information, management guidance for climate- smart actions to address impacts on RSGCN and their habitats in the region. Some of the key projects are listed below as resources. For a complete list of these projects, see Table 4.1.1 and *Appendix 4B*. For additional partner information, see *Chapter 7*; and to learn more about the threats themselves, see *Chapter 3*. More detailed information on RSGCN and habitats can be found in *Chapters 1* and *2* respectively. *Chapter 2* provides information on Northeast habitat status and condition as well as RSGCN supported by each and provides examples of management and conservation plans and efforts that address these threats in the region.

Appendix 4B provides a list of projects that have advanced the conservation of these regional species and habitats through the RCN, CSWG, SA programs from 2007- 2023. This Chapter provides a list (Table 4.1.1) and summaries for those projects implemented since the 2013 Synthesis, organized by the predominant information or tool and SWAP element they address. Key regional programs and resources developed by partners to inform and address regional climate adaptation strategies in the Northeast are presented below.

Regional Focal Areas for SGCN Based on Site Adaptive Capacity, Network Resilience and Connectivity (2007-11) (RCN). This project identified the most resilient examples of key geophysical settings (sand plains, granitic mountains, limestone valleys, etc.), in relation to SGCN, providing conservationists with a nuanced picture of the places where conservation is most likely to succeed under climate change. The central idea was that by mapping key geophysical settings and evaluating them for landscape characteristics that buffer against climate effects, it would be possible to

identify the most resilient examples of each setting. This approach was based on observations that: 1) species diversity is highly correlated with geophysical diversity; 2) that species take advantage of the micro-climates available in complex landscapes; and 3) if the area is permeable, species can move to adjust to climatic changes. Developing a quantitative estimate of site resilience was the essence of the project, and this was accomplished by measuring the landscape complexity and permeability every 30 square meters of the region, creating comprehensive wall-to-wall data on the physical components of resilience. This information was applied to known species sites and compared the scores between sites with a similar geophysical composition to identify the most resilient sites for each setting. Further analysis of broad east-west and north-south permeability gradients identified areas where ecological flows and species movements potentially become concentrated. These areas may need conservation attention to allow the biota to adjust to a changing climate.

Impact of Climate Change on SGCN (2009-13) (RCN). In a project extending from Maine to the Virginias, the Northeastern Association of Fish and Wildlife Agencies (NEAFWA), **Manomet Center for Conservation Sciences** (Manomet)[189], and the **National Wildlife Federation** (NWF)[190] collaborated with other major northeastern stakeholders, including federal agencies and nonprofit organizations, to protect fish and wildlife and their habitats from climate change. Specifically, Manomet, NWF, and NEAFWA embarked on a three-year effort to evaluate the vulnerabilities of the northeast's key habitats and species, and to help increase the capabilities of state fish and wildlife agencies to respond to these challenges. The overarching goal of the project is to provide vulnerability and adaptation information that will help the Northeastern states to plan their conservation of fish and wildlife under a changing climate. The objectives of the project were:

1. To quantify the vulnerabilities to climate change of fish and wildlife and their habitats across the region and thereby identify those habitats and species that are likely to be more or less vulnerable, and how these vulnerabilities vary spatially.
2. To project how these habitats and species will change their status and distributions under climate change.
3. To identify potential adaptation options (including the mitigation of non-climate stressors) that can be used to safeguard vulnerable habitats and species.
4. To identify monitoring strategies that will help track the onset of climate change and the success, or otherwise, of adaptation actions.
5. To work with states to increase their institutional knowledge and capabilities to respond to climate change through educational and planning workshops and other events.

Three final reports were provided (through additional funding from the North Atlantic LCC).

- Climate Change and Cold-Water Fish Habitat in the Northeast: A Vulnerability Assessment (Manomet and NWF 2013a).
- The Vulnerability of Fish and Wildlife Habitats in the Northeast to Climate Change (Manomet and NWF 2013b).
- The Vulnerability of Northeastern Fish and Wildlife Habitats to Sea Level Rise (NWF and Manomet 2014).

The NEAFWA Habitat Vulnerability Assessment Model has been used by at least half of the Northeast states to complete their respective vulnerability assessments. In addition, the model has been used as an important component of training courses in vulnerability assessment for Federal and NGO practitioners.

Northeast Climate Adaptation Science Center (NECASC). NE CASC has developed more than 150 science projects with partners since its inception in 2012. Many of these address key northeast wildlife and their habitats and are listed with links below and on the NECASC website[50] . These will all be included in the 2023 Climate Change Synthesis (Staudinger et al. 2023).

- **Science to Support Marsh Conservation and Management Decisions in the Northeastern United States.** A synthesis of scientific and socio-economic perspectives on changing coastal systems is urgently needed. This project will develop a region-wide strategic capacity to provide timely scientific information and support for decision-makers dealing with climate-induced changes in coastal resilience and vulnerability.
- **Putting the sampling design to work: Enhancing species monitoring programs in the face of climate change.** The goal of this project is to develop statistical methods to enhance the ability of monitoring programs to understand climate effects on fish and wildlife. Project results will augment monitoring programs that are collecting critical data used to directly inform regulatory and policy decisions.
- **Understanding the Future of Red-Backed Salamanders as an Indicator of Future Forest Health.** Climate change will have sweeping impacts across the Northeast, yet there are key gaps in our understanding about whether species will be able to adapt to this changing environment. Results from this project will illuminate local and region-wide changes in forest ecosystems.
- **Future aquatic invaders of the Northeast U.S.: how climate change, human vectors, and natural history could bring southern and western species north.** Currently, hundreds of invasive aquatic species occur in the southeast and the western U.S. and can potentially move into the Northeast region. This project will help guide future monitoring efforts and bring attention

to high-risk areas that could be invaded by southern and western invasive aquatic species**.**

- **Effects of Urban Coastal "Armoring" on Salt Marsh Sediment Supplies and Resilience to Climate Change.** Along exposed coasts, humans have built seawalls and other structures to protect homes and infrastructure from erosion. Reduced erosion caused by this “coastal armoring” may have made it harder for salt marshes to thrive along urbanizing, armored shorelines.
- **Climate-Adaptive Population Supplementation (CAPS) to Enhance Fishery and Forestry Outcomes.** It is critical that population supplementation programs choose species that will thrive under future climate conditions while still promoting and maintaining genetic diversity. Climate-Adaptive Population Supplementation (CAPS) seeks to boost the efficiency of these programs.
- **A regional synthesis of climate data to inform the 2025 State Wildlife Action Plans in the Northeast U.S.** This project addresses the direct needs of Northeast states by developing a regional synthesis across four key areas of climate science, focused on the unique threats to RSGCN. It summarizes current data and information on regional climate changes, species’ responses to climate change, climate vulnerabilities and risks, and scale-appropriate adaptation strategies and actions. Case studies of successful climate adaptation efforts and climate threat-to-action narratives provide illustrative examples of how climate change data has been integrated into decision-making processes. Lists of recent climate resources and partner projects will also be synthesized to help SWAP writing teams connect with existing regional efforts.
- **Refugia are Important but are they Connected? Mapping Well-Connected Climate Refugia for Species of Conservation Concern in the Northeastern U.S.** As the climate continues to change, vulnerable wildlife species will need management strategies to help them adapt to these changes. One specific management strategy is based on the idea that, in certain locations, climate conditions will allow native species to continue inhabiting those locations into the future. The main objective of this project was to provide maps of projected refugia networks at the end of the 21st century for each of 10 representative SGCN in the Northeastern U.S. A preliminary list of these species includes Canada Lynx, Saltmarsh Sparrow, Spotted Turtle, Wood Turtle, Bicknell’s Thrush, Moose, Prairie Warbler, Cerulean Warbler, Blackpoll Warbler, and Virginia Rail. The list was compiled with input from stakeholders in the region. This information will support efforts of the USFWS Northeast Region to assess habitat needs for several species under federal consideration for listing as well as other SGCN. Maps of refugia connectivity will also support the development of priorities for on-the-ground habitat management in the region.

- **Climate-Adaptive Population Supplementation.** Climate-Adaptive Population Supplementation (CAPS) is a framework for enhancing species by matching climate-associated traits of cultivated strains with present and future environmental conditions. A cross-taxa approach simultaneously conducts trait/environment classification, stocking/planting experimentation, and conceptual framework development for fish and tree species. The project identifies strain-specific climate-associated traits in one trout and one oak species; characterizes several Northeast environments that fit the spectrum of traits; stocks/plants tagged individuals from each strain across different environments; and tracks the productivity and fitness of each strain over time. For example, several brook trout strains can be stocked across three lakes with different oxythermal profiles while several red oak strains can be planted across habitats with varying rainfall or drought frequency.
- **Future aquatic invaders of the Northeast U.S.: how climate change, human vectors, and natural history could bring southern and western species north.** Currently, hundreds of invasive aquatic species occur in the Southeast and the Western U.S. and can potentially move into the Northeast region. This project will help guide future monitoring efforts and bring attention to high-risk areas that could be invaded by Southern and Western invasive aquatic species.

Climate Change Response Framework. Development of a Wildlife Adaptation Menu for Resource Managers. The Climate Change Response Framework[191] is an example of a collaborative, cross-boundary approach to creating tools, partnerships, and actions that support climate-informed conservation and land management. This effort focused on the needs of forest managers and forestry professionals, but there has been increasing demand for science and tools to address climate change adaptation in wildlife management--and in conservation, more broadly. Wildlife and resource managers need the best available science in a usable format with feasible options within the purview of an individual manager. A comprehensive overview of peer-reviewed studies summarizing wildlife-related management actions as they currently exist for climate change adaptation was followed by a "menu" of actions that are suitable for wildlife management in terrestrial ecosystems. This Wildlife Adaptation Menu was modeled on existing adaptation menus for Forestry, including Urban Forestry, and is designed to be used in conjunction with the Adaptation Workbook. In addition to a menu of adaption strategies and approaches, the scientists identified site-level tactics and developed case studies demonstrating the use and implementation of the menu. To ensure that the information and tools meet the needs of managers, the team integrated input from wildlife managers at every step of the process.

4th National Climate Assessment- Northeast Climate Toolkit[192]. The seasonality of the Northeast is central to the region's sense of place. Milder winters and earlier springs in the region are altering ecosystems and environments in ways that adversely impact tourism, farming, and forestry. The region's rural industries and livelihoods are at risk as less distinct seasons lead to further changes in forests, wildlife, snowpack, and streamflow. Climate change impacts in the Northeast—including extreme precipitation events, sea level rise, coastal and riverine flooding, and heat waves—will challenge its environmental, social, and economic systems, increasing the vulnerability of its residents, especially its most disadvantaged populations. Communities in the Northeast are proactively planning and implementing actions to reduce risks posed by climate change. Using decision support tools to develop and apply adaptation strategies informs both the value of adopting solutions and the remaining challenges. Adapted from the Fourth National Climate Assessment[193].

Climate Change in the Northeast U.S. Shelf Ecosystem (NOAA). Over the past several decades, the Northeast continental shelf has warmed faster than any other U.S. Ocean region. Part of NOAA's mission is to understand and predict the impacts of this ocean change on the ecosystem and its living marine resources. Climate-related changes such as warming oceans, rising seas, droughts, and ocean acidification are affecting the distribution and abundance of marine species in the Northeast U.S. continental shelf ecosystem. Understanding the impacts of climate change is necessary to reduce climate-related effects on living marine resources and the people and communities that depend on them[194]. The NOAA Fisheries Climate Science Strategy is part of a proactive approach to increasing the production, delivery, and use of climate-related information needed to fulfill NOAA Fisheries mandates[195]. The Strategy is designed to be customized and implemented through Regional Action Plans[196] that focus on building regional capacity, partners, products, and services. The Northeast Fisheries Science Center[197] has a variety of research and monitoring efforts that help researchers track, understand, and forecast climate-related impacts on resources and resource-dependent communities.

- New England/Mid-Atlantic;
- Northeast US Shelf Ecosystem[198];
- **Northeast Shelf: A Changing Ecosystem storymap[199];**
- Northeast Regional Action Plan[200].

Projected Impacts of Climate Change on Shelf Habitat: The majority of research on historical and projected climate change impacts to the Northeast U.S. continental shelf ecosystem has focused on species distributions. Most of these studies use the Northeast Fisheries Science Center's fall and spring bottom trawl survey data to build species distribution models (SDMs) for fish, sharks, and invertebrates. The SDMs are compared to observations, and then future shifts are projected using global climate models. Most of these studies have focused exclusively on species' thermal habitat (the preferred temperature range of a species) and on ocean temperature change using only fall/spring

fishery-independent data. New research explores other variables in addition to ocean temperature. Moreover, this new research (McHenry et al. 2019) also uses data collected by fishery observers to build SDMs throughout the entire year instead of just for the fall and spring. Results, which can be viewed as interactive graphics[201], suggest that SDMs based only on temperature can mask climate vulnerability for key commercial and recreational species such as Shortfin Squid, American Lobster, Atlantic Cod, Black Sea Bass, Striped Bass, Summer Flounder, and Winter Flounder.

Enhanced warming is accompanied by an increase in salinity due to a change in water mass distribution related to a retreat of the Labrador Current and a northerly shift of the Gulf Stream. A robust relationship between a weakening Atlantic Meridional Overturning Circulation and an increase in the proportion of Warm-Temperate Slope Water entering the Northwest Atlantic Shelf indicate that prior climate change projections for the Northwest Atlantic Shelf may be far too conservative and underestimate the amount of warming expected in the Northeast U.S. continental shelf ecosystem. Example projects include:

- New England's Groundfish in a Changing Climate[202]
- The Effect of Ocean Warming on Black Sea Bass (Slesinger et al. 2019)
- Atlantic Salmon Climate Scenario Plan (Borggaard et al. 2020)
- North Atlantic Right Whale Scenario Plan (Borggaard et al 2019)
- Impacts of Ocean Warming on Predator–Prey Interactions (Selden et al. 2017)
- Rebuilding Fisheries in the Face of Climate Change (Bell et al. 2018)

Designing Sustainable Landscapes and Nature's Network. Designing Sustainable Landscapes (DSL)[71] is a landscape conservation project applied to 13 states in the Northeastern United States. The purpose is to provide guidance for strategic habitat conservation by assessing ecological integrity and landscape capability for a suite of focal species across the landscape. Assessments are done for both the current landscape and potential future landscapes, as modified by models of urban growth, climate change, and sea level rise. The DSL project provides much of the basis of the conservation planning tools Nature's Network[72] and Connect the Connecticut[79].

Northeast USDA Climate Hub[203]. The effects of agricultural irrigation and runoff on coastal habitats are of concern to many states in the Northeast region. The Northeast USDA Climate Hub will help foster federal-state partnerships that address agricultural runoff into streams and river systems. See especially the Northeast CASC projects focusing on headwaters-to-coastal-scale conservation and management solutions aimed at reducing runoff from upstream land uses, including agriculture.

Massachusetts Fish and Wildlife Climate Action Tool.[84] The Massachusetts Wildlife Climate Action Tool is designed to inform and inspire local action to protect the

Commonwealth's natural resources in a changing climate. This Tool focuses on providing information for a range of local decision-makers, including conservation practitioners and landowners. For an example of new approaches to addressing non-native and invasive species in light of current and anticipated climate change, see the Tool website[204] and the Regional Invasive Species and Climate Change Management Network[205].

4.7 COORDINATE ACROSS STATE BOUNDARIES TO MAXIMIZE EFFICIENCY AND EFFECTIVENESS OF FISH AND WILDLIFE DIVERSITY CONSERVATION IN THE NORTHEAST

4.7.1 REGIONAL NEED AND PRIORITY ACTIONS

Regional Need: Conservation efforts for RSGCN must continue to include collaborative, cooperative landscape and watershed scale approaches, as species distributions and movements are not restricted by state boundaries. At the same time, constraints posed by limitations of funding and capacity make such collaborative efforts challenging. NEAFWA's technical committees are charged with developing and implementing regional projects that identify and address the top conservation targets and threats in the Northeast. Many of the needed actions are not under the authority or purview of state fish and wildlife agencies, so coordination and effective communication between the agencies impacting or regulating those impacts is essential. Clear, consistent, inclusive messaging and communication are needed to inform and engage broader participation across the region.

Priority Actions: Continue to collaborate and coordinate across state boundaries for effective landscape and watershed scale conservation of these regional priority species and habitats. Build state capacity and funding to more fully conserve, restore, and protect the SGCN, RSGCN, and their key habitats as identified in the 14 Northeast SWAPs. Develop improved, inclusive communication approaches for outreach, education, and technical assistance to target audiences including policy and land use decision makers, land managers, stakeholders, and the broader public to inform and engage them in addressing the top threat impacts to SGCN and key habitats. Coordinate with agencies and entities that regulate key impacts to fish and wildlife to develop and implement effective, consistent policies and approaches across Northeast lands and waters.

See Priority Species in Chapter 1, Priority Habitats in Chapter 2, Priority Threats in Chapter 3, each with partner and program opportunities and examples. See Table 4.1.1 and Appendix 4A for priority projects completed and Appendix 4B, the SWAP Synthesis, and individual SWAPs for additional priority Conservation Actions that all reflect decades of regional collaboration and coordination at the landscape and watershed scale.

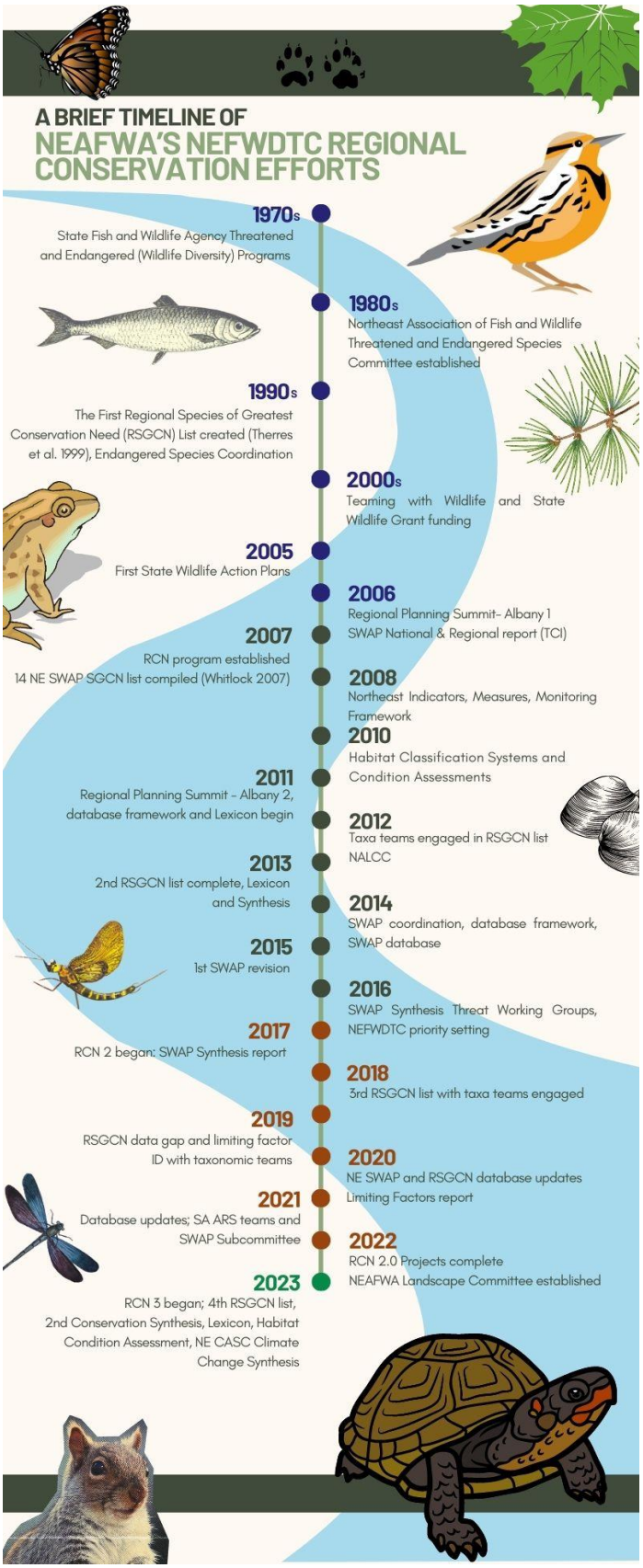


Figure 4.7.1 Timeline of the Northeast 14 state Fish and Wildlife Diversity Conservation Program Collaboration.

4.7.2 APPROACH

For more than four decades, the 14 states in NEAFWA's NEFWDTC have collaborated to identify priorities and conserve regional fish and wildlife diversity across state boundaries. Since the 1980s they have worked together to identify species conservation priorities and support coordinated actions[1] that address regional resource concerns (NEFWDTC 2017). In 2001, the State & Tribal Wildlife Grants program was created to support development of comprehensive wildlife conservation strategies, now called State Wildlife Action Plans. The first-generation plans were completed in 2005, marking an historic milestone for state-based fish and wildlife conservation (Meretsky et al. 2012). This work advanced the creation of the RCN program, which in turn led to more than 150 jointly funded research projects summarized in the 2013 Northeast Regional Synthesis for State Wildlife Action Plans (TCI and NEFWDTC 2013) and updated in this 2023 Synthesis.

The NEFWDTC undertook an unprecedented compilation of all 14 State Wildlife Action Plans (SWAPs) in the Northeast Region. This collaboration led to a coordinated revision of the 2015 SWAPs, with all

the Northeast states utilizing a common framework, guidance, and terminology from the Northeast Lexicon. This enabled compilation of information on RSGCN, their habitats, and the threats they face. The goal was to find common threats to SGCN and their habitats, determine common conservation priorities, and identify actions that could be implemented through regional collaboration and coordination. This allowed for the compilation, analysis, and development of a Regional SWAP Synthesis (TCI and NEFWDTC 2017) that summarized the threats to SGCN and their habitats as well as regional conservation priority actions with recommendations for collaborative steps. The resulting regional priorities summarized in the 2017 SWAP Synthesis were further prioritized and refined by NEFWDTC's taxonomic teams and Regional Threat Working Groups to identify top threats and actions to address them. This Synthesis presents those top regional priorities and actions developed collaboratively by the NEFWDTC in 2017.
In 2018, AFWA adopted a landscape conservation resolution.

In 2020, the **AFWA President's Task Force on Shared Science and Landscape Conservation Priorities** recommended convening a new working group to develop recommendations on how SWAPs could become even more effective at improving range-wide conservation of SGCN by leading or contributing to national and/or regional landscape conservation priorities. The AFWA SWAP and Landscape Conservation Working Group subsequently prepared the *Leading At-risk Fish and Wildlife Conservation: A Framework to Enhance Landscape-Scale and Cross-Boundary Conservation through Coordinated State Wildlife Action Plans* report in 2021 (AFWA 2021). This report summarizes five Guiding Principles:

1. Identify and apply regional and shared approaches for development, implementation and measuring progress of SWAPs, to improve effectiveness, efficiency, cost-savings, and consistency.
2. Increase consistency and alignment of SWAPs across jurisdictions so conservation can more readily be implemented at biologically relevant scales.
3. Provide support and incentives to leverage and build capacity for cross-jurisdictional and landscape conservation.
4. Ensure SWAPs are developed and implemented collaboratively and in partnership with a diverse set of partners.
5. Make SWAPs more accessible, understandable, and relevant to broad constituencies.

Each of these Guiding Principles has specific Recommended Actions, associated outcomes, and a recommended implementation framework. Kanter and Newsome (2022) provide a summary of regional and interregional approaches and efforts to implement these principles.

A NEAFWA Landscape Committee was established in 2022 to guide the implementation of this report in the Northeast. The NEFWDTC and its SWAP coordinators subcommittee contribute to this effort on a monthly basis as they work together to identify and prioritize projects that facilitate even more robust and strategic collaboration while the 2025 SWAP revisions are being developed. A draft of this synthesis was shared with this new committee as they began their work to document how these principles are being addressed in the Northeast.

Each of the Chapters of this Regional Conservation Synthesis addresses multiple Recommended Actions, implementing the first four of the five Guiding Principles. This Regional Conservation Synthesis implements at least 11 of the AFWA Recommended Actions:

- **1.1** Using clear and consistent criteria, identify priority species, habitats, landscapes, threats, and conservation actions for regional conservation.
- **1.2** Develop and use a common lexicon and classification system for species, habitats, threats, and conservation actions.
- **1.3** Develop and refine best practices for habitat and population restoration and management.
- **1.4** Promote the development of shared science, data, research, and monitoring protocols.
- **2.1** Incorporate regional priorities and approaches into SWAP development and implementation.
- **2.2** Work at landscape and regional scales to address key threats such as climate change, habitat loss/fragmentation, and invasive species.
- **2.3** Promote the use of adaptive management, best available science, and shared learning so the plans keep pace with changing conditions and innovations.
- **3.1** Provide funding and support for regional tool development, shared science, and landscape conservation projects.
- **3.3** Explore options for sharing resources, leveraging partnership contributions, and engaging non-traditional partners as well as options to lower grant match requirements and develop other incentives to encourage regional collaboration.
- **4.1** Increase collaboration and involvement of local, regional, and national partners in the development and implementation of SWAPs, including cross-jurisdictional efforts.
- **4.4** Incorporate scalable goals/strategies and priority landscapes from other planning efforts into SWAPs (i.e., State Forest Action Plans, State Comprehensive Outdoor Recreation Plans, National Fish Habitat Plan, North American Waterfowl Management Plan, TNC Ecoregional Plans, etc.).

Several recent grant projects were prioritized and funded to accomplish this in 2022-2023. The **Updating Three Foundational Tools for the 2025 State Wildlife**

Action Plan Revisions project added the development and production of the 2022 Northeast Lexicon (Crisfield and NEFWDTC 2022); the 2023 Northeast Conservation Synthesis (TCI and NEFWDTC 2023); and the 2023 Northeast Conservation Status Assessment (Anderson et al. 2023a). NEFWDTC's SWAP subcommittee also secured WSFR CSWG funding to upgrade and **Modernize the Northeast SWAP Database**. These projects facilitate coordination, providing the 14 Northeast SWAPs with a common terminology, data framework, and a portal to enter and analyze consistent SWAP data. Significant progress enhancing SWAP coordination for the 2025 revisions continues through the NEFWDTC and its SWAP Subcommittee.

This Northeast legacy of collaboration continues through monthly coordination between the 14 states and annually through the RSGCN and RCN prioritization and planning processes. This shapes the NEFWDTC's ability to respond to its regional charges through its technical services and RCN projects that focus action on the highest priority land, water, and seascapes in the Northeast. RCN and key partner projects (Table 4.1.1 and *Appendix 4A*) enable the states to collaboratively address these emerging and current priorities through mutual investment and consistent, more effective regional implementation. This high level of commitment and coordination has enabled the Northeast states to emerge as national leaders in regional landscape and watershed conservation. As a result, agencies and organizations incorporating this information at all scales have greatly advanced the effectiveness of Northeast fish and wildlife diversity conservation.

Consistent Regional Incentives, Laws, and Policies

Among the most important monitoring and evaluation actions identified in the SWAP Synthesis are efforts to review and evaluate the various approaches, incentives, laws, and policies that address the top regional threats, priority species, and habitats, thus ensuring currency and conservation effectiveness both state and regionwide. This includes environmental review and permitting processes that should more fully incorporate the monitoring needs of SGCN/RSGCN and key habitats, especially in the context of climate change. State Threatened and Endangered Species laws and policies differ significantly, yet there is a need for regional consistency. More coordination and consistency are needed between regulatory and other agencies and stakeholders to provide a more holistic approach to conserving priority state and regional species and habitats.

Encouraging consistent policies and approaches to RSGCN protection

The increased threat of take and collection of reptiles and amphibians has met with increased protection efforts. NEPARC and PARC developed important new outreach and education resources (www.northeastturtles.org). The USFWS CSWG project "Addressing Population Declines Due to Loss of Adult and Juvenile Turtles to Illegal

Wildlife Trade" along with SA ARS and state efforts provided additional capacity for strategic protection through targeted law enforcement and repatriation of confiscated animals. At the same time, states responded with stronger policies, regulations, and outreach for protection of reptiles and amphibians. An example of this is the coordination WV DNR provided during the effort to update its reptile and amphibian regulations (WV DNR 2021). They consulted and collaborated with NEPARC and other Northeast states and developed new regulations that better addressed the emerging threats to these taxa from collection, disease, and climate change. The regulations (Figure 4.7.1) were shared with all NEAFWA states and are used a model for the Northeast region.

Figure 4.7.1 West Virginia's reptile and amphibian regulations shared for consistency across the Northeast region.

Consistency in Threatened and Endangered Species Laws and Regulations

Since the 1980s, the 14 NEAFWA Fish and Wildlife Jurisdictions have collaborated to share information affecting their laws and regulations on fish and wildlife diversity. Most recently, in 2015 and again in 2020, the NEFWDTC collaborated to share information on Northeast state approaches and regulations on Threatened and Endangered species in the Northeast states. Results of these continuing efforts help inform all states and provide a foundation for consistency, coordination, and information sharing between states in the region. This promotes and helps facilitate use of best available scientific information. It also encourages support for the development of the most effective regulatory approaches for the region.

Consistency in approaches and management of invasive species

One of the primary tools states can use to reduce the number of invasive plants introduced as ornamentals is the development and use of incentives and "green light" alternatives. Encouraging the use of native species by local nurseries and seed banks provides industry incentives. Important incentives, outreach and messaging should include the use of native seed banks and "green lists" of native species alternatives. Dumroese (2009) provides a manual of native plants to the nurseries.

Another tool that states can use to reduce the introduction of invasive plants as ornamentals is the control or regulation of species as noxious weeds. There are opportunities for improved coordination and consistency of invasive plant regulation across state borders (Lakoba et al. 2020, Beaury et al. 2021b). For the lower 48 states, Beaury et al. (2021b) found only a 17% overlap in regulated plants between adjacent states. Focusing on six Northeastern states (CT, MA, ME, NH, NY, and VT), Bradley et al. (2022b) showed that these inconsistencies are largely due to the pool of species evaluated by each state rather than the different outcomes of state risk assessment protocols. Regulatory inconsistencies across state borders are often due to lack of state capacity to evaluate and recommend invasive plants for regulation. In order to increase consistency, Northeast states could evaluate risk from plants already regulated by adjacent states. A taxonomically standardized list of regulated plants as of April 2021 is available as supplementary material in Beaury et al. (2021b), and updated lists are posted online through the National Plant Board[206]. Increasing coordination and sharing of risk assessment resources across state borders could improve consistency and reduce the sale of known invasive plants (Bradley et al. 2022a, 2022b).

RSGCN Coordination within and between Regions

The Northeast continues to lead the RSGCN effort nationally with this 4th RSGCN list update to inform 2025 SWAP revisions. This effort allows the 14 states to prioritize and focus their efforts together at a landscape or watershed scale where many of these conservation issues are most effectively addressed. This approach also enables each state to see the important role it plays in the overall conservation effort. Similarly, when expanded to the species entire range, this concept provides the opportunity for interregional coordination. Table 4.7.1 shows the number of shared RSGCN/Proposed RSGCN between AFWA regions; and these overlaps represent opportunities for additional coordination. Just as the coordination of federally listed Threatened and Endangered species are afforded coordination through USFWS At-Risk and ESA recovery efforts, states and their partners can proactively work together to conserve these species across their ranges to preempt the need for federal listing. This is often most effectively accomplished at the multi-species landscape or watershed scale.

Table 4.7.1. Number of shared RSGCN/Proposed RSGCN between AFWA Regions.

AFWA Regions	Number of Shared RSGCN and Proposed RSGCN Species
NEAFWA and SEAFWA	120
NEAFWA and MLI / MAFWA	64
NEAFWA, SEAFWA, and MLI / MAFWA	30

The advancements in the RSGCN method now offer NEAFWA additional opportunities for coordination with other regions. The Watchlist Deferral category provides not only an effective way to address "peripheral species" at the state and regional level; it also provides opportunities to coordinate conservation of those species with neighboring regions for more holistic management across their range. Table 4.7.2 shows the number of Watchlist Deferral Species from the 2023 Northeast RSGCN update, indicating significant opportunities for collaboration and coordination for these species as each region continues to fulfill its role in the overall conservation of each species.

Figure 4.7.2. Number of Watchlist Species Deferral to other AFWA regions identified in the RSGCN list update.

Watchlist [Deferral] Region	Number of Species
SEAFWA	56
MAFWA / MLI	18
SEAFWA and MAFWA	15
Canada	2
Canada and WAFWA	3
MAFWA and WAFWA	1
Total	**95**

The Northeast deferred 56 species to the Southeast as a reflection of the fact that those species have more secure populations centered the Southeast while the mid-Atlantic states (VA and W VA watersheds, Appalachian Mountains, or Atlantic coast) represent the northern extent of their range. Almost 20 species were deferred to the Midwest region (MAFWA) reflecting species whose populations primarily occur in the Midwest but overlap with NEAFWA in the Ohio River drainage, Great Lakes, or eastern Midwest landscapes. In all, almost 100 species provide opportunities for coordinated

interregional conservation that secures both the core and peripheral ranges of these species.

INCREASING FUNDING AND CAPACITY FOR RSGCN CONSERVATION

In the Northeast, both funding and staffing capacity are insufficient to effectively address the 418 RSGCN and proposed RSGCN, and 388 additional Watchlist and proposed Watchlist species currently under the jurisdiction of state fish and wildlife agencies in the Northeast. The NEAFWA NEFWDTC and their partners prioritized the need for additional support, funding, and capacity in state wildlife agencies to strengthen wildlife diversity conservation and education. They also prioritized efforts to create broader awareness of and support for state wildlife diversity conservation programs, including the SWAPs.

Adequate funding and staff capacity are both sorely lacking to effectively conserve the almost 4800 SGCN and their habitats listed in the 14 Northeast SWAPs and the thousands of additional species that were not able to be addressed in this RSGCN process due to lack of information and expertise across the region. Key conservation groups have joined the Alliance for America's Fish and Wildlife to fill the need for additional funding to strategically address priority SGCN and RSGCN conservation. In 2001, a partnership with the Teaming with Wildlife Coalition resulted in core fish and wildlife diversity funding through State Wildlife Grants. Two decades later, more adequate levels of funding and capacity are still needed. The Alliance for America's Fish & Wildlife's created a 21st century funding model to secure additional funding for much needed conservation[207].

The Wildlife Society[208] stated that the Recovering America's Wildlife Act (H.R. 2773; S. 2372) would bring much-needed resources to wildlife professionals tasked with conserving the diversity of America's native species. These resources were intended to fund multi-stakeholder efforts to conserve and monitor at-risk species, with the goal of reversing population declines. Since 2000, state and tribal wildlife agencies relied on a much smaller funding stream, the **State[209] and Tribal Wildlife Grant[210]** programs. This program depends on annual congressional appropriations which fluctuate and are not guaranteed. This limits state agencies from implementing the many SGCN projects identified in their SWAP conservation action blueprints by their many taxonomic experts and partners.

The National Wildlife Federation describes "America's Wildlife Crisis" with a stark statistic: one-third of America's wildlife species are at elevated risk of extinction (Stein et al. 2018). More than 1,600 U.S. species are already listed under the federal Endangered Species Act; more than 150 U.S. species are already extinct; and

nearly 500 additional species have not been seen in decades[211]. This loss will have a negative impact on the quality of *human* life and harm local and regional economies. National Wildlife Federation[216] also notes that birds, bats, and butterflies create hundreds of billions of dollars in benefits to farmers by eating pests and pollinating plants, but all are currently experiencing stress and/or steep population declines. Outdoor recreation adds nearly $900 billion to the economy each year and much of this depends on healthy wildlife populations and habitats.

Responsive legislation and funding (e.g., proposed by the Recovering America's Wildlife Act) would allow the states, territories, and Tribes to invest $1.4 billion annually in proactive, on-the-ground, collaborative efforts to help species at risk by restoring habitat, controlling invasive species, reconnecting migration routes, addressing emerging diseases, and more. In the Northeast, the priority conservation targets, habitats and threats have already been identified, allowing this funding to be focused where it is most needed. The State Wildlife Grants Program is the main source of federal funding for implementing these plans. It currently provides around $65 million a year, split between all the states and territories. More than two decades of surveys and studies have shown that this is less than five percent of what would be needed to implement all recommendations contained in the SWAPS.

Additional coordination and capacity are needed to implement RCN and Competitive State Wildlife Grant-funded conservation projects seeking to develop conservation strategies for RSGCN across the Northeast. The list of projects in *Appendix 4A* underscores the impact of regional collaboration and funding across the region. There is a continuing need to develop and improve coordinated conservation incentives, laws, policies, and decisions regionwide. These in turn can assist the 14 jurisdictions, both in delivering consistent and effective actions that address the top regional threats listed in chapter 3, and in implementing the priority actions presented in this chapter. However, this cannot be accomplished without additional funding and capacity in the region and beyond.

IMPROVING INCLUSIVITY, RELEVANCE, COMMUNICATION AND OUTREACH

Effective regional conservation will depend on providing clear and consistent information about state and regional conservation targets, specifically: SGCN and Conservation Opportunity Areas in SWAPs and RSGCN and Regional Conservation Opportunity Areas/ habitats. When engaging partners, stakeholders, and the public, it is important to clearly state how top threats in the Northeast region impair RSGCN and then to show how conservation actions can address those impacts. It is also important to reach out to and engage broader audiences, helping them to better understand the needs

and priorities of wildlife conservation, their urgency, and how to participate. This will require regionally consistent messaging of SWAP priorities and conservation needs as well as improved communication approaches targeting broader and more diverse audiences more effectively.

Consistent outreach information and messaging encourages the inclusion of RSGCN in Northeast agency and partner programs. NEAFWA's Northeast Conservation Information & Education Association could be engaged to assist; and the same is true of other social scientists and communication specialists. Creating new and more effective communication tools depends in part on capacity and funding. Targeted action items and messages could be developed for each internal and external partner on why and how to conserve RSGCN. As BMPs and protocols for the priority taxa presented in this synthesis are developed, they should continue to be promoted and distributed regionally. Improved social media and web presence are needed for achieving broader, more effective outreach.

Additional information and tools are available to help guide and support these outreach efforts. AFWA and its partners developed the **Relevancy Roadmap**[212] as a practical guide for use by state and provincial fish and wildlife conservation agencies, helping overcome barriers to public awareness, engagement, and support. The roadmap provides multiple pathways for navigating the diverse social, economic, demographic, political and environmental changes that states and provinces face (AFWA 2016, 2018, AFWA and MLI 2019, AFWA 2021). Several key resources are listed below, and please see Chapter 8 for additional, more detailed information:

Relevancy Roadmap Resources

- **Fish and Wildlife Relevancy Roadmap-Final Report** (December 2019)
- AFWA Fish and Wildlife Relevancy Resolution (Adopted September 2019)
- Fish and Wildlife Relevancy Roadmap Fact Sheet (January 2020)
- Presentation on Fish and Wildlife Relevancy Roadmap (January 2020)

Key Resources on Fish and Wildlife Relevancy

- State Fish and Wildlife Agency Transformation: An annotated bibliography (July 2018)
- Governance Principles for Wildlife Conservation in the 21st Century
- America's Wildlife Values: The Social Context of Wildlife Management in the U.S.
- Nature of Americans Study

Among the Northeast states, Virginia and Connecticut are working with the Wildlife Management Institute (WMI) and other partners, seeking to engage broader constituencies and increase understanding of the need for wildlife and habitat

protection/restoration. The Association of Fish and Wildlife Agencies' Blue-Ribbon Panel[213] on the future of fish and wildlife conservation recommended that state agencies focus on public outreach and education as a way to broaden political and financial support. In response, WMI and AFWA coordinated development of strategies and tactics designed to overcome barriers to engaging broader constituencies. These strategies and tactics were incorporated into the Fish and Wildlife Relevancy Roadmap (AFWA and WMI 2019). WMI then began working with six "pilot" states under a 2020 Multi-State Conservation Grant (MSCG)[214] to implement the roadmap and launch a new Conservation Relevancy Community of Practice website[215].

Virginia's Department of Wildlife Resources' 2022-2025 Inclusive Excellence Strategic Plan, developed from staff throughout the agency via its Inclusive Excellence Council, outlines goals and initiatives to build a workforce that will deliver on its mission to "CONSERVE. CONNECT. PROTECT." Implementing the Inclusive Excellence Strategic Plan will increase DWR's capabilities; promote diversity, equity, and inclusion among the agency's staff; make the outdoors available, accessible, and safe for all Virginians; and help ensure that wildlife and outdoor recreation are enjoyed and supported by generations to come (VA DWR 2022).

4.7.3 REGIONAL EXAMPLES AND OPPORTUNITIES

See *Chapter 7* for additional information on partners and programs. Each Chapter of this synthesis provides information and examples for the specific SWAP Element it addresses (Species- *Chapter 1*, habitats- *Chapter 2*, threats- *Chapter 3*, actions- *Chapter 4*, monitoring- *Chapter 5*, and partner/public participation-*Chapters 7 and 8*). Conservation groups and individuals at the national, regional, state, and local levels joined the **Alliance for America's Fish and Wildlife** in seeking additional funding and capacity to strategically address priority SGCN/RSGCN conservation. This was successfully done for SWG funding in 2001 with the Teaming for Wildlife Coalition. Two decades later, additional funding and capacity are still needed. The Alliance for America's Fish & Wildlife's purpose is to create a 21st century funding model for much needed conservation of our most precious natural resources, our fish and wildlife[237].

Although the RAWA effort was not successful in 2022, there is a growing need that must be addressed if fish and wildlife diversity is to be conserved at any scale. To inform this effort, state fish and wildlife agencies are assessing and evaluating their effectiveness and relevancy in performing their public trust responsibility for wildlife conservation (AFWA 2016, 2018, AFWA and WMI 2019). Significant work has been conducted through a social science lens to better inform and equip agencies to be more effective in addressing their constituencies. Key projects and programs are described below, and Chapter 8 provides more detailed information on the effort to better align agency programs with America's Values and the needs of fish and wildlife.

The Association of Fish and Wildlife Agencies (AFWA) has provided guidance through Best Practices for SWAPS and on the participation of the public and their partners in the work of wildlife conservation (Elements 7 and 8) (AFWA 2012). AFWA (2016) also coordinated the "Future of America's Fish and Wildlife: A 21st Century Vision for Investing in and Connecting People to Nature," resulting in a Report and Recommendations from the Blue-Ribbon Panel on Sustaining America's Diverse Fish and Wildlife Resources. In 2018, AFWA produced an Annotated Bibliography (State Fish and Wildlife Agency Transformation) through the efforts of a Blue-Ribbon Panel Relevancy Working Group (AFWA 2018). In 2019, AFWA and the Wildlife Management Institute developed the Fish and Wildlife Relevancy Roadmap as guidance to "Enhance Conservation Through Broader Engagement" (AFWA and WMI 2019).

The Nature of Americans: Disconnection and Recommendations for Reconnection (Kellert et al. 2017) indicates that the relationship of Americans to nature and the natural world is changing. Adults and children alike spend evermore time indoors. Participation in activities like hunting and fishing is stagnant or declining and shifts in social expectations treat engagement with nature as an amenity. These trends pose a nationwide problem, since overwhelming evidence shows the physical, psychological, and social wellbeing of humans depends on contact with nature. To monitor these trends and to understand how to restore this relationship, social scientists conducted an unprecedented study of 11, 817 adults and children across the United States in 2015–16. This study was conducted as part of a national initiative called The Nature of Americans, which seeks to understand and connect (or reconnect) Americans and nature. Three different methods were used in this study. The first method involved 15 focus groups with 119 adults conducted in major cities of the five most populous US states. The second method featured personal interviews with 771 children, 8–12 years old, along with an online survey of one parent of each of the participating children. The third method was a nationwide online survey of 5, 550 adults, measuring their feelings toward nature, activities in nature, how they perceived benefits of nature, and the barriers and incentives to connect with nature. Oversamples of African Americans, Hispanics, and Asians provide a closer look at these important groups. The report offers 22 actionable recommendations.

Providing further guidance on collaborative conservation, AFWA (2021) also developed guidelines and recommendations for a "Framework to Enhance Landscape-Scale and Cross-Boundary Conservation through Coordinated State Wildlife Action Plans". This report from the AFWA State Wildlife Action Plan and Landscape Conservation Work Group to the AFWA Wildlife Diversity Conservation and Funding Committee set forth principles for conservation collaboration (see *Chapters 7* and *8* for more details).

Draft Summary Recommended Actions (April 2022) from the Future of Conservation Forum. In January 2022, the Future of Conservation Forum brought together more than 200 professionals to discuss and begin to prioritize the actions needed to ensure a durable future for conservation. Participants included representatives from federal, provincial, and state governments, Indigenous groups, NGOs, philanthropic organizations, businesses, landowners, and others, working together to identify cross-cutting themes with actions in a "living document". These themes and recommendations address the concepts of inclusivity and relevancy (AFWA and WMI 2019:

1. build trust to strengthen collaboration and achieve greater impact.
2. inventory approaches to landscape conservation and collaboration.
3. establish support for critical functions.
4. advance a framework that increases equity and inclusion.
5. secure new funding and develop a comprehensive funding approach.

Collaborative Conservation with Tribes in Virginia[216]. The Wildlife Management Institute (WMI), in partnership with the Metropolitan Group (MG) and the Virginia Department of Wildlife Resources (VA DWR) recently completed a 20-month effort to implement several recommendations presented in the Fish and Wildlife Relevancy Roadmap[242]. Information on WMI website describes the project, which was funded through a 2021 AFWA Multi-state Conservation Grant, and the journey undertaken by the VA DWR with Outdoor Afro, the Upper Mattaponi Indian Tribe, and the Rappahannock Tribe.

4.8 DEVELOP AND IMPLEMENT EFFECTIVE REGIONAL-SCALE MONITORING TO INFORM ADAPATIVE MANAGEMENT OF REGIONAL CONSERVATION PRIORITIES IN THE NORTHEAST

4.8.1 REGIONAL NEED AND PRIORITY ACTIONS

Regional Need: The 14 Northeast 2005 and 2015 SWAPS, the 2017 SWAP Synthesis, and the 2023 RSGCN process identified monitoring as a key need for effective fish and wildlife diversity conservation in the Northeast**.** Substantial efforts and investments have been made to conserve RSGCNs and key habitats across the Northeast region. A coordinated monitoring approach and consistent methodologies are also necessary to determine the effectiveness of these conservation efforts and inform adaptive management at the regional scale.

Priority Actions: Review and evaluate priorities, data and tools and their implementation. Review regional targets, indicators, incentives, laws, programs, and policies to ensure current relevance and conservation effectiveness. Develop and improve regional monitoring efforts to evaluate effectiveness and inform adaptive management at multiple scales. Work with agencies and entities that regulate impacts to fish and wildlife habitats to develop and implement effective, consistent monitoring policies and approaches across Northeast lands and waters.

See Priority Species in Chapter 1, Priority Habitats in Chapter 2, Priority Threats in Chapter 3, each with partner and program opportunities and examples. See Table 4.1.1 and Appendix 4A for priority projects completed and Appendix 4B, the SWAP Synthesis, and individual SWAPs for additional priority Conservation Actions that all reflect decades of regional collaboration and coordination to develop and improve monitoring at the landscape and watershed scale.

4.8.2 APPROACH

NEAFWA member states have long recognized the value of regional-scale monitoring. The importance of these regional efforts to improving the consistency and effectiveness of monitoring is reflected in the SWAPs and SWAP Synthesis. This section presents a chronology of Northeast Fish and Wildlife Diversity Technical Committee (NEFWDTC) efforts to support Northeast SWAPs by addressing regional monitoring needs in a coordinated, strategic way.

Ideally, the needs, actions, and projects presented in this and other chapters and appendices should all be monitored at the local, state, and regional levels to document their effectiveness. Unfortunately, monitoring has historically been one of the lowest funding priorities in conservation. On a practical level, priority key indicators and projects can be identified that address the needs of most RSGCN species and their habitats faced with the highest degree of threat. Using this approach, a Northeast Monitoring Framework was developed in 2008 through the RCN program. It identified eight key indicators (NEAFWA 2008). This RCN and Duke Foundation-funded project **"Monitoring the Conservation of Fish and Wildlife in the Northeast: A Report on the Monitoring and Performance Reporting Framework for the Northeast Association of Fish and Wildlife Agencies"** produced a regional monitoring framework report on the status of SGCN and their habitats while also evaluating the effectiveness of conservation projects implemented as part of SWAPs and the State Wildlife Grants program (NEAFWA 2008). The monitoring framework includes eight conservation targets (see Section 5.2.1 for more detailed information):

1. Forests
2. Freshwater streams and river systems
3. Freshwater wetlands
4. Highly migratory species
5. Lakes and ponds
6. Managed grasslands and shrublands
7. Regionally significant SGCN
8. Unique habitats in the Northeast

The report noted that additional work was needed to include coastal and marine systems. Specific indicators and stressors are identified for monitoring to assess each of the eight conservation targets, except for the managed grasslands and shrublands target where information was lacking (see Table 4.8.1 for an example of indicators).

Table 4.8.1 Northeast Regional Monitoring Performance Reporting target indicators for selected conservation target habitats.

Conservation Target	Example Indicators
Freshwater Wetlands	1. Extent of freshwater wetlands
	2. Percent impervious surface flow
	3. Buffer area and condition (buffer index)
	4a. Hydrology upstream surface water retention
	4b. Hydrology high and low stream
	5. Wetland bird population trends
	6. Road density
Highly Migratory Species	1. Migratory raptor population index
	2. Shorebird abundance
	3. Bat population trends
	4. Abundance of diadromous fish
	5. Presence of monarch butterfly

A few years later, the RCN program awarded funds to The Nature Conservancy (TNC) to assess these eight conservation targets as part of the **Conservation Status of Fish, Wildlife, and Natural Habitats in the Northeast Landscape: Implementation of the Northeast Monitoring Framework** (Anderson and Olivero Sheldon 2011). These metrics were identified as critical indicators for Northeast land and waterscapes in the NEAFWA region and were addressed in subsequent RCN projects. The **Condition of the Northeast Terrestrial and Aquatic Habitats: A Geospatial Analysis and Tool Kit** contains an analysis of 116 habitats in relation to 14 regionally assessed condition metrics (Anderson et al. 2013a). Additional RCN projects funded these important regional efforts to monitor the key indicators identified for Northeast habitats, resulting in reports, databases, and geospatial tools (Anderson et al. 2013b,

Anderson et al. 2016a, 2016b, Olivero and Anderson 2008, Olivero Sheldon et al 2015, Olivero Sheldon and Anderson 2016).

Another recent RCN-supported project allowed The Nature Conservancy to update this condition assessment with new information and analysis tools. Trend information reflecting a decade of critical data on several key Northeast habitats and several RSGCN taxa are now available through the updated **Northeast Habitat Condition Assessment** (Anderson et al. 2023a). Chapter 2 of this Regional Conservation Synthesis supplements the 2023 condition assessment of Anderson et al. (2023a) by addressing the information need to assess the status and condition of the region's coastal and marine systems that are not currently included in the monitoring framework.

In 2012 the Association of Fish and Wildlife Agencies (AFWA) released national guidance for SWAPs under the title: **Best Practices for State Wildlife Action Plans – Voluntary Guidance to States for Revision and Implementation,** (AFWA 2012). The AFWA Best Practices defines monitoring under Element 5 "as the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective" (AFWA 2012). Figure 4.8.1 provides an example of the three levels of monitoring from the AFWA Best Practices (2012).

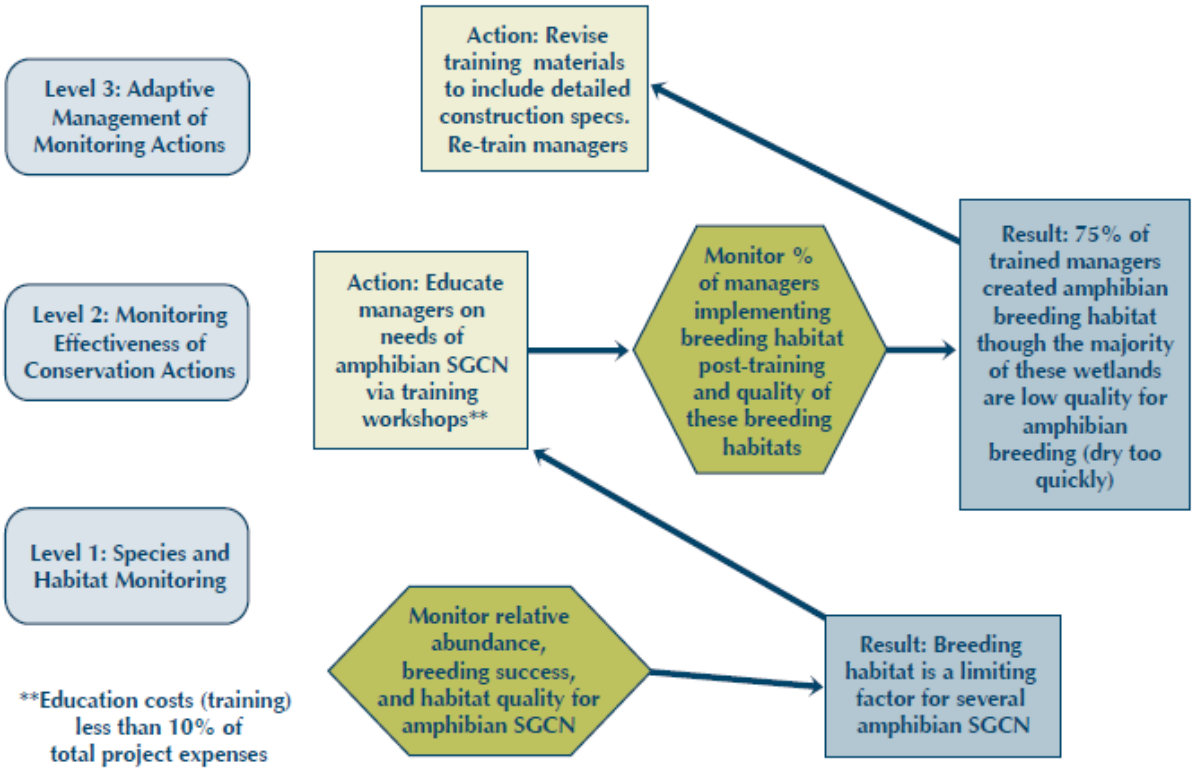


Figure 4.8.1. Example from AFWA Best Practices (2012) of the three levels of monitoring required by Congress in Element 5 of the Eight Required Elements for SWAPS.

The 2012 SWAP Best Practices Guidance also recommended the use of results chains to improve the evaluation of actions, which is the core of the Adaptive Management concept. Results Chains are important tools that help project managers be more adaptive. Open Standards for the Practice of Conservation v 4.0 was developed by Conservation Measures Partnership in 2020. CMP is a partnership of conservation-oriented NGOs, government agencies, and funders that works collectively to achieve greater impact and seek better ways to design, manage, and measure the effectiveness of conservation actions (CMP 2020).

The Northeast conservation community has worked for nearly a decade to reduce or eliminate threats outlined in the 2015 SWAPS and 2017 SWAP Synthesis. However, the challenge of how to fully demonstrate the effectiveness of each effort remains. The lack of funding and capacity constrains monitoring efforts, including finding available tools and methods. Results Chains graphically represent a project's life cycle and serve three important purposes (Margoluis et al. 2013). They help illustrate and clarify the steps needed to achieve specific conservation targets. They also help identify the specific type of output and outcome data needed to adequately evaluate the performance and

effectiveness of a project. Finally, Results Chains are used to determine when output and outcome data should be available during the course of a project. Each step is critical to ensuring that data, collected by different organizations in varied locations, are consistent and therefore applicable to the management of regional conservation actions (CMP 2020, Foundations of Success 2007, 2008)[217].

The year 2015 marked the beginning of an annual, internationally focused effort to review the effectiveness of conservation interventions **Conservation Evidence: Providing Evidence to Improve Practice was established[218]**. Actions taken to benefit amphibians, bats, birds, and other conservation targets are reviewed to assess the effectiveness of various actions in achieving the intended goals. Projects with inconclusive evidence are also included. The international nature of the analysis can make larger-scale conclusions more difficult, but the database provided along with the **What Works in Conservation** summary publications offers a platform for measuring the effectiveness of a broad range of common conservation actions (Sutherland et al. 2021). Two separate databases inventory conservation actions and scientific studies of their effectiveness; and both are available online.

To effectively monitor or measure conservation targets or actions, consistency of language is important. The NEFWDTC and SWAP Coordinators recognized the need for a standard lexicon that provides conservationists with a uniform terminology that accurately describes the work of state fish and wildlife agencies. Therefore, the NEFWDTC developed a regional conservation lexicon in 2013 and updated it in 2022. This lexicon can be used by state fish and wildlife agencies and partners to better describe and monitor their conservation projects (Crisfield and NEFWDTC 2013 and 2022). Best practice recommendations are addressed in Chapter 5 of this Regional Conservation Synthesis and include incorporation of monitoring information into adaptive management approaches.

The 2017 SWAP Synthesis drew from the 14 individual Northeast SWAPs to identify the monitoring needs for priority threats, species, and habitats. State-specific actions and monitoring needs can be found in searchable format in the Northeast SWAP Database[1]. These are summarized and presented in the SWAP synthesis (TCI and NEFWDTC 2017), *Appendix 4A* and *Supplementary Information 5*. The SWAP Synthesis and the Limiting Factors report (TCI and NEFWDTC 2017, 2020a) both found common, recurring monitoring themes and needs reported across multiple taxa. Key overarching monitoring actions from the synthesis include:

- **Develop regionally coordinated and cost-effective monitoring protocols** that meet multiple objectives across states and monitor changes to the Northeast's land and waters and how those changes impact wildlife and people.

- **Measure and report the effectiveness of actions** to improve and enhance future conservation efforts; improve competitive grant applications; and recruit new partners by demonstrating the utility and efficacy of conservation programs.
- **Conduct adequate research, surveys, and then monitoring to determine baseline status and detect changes in SGCN, RSGCN, and key habitats** before they reach critical levels beyond which they cannot be recovered.

Multiple taxa recommendations included the need for consistent monitoring protocols range wide. This approach provides for improved status assessments as well as additional opportunities for conservation, thus avoiding the need to list target species at the federal level. Key RCN projects were developed that addressed some of these taxa needs; however, many other needs remain unaddressed. Priority RSGCN/watchlist species and their habitat needs identified in the 14 Northeast SWAPs and flagged for further investigation and monitoring, especially in the face of climate change, include:

- **Invertebrate biomass decline**. Because of the high number of vertebrate RSGCN relying on invertebrate food sources, there is a need to understand invertebrate biomass declines and the thresholds of food availability required to maintain or increase populations (Wagner 2020).
- **Insecticide toxicity for the high number of RSGCN invertivores**. Taxa experts cited concerns about the impact of insecticide spraying on forest-dwelling vertebrate RSGCN including bats, birds, reptiles, amphibians, fish, and aquatic invertebrates, especially the ingestion of harmful substances through food or water.
- **Disease**. There is an ongoing need to track the impacts of disease in RSGCN, particularly reptiles and amphibians, freshwater mussels, crayfish, and mammals.
- **Loss of genetic diversity in RSGCN**. Species in particular need monitoring include the Northern Right Whale, Sturgeon, the New England Cottontail and Allegheny Woodrat.
- **Wintering RSGCN vulnerabilities**. These are either poorly understood or increasing due to climate change.
- **Take and Collection**. The impact of collection is dynamic and responsive to changes in world markets.
- **Changes in hydrologic regimes**. Because of the large number of RSGCN associated with hydrologically defined habitats, changes in precipitation regimes, evapotranspiration, and water management structures will affect many RSGCN.

- **Coastal habitats**. These habitats have been degraded or reduced in size by intensive development and are now further threatened by sea level rise and storm surge.

The Northeast states recognized the importance of monitoring conservation efforts and using monitoring data to guide and improve future management. In the Northeast, monitoring to evaluate effectiveness has been a challenge exacerbated by lack of funding and capacity. Several examples are provided in this section that reflect approaches to capturing regional and state level species and monitoring. *Chapter 5* provides more detail on monitoring; and its appendices describe existing monitoring programs and projects across the region.

The RCN and other programs are most effective when they can demonstrate that project results have been implemented on the ground and across the region to improve and sustain RSGCN and the habitats on which they depend. Such an approach supports efforts to keep species from becoming imperiled, necessitating inclusion on the federal list of endangered and threatened species. Large scale collaborative conservation actions for New England Cottontails, Blanding's Turtles, Wood Turtles, and others presented in *Appendix 4A* illustrate the need for the continual evaluation of priority targets and the development of conservation plans and actions. They rely on an adaptive approach of periodic review and update to the RSGCN, SGCN and COAs, underpinned by an evolving database that is updated with information from the 14 jurisdictions as changes are made to individual SWAPs and supported by regional prioritization and evaluation.

Consideration should be given to how climate change may alter the effectiveness of monitoring programs in capturing true population trends and dynamics. (e.g., managers may erroneously conclude that a population has declined when it has shifted in space or seasonality because survey effort has remained static). Also monitoring efforts need to be expanded to: 1) observe and understand changes in climate variables; 2) detect species shifts in space and time that are out of the bounds of their historical ranges; 3) track novel species moving into a region to effect community structure and function; and 4) fill needed data gaps and reduce uncertainty in RSGCN responses to climate change and other stressors.

Monitoring occurs at multiple levels across the Northeast. *Chapters 1, 2, and 3* summarize monitoring efforts for SWAP Elements 1-3: RSGCN, their habitats, and threats respectively. Multiple RCN and other monitoring projects have been summarized in this and previous chapters. *Chapter 5* summarizes these important monitoring efforts in the Northeast and *Supplementary Information 5* provides a list of many regional and state standardized monitoring programs. Tracking SWAP Element 4-

Actions, remains a challenge at all scales, as it requires a robust monitoring effort that is seldom funded. Recent projects include states' efforts to track their SWAP implementation. **Maine's Conservation Action Tracker[219] is an example of this kind of monitoring project, designed to capture both state and partner efforts to conserve their SGCN and habitats**.

Conservation Evidence maintains a website and searchable database that allows users to search by species, habitat or an issue of interest[220]. The site provides both a list of possible actions conducted at a global scale (International Union for the Conservation of Nature (IUCN)'s Conservation Actions Classification Scheme)[221] and a summary of the projects and their effectiveness[222]. For more details see *What Works in Conservation*[223].

4.8.3 REGIONAL EXAMPLES AND OPPORTUNITIES

RCN, CSWG AND SA PROJECTS THAT ADDRESS MONITORING

The NEFWDTC and SWAP Synthesis identified monitoring as a top regional need in the 2005 and 2015 SWAPs. To address this, NEAFWA's RCN and key partner programs prioritized and funded multiple projects to provide information, guidance, BMPs, and protocols to improve assessment and monitoring of the impacts on RSGCN and their habitats in the region. Some of the key projects are listed below as resources. For a complete list of these projects please see Table 4.1.1 and *Appendix 4A,* for additional partner information see Chapter 7, and to see more about these threats see *Chapter 3*. For more detailed information on monitoring RSGCN and habitats, see *Chapters 1 and 2* respectively. *Chapter 2* provides information on Northeast habitat status and condition as well as RSGCN supported by each and provides examples of management and monitoring efforts that address monitoring across the region. *Chapter 3* provides

information on threats, and *Chapter 5* provides more detail on monitoring across the Northeast.

Multiple RCN, CSWG, and SA efforts address survey and monitoring within species and habitat conservation strategies and plans, including the following RCN, CSWG and SA projects listed in Table 4.1.1 and *Appendix 4A*.

- Northeast Monitoring Framework
- Habitat Condition Assessment
- Rare Wetland Turtles (survey and monitoring protocols and forms)
- Xeric Woodlands and Barrens (pollinator and vegetation protocols)
- Freshwater mussels-Brook Floater (survey and monitoring)
- Chesapeake Logperch Conservation Strategy
- Hellbender (disease prevention, monitoring, eDNA, etc.)
- Diamondback Terrapin Conservation Strategy
- Wetland, Grassland, Mountain, Forest Bird survey/monitoring handbook
- Odonate Assessment
- Wetland butterfly Best Practices
- Coastal/Marsh Birds- Black Rail, Saltmarsh Sparrow
- Frog Monitoring
- New England Cottontail Conservation Strategy
- Others- please see Table 4.1.1 for links to these projects and *Appendix 4A*.

Northeast Monitoring Framework. One of the original RCN projects laid the foundation for collaborative, regional monitoring, and evaluation. The Northeast Monitoring Framework (NEAFWA 2008 and described in *Chapter 5*) was established to monitor key Northeast indicators and measures of fish and wildlife species and their habitats in the Northeast. NEAFWA RCN program supported The Nature Conservancy (TNC) in assessing the condition of species and habitats in the Northeast through the Conservation Status Project (Anderson et al. 2013a, 2023a). This project (incorporated into Chapter 2) used a GIS analysis to examine the relationship between species and habitat condition as well as land ownership and conservation management status. The original assessment project merged with another RCN-funded project, titled Regional

Indicators and Measures: Beyond Conservation Land (Anderson and Olivero Sheldon 2011), which focused on approximately 30 indicators of habitat condition and species and ecosystem health in the Northeast states. Together these projects implemented approximately 75% of the Northeast Regional Monitoring and Performance Measures Framework (NEAFWA 2008), previously funded by the NFWF and the RCN Grant Program[1].

Northeast State of the Frogs: Monitoring. This 2010 RCN project produced the first regional analysis of frog call survey data from the **North American Amphibian Monitoring Program** (NAAMP)[224]. Eleven years of survey data (2001-2011) from the NAAMP was used to provide a regional trend assessment and associated analytical methods for amphibians in the Northeast. NAAMP is a collaborative effort among USGS, State Agencies, and other partners to monitor calling amphibians using a standard, peer-reviewed protocol. NAAMP is active in more than 20 states, including 11 northeastern states (Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, Hudson region of New York, Pennsylvania, Vermont, Virginia, and West Virginia). This project developed the modeling and trend assessment framework for regional reporting, resulting in the first regional-level analysis using NAAMP data. This framework became the methodology for future reporting on NAAMP results.

This RCN project addressed RCN Topic 6: Design and implement monitoring protocols, measures, and indicators for NE Species of Greatest Conservation Need (SGCN) and targeted amphibians. Of the 30 species of frogs and toads in the Northeast, this study was able to report occupancy trends for 18, with the majority of omitted species being restricted to southeastern Virginia. Of the 18 species, 12 are SGCN in one or more Northeastern states. NEPARC has proposed 7 of these species as "high responsibility" for the Northeast.

Published results presented the first regional trends in anuran occupancy from North American Amphibian Monitoring Program (NAAMP) data from 11 Northeastern states. NAAMP's long-term monitoring program collected data at assigned random roadside routes, using a calling survey technique to assess occupancy trends for 17 species. Eight species had regional trends whose 95% posterior interval did not include zero; of these seven were negative (*Anaxyrus fowleri, Acris crepitans, Pseudacris brachyphona, Pseudacris feriarum-kalmi complex, Lithobates palustris, Lithobates pipiens, and Lithobates sphenocephalus*) and one was positive (*Hyla versicolor-chrysoscelis* complex). The project also assessed state-level trends for 103 species/state combinations; of these, 29 showed a decline and nine showed an increase in occupancy (Weir et. al. 2014).

Motus 1-3: Identifying Landscape-scale Habitat Use of Multiple SGCN in the Mid-Atlantic Region Using Nanotag Technology (2018, 2019, 2022) (CSWG). This project provides: 1) geographic and temporal data on migration; 2) full life cycle data to inform habitat management and conservation action decisions for SGCN; 3) corroboration of recent modeling based on NEXRAD radar data identifying high-use migratory stopover sites; and 4) expansion of telemetry monitoring network by adding 46 automated telemetry receiving stations. In 2019, CSWG supported Motus II: Using Nanotag Technology to Identify Landscape-scale Habitat Use of Multiple SGCN in New England. The project will provide these data outputs with an additional focus on American Kestrel (*Falco sparverius*) and Monarch butterfly (*Danaus plexippus*), with full life cycle data to inform habitat management and conservation action decisions for SGCN; provide new data on detection distances to optimize tower construction and placement for species tracking; and expand the telemetry monitoring network by adding 50 automated telemetry receiving stations. The Motus project contributes significantly to landscape- scale monitoring of migratory species in the region. Motus III: PA and VT Portion of Identifying SGCN Habitat Use Across Multiple Scales Throughout the Eastern U.S. Using the Motus Wildlife Tracking System expanded and employed Motus receiving stations to detect animal movements and determine the location of stopover habitats, where populations are breeding, and where they are migrating and wintering. Additionally, the Project expanded the telemetry monitoring network by adding 35 automated telemetry receiving stations across West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Connecticut, Delaware, Maine, Maryland, Massachusetts, Pennsylvania, New Hampshire, New Jersey, New York, Rhode Island.

Bird Assessment and Monitoring Standard Operating Procedures (2007-08) (RCN). The RCN program funded the Development of Avian Indicators and Measures for Monitoring Threats and Effectiveness of Conservation Actions in the Northeast. Northeast regional monitoring procedures are now available for birds of grasslands, tidal marshes, and mountain forests - habitats that span the Northeastern landscape, contain a high percentage of vulnerable species, and encompass the region's major management issues. These coordinated bird monitoring programs can measure region-level threats and management impacts on target birds and habitats identified by the SWAPs as being of greatest conservation need. Products of this work include peer-reviewed survey design, protocols, and standard operating procedures for each indicator group (grassland, tidal marsh, and mountain forest birds) along with a regional database for each of these groups. This project also resulted in the development and implementation of a regional coordinated bird monitoring framework (Northeast Coordinated Bird Monitoring Partnership 2007) and the Northeast Bird Monitoring Handbook (Lambert et al. 2009). The mountain bird survey data was gathered as part of

the Vermont Center for Ecostudies' high-elevation bird monitoring program, Mountain Birdwatch.

CONSERVATION ACTION TRACKER – MAINE

The state of Maine developed a system to track actions identified in its State Wildlife Action Plan. Maine's Conservation Action Tracker (CAT) is an example of an effort to capture both state and partner actions and of successful on-the-ground efforts to conserve their SGCN and habitats. It allows users to document and showcase the conservation of Maine's most vulnerable species and habitats, learn about Wildlife Action Plan conservation projects statewide, search projects by the species or habitats they benefit, and make connections with other partners throughout the state[252].

Figure 4.8.1 Maine's State Wildlife Action Tracker.

CONSERVATION OPPORTUNITY AREA TOOL – PENNSYLVANIA

The Pennsylvania Conservation Opportunity Area (COA) Tool[225] is a component of the 2015-2025 Pennsylvania Wildlife Action Plan. The Tool can be used in several ways: 1) to discover SGCN in a user-defined area of interest; 2) to develop an output report with actions identified to support the species and habitats in an area of interest; 3) to produce a list of SGCN by county or watershed; and 4) to see range maps for most

SGCN. The COA Tool also expands access to core components of the SWAP and facilitates its use. The Pennsylvania COA Tool guides conservation actions and is filled with important information about species, habitats, environmental stressors, needed conservation actions and more.

EPA'S REPORT ON THE ENVIRONMENT

EPA's Report on the Environment[66] includes a broad set of indicators of ecological condition that provide insight into the degree to which the natural environment is being protected. These indicators and status are summarized below and in *Chapter 2*, as well as in the 2023 Northeast Habitat Condition Assessment (Anderson et al. 2023a)

Extent and Distribution. This indicator examines trends in the overall extent (area and location) of different kinds of ecological systems. It also examines spatial patterns in the distribution of ecological systems that affect interactions of nutrients, energy, and organisms.

- Ecological Connectivity
- Forest Extent and Type
- Forest Fragmentation
- Land Cover
- Land Use
- Urbanization and Population Change
- Wetlands

Diversity and Biological Balance. These indicators identify trends in the types and numbers of species that live within ecological systems and how they interact with each other.

- Benthic Macroinvertebrates in Wadeable Streams
- Bird Populations
- Coastal Benthic Communities
- Cyanobacteria in Lakes
- Fish Faunal Intactness
- Submerged Aquatic Vegetation in Chesapeake Bay

Ecological Processes. These indicators focus on trends in the critical processes that sustain ecological systems, such as primary and secondary productivity, nutrient cycling, decomposition, and reproduction.

Physical and Chemical Attributes. *Physical attributes* can include temperature, hydrology, and physical habitat, as well as major physical events that reshape ecological

systems, such as fires, floods, and windstorms. *Chemical attributes* can include pH, dissolved oxygen concentrations, and nutrients (e.g., nitrogen and phosphorus).

Ecological Exposure to Contaminants. This indicator set provides information on biomarkers of exposure to contaminants that are particularly important with respect to the health of plants and animals, as well as to humans who might consume them.

US Forest Service PRISM[226] allows users to interactively explore key accomplishments of the Forest Service State and Private Forestry Programs and discover a current assessment of landscape impact. It can be queried by state, region, county, watershed, or congressional district. It presents information in a dashboard format to provide the number and acres of completed projects, as well as the number of acres of priority land impacted.

Wildfire Hazard Explorer[227]. This Portal contains the spatial footprints and associated metadata for known wildfire risk, threat, hazard and burn probability maps. The project was commissioned by the USFS and National Association of State foresters (NASF) to better catalog the existing wildfire data resources available to States, Federal Agencies, and Private and NGO partners. The site does not house the actual data for the risk / threat / hazard maps, but instead provides metadata and links to the sources (where available). The project team continues to look for new sources of data that might help interested parties. A link is provided (see "Useful Links"), allowing users to contribute information. The site was designed to be easy to use with simple filters and the ability to search by text or map.

Chapter 5 provides additional information and links to other key regional/national monitoring projects, including those conducted by the US Geological Survey, EPA, USFWS, USDA, NOAA and many more.

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