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APPENDIX A: DELAWARE RECOVERY UNIT ACTION PLAN

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I. DEFINITIONS

Core Habitat – A wetland that meets Bog Turtle suitable habitat requirements where turtles are most frequently found. Multiple Core Habitat areas may be found within a single delineated wetland but may cross multiple parcels.

Extant Population – Populations where there has been a turtle observation in appropriate habitat in the past 30 yrs.

Extirpated Population – Population where the habitat was destroyed and no habitat remains.

Historical Population – Populations where habitat is present, no turtles were observed in the past 30 yrs or a full Phase 2 survey occurred (since turtles were last found within 30 years) and no turtles were found

Metapopulation - Populations with genetic exchange feasible through occasional dispersal events. Populations are close enough to each other to allow occasional movements within one generation time (10-40 years) of an individual: < 3 km of contiguous wetland, < 2 km of intermediate or mosaic upland-wetland habitat, or < 1.5 km undeveloped upland habitat.

Population - A functionally reproductive group of individuals (e.g. at least one individual from each sex or evidence of reproduction such as presence of a hatchling or juvenile) using one or more Core Habitat areas, which are within 300 m of each other with no major barriers between them. Movement between Core Habitat patches likely occurs every 1-10 years.

Unknown Population – Locations where there has been a turtle observation in past 30 yrs, a full Phase II survey has NOT been completed, and one or more of the following is true:

- Historical observation, but no survey work occurred and habitat exists
- Recent road observation, no surveys occurred, and habitat exists within 30 m
- Recent observation resulting from environmental review project, survey stopped as soon as a turtle was found, no further surveys were performed, and habitat exists.

II. INTRODUCTION

2.1. ACTION PLAN USE AND PURPOSE

This document is for use by state and federal partners to guide their conservation efforts over the next 5-10 years, for the Bog Turtle in the Delaware Recovery Unit. This Action Plan summarizes the most prominent threats and limiting factors, describes the status of the species within this recovery unit, and identifies and prioritizes specific strategies needed for recovery of the species. It also provides an implementation schedule with a timeline for completing these actions. This Recovery Unit Action Plan identifies specific recovery unit priorities and should be used in conjunction with the Conservation Plan (2019), which identifies regional level priorities across all recovery units in the Northern population range (Figure 1). Data resulting from Bog Turtle expert surveys provides the basis for these recommendations. This living document should periodically be re-evaluated and updated.

2.2. DELAWARE RECOVERY UNIT

The Delaware Recovery Unit is located centrally within the Northern population range (Fig. 1). It extends from Northern Delaware to Northeastern Pennsylvania and northwestern New Jersey (Fig. 2). Sub-units are uncertain for the Delaware Recovery Unit so, for this reason, results are not shown by sub-unit.

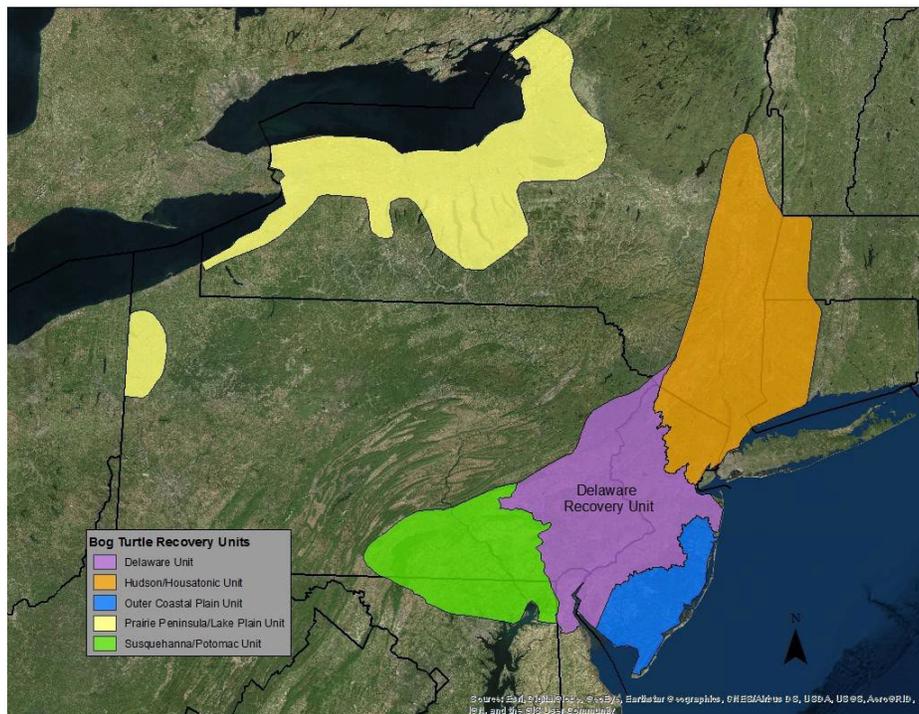


Figure 1. Map showing the Northern population range of the Bog Turtle, separated into 5 recovery units. The Delaware Unit (purple) is centrally located within the range.

2.3. POPULATION STATUS

Some information exists on the current status of populations in the northeast. Below we summarize data on range changes, the number of newly discovered populations (since time of federal listing), number of extant populations, and population viability based on a recent assessment.

- **Range changes:** Historical and current (within past 30 years) Bog Turtle observation data were used to create historical and current range maps. The historical range map was delineated by creating a 10 km buffer off all HUC12 sub-watersheds containing historically and/or current turtle observations. A current range map was similarly created using only the HUC12 sub-watersheds with current observations. Based on these data the species' range has contracted by 12% in the Delaware Recovery Unit, resulting in a loss of 670,300 acres. The historical range includes all observations of the Bog Turtle (historical, extirpated, extant, and unknown) whereas the current range only includes the range for extant populations.
- **Number of populations in the recovery unit discovered since 1997 (time of federal listing):** Two DE, 117 PA, and 37 NJ populations.
- **Number of Extant Populations, Metapopulations and Core Habitats:** Number of each is listed by state in Table 1.

Table 1. Number of extant populations, extant metapopulations and extant core habitats identified by state biologists in Delaware, Pennsylvania, and New Jersey, which make up the Delaware Recovery Unit.

	<i># Extant Pops</i>	<i># True Metapops</i>	<i># Core Habitats</i>
Delaware	5	2	5
Pennsylvania*	125	17	141
New Jersey*	89	17	93
Total	219	36	239

*Additional extant populations, extant metapopulations and core habitats are found in PA and NJ – see Susquehanna-Potomac, Outer Coastal Plain, and Hudson-Housatonic Recovery Unit Action Plans.

- **Extant Population Viability Ranking:** Below is a breakdown of the rankings of populations in the Delaware Recovery Unit (Table 2). For additional information on the methodology used to rank populations, see section 4.2.2 of the Conservation Plan.

Table 2. The number of populations by state that were ranked as Good, Fair, and Poor for their potential to be viable over the long term in the Delaware Recovery Unit.

	<i>Good</i>	<i>Fair</i>	<i>Poor</i>	<i>Total</i>
Delaware	2	2	1	5
Pennsylvania	12	29	84	125
New Jersey	7	17	65	89
Total	21	48	150	219

III.

THREATS AND LIMITING FACTORS

This section identifies and ranks threats and limiting factors effecting the status and recovery of the Bog Turtle. A list of threats and limiting factors was developed for the Recovery Plan and expanded during a species recovery meeting in 2011. In 2017-2018, experts in each of the recovery units participated in ranking these threats and limiting factors based on the risk level or degree of negative influence each has on the Bog Turtle populations in that recovery unit. Threats were ranked as high (3 points), moderate (2 points), low (1 point), or unknown risk (no points) and limiting factors were ranked as very limiting (3 points), somewhat limiting (2 points), not limiting (1 point) and Unknown (no points). Mean scores were calculated and used in a relative comparison (Fig. 2 and 3).

3.1. THREATS

The top current threats identified by experts in the Delaware Recovery Unit included proliferation of invasive plants, ecological succession, habitat degradation due to direct and indirect effects of increased development, altered hydrology, and roads (Fig. 2). Agricultural activities also ranked fairly high. A high degree of uncertainty was associated with disease, predation, and salt/contaminants. For more details see the Species Status Assessment (currently in development).

State lead biologists compiled historical and current observational data, which was entered into a centralized regional database developed by USFWS. For each population, they provided information (to the best of their knowledge) on current habitat conditions for hydrology and percent of invasive plants and succession. The state biologist also noted any predation events and/or poaching events that were known or likely to have occurred at any time in the past. These data extracted from the regional database also provide some insights on threats although these numbers are almost certainly underestimations of the true values:

- Disturbance to Hydrology: This was noted for 69 PA populations, 1 DE population and 64 NJ populations.
- Invasive Plants and Succession: Cover >60% of the Core Habitat in 30 PA populations, 1 DE population. Succession coverage of the Core Habitat was >41% for 6 NJ populations.
- Development Pressure: Exists in the Core Habitat or both the Core and Buffer areas in 10 PA populations.
- Predation: This occurred in 4 extant PA populations between 2012 and 2017. Data on NJ populations should be added.
- Poaching: This occurred in 2 extant PA populations between the years 2009 and 2014. Data on NJ population should be added.

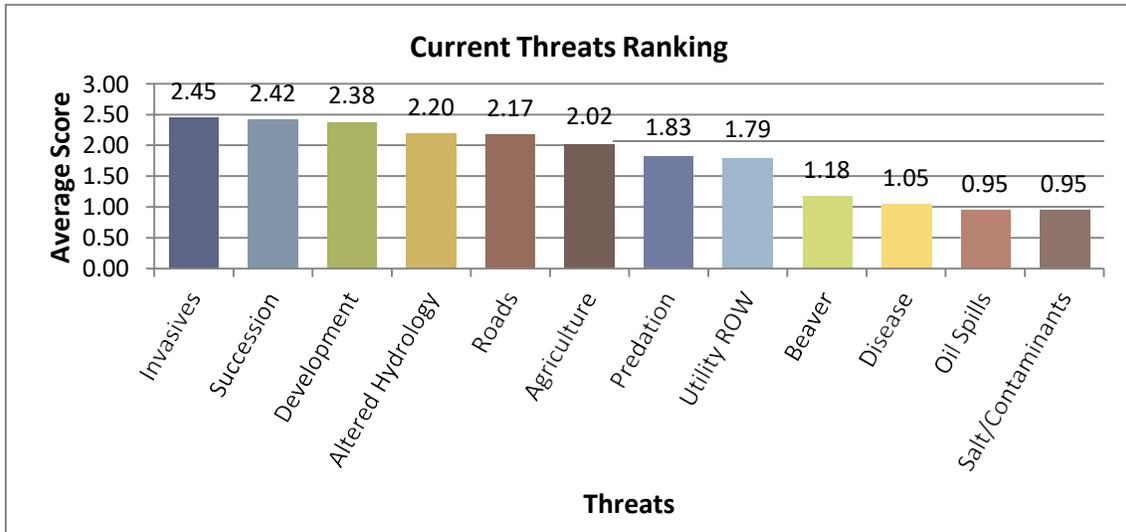


Figure 2. Threats to the Bog Turtle ranked in order of degree of their effect on populations within the Delaware Recovery Unit. Higher average scores indicate threats of greater effect.

3.2. LIMITING FACTORS TO RECOVERY

Experts ranked current Limiting Factors that limit recovery of a species beyond threats. Top limiting factors for the Delaware Recovery Unit include lack of connectivity between populations, habitat quality, habitat protection, and lack of knowledge about the distribution of the species (Fig. 3). For more details, see the Species Status Assessment (currently in development).

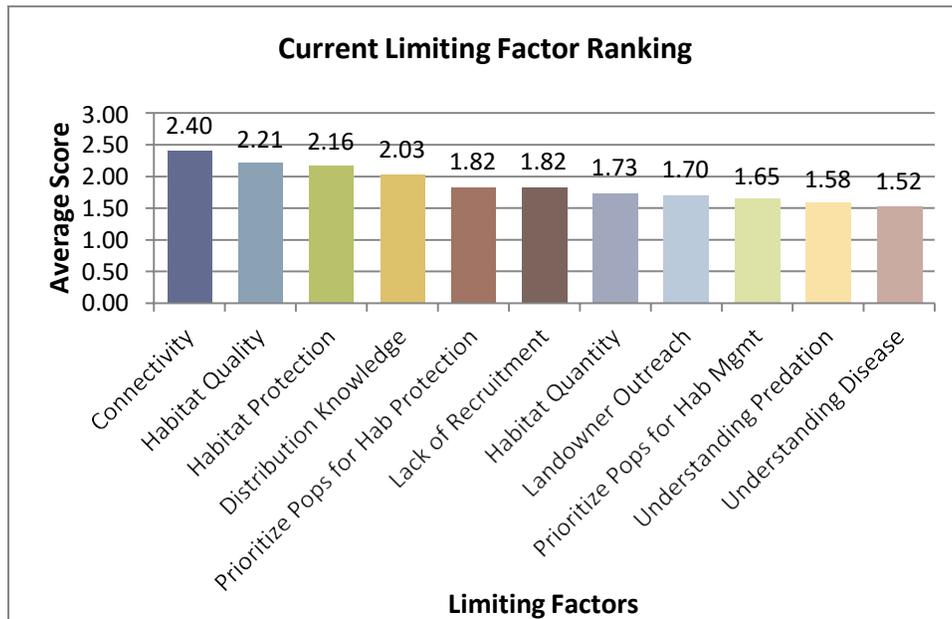


Figure 3. Limiting factors ranked in order of the degree of effect on population in the Delaware Recovery Unit. Higher scores indicate threats of greater effect.

IV.

PROGRESS

The data presented below were compiled using information from the multi-state regional database for all years. The health assessments did not begin until 2001 and the regional population and habitat monitoring did not begin until 2014. The values below only represent partial data for the 2018 field season.

4.1. PROGRESS TOWARDS RECOVERY

Considerable effort has gone into discovering new populations, better understanding population abundance and recruitment of known populations, protecting habitat, improving habitat quality, and understanding demographics of populations and site-specific habitat use. The values below are for all actions noted for all years data is present.

4.1.1. POPULATION SURVEYS

Various types of surveys have been conducted over the years (Table 3). Regional sampling occurred in recent years for tracking of population trends (survey protocols can be found in Section 4.2.5 and 4.2.6 of the Conservation Plan). Phase 1, 2, 3 surveys are designed to determine presence/absence of Bog Turtle in wetlands and are typically performed in response to a development project proposal (see USFWS 2018 for more details). Health assessments have also been completed for numerous populations in the Delaware Recovery Unit.

Table 3. The type of survey and number of populations where each survey type was performed in Delaware, Pennsylvania, and New Jersey in the Delaware Recovery Unit. This is based on all available data in the state’s database. Negative data have not been tracked in most states.

Type of Survey	DE	PA	NJ	Total
Regional Population Monitoring: Rapid Assessments	0	19	13	32
Regional Population Monitoring: Intensive Sampling	0	5	0	5
Regional Habitat Monitoring: Random Sampling	1	5	7	13
Regional Habitat Monitoring: Targeted Sampling	0	4	1	5
Phase 1 surveys	0	115	?	115
Phase 2 surveys	1	118	?	119
Phase 3 surveys	3	26	?	29
Health Assessments	2	2	2	2

4.1.2. HABITAT PROTECTION

Habitat protection here includes properties purchased for conservation purposes and properties with an easement (conservation or agricultural; Table 4).

Table 4. Different levels of habitat protection and the number of populations with each type of protection level for Delaware, Pennsylvania, and New Jersey populations in the Delaware Recovery Unit.

<i>Type and Location of Protection</i>	<i>DE</i>	<i>PA</i>	<i>NJ</i>	<i>Total</i>
<i>Full permanent protection of the Core Habitat</i>	2	24	16	24
<i>Partial permanent protection of the Core Habitat</i>	0	24	16	24
<i>Full permanent protection of the 300 ft Buffer</i>	0	9	2	9
<i>Partial permanent protection of the 300 ft Buffer</i>	2	41	11	41
<i>Partial temporary protection</i>	0	1	0	1

4.1.3. HABITAT MANAGEMENT

Habitat management to remove woody and invasive plants has been a key conservation measure used in previous year. Below is a rough summary (based on what information exists) of prior management actions.

- **Habitat Management Projects:** Occurred at 3 DE, 42 PA, 5 NJ populations.
- **Habitat Management Plans:** No site-specific habitat management plans have been drafted for the Delaware populations. Data should be added for PA and NJ.

4.1.4. DEMOGRAPHIC AND HABITAT USE DATA

Site-specific demographics and habitat use can provide insight on critical habitat features and inform habitat management actions. Several such studies have occurred since the species was listed. Below is a rough summary (based on what information exists) of prior research in this area of study.

- Number of sites with demographic research: Pennsylvania conducted trapping efforts for environmental review projects and research providing some knowledge of the demographics of 15 populations. Delaware has performed intensive surveys at 3 populations. Data should be added for NJ.
- Number of site with site-specific habitat use: Pennsylvania conducted radio telemetry and/or trapping efforts for environmental review projects and research providing some habitat use information for 7 populations. Delaware has performed trapping and/or tracking of turtles for 3 populations. Data should be added for NJ.

V.

CONSERVATION APPROACH

The following sections identify and prioritize conservation strategies to be implemented, populations and important habitat corridors to target for these conservation actions, and lay out an implementation plan and benchmarks recommended for the Delaware Recovery Unit. This

approach is based on a broad-scale perspective, which is important to obtain recovery of the species across the Northern range. Priorities outlined here should be used to determine actions to propose for grants and other funding opportunities. As funding and resources become available conservation partners should use this action plan to address the highest priority actions, not yet completed, in the Delaware Recovery Unit and use these priority population lists to maintain and recover populations. However, lower priority conservation actions or actions at lower priority populations may still be warranted based on opportunities that arise and other agency priorities. Non-prioritized conservation actions for particular populations or innovative new ideas may also help with recovery of the Bog Turtle. In addition, the formal establishment of a working group for the Susquehanna-Potomac Recovery Unit would be beneficial. It is recommended that this group is created by the end of 2020, and that at a minimum the group holds annual meetings to discuss progress on conservation actions and planned activities for the following year.

VI.

RANKING CONSERVATION STRATEGIES

Bog Turtle expert surveys were used to rank conservation strategies in order of effectiveness and/or need. Experts that work in the Delaware Recovery Unit were polled to determine what conservation strategies would be most effective and are in greatest need for the recovery of the species in this region. A list of conservation strategies was developed during a species recovery meeting in 2011. In 2017-2018, experts in each of the recovery units participated in ranking these strategies based on the risk level or degree of positive influence each has on the Bog Turtle populations in that recovery unit. Conservation strategies were ranked from 1-5 with 5 being very important for the recovery of the species and 1 being less important. Mean scores were calculated and used to identify priority actions (Table 5) and strategies were grouped into categories (Table 6).

6.1. CONSERVATION STRATEGIES PRIORITY LEVEL DESCRIPTION

Priority 1: Strategies that experts within the Delaware Recovery Unit deemed to be the most urgent and effective for recovery. These actions should be completed before all other conservation strategies. Some of these actions have already been completed, are currently being implemented, or are planned for implementation in the next few years.

Priority 2: Strategies that should be implemented after priority 1 strategies are underway or have been completed.

Priority 3: Strategies that are of lowest priority for implementation. However, these strategies have been identified as being useful for the recovery of Bog Turtles. While these measures are considered to be of lesser need, they may prove to be valuable in particular circumstances. In general, these actions should only be implemented after priority 1 and 2 strategies are underway or have been completed.

6.2. CONSERVATION STRATEGIES PRIORITIZATION

Bog Turtle experts that work in the Delaware Recovery Unit ranked conservation strategies for the Delaware Recovery Unit (Table 6). Survey results are shown below with the conservation strategies

organized from those deemed of greatest importance (or most effective for achieving recovery of the Bog Turtle) in this recovery unit to those that were considered least important. However, all conservation strategies listed were identified as needs for the Bog Turtle. This information should be used to prioritize conservation efforts in the Delaware Recovery Unit, to determine which strategies should be implemented first, and to justify funding for related projects. Ranking categories are as follows: strategies that scored ≥ 3.80 are ranked as Priority 1, 3.50-3.79 are Priority 2, and ≤ 3.50 are Priority 3.

Table 5. A list of abbreviations for categories of conservation strategies used to recover the Bog Turtle.

<i>Abbreviation</i>	<i>Conservation Strategy Category</i>
<i>BMPs</i>	Best Management Practices
<i>BSC</i>	Broad Scale Conservation
<i>HM</i>	Habitat Management
<i>HP</i>	Habitat Protection
<i>LR</i>	Laws and Regulations
<i>PBC</i>	Predators and Beaver Control
<i>PM</i>	Population Management
<i>RN</i>	Research Needs

Table 6. Conservation strategies for the Northern population of the Bog Turtle. Strategies are listed in order of their expected benefit to the recovery of the Bog Turtle based on Delaware Recovery Unit expert survey scores. Conservation strategies are grouped into categories (e.g., habitat protection, laws and regulations, etc.) and the Conservation Plan section is provided (CP Section).

<i>Conservation Strategy</i>	<i>Strategy Category</i>	<i>RU Mean Score</i>	<i>Priority Level</i>
<i>Obtain Funding</i>	BSC	4.88	1
<i>Conduct Succession/Invasive Plant Management</i>	HM	4.69	1
<i>Research the Effectiveness of Habitat Management</i>	RN	4.60	1
<i>Require Surveyor Qualifications</i>	LR	4.60	1
<i>Engage in Landowner Outreach for Habitat Management</i>	HM	4.56	1
<i>Restore Hydrology</i>	HM	4.56	1
<i>Engage in Landowner Outreach for Habitat Protection</i>	HP	4.53	1
<i>Prioritize Populations for Habitat Protection and Management</i>	BSC	4.50	1
<i>Develop a Communication Strategy</i>	BSC	4.50	1

<i>Conservation Strategy</i>	<i>Strategy Category</i>	<i>RU Mean Score</i>	<i>Priority Level</i>
<i>Conduct Inventory/Gap Surveys</i>	RN	4.46	1
<i>Rank Populations for Viability</i>	BSC	4.44	1
<i>Seek Max Penalties on Violations of the ESA</i>	LR	4.36	1
<i>Map Important Habitat Corridors</i>	BSC	4.31	1
<i>Revise the Recovery Plan and Re-evaluate the Recovery Criteria</i>	LR	4.31	1
<i>Connect Fragmented Habitat</i>	HP	4.17	1
<i>Implement Population and Habitat Monitoring</i>	BSC	4.14	1
<i>Research the Effects of Agriculture, Pesticide, and Herbicide</i>	RN	4.13	1
<i>Draft a Population Management Decision Tree</i>	PM	4.07	1
<i>Identify Best Population Management Techniques</i>	PM	4.07	1
<i>Monitor Progress on Conservation Actions</i>	BSC	4.06	1
<i>Research Hydrology and Water Chemistry</i>	RN	4.00	2
<i>Draft BMPs to Reduce Impacts from Development Projects</i>	BMP	4.00	2
<i>Engage in Mitigation Banking to Protect Habitat</i>	HP	4.00	2
<i>Research the Effects of Development</i>	RN	3.93	2
<i>Develop a Stewardship Program(s)</i>	HP	3.93	2
<i>Revise Regulations to Improve Protection</i>	LR	3.88	2
<i>Restore Relic Fens</i>	HM	3.88	2
<i>Draft BMPs to Improve Road Passageways</i>	BMP	3.87	2
<i>Create a Standardized Regional Database</i>	BSC	3.86	2
<i>Train Law Enforcement</i>	PBC	3.86	2
<i>Implement USFWS Survey Protocols</i>	LR	3.81	2
<i>Protect Nests and Perform Predator Control</i>	PBC	3.79	2

<i>Conservation Strategy</i>	<i>Strategy Category</i>	<i>RU Mean Score</i>	<i>Priority Level</i>
<i>Develop and Evaluate eDNA Techniques</i>	RN	3.75	2
<i>Draft Guidelines for Population Management</i>	PM	3.73	2
<i>Draft Guidelines to Reduce Adverse Effects</i>	LR	3.73	2
<i>Draft BMPs to Reduce Impacts from Stream Restoration, Culvert, or Bridge Projects</i>	BMPs	3.69	2
<i>Conduct Health Assessments</i>	RN	3.64	2
<i>Draft BMPs for Radio-Telemetry Research</i>	BMP	3.63	2
<i>Develop an Anti-poaching/Collection Strategy</i>	PBC	3.57	2
<i>Research Macro and Microhabitat Use</i>	RN	3.56	2
<i>Conduct Staff Trainings</i>	HP	3.50	3
<i>Draft BMPs to Reduce Impacts from Pipeline Projects</i>	BMP	3.50	3
<i>Evaluate Population Genetics and Develop a Genetic Library</i>	RN	3.38	3
<i>Draft BMPs to Reduce Impacts from Roadside Mowing Practices</i>	BMP	3.38	3
<i>Research Life History Traits</i>	RN	3.36	3
<i>Research the Effects of Roads</i>	RN	3.31	3
<i>Evaluate PIT Tagging Techniques</i>	RN	3.31	3
<i>Perform Population Management</i>	PM	3.27	3
<i>Improve Environmental Review Tools</i>	LR	3.25	3
<i>Research the Effects of Beaver</i>	RN	3.14	3
<i>Draft BMPs for Beaver Management</i>	BMP	3.13	3
<i>Draft BMPs for Controlling Predators</i>	BMP	3.06	3
<i>Develop a Climate Change Strategy</i>	BSC	3.06	3
<i>Compile a Bibliography of Bog Turtle Literature</i>	BSC	3.06	3
<i>Perform Beaver Control</i>	PBC	NA	3
<i>Research the Effects of Depredation</i>	RN	NA	3

7.1. POPULATION VIABILITY POTENTIAL

Bog Turtle experts from across the Northern range developed population-ranking methodology to categorize populations in terms of their potential to be viable over the long-term. Populations were ranked using 3 population quality parameters and 5 habitat quality parameters. Experts determined a weighted average for each parameter and based on overall population scores (including both the population and habitat quality parameters) populations were grouped into 3 categories: Good, Fair, and Poor. A full table of the results was sent to the state leads and the USFWS federal coordinator for Bog Turtle. For details on the ranking methodology, see section 4.2.2 in the Conservation Plan. These ranking results and/or particular ranking parameters were used to identify priority populations for specific conservation actions such as habitat protection, habitat management, and specific research projects. Resulting population priority lists are provided below.

7.2. POPULATION PRIORITY LEVEL DESCRIPTION

Priority 1: Populations that experts within the Delaware Recovery Unit deemed to be of highest priority for specific conservation actions as described below.

Priority 2: Populations that should be of next highest priority after conservation actions at priority 1 populations are underway or have been completed.

Priority 3: Populations that should be of next highest priority after conservation actions at priority 2 populations are underway or have been completed.

Priority 4: Populations that are of lowest priority for conservation actions. However, all populations are of importance for the recovery of Bog Turtles. While conservation measures are considered to be of lesser need at these populations due to the perceived likelihood of their effectiveness at recovering the species, they may prove to be valuable in particular circumstances. In general, Priority 4 populations should only be a target for conservation strategies when all other populations are considered stable or increasing, unless opportunities arise for conservation actions that will benefit these sites without affecting efforts on higher priority sites.

7.3. POPULATION PRIORITIZATION FOR HABITAT PROTECTION

Within the Delaware Recovery Unit, populations were ranked according to the effectiveness of habitat protection measure for the recovery of the species across the Northern range (Table 7). Below are the criteria used to prioritize populations for habitat protection. See section 4.2.3 in the Conservation Plan for more information.

Priority 1:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 2-4 OR

- Populations ranked as having “Good” population quality and “Good” or “Fair” habitat quality and a habitat protection score of 2-4

Priority 2:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 1 OR
- Populations ranked as having “Good” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1 OR
- Populations ranked as having “Fair” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1-4

Priority 3: “Good” or “Fair” population quality rank and “Poor” habitat quality rank and a habitat protection score of 1-4

Priority 4: All other population

Table 7. Priority level for habitat protection measures and a list of populations that fall into each priority level in Delaware, Pennsylvania and New Jersey within the Delaware Recovery Unit.

<i>Delaware</i>		<i>Pennsylvania</i>	<i>New Jersey</i>
Priority 1	None	BERK-02, BERK-12, BERK-17, BUCK-01, CHES-19, MONR-12, MONR-15, MONR-16, MONR-18	032.1, 040.2, 048.1, 052.4, 052.8, 123.1, 147.2
Priority 2	DE-2.2	BERK-03, BERK-09, BERK-10, BERK-23, BUCK-04, CHES-16, LANC-17, LEBA-07, MONR-06, MONR-13, NORT-02,	040.1, 046.2, 046.3, 049.1, 052.4, 052.7, 055.2, 067.1, 071.1, 101.1, 101.2, 147.2, 149.3
Priority 3	None	BERK-24, CHES-41, CHES-51, LEBA-04, LEHI-04, MONR-05, MONR-10, MONR-11, MONR-14, MONR-20, NORT-01, NORT-03	025.2, 061.1, 131.1, 149.2

7.4. POPULATION PRIORITIZATION FOR HABITAT MANAGEMENT

Populations were ranked within this recovery unit according to the effectiveness of habitat management measure for the recovery of the species across the Northern range (Table 8). Below are the criteria used to prioritize populations for habitat management actions. See section 4.2.3 in the Conservation Plan for more information.

Priority 1:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 3-5 OR

- Populations ranked as having “Good” population quality and “Good” or “Fair” habitat quality and a habitat protection score of 3-5

Priority 2:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 1-2 OR
- Populations ranked as having “Good” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1-2 OR
- Populations ranked as having “Fair” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 2-5

Priority 3: “Fair” population quality rank and a habitat protection score of 1

Priority 4: All other populations

Table 8. Priority level for habitat management actions and a list of populations that fall into each priority level in Delaware, Pennsylvania and New Jersey within the Delaware Recovery Unit.

	<i>Delaware</i>	<i>Pennsylvania</i>	<i>New Jersey</i>
Priority 1	DE-3.2	BERK-02, BERK-12, BERK-17, BERK-28, BUCK-01, CHES-05, CHES-15, CHES-19, MONR-12, MONR-15, MONR-16, MONR-18	032.1, 040.2, 048.1, 052.4, 052.8, 095.2, 123.1, 147.2
Priority 2	DE-2.2	BERK-23, CHES-16, CHES-18, CHES-34, LANC-17, NORT-02	040.1, 046.2, 046.3, 049.1, 052.4, 052.7, 101.1, 147.2, 149.3
Priority 3	None	BERK-03, BERK-09, BERK-10, BERK-24, BUCK-04, CHES-41, LEBA-10, LEHI-04, MONR-06, MONR-10, MONR-13, MONR-14, MONR-20	025.2, 055.2, 061.1, 067.1, 071.1

7.5. POPULATION PRIORITIZATION FOR POPULATION MONITORING, HABITAT MONITORING, AND INVENTORY/GAP SURVEYS

Extant populations were ranked for their potential to be viable over the long-term. Ranking metrics included parameters associated with population quality (e.g., population size and recruitment) and other for habitat quality (e.g., percent success and road density within and adjacent to Core Habitat). Each population was given a score for each metric and metric scores were summed for an overall population score. An expert group ranked the importance of each metric for determining a population’s ability to remain stable. Results from the survey were used to determine the weighting of each metric in the overall population score. For more details, see Section 4.2.2 of the Conservation Plan.

7.5.1. POPULATION PRIORITIZATION FOR POPULATION MONITORING

Populations with a population size score of 4-5 (Table 9) and where landowner access is granted.

Table 9. Priority populations in the Delaware Recovery Unit for population and habitat monitoring.

<i>Priority Populations for Population and Habitat Monitoring</i>	
Delaware	DE-2.2, DE-3.2
Pennsylvania	BERK-02, BERK-12, BERK-17, BERK-23, BERK-28, CHES-05, CHES-19, CHES-51, LANC-17, LEBA-07, MONR-11, MONR-12, MONR-15, MONR-16, MONR-18, NORT-01
New Jersey	040.1, 040.2, 046.3, 049.1, 052.8, 061.1, 071.1, 095.2, 123.1, 131.1, 149.3

7.5.2. POPULATION PRIORITIZATION FOR HABITAT MONITORING

Random habitat sampling should occur in Core Habitats where the population size score was 4-5 (Table 9) and landowner permission to access is granted. Targeted habitat monitoring should occur at locations where habitat management is planned, including pre- and post-management assessments, and landowner permission to access is granted.

7.5.3. POPULATION PRIORITIZATION FOR INVENTORY/GAP SURVEYS

Populations to target for inventory/gap survey are populations of Unknown occupancy (see definitions in section 1), or Extant populations with a population size score of 2 (unknown due to insufficient survey effort; Table 10). In addition, historical habitat and potential habitat patches (of unknown occupancy) should be targeted, particularly within the important habitat corridors and outside the current species' range.

Table 10. Extant populations in the Delaware Recovery Unit with unknown population size due to a lack of survey effort. These are priority sites for inventory/gap surveys in addition to site of unknown occupancy, historical, and potential habitats.

<i>Priority Populations for Inventory/Gap Surveys</i>	
Delaware	DE-2.1
Pennsylvania	BERK-03, BERK-04, BERK-08, BERK-18, BERK-19, BERK-21, BERK-27, BERK-31, BERK-36, BERK-41, BERK-42, BERK-43, CHES-08, CHES-09, CHES-14, CHES-27, CHES-28, CHES-31, CHES-38, CHES-39, CHES-41, CHES-44, CHES-53, CHES-62, DELA-01, LEBA-10, LEHI-02, LEHI-03, LEHI-07, MONR-01, MONR-02, MONR-03, MONR-04, MONR-07, MONR-14, MONR-22, MONT-02, NORT-11, NORT-13, NORT-14, NORT-18, NORT-19, NORT-20, NORT-21,
New Jersey	None listed as Population Size = 2

7.6. POPULATION PRIORITIZATION FOR POPULATION MANAGEMENT

Implementation of population management actions (i.e., captive management) have been identified as of low priority, but evaluation and identification of the most efficient and effective population

management techniques were considered a Priority 1 action. Therefore, we identify a set of priority populations as potential recipient and donor populations.

7.6.1. PRIORITY RECIPIENT POPULATIONS

Priority Recipient Populations are populations that ranked “Poor” for population quality and “Good” for habitat quality based on results from the population viability-ranking project (Table 11).

Table 11. A list of priority population for population management actions in Delaware, Pennsylvania and New Jersey for the Delaware Recovery Unit.

<i>Priority Recipient Populations</i>	
Delaware	DE-2.1, DE-3.1
Pennsylvania	BERK-19, BERK-26, CHES-53, LEBA-05, LEBA-06, MONR-03, MONR-08
New Jersey	041.1

7.6.2. PRIORITY DONOR POPULATIONS

Priority Donor Populations are populations that scored a 5 for both population size and recruitment, and ranked as “Good” for both Habitat Quality and Population Viability (Table 12). It is also recommended that population viability analysis modeling be used to determine what impact removals will have on donor populations, specifically determine what number by sex and age class can be removed without causing negative population trend.

Table 12. A list of potential donor populations for population management actions to recover populations in need (listed in table 9) in the Delaware Recovery Unit.

<i>Priority Donor Populations</i>	
Delaware	DE-3.2
Pennsylvania	BERK-28, CHES-05, MONR-15, MONR-18
New Jersey	052.8, 123.1

7.7. IMPORTANT HABITAT CORRIDORS

Important habitat corridors were identified and mapped for the purpose of improving or maintaining metapopulation dynamics. Results from geospatial analyses and evaluation of observational and population data were used to identify the most important habitat corridors between top-ranking Core Habitats throughout the Northeastern range. Corridors were ranked in order of importance for habitat protection and management actions. Below are the criteria used to prioritize populations for habitat management actions. Spatial data (with ranking results) were

provided to the state leads and the regional federal coordinator for Bog Turtle conservation. See section 4.2.4 in the Conservation Plan for more information.

Priority 1: Habitat between all extant populations within a single Metapopulation and with ≥ 1 population that ranked as “Good” for viability. These locations are of highest priority for habitat protection and management actions. These are also important locations for locating and surveying other potential wetland habitat.

Priority 2: Habitat between all extant populations (and Core Habitats within each population) within a single Metapopulation and with ≥ 1 population that ranked as “Fair” for viability.

Priority 3: Habitat between all extant populations (and Core Habitats within each population) within a single Metapopulations and with only populations that ranked as “Poor” for viability.

Priority 4: Linkages between two or more populations that ranked as “Good” for viability and are not currently part of the same metapopulation (based on the mapping guidelines), are within 2 km of each other, and are not separated by a 4-lane highway or multiple high traffic state roads.

VIII.

IMPLEMENTATION PLAN

This implementation plan should be used to identify top priority strategies needed for the recovery of populations in the Susquehanna-Potomac Recovery Unit (Table 14). It identifies populations where specific actions are most needed, a rough target timeline benchmarks for completing each action, identifies the responsible organization and potential partners to assist with each strategy.

Table 13. A list of agencies that are potential partners for one or more conservation strategy and their abbreviation code. These codes are found in Table 14.

<i>Code</i>	<i>Agency</i>
AI	Academic Institutions
BZOO	Baltimore Zoo
COE	U.S. Army Corps of Engineers
DOD	U.S Department of Defense
DOT	Federal or State Departments of Transportation
EC	Environmental Consultants
EPA	U.S. Environmental Protection Agency
ES	USFWS, Ecological Services
LE	Federal or State Law Enforcement
LG	Local and Municipal Agencies
NGO	Nongovernmental Organizations
NRCS	USDA, Natural Resource Conservation Service
NWR	USFWS, National Wildlife Refuges

<i>Code</i>	<i>Agency</i>
PFW	USFWS, Partners for Fish and Wildlife
PL	Private Landowners
SA	State Agencies, other than the wildlife agencies
SL	State Legislature
SWA	State Wildlife Agencies
USFWS	USFWS, other programs
USGS	U.S. Geological Survey

8.1. IMPLEMENTATION TABLE

An implementation table was constructed to help guide conservation partners to address the most pressing conservation needs (Table 14).

Table 14. Conservation Strategy descriptions, their priority level of implementation, the location in the Conservation Plan (CP Section) where specific actions are outlined, priority populations to target for each strategy, the timeline for action, organizations responsible for implementation and potential partners to complete the work.

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.2.1	Obtain Funding to support conservation actions	Extant Populations	Ongoing	ES, SWA	All Partners
1	4.4.1	Conduct Succession/Invasive Plant Management	Use the Habitat Management Priority List	Ongoing	ES, SWA	All Partners except LE and SL
1	4.5.1	Research the Effectiveness of Habitat Management to evaluate specific techniques and compare results among techniques	Use the Habitat Management Priority List	<5 yrs	ES, SWA	NRCS, AI, NGO, EC
1	4.6.3	Require Surveyor Qualifications	Not Applicable	Completed†	ES, SWA	EC
1	4.4.3	Engage in Landowner Outreach for Habitat Management	Use the Habitat Management Priority List	Ongoing	ES, SWA	All Partners except LE and SL

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.4.2	Restore Hydrology within Core Habitat	Populations with “Good” or “Fair” Population Quality and “Fair” Habitat Quality due to disturbed hydrology	<5 yrs	ES, SWA, NRCS	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA, USFWS, USGS
1	4.3.2	Engage in Landowner Outreach for Habitat Protection	Use the Habitat Protection Priority List	Ongoing	ES, SWA	NRCS, PFW, RW, NGO, LG, EC, PL
1	4.2.3	Prioritize Populations for Habitat Protection	Use the Habitat Management Priority List	Completed†	ES, SWA	NGO, AI, EC
1	4.2.3	Prioritize Populations for Habitat Management	Use the Habitat Management Priority List	Completed†	ES, SWA	NGO, AI, EC
1	4.2.8	Develop a Communication Strategy	Not Applicable	<5 yrs	ES, SWA	All Partners
1	4.5.2	Conduct Inventory/Gap Surveys to identify populations and improve our understanding of the species distribution	N/A	Ongoing	ES, SWA	NGO, AI, EC, PL
1	4.2.2	Rank Populations for Viability , their potential to be viable	Extant Populations	Completed†	ES, SWA	NGO, AI, EC
1	4.6.1	Seek Max Penalties on Violations of the ESA	N/A	5-10 yrs	ES, SWA	LE, SL
1	4.2.4	Map Important Habitat Corridors	Between Populations with “Good” or “Fair” viability and within 3 km of each other	Completed†	ES, SWA	NGO, AI
1	4.6.2	Revise the Recovery Plan and Re-evaluated the Recovery Criteria	Not Applicable	<5 yrs	ES, SWA	EC, AI, NGO

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.3.1	Connect Fragmented Habitat	Within Important Habitat corridors	5-10 yrs	ES, SWA	NGO, LG, SA, USFWS
1	4.2.5, 4.2.6	Implement Population and Habitat Monitoring	Extant Populations with Pop Size Score of ≥3	Ongoing	ES, SWA	EC, NGO
1	4.5.3	Research the Effects of Agriculture, Pesticides, and Herbicides on Core Habitat quality	Extant Population Adjacent to Agriculture; Populations with “Poor” Population Quality and “Good” Habitat Quality and Reference Populations*	<5 yrs	ES, SWA	NRCS, AI, EC, NGO
1	4.7.2	Draft a Population Management Decision Tree , proactive and reactive versions	Not Applicable	Completed	ES, SWA	NGO
1	4.7.1	Identify Best Population Management Techniques to recover Bog Turtle populations	Use Population Management Priority List	<5 yrs	ES, SWA	AI, Zoos
1	4.2.9	Monitor Progress of Conservation Actions	All Populations	Ongoing	ES, SWA	None
2	4.5.4	Research Hydrology and Water Chemistry at Bog Turtle sites including the collection of baseline data	Opportunistic ally	<5 yrs	ES, SWA	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA, NRCS, USFWS, USGS, AI
2	4.9.3	Draft BMPs to Reduce Impacts from Development Projects	Extant Populations	<5 yrs	ES, SWA	NGO, AI,

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
2	4.3.3	Engage in Mitigation Banking to Protect Habitat	Population with “Good” viability or “Good” Population Quality and Fair Habitat Quality	<5 yrs	ES, SWA	LG, NGO, EC
2	4.5.5	Research the Effects of Development on Core Habitat quality	Populations pre- and post-development or affected populations and reference populations*	<5 yrs	ES, SWA	AI, NGO, EC
2	4.3.4	Develop a Stewardship Program(s)	Opportunistic ally	5-10 yrs	ES, SWA	NRCS, PL, EC, NGO, AI
2	4.6.6	Revise Regulations to Improve Protection for the Bog Turtle	Not Applicable	5-10 yrs	ES, SWA	EC, NGO, AI
2	4.4.4	Restore Relic Fens	Historic Populations ≤1.5 km from an Extant Population with “Good” Viability	5-10 yrs (opportunistically)	ES, SWA	COE, USGS, EPA
2	4.9.1, App. F	Draft BMPs to Improve Road Passageways near Bog Turtle habitat and protective measures during construction	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, AI, EC
2	4.2.7	Create a Standardized Regional Database	All Populations	Ongoing	ES, SWA	NGO, AI, EC
2	4.8.5	Train Law Enforcement on the turtle collection threat and abatement measures	All Populations	Ongoing	ES, SWA	LE, NGO, EC, AI
2	4.6.4	Implement Regional Survey Protocols for Consultants	Not Applicable	Ongoing	ES, SWA	EC

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
2	4.8.1	Protect Nests from predators	Populations with “Fair” Population Quality and “Good” Habitat Quality	Ongoing (as needed)	ES, SWA	NGO, EC, AI
2	4.8.1	Perform Predator Control	As the need arises	Ongoing (as needed)	ES, SWA	NRCS, USFWS, SA, RW, Trappers
2	4.5.7	Develop and Evaluate eDNA techniques	Not Applicable	Completed; some continued research possible	ES, SWA	AI, NGO
2	4.7.3	Draft Guidelines for Population Management	Extant Populations	<5 yrs	ES, SWA	Zoos (particularly TN Zoo and WCS), NGOs
2	4.6.5	Draft Guidelines to Reduce Adverse Effects	Not Applicable	5-10 yrs	ES, SWA	EC, AI, NGO
2	4.9.4, App. I	Draft BMPs to Reduce Impacts from Stream Restoration, Culvert, and Bridge Projects	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, EC, AI
2	4.5.9	Conduct Health Assessments	Populations where disease is suspected and a subset of Pops with “Good” and “Fair” viability	Ongoing	ES, SWA	WCS, BZOO, Veterinarians, Animal Health Research Laboratories
2	4.9.6	Draft BMPs for Radio-Telemetry Research	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO
2	4.8.4	Develop an Anti-Poaching/Collection Strategy	All Populations	<5 yrs	ES, SWA	LE, AI, NGO
2	4.5.6	Research Macro and Microhabitat Use	As the need arises	Ongoing (as needed)	ES, SWA	AI, NGO

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
3	4.3.5	Conduct Staff Trainings for state and federal partners as well as non-governmental conservation organizations.	Not Applicable	<5 yrs	ES, SWA	NGO, EC, RW
3	4.9.5	Draft BMPs to Reduce Impacts from Pipeline Projects	Extant Populations	<5 yrs	ES, SWA	EC, AI, NGO
3	4.5.13	Evaluate Population Genetics and Develop a Genetic Library	Extant Populations	5-10 yrs or <5 yrs if done in conjunction with other genetic projects	ES, SWA	AI, EC, NGO
3	4.9.2	Draft BMPs to Reduce Impacts from Roadside Mowing Practices	Extant Populations	Ongoing	ES, SWA	DOT, LG, NGO
3	4.5.14	Research Life History Traits	As the need arises	Ongoing (if needed)	ES, SWA	AI, EC, NGO
3	4.5.8	Research the Effects of Roads on Bog Turtles and their habitat	Populations with "Poor" Population Quality and "Good" Habitat Quality and Reference Populations*	<5 yrs	ES, SWA	DOT, EC, AI, NGO, COE, EPA, LG
3	4.5.11	Evaluate PIT Tagging Techniques	Not Applicable	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.7.4	Perform Population Management	Use Population Management Decision Tree	5-10 yrs (if needed)	ES, SWA	Zoos, AI
3	4.6.7	Improve Environmental Review Tools	Not Applicable	Ongoing	ES, SWA	EC
3	4.5.12	Research the Effects of Beaver on Bog Turtles and their habitat	As the need arises	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.9.8	Draft BMPs for Beaver Management, particularly for the Hudson-Housatonic Recovery Unit	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
3	4.9.7	<i>Draft BMPs for Controlling Predators</i>	Extant Populations	5-10 yrs	ES, SWA	NRCS, USFWS, SA, RW, Trappers
3	4.2.10	<i>Develop a Climate Change Strategy</i>	All Populations	5-10 yrs or <5 yrs if done in conjunction with other related projects	ES, SWA	AI, USFWS, SA, USGS, EC, NGO
3	4.2.11	<i>Compile a Bibliography of Bog Turtle Literature</i>	Not Applicable	Ongoing	ES, SWA	None
3	4.8.2	<i>Perform Beaver Control</i>	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.5.10	<i>Research the Effects of Depredation</i>	As the need arises	5-10 yrs (if needed)	ES, SWA	AI, NGO

*CP=Conservation Plan

† These actions should periodically be re-evaluated

IX. MECHANISM FOR REPORTING AND/OR UPDATING THE PLANS

The Conservation Plan should be reviewed and updated every 5-10 years. It is recommended that the Conservation Plan be updated just prior to USFWS 5-year review.

X. LIST OF RECOVERY UNIT MEETING PARTICIPANTS

In both 2016 and 2017 a group of Bog Turtle experts, professionals who work in the Delaware Recovery Unit, gathered to participate in expert surveys to determine the top threats and limiting factors negatively affecting Bog Turtle populations in this recovery unit. They also ranked conservation strategies to provide insights on the most needed actions for the recovery of the species in the Delaware Recovery Unit.

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APPENDIX B: HUDSON-HOUSATONIC RECOVERY UNIT ACTION PLAN

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I. DEFINITIONS

Core Habitat – A wetland that meets Bog Turtle suitable habitat requirements where turtles are most frequently found. Multiple Core Habitat areas may be found within a single delineated wetland but may cross multiple parcels.

Extant Population – Populations where there has been a turtle observation in appropriate habitat in the past 30 yrs.

Extirpated Population – Population where the habitat was destroyed and no habitat remains.

Historical Population – Populations where habitat is present, no turtles were observed in the past 30 yrs or a full Phase 2 survey occurred (since turtles were last found within 30 years) and no turtles were found

Metapopulation - Populations with genetic exchange feasible through occasional dispersal events. Populations are close enough to each other to allow occasional movements within one generation time (10-40 years) of an individual: < 3 km of contiguous wetland, < 2 km of intermediate or mosaic upland-wetland habitat, or < 1.5 km undeveloped upland habitat.

Population - A functionally reproductive group of individuals (e.g. at least one individual from each sex or evidence of reproduction such as presence of a hatchling or juvenile) using one or more Core Habitat areas, which are within 300 m of each other with no major barriers between them. Movement between Core Habitat patches likely occurs every 1-10 years.

Unknown Population – Locations where there has been a turtle observation in past 30 yrs, a full Phase II survey has NOT been completed, and one or more of the following is true:

- Historical observation, but no survey work occurred and habitat exists
- Recent road observation, no surveys occurred, and habitat exists within 30 m
- Recent observation resulting from environmental review project, survey stopped as soon as a turtle was found, no further surveys were performed, and habitat exists.

II. INTRODUCTION

2.1. ACTION PLAN USE AND PURPOSE

This document is for use by state and federal partners to guide their conservation efforts over the next 5-10 years, for the Bog Turtle in the Hudson-Housatonic Recovery Unit. This Action Plan summarizes the most prominent threats and limiting factors, describes the status of the species within this recovery unit, and identifies and prioritizes specific strategies needed for recovery of the species. It also provides an implementation schedule with a timeline for completing these actions. This Recovery Unit Action Plan identifies specific recovery unit priorities and should be used in conjunction with the Conservation Plan (2019), which identifies regional level priorities across all recovery units in the Northern population range (Figure 1). Data resulting from Bog Turtle expert surveys provides the basis for these recommendations. This living document should periodically be re-evaluated and updated.

2.2. HUDSON-HOUSATONIC RECOVERY UNIT

The Hudson-Housatonic Recovery Unit extends from Northeastern New Jersey north through western Connecticut, western Massachusetts, and southeastern New York (Fig. 1). This recovery unit has three sub-units (Fig. 2).

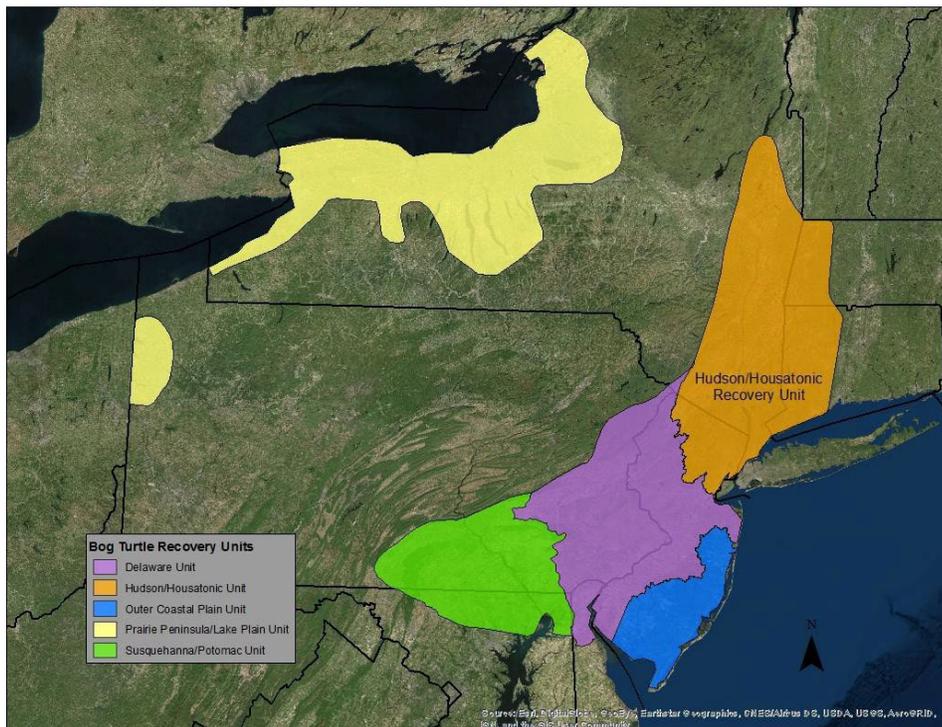


Figure 1. Map showing the Northern population range of the Bog Turtle, separated into 5 recovery units. The Hudson-Housatonic Unit (orange) is along the Northern end of the range.

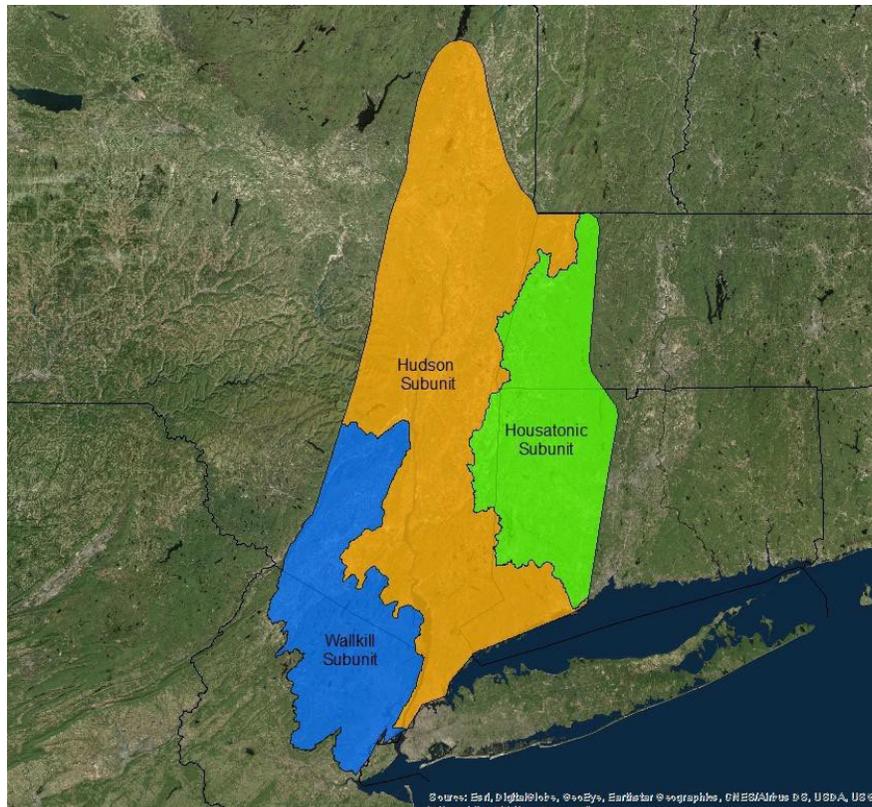


Figure 2. Map showing the Hudson-Housatonic Recovery Unit and its three subunits, the Wallkill (blue), Hudson (orange), Housatonic (green) subunits.

2.3. POPULATION STATUS

Some information exists on the current status of populations in the northeast. Below we summarize data on range changes, the number of newly discovered populations (since time of federal listing), number of extant populations, and population viability based on a recent assessment.

- Range changes: Historical and current (within past 30 years) Bog Turtle observation data were used to create historical and current range maps. The historical range map was delineated by creating a 10 km buffer off all HUC12 sub-watersheds containing historically and/or current turtle observations. A current range map was similarly created using only the HUC12 sub-watersheds with current observations. Based on these data the species' range has contracted by 58% in the Hudson-Housatonic Recovery Unit, resulting in a loss of 3,932,020 acres. The historical range includes all observations of the Bog Turtle (historical, extirpated, extant, and unknown) whereas the current range only includes the range for extant populations.
- Number of populations in the recovery unit discovered since 1997 (time of federal listing): Twelve NJ, 41 NY, and 1 CT population.
- Number of Extant Populations, Metapopulations and Core Habitats: Number of each is listed by state in Table 1.

Table 1. Number of extant populations, extant metapopulations and extant core habitats identified by state biologists in New Jersey, New York, Connecticut, and Massachusetts, which make up the Hudson-Housatonic Recovery Unit.

	<i># Extant Pops</i>	<i># Extant Metapops</i>	<i># Extant Core Habitats</i>
<i>New Jersey*</i>	67	12	76
<i>New York</i>	54	14	62
<i>*Connecticut</i>	4	0	4
<i>*Massachusetts</i>	2	0	2
<i>Total</i>	127	26	144

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*Additional extant populations, extant metapopulations and core habitats are found in New Jersey – see Delaware and Outer Coastal Plan Recovery Unit Action Plans.

- **Extant Population Viability Ranking:** Below is a breakdown of the rankings of populations in the Hudson-Housatonic Recovery Unit (Table 2). For additional information on the methodology used to rank populations, see section 4.2.2 of the Conservation Plan.

Table 2. The number of populations by state that were ranked as Good, Fair, and Poor for their potential to be viable over the long term in the Hudson-Housatonic Recovery Unit.

	<i>Good</i>	<i>Fair</i>	<i>Poor</i>	<i>Total</i>
<i>New Jersey</i>	17	14	36	67
<i>New York</i>	11	13	30	54
<i>Connecticut</i>	0	3	1	4
<i>Massachusetts</i>	2	0	0	2
<i>Total</i>	30	30	67	127

III.

THREATS AND LIMITING FACTORS

This section identifies and ranks threats and limiting factors affecting the status and recovery of the Bog Turtle. A list of threats and limiting factors was developed for the Recovery Plan and expanded during a species recovery meeting in 2011. In 2017-2018, experts in each of the recovery units participated in ranking these threats and limiting factors based on the risk level or degree of negative influence each has on the Bog Turtle populations in that recovery unit. Threats were ranked as high (3 points), moderate (2 points), low (1 point), or unknown risk (no points) and limiting factors were ranked as very limiting (3 points), somewhat limiting (2 points), not limiting (1 point) and Unknown (no points). Mean scores were calculated and used in a relative comparison (Fig. 3 and 5).

3.1. THREATS

The top current threats identified by experts in the Hudson-Housatonic Recovery Unit included habitat degradation due to direct and indirect effects of increased development, altered hydrology, ecological succession, beaver, roads, proliferation of invasive plants, and agricultural activities (Fig. 3). Rankings differed slightly among the sub-units (Fig. 4) for a few threats. Beaver and oil spills

appear to be of lower concern in the Hudson subunit. Development, roads, and salt/contaminants are of lower concern in the Housatonic subunit, while disease is of lower concern in the Wallkill subunit. Invasive plants are a greater concern in the Housatonic and Agriculture is of greater concern in the Wallkill subunit. There were also some differences in the order of these threats among the subunits, however, development and altered hydrology ranked among the top 5 threat for all three subunits. The threat of beaver and invasive plants were of greater concern in the Housatonic subunit. Succession was a top threat in the Housatonic and Hudson subunits and roads were a top threat in the Hudson and Wallkill subunits (Fig. 3). A high degree of uncertainty was associated with disease. For more details, see the Species Status Assessment (currently in development).

State lead biologists compiled historical and current observational data, which was entered into a centralized regional database developed by USFWS. For each population, they provided information (to the best of their knowledge) on current habitat conditions for hydrology and percent of invasive plants and succession. The state biologist also noted any depredation events and/or poaching events that were known or likely to have occurred at any time in the past. These data extracted from the regional database also provide some insights on threats although these numbers are almost certainly underestimations of the true values:

- Disturbance to Hydrology: This was noted for 40 NJ, 42 NY, 4 CT, and 1 MA population
- Invasive Plants and Succession: Cover >60% of the Core Habitat in 1 NY and 1 CT population. Succession was >41% for 7 NJ populations.
- Development Pressure: Exists in the Core Habitat or both the Core Habitat and the 300ft Buffer in 3 NJ and 35 NY populations in this recovery unit.
- Depredation: This occurred in 6 extant NJ and 1 MA population between 2008 and 2016, and likely occurred at another 2 NY populations. Data should be added for NJ.
- Poaching: This occurred in 1 extant NY population in 1990 and likely occurred in another 4 NY populations (dates unknown). Data should be added for NJ.

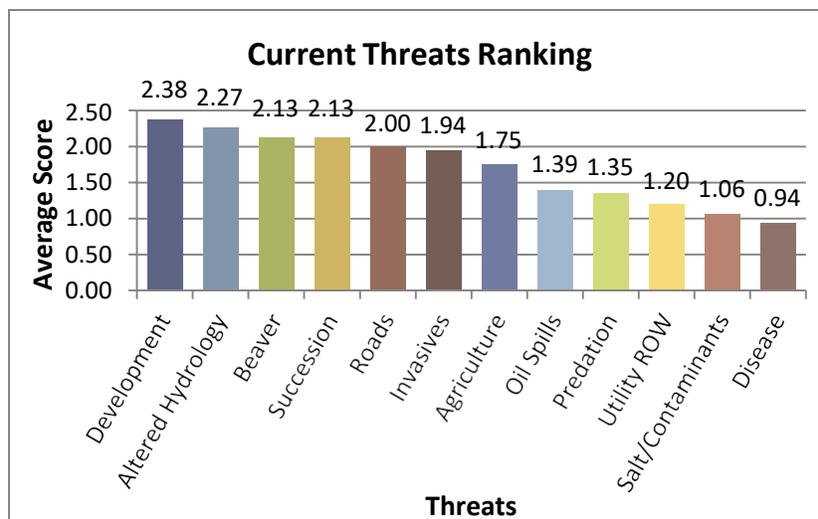


Figure 3. Threats to the Bog Turtle ranked in order of degree of their effect on populations within the Hudson-Housatonic Recovery Unit. Higher average scores indicate threats of greater effect.

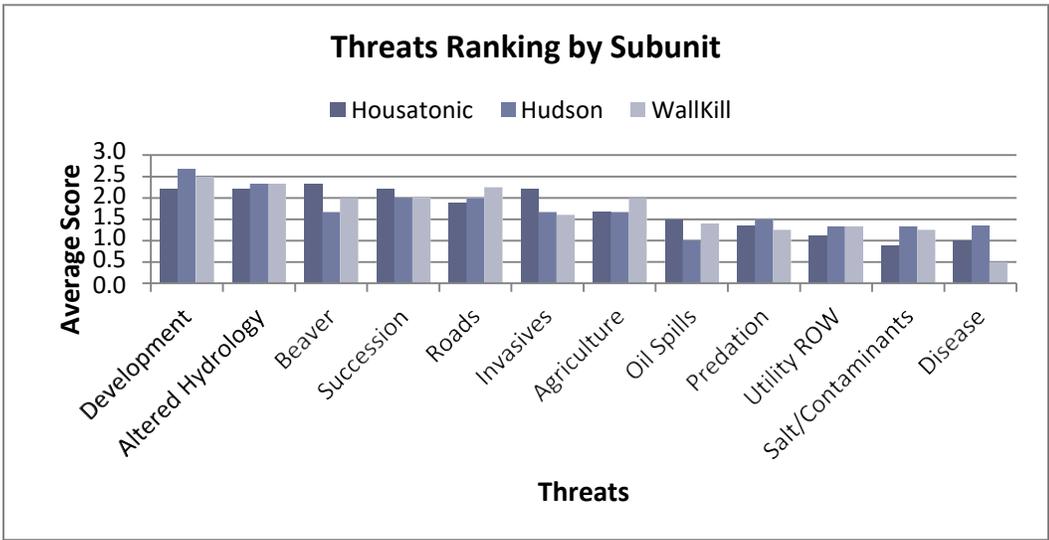


Figure 4. A comparison of the degree of effect of threats among sub-units of the Hudson-Housatonic Recovery Unit.

3.2. LIMITING FACTORS TO RECOVERY

Experts ranked current Limiting Factors that limit recovery of a species beyond threats. Top limiting factors for the Hudson-Housatonic Recovery Unit include the degree of habitat protection measures, habitat quality, a lack of connectivity between populations, coordination among the conservation partners, and landowner outreach (Fig. 5). Ranking of limiting factors differed somewhat among the sub-units (Fig. 6).

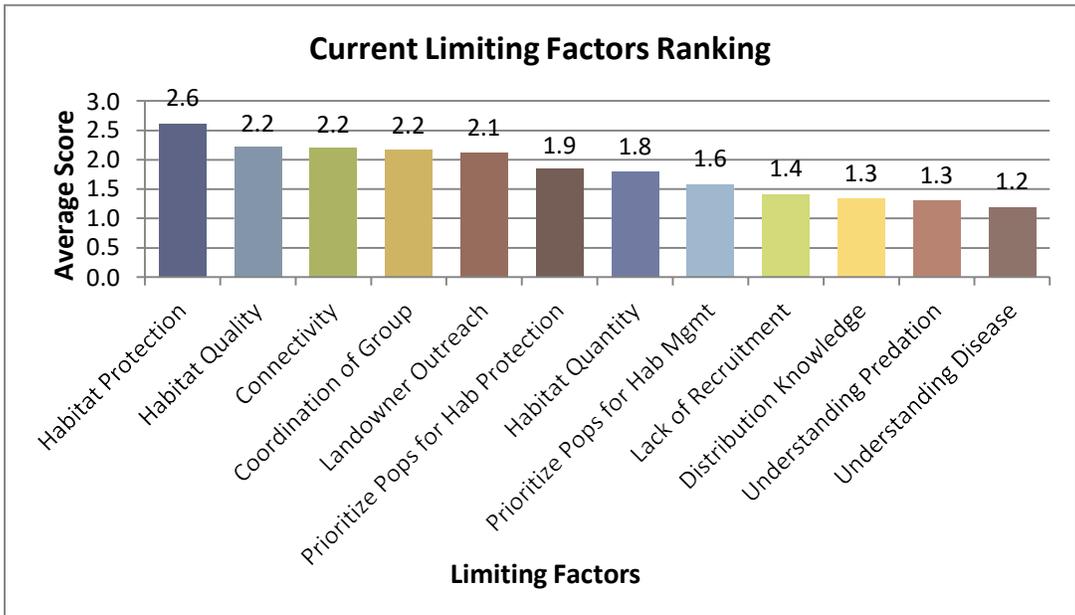


Figure 5. Limiting factors ranked in order of the degree of effect on population in the Hudson-Housatonic Recovery Unit. Higher scores indicate threats of greater effect.

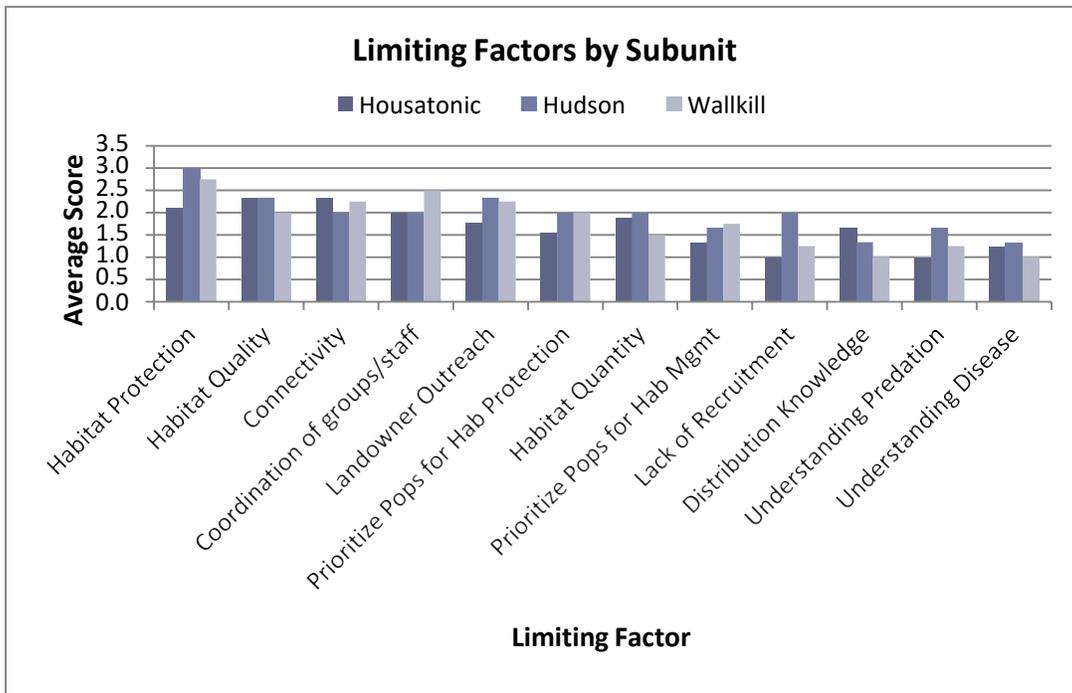


Figure 6. A comparison of the degree of effect of limiting factors among sub-units of the Hudson-Housatonic Recovery Unit.

Habitat protection was a top concern for all three subunits. Habitat quality, connectivity and coordination of groups were top limiting factors in the Housatonic subunit. Habitat quality and landowner outreach were among the top three factors in the Hudson subunit. Connectivity, coordination of groups, and landowner outreach were the other top limiting factors for the Wallkill subunit. For more details, see the Species Status Assessment (currently in development).

IV. PROGRESS

The data presented below were compiled using information from the multi-state regional database for all years. The health assessments did not begin until 2001 and the regional population and habitat monitoring did not begin until 2014. The values below only represent partial data for the 2018 field season.

4.1. PROGRESS TOWARDS RECOVERY

Considerable effort has gone into discovering new populations, better understanding population abundance and recruitment of known populations, protecting habitat, improving habitat quality, and understanding demographics of populations and site-specific habitat use. The values below are for all actions noted for all years data is present.

4.1.1. POPULATION SURVEYS

Various types of surveys have been conducted over the years (Table 3). Regional sampling occurred in recent years for tracking of population trends (survey protocols can be found in Section 4.2.5 and 4.2.6 of the Conservation Plan). Phase 1, 2, 3 surveys are designed to determine presence/absence of Bog Turtle in wetlands and are typically performed in response to a development project proposal (see USFWS 2018 for more details). Health assessments have also been completed for numerous populations in the Hudson-Housatonic Recovery Unit.

Table 3. The type of survey and number of populations where each survey type was performed in New York, New Jersey, Connecticut and Massachusetts for populations in the Hudson-Housatonic Recovery Unit. This is based on all available data in the state's database. Negative survey data has not been tracked in most states.

<i>Type of Survey</i>	<i>NY</i>	<i>NJ</i>	<i>CT</i>	<i>MA</i>
<i>Regional Population Monitoring: Rapid Assessments</i>	19	6	1	2
<i>Regional Population Monitoring: Intensive Sampling</i>	2	0	0	2
<i>Regional Habitat Monitoring: Random Sampling</i>	19	8	0	0
<i>Regional Habitat Monitoring: Targeted Sampling</i>	0	2	0	2
<i>Phase 1 surveys</i>	0	?	0	2
<i>Phase 2 surveys</i>	0	?	4	2
<i>Phase 3 surveys</i>	1	?	?	2
<i>Health Assessments</i>	3	10	0	2

4.1.2. HABITAT PROTECTION

Habitat protection here includes properties purchased for conservation purposes and properties with an easement (conservation or agricultural; Table 4).

Table 4. Different levels of habitat protection and the number of populations with each type of protection level for New York, New Jersey, Connecticut and Massachusetts populations in the Hudson-Housatonic Recovery Unit.

<i>Type and Location of Protection</i>	<i>NY</i>	<i>NJ</i>	<i>CT</i>	<i>MA</i>
<i>Full permanent protection of the Core Habitat</i>	10	15	1	2
<i>Partial permanent protection of the Core Habitat</i>	2	15	1	0
<i>Full permanent protection of the 300 ft Buffer</i>	5	4	0	0
<i>Partial permanent protection of the 300 ft Buffer</i>	9	13	4	2
<i>Partial temporary protection</i>	12	0	0	0

4.1.3. HABITAT MANAGEMENT

Habitat management to remove woody and invasive plants has been a key conservation measure used in previous years. Below is a rough summary (based on what information exists) of prior management actions.

- Habitat Management Projects: Occurred in 15 NY, 9 NJ, 1 CT, and 2 MA populations
- Habitat Management Plans: Data should be added for the number of site-specific habitat management plans

4.1.4. DEMOGRAPHIC AND HABITAT USE DATA

Site-specific demographics and habitat use can provide insight on critical habitat features and inform habitat management actions. Several such studies have occurred since the species was listed. Below is a rough summary (based on what information exists) of prior research in this area of study.

- Data should be added for the number of sites with demographic research since listing.
- Data should be added for the number of sites with site-specific habitat use (tracking) data.

V.

CONSERVATION APPROACH

The following sections identify and prioritize conservation strategies to be implemented, populations and important habitat corridors to target for these conservation actions, and lay out an implementation plan and benchmarks recommended for the Hudson-Housatonic Recovery Unit. This approach is based on a broad-scale perspective as well as a local perspective, which is important to obtain recovery of the species across the Northern range. Priorities outlined here should be used to determine actions to propose for grants and other funding opportunities. As funding and resources become available conservation partners should use this action plan to address the highest priority actions, not yet completed, in the Hudson-Housatonic Recovery Unit and use these priority population lists to maintain and recover populations. However, lower priority conservation actions or actions at lower priority populations may still be warranted based on opportunities that arise and other agency priorities. Non-prioritized conservation actions for particular populations or innovative new ideas may also help with recovery of the Bog Turtle.

VI.

RANKING CONSERVATION STRATEGIES

Bog Turtle expert surveys were used to rank conservation strategies in order of effectiveness and/or need. Experts that work in the Hudson-Housatonic Recovery Unit were polled to determine what conservation strategies would be most effective and are in greatest need for the recovery of the species in this region. A list of conservation strategies was developed during a species recovery meeting in 2011. In 2017-2018, experts in each recovery unit participated in ranking these strategies based on the risk level or degree of positive influence each has on the Bog Turtle populations in that recovery unit. Conservation strategies were ranked from 1-5 with 5 being very important for the recovery of the species and 1 being less important. Mean scores were calculated to identify priority actions (Table 5) and strategies were grouped into categories (Table 6).

6.1. CONSERVATION STRATEGIES PRIORITY LEVEL DESCRIPTION

Priority 1: Strategies that experts within the Hudson-Housatonic Recovery Unit deemed to be the most urgent and effective for recovery. These actions should be completed before all other conservation strategies. Some of these actions have already been completed, are currently being implemented, or are planned for implementation in the next few years.

Priority 2: Strategies that should be implemented after priority 1 strategies are underway or have been completed.

Priority 3: Strategies that are of lowest priority for implementation. However, these strategies have been identified as being useful for the recovery of Bog Turtles. While these measures are considered to be of lesser need, they may prove to be valuable in particular circumstances. In general, these actions should only be implemented after priority 1 and 2 strategies are underway or have been completed.

6.2. CONSERVATION STRATEGIES PRIORITIZATION

Bog Turtle experts that work in the Hudson-Housatonic Recovery Unit ranked conservation strategies for the Hudson-Housatonic Recovery Unit. Survey results are shown below with the conservation strategies organized from those deemed of greatest importance (or most effective for achieving recovery of the Bog Turtle) in this recovery unit to those that were considered least important. However, all conservation strategies listed were identified as needs for the Bog Turtle. This information should be used to prioritize conservation efforts in the Hudson-Housatonic Recovery Unit, to determine which strategies should be implemented first, and to justify funding for related projects. Ranking categories are as follows: strategies that scored ≥ 3.80 are ranked as Priority 1, 3.50-3.79 are Priority 2, and ≤ 3.50 are Priority 3.

Table 5. A list of abbreviations for categories of conservation strategies used to recover the Bog Turtle.

<i>Abbreviation</i>	<i>Conservation Strategy Category</i>
BMPs	Best Management Practices
BSC	Broad Scale Conservation
HM	Habitat Management
HP	Habitat Protection
LR	Laws and Regulations
PBC	Predators and Beaver Control
PM	Population Management
RN	Research Needs

Table 6. Conservation strategies for the Northern population of the Bog Turtle. Strategies are listed in order of their expected benefit to the recovery of the Bog Turtle based on Hudson-Housatonic Recovery Unit expert survey scores. Conservation strategies are grouped into categories (e.g.,

habitat protection or laws and regulations) and the Conservation Plan section is provided (CP Section).

<i>Conservation Strategy</i>	<i>Strategy Category</i>	<i>RU Mean Score</i>	<i>Priority Level</i>
<i>Obtain Funding</i>	BSC	5.00	1
<i>Implement Population and Habitat Monitoring</i>	BSC	4.83	1
<i>Engage in Landowner Outreach for Habitat Protection</i>	HP	4.75	1
<i>Conduct Succession/Invasive Plant Management</i>	HM	4.67	1
<i>Research the Effectiveness of Habitat Management</i>	RN	4.50	1
<i>Connect Fragmented Habitat</i>	HP	4.50	1
<i>Map Important Habitat Corridors</i>	BSC	4.50	1
<i>Research Hydrology & Water Chemistry</i>	RN	4.50	1
<i>Research the Effects of Agriculture, Pesticide, and Herbicide</i>	RN	4.42	1
<i>Engage in Landowner Outreach for Habitat Management</i>	HM	4.42	1
<i>Revise the Recovery Plan and Re-evaluate the Recovery Criteria</i>	LR	4.36	1
<i>Restore Hydrology</i>	HM	4.33	1
<i>Monitor Progress on Conservation Actions</i>	BSC	4.33	1
<i>Prioritize Populations for Habitat Protection and Management</i>	BSC	4.25	1
<i>Conduct Health Assessments</i>	RN	4.25	1
<i>Rank Populations for Viability</i>	BSC	4.23	1
<i>Seek Max Penalties on Violations of the ESA</i>	LR	4.17	1
<i>Conduct Inventory/Gap Surveys</i>	RN	4.17	1
<i>Research the Effects of Beaver</i>	RN	4.17	1
<i>Draft BMPs to Reduce Impacts from Development Projects</i>	BMP	4.08	1
<i>Implement USFWS Survey Protocols</i>	LR	4.08	1
<i>Require Surveyor Qualifications</i>	LR	4.08	1
<i>Develop a Communication Strategy</i>	BSC	4.00	2

<i>Conservation Strategy</i>	<i>Strategy Category</i>	<i>RU Mean Score</i>	<i>Priority Level</i>
<i>Draft BMPs to Improve Road Passageways</i>	BMP	4.00	2
<i>Research the Effects of Development</i>	RN	4.00	2
<i>Protect Nests and Perform Predator Control</i>	PBC	4.00	2
<i>Identify Best Population Management Techniques</i>	PM	4.00	2
<i>Engage in Mitigation Banking to Protect Habitat</i>	HP	4.00	2
<i>Draft BMPs for Beaver Management</i>	BMP	4.00	2
<i>Draft Guidelines for Population Management</i>	PM	3.92	2
<i>Research Macro & Microhabitat Use</i>	RN	3.83	2
<i>Draft BMPs to Reduce Impacts from Stream Restoration, Culvert, or Bridge Projects</i>	BMPs	3.82	2
<i>Develop and Evaluate eDNA Techniques</i>	RN	3.75	2
<i>Draft a Population Management Decision Tree</i>	PM	3.73	2
<i>Create a Standardized Regional Database</i>	BSC	3.70	2
<i>Conduct Staff Trainings</i>	HP	3.67	2
<i>Draft BMPs to Reduce Impacts from Roadside Mowing Practices</i>	BMP	3.67	2
<i>Research the Effects of Depredation</i>	RN	3.62	2
<i>Research the Effects of Roads</i>	RN	3.62	2
<i>Draft BMPs for Radio-Telemetry Research</i>	BMP	3.67	2
<i>Develop a Stewardship Program(s)</i>	HP	3.58	2
<i>Restore Relic Fens</i>	HM	3.58	2
<i>Research Life History Traits</i>	RN	3.50	3
<i>Develop a Climate Change Strategy</i>	BSC	3.50	3
<i>Improve Environmental Review Tools</i>	LR	3.50	3
<i>Evaluate Population Genetics and Develop a Genetic Library</i>	RN	3.42	3
<i>Revise Regulations to Improve Protection</i>	LR	3.33	3
<i>Draft BMPs to Reduce Impacts from Pipeline Projects</i>	BMP	3.33	3
<i>Draft Guidelines to Reduce Adverse Effects</i>	LR	3.33	3

<i>Conservation Strategy</i>	<i>Strategy Category</i>	<i>RU Mean Score</i>	<i>Priority Level</i>
<i>Compile a Bibliography of Bog Turtle Literature</i>	BSC	3.33	3
<i>Evaluate PIT Tagging Techniques</i>	RN	3.33	3
<i>Draft BMPs for Controlling Predators</i>	BMP	3.25	3
<i>Develop an Anti-poaching/Collection Strategy</i>	PBC	3.17	3
<i>Train Law Enforcement</i>	PBC	3.08	3
<i>Perform Population Management</i>	PM	2.73	3
<i>Perform Beaver Control</i>	PBC	NA	3

VII. PRIORITY POPULATIONS AND IMPORTANT HABITAT CORRIDORS

7.1. POPULATION VIABILITY POTENTIAL

Bog Turtle experts from across the Northern range developed a population-ranking methodology to categorize populations in terms of their potential to be viable over the long-term. Populations were ranked using 3 population quality parameters and 5 habitat quality parameters. Experts determined a weighted average for each parameter and based on overall population scores (including both the population and habitat quality parameters) populations were grouped into 3 categories: Good, Fair, and Poor. A full table of the results was sent to the state leads and the USFWS federal coordinator for Bog Turtle. For details on the ranking methodology, see section 4.2.2 in the Conservation Plan. These ranking results and/or particular ranking parameters were used to identify priority populations for specific conservation actions such as habitat protection, habitat management, and specific research projects. Resulting population priority lists are provided below.

7.2. POPULATION PRIORITY LEVEL DESCRIPTION

Priority 1: Populations that experts within the Hudson-Housatonic Recovery Unit deemed to be of highest priority for specific conservation actions as described below.

Priority 2: Populations that should be of next highest priority after conservation actions at priority 1 populations are underway or have been completed.

Priority 3: Populations that should be of next highest priority after conservation actions at priority 2 populations are underway or have been completed.

Priority 4: Populations that are of lowest priority for conservation actions. However, all populations are of importance for the recovery of Bog Turtles. While conservation measures are considered to be of lesser need at these populations due to the perceived likelihood of their effectiveness at recovering the species, they may prove to be valuable in particular circumstances. In general, Priority 4 populations should only be a target for conservation strategies when all other populations are considered stable or increasing, unless

opportunities arise for conservation actions that will benefit these sites without affecting efforts on higher priority sites.

7.3. POPULATION PRIORITIZATION FOR HABITAT PROTECTION

Within the Hudson-Housatonic Recovery Unit, populations were ranked according to the effectiveness of habitat protection measure for the recovery of the species across the Northern range (Table 7). Below are the criteria used to prioritize populations for habitat protection. See section 4.2.3 in the Conservation Plan for more information.

Priority 1:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 2-4 OR
- Populations ranked as having “Good” population quality and “Good” or “Fair” habitat quality and a habitat protection score of 2-4

Priority 2:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 1 OR
- Populations ranked as having “Good” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1 OR
- Populations ranked as having “Fair” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1-4

Priority 3: “Good” or “Fair” population quality rank and “Poor” habitat quality rank and a habitat protection score of 1-4

Priority 4: All other populations

Table 7. Priority level for habitat protection measures and a list of populations that fall into each priority level in New York, New Jersey, Connecticut and Massachusetts within the Hudson-Housatonic Recovery Unit.

	<i>New York</i>	<i>New Jersey</i>	<i>Connecticut</i>	<i>Massachusetts</i>
<i>Priority 1</i>	14-01, 14-03, 14-17, 14-23, 14-32, 14-34, 14-37, 14-53	002.2, 011.1, 011.2, 011.9, 011.10, 011.11, 011.12, 014.1, 031.9	3182	None
<i>Priority 2</i>	11-01, 14.28, 14.39, 14.51	001.1, 001.4, 011.8, 005.1, 011.14, 011.3, 031.7, 052.5, 052.6, 075.2, 081.1	2725	None
<i>Priority 3</i>	11-06, 11-07, 14-03, 14-05, 14-22, 14-30, 14-43, 40-06	001.3, 011.5	HH-CT-04	None

7.4. POPULATION PRIORITIZATION FOR HABITAT MANAGEMENT

Populations were ranked within this recovery unit according to the effectiveness of habitat management measure for the recovery of the species across the Northern range (Table 8). Below are the criteria used to prioritize populations for habitat management actions. See section 4.2.3 in the Conservation Plan for more information.

Priority 1:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 3-5 OR
- Populations ranked as having “Good” population quality and “Good” or “Fair” habitat quality and a habitat protection score of 3-5

Priority 2:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 1-2 OR
- Populations ranked as having “Good” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1-2 OR
- Populations ranked as having “Fair” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 2-5

Priority 3: “Fair” population quality rank and a habitat protection score of 1

Priority 4: All other populations

Table 8. Priority level for habitat management actions and a list of populations that fall into each priority level in New York, New Jersey, Connecticut, and Massachusetts within the Hudson-Housatonic Recovery Unit.

	<i>New York</i>	<i>New Jersey</i>	<i>Connecticut</i>	<i>Massachusetts</i>
Priority 1	14-01, 14-03, 14-17, 14-23, 14-32, 14-34, 14-37, 14-53	002.1, 002.2, 011.1, 011.10, 011.11, 011.12, 011.2, 011.9, 014.1, 031.9, 045.1, 083.1, 095.3	3182	MA-3, MA-4
Priority 2	11-01, 14-28, 11-39, 14-51, 40-04, 53-02	001.1, 001.4, 005.1, 011.14, 011.3, 011.8, 031.7, 052.6, 075.2, 081.1, 083.1	None	None
Priority 3	11-06, 11-07, 14-05	011.5, 052.5	2725	None

7.5. POPULATION PRIORITIZATION FOR POPULATION MONITORING, HABITAT MONITORING, AND INVENTORY/GAP SURVEYS

Extant populations were ranked for their potential to be viable over the long-term. Ranking metrics included parameters associated with population quality (e.g., population size and recruitment) and other for habitat quality (e.g., percent success and road density within and adjacent to Core Habitat). Each population was given a score for each metric and metric scores were summed for an overall population score. An expert group ranked the importance of each metric for determining a population’s ability to remain stable. Results from the survey were used to determine the weighting of each metric in the overall population score. For more details, see Section 4.2.2 of the Conservation Plan.

7.5.1. POPULATION PRIORITIZATION FOR POPULATION MONITORING

Populations with a population size score of 4 or 5 (Table 9) and where landowner access is granted.

Table 9. Priority populations in the Hudson-Housatonic Recovery Unit for population and habitat monitoring in each state.

<i>Priority Populations for Population and Habitat Monitoring</i>	
New York	11-01, 14-01, 14-03, 14-17, 14-21, 14-22, 14-23, 14-28, 14-30, 14-32, 14-34, 14-37, 14-39, 14-45, 14-51, 14-53
New Jersey	001.1, 001.3, 001.4, 002.2, 005.1, 011.1, 011.10, 011.11, 011.12, 011.14, 011.2, 011.3, 011.9, 014.1, 031.7, 031.9, 045.1, 083.1
Connecticut	3182
Massachusetts	MA-3, MA-4

7.5.2. POPULATION PRIORITIZATION FOR HABITAT MONITORING

Random habitat sampling should occur in Core Habitats where the population size score was 4-5 (Table 9) and landowner permission to access is granted. Targeted habitat monitoring should occur at locations where habitat management is planned, including pre- and post-management assessments, and landowner permission to access is granted.

7.5.3. POPULATION PRIORITIZATION FOR INVENTORY/GAP SURVEYS

Populations to target for inventory/gap survey are populations of Unknown occupancy (see definitions in section 1), or Extant populations with a population size score of 2 (unknown due to insufficient survey effort; Table 10). In addition, historical habitat and potential habitat patches (of unknown occupancy) should be targeted, particularly within the important habitat corridors and outside the current species’ range.

Table 10. Extant populations in the Hudson-Housatonic Recovery Unit with unknown population size due to a lack of survey effort. These are priority sites for inventory/gap surveys in addition to site of unknown occupancy, historical, and potential habitats.

<i>Priority Populations for Inventory/Gap Surveys</i>	
New York	11-06, 11-07, 14-05, 40-04, 53-02
New Jersey	011.5
Connecticut	HH-CT-04
Massachusetts	None

7.6. POPULATION PRIORITIZATION FOR POPULATION MANAGEMENT

Implementation of population management actions (i.e., captive management) have been identified as of low priority, but evaluation and identification of the most efficient and effective population management techniques were considered a Priority 1 action. Therefore, we identify a set of priority populations as potential recipient and donor populations.

7.6.1. PRIORITY RECIPIENT POPULATIONS

Priority recipient populations are populations that ranked “Poor” for population quality and “Good” for habitat quality based on results from the population viability-ranking project (Table 11). There are no priority populations for population management actions in the Hudson-Housatonic Recovery Unit.

Table 11. A list of priority population for population management actions in New York, New Jersey, Connecticut, and Massachusetts for the Hudson-Housatonic Recovery Unit.

<i>Priority Recipient Populations</i>	
New York	14-50, 40-01
New Jersey	007.1, 073.1, 075.3, 123.4, 127.1
Connecticut	None
Massachusetts	None

7.6.2. PRIORITY DONOR POPULATIONS

Priority Donor Populations are populations that scored a 5 for both population size and recruitment, and ranked as “Good” for both Habitat Quality and Population Viability (Table 12). It is also recommended that population viability analysis modeling be used to determine what impact removals will have on donor populations, specifically determine what number by sex and age class can be removed without causing negative population trend.

Table 12. A list of potential donor populations for population management actions to recover populations in need (listed in table 9) in the Hudson-Housatonic Recovery Unit.

<i>Priority Donor Populations</i>	
<i>New York</i>	14-01, 14-34
<i>New Jersey</i>	011.1, 011.3
<i>Connecticut</i>	None
<i>Massachusetts</i>	MA-3, MA-4

7.7. IMPORTANT HABITAT CORRIDORS

Important habitat corridors were identified and mapped for the purpose of improving or maintaining metapopulation dynamics. Results from geospatial analyses and evaluation of observational and population data were used to identify the most important habitat corridors between top-ranking Core Habitats throughout the Northeastern range. Corridors were ranked in order of importance for habitat protection and management actions. Below are the criteria used to prioritize populations for habitat management actions. Spatial data were provided to the state leads and the regional federal coordinator for Bog Turtle conservation. See section 4.2.4 in the Conservation Plan for more information.

Priority 1: Habitat between all extant populations within a single Metapopulation and with ≥ 1 population that ranked as “Good” for viability. These locations are of the highest priority for habitat protection and management actions. These are also important locations for locating and surveying other potential wetland habitats.

Priority 2: Habitat between all extant populations (and Core Habitats within each population) within a single Metapopulation and with ≥ 1 population that ranked as “Fair” for viability.

Priority 3: Habitat between all extant populations (and Core Habitats within each population) within a single Metapopulations and with only populations that ranked as “Poor” for viability.

Priority 4: Linkages between two or more populations that ranked as “Good” for viability and are not currently part of the same metapopulation (based on the mapping guidelines), are within 2 km of each other, and are not separated by a 4-lane highway or multiple high traffic state roads.

VIII.

IMPLEMENTATION PLAN

This implementation plan should be used to identify top priority strategies needed for the recovery of populations in the Susquehanna-Potomac Recovery Unit. It identifies populations where specific actions are most needed, a rough target timeline benchmarks for completing each action, identifies the responsible organization (Table 13) and potential partners to assist with each strategy.

Table 13. A list of agencies that are potential partners for one or more conservation strategy and their abbreviation code. These codes are found in Table 14.

<i>Code</i>	<i>Agency</i>
AI	Academic Institutions
BZOO	Baltimore Zoo
COE	U.S. Army Corps of Engineers
DOD	U.S. Department of Defense
DOT	Federal or State Departments of Transportation
EC	Environmental Consultants
EPA	U.S. Environmental Protection Agency
ES	USFWS, Ecological Services
LE	Federal or State Law Enforcement
LG	Local and Municipal Agencies
NGO	Nongovernmental Organizations
NRCS	USDA, Natural Resource Conservation Service
NWR	USFWS, National Wildlife Refuges
PFW	USFWS, Partners for Fish and Wildlife
PL	Private Landowners
SA	State Agencies, other than the wildlife agencies
SL	State Legislature
SWA	State Wildlife Agencies
USFWS	USFWS, other programs
USGS	U.S. Geological Survey

8.1. IMPLEMENTATION TABLE

Table 14. Conservation Strategy descriptions, their priority level of implementation, the location in the Conservation Plan (CP Section) where specific actions are outlined, priority populations to target for each strategy, the timeline for action, organizations responsible for implementation and potential partners to complete the work.

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.2.1	Obtain Funding to support conservation actions	Extant Populations	Ongoing	ES, SWA	All Partners
1	4.2.5, 4.2.6	Implement Population and Habitat Monitoring	Extant Populations with Pop Size Score of ≥3	Ongoing	ES, SWA	EC, NGO
1	4.3.2	Engage in Landowner Outreach for Habitat Protection	Use the Habitat Protection Priority List	Ongoing	ES, SWA	NRCS, PFW, RW, NGO, LG, EC, PL

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.4.1	Conduct Succession/Invasive Plant Management	Use the Habitat Management Priority List	Ongoing	ES, SWA	All Partners except LE and SL
1	4.5.1	Research the Effectiveness of Habitat Management to evaluate specific techniques and compare results among techniques	Use the Habitat Management Priority List	<5 yrs	ES, SWA	NRCS, AI, NGO, EC
1	4.3.1	Connect Fragmented Habitat	Within Important Habitat corridors	5-10 yrs	ES, SWA	NGO, LG, SA, USFWS
1	4.2.4	Map Important Habitat Corridors	Between Populations with “Good” or “Fair” viability and within 3 km of each other	Completed†	ES, SWA	NGO, AI
1	4.5.4	Research Hydrology and Water Chemistry at Bog Turtle sites including the collection of baseline data	Opportunistically	<5 yrs	ES, SWA	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA, NRCS, USFWS, USGS, AI
1	4.5.3	Research the Effects of Agriculture, Pesticides, and Herbicides on Core Habitat quality	Extant Population Adjacent to Agriculture; Populations with “Poor” Population Quality and “Good” Habitat Quality and Reference Populations*	<5 yrs	ES, SWA	NRCS, AI, EC, NGO
1	4.4.3	Engage in Landowner Outreach for Habitat Management	Use the Habitat Management Priority List	Ongoing	ES, SWA	All Partners except LE and SL

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.6.2	Revise the Recovery Plan and Re-evaluated the Recovery Criteria	Not Applicable	<5 yrs	ES, SWA	EC, AI, NGO
1	4.4.2	Restore Hydrology within Core Habitat	Populations with “Good” or “Fair” Population Quality and “Fair” Habitat Quality due to disturbed hydrology	<5 yrs	ES, SWA, NRCS	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA, USFWS, USGS
1	4.2.9	Monitor Progress of Conservation Actions	All Populations	Ongoing	ES, SWA	None
1	4.2.3	Prioritize Populations for Habitat Protection	Use the Habitat Management Priority List	Completed†	ES, SWA	NGO, AI, EC
1	4.2.3	Prioritize Populations for Habitat Management	Use the Habitat Management Priority List	Completed†	ES, SWA	NGO, AI, EC
1	4.5.9	Conduct Health Assessments	Populations where disease is suspected and a subset of Pops with “Good” and “Fair” viability	Ongoing	ES, SWA	WCS, BZOO, Veterinarians, Animal Health Research Laboratories
1	4.2.2	Rank Populations for Viability , their potential to be viable	Extant Populations	Completed†	ES, SWA	NGO, AI, EC
1	4.6.1	Seek Max Penalties on Violations of the ESA	N/A	5-10 yrs	ES, SWA	LE, SL
1	4.5.2	Conduct Inventory/Gap Surveys to identify populations and improve our understanding of the species distribution	N/A	Ongoing	ES, SWA	NGO, AI, EC, PL

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.5.12	Research the Effects of Beaver on Bog Turtles and their habitat	As the need arises	5-10 yrs	ES, SWA	AI, EC, NGO
1	4.9.3	Draft BMPs to Reduce Impacts from Development Projects	Extant Populations	<5 yrs	ES, SWA	NGO, AI,
1	4.6.4	Implement Regional Survey Protocols for Consultants	Not Applicable	Ongoing	ES, SWA	EC
1	4.6.3	Require Surveyor Qualifications	Not Applicable	Completed†	ES, SWA	EC
2	4.2.8	Develop a Communication Strategy	Not Applicable	<5 yrs	ES, SWA	All Partners
2	4.9.1, App. F	Draft BMPs to Improve Road Passageways near Bog Turtle habitat and protective measures during construction	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, AI, EC
	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
2	4.5.5	Research the Effects of Development on Core Habitat quality	Populations pre- and post-development or affected populations and reference populations*	<5 yrs	ES, SWA	AI, NGO, EC
2	4.8.1	Protect Nests from predators	Populations with “Fair” Population Quality and “Good” Habitat Quality	Ongoing (as needed)	ES, SWA	NGO, EC, AI
2	4.8.1	Perform Predator Control	As the need arises	Ongoing (as needed)	ES, SWA	NRCS, USFWS, SA, RW, Trappers
2	4.7.1	Identify Best Population Management Techniques to recover Bog Turtle populations	Use Population Management Priority List	<5 yrs	ES, SWA	AI, Zoos

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
2	4.3.3	Engage in Mitigation Banking to Protect Habitat	Population with “Good” viability or “Good” Population Quality and Fair Habitat Quality	<5 yrs	ES, SWA	LG, NGO, EC
2	4.9.8	Draft BMPs for Beaver Management, particularly for the Hudson-Housatonic Recovery Unit	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO
2	4.7.3	Draft Guidelines for Population Management	Extant Populations	<5 yrs	ES, SWA	Zoos (particularly TN Zoo and WCS), NGOs
2	4.5.6	Research Macro and Microhabitat Use	As the need arises	Ongoing (as needed)	ES, SWA	AI, NGO
2	4.9.4, App. I	Draft BMPs to Reduce Impacts from Stream Restoration, Culvert, and Bridge Projects	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, EC, AI
2	4.5.7	Develop and Evaluate eDNA techniques	Not Applicable	Completed; some continued research possible	ES, SWA	AI, NGO
2	4.7.2	Draft a Population Management Decision Tree, proactive and reactive versions	Not Applicable	Completed	ES, SWA	NGO
2	4.2.7	Create a Standardized Regional Database	All Populations	Ongoing	ES, SWA	NGO, AI, EC
2	4.3.5	Conduct Staff Trainings for state and federal partners as well as non-governmental conservation organizations.	Not Applicable	<5 yrs	ES, SWA	NGO, EC, RW
2	4.9.2	Draft BMPs to Reduce Impacts from Roadside Mowing Practices	Extant Populations	Ongoing	ES, SWA	DOT, LG, NGO

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
2	4.5.10	Research the Effects of Depredation	As the need arises	5-10 yrs (if needed)	ES, SWA	AI, NGO
2	4.5.8	Research the Effects of Roads on Bog Turtles and their habitat	Populations with “Poor” Population Quality and “Good” Habitat Quality and Reference Populations*	<5 yrs	ES, SWA	DOT, EC, AI, NGO, COE, EPA, LG
2	4.9.6	Draft BMPs for Radio-Telemetry Research	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO
2	4.3.4	Develop a Stewardship Program(s)	Opportunistically	5-10 yrs	ES, SWA	NRCS, PL, EC, NGO, AI
2	4.4.4	Restore Relic Fens	Historic Populations ≤1.5 km from an Extant Population with “Good” Viability	5-10 yrs (opportunistically)	ES, SWA	COE, USGS, EPA
3	4.5.14	Research Life History Traits	As the need arises	Ongoing (if needed)	ES, SWA	AI, EC, NGO
3	4.5.14	Research Life History Traits	As the need arises	Ongoing (if needed)	ES, SWA	AI, EC, NGO
3	4.2.10	Develop a Climate Change Strategy	All Populations	5-10 yrs or <5 yrs if done in conjunction with other related projects	ES, SWA	AI, USFWS, SA, USGS, EC, NGO
3	4.6.7	Improve Environmental Review Tools	Not Applicable	Ongoing	ES, SWA	EC
3	4.5.13	Evaluate Population Genetics and Develop a	Extant Populations	5-10 yrs or <5 yrs if	ES, SWA	AI, EC, NGO

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
		Genetic Library		done in conjunction with other genetic projects		
3	4.6.6	Revise Regulations to Improve Protection for the Bog Turtle	Not Applicable	5-10 yrs	ES, SWA	EC, NGO, AI
3	4.9.5	Draft BMPs to Reduce Impacts from Pipeline Projects	Extant Populations	<5 yrs	ES, SWA	EC, AI, NGO
3	4.6.5	Draft Guidelines to Reduce Adverse Effects	Not Applicable	5-10 yrs	ES, SWA	EC, AI, NGO
3	4.2.11	Compile a Bibliography of Bog Turtle Literature	Not Applicable	Ongoing	ES, SWA	None
3	4.5.11	Evaluate PIT Tagging Techniques	Not Applicable	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.9.7	Draft BMPs for Controlling Predators	Extant Populations	5-10 yrs	ES, SWA	NRCS, USFWS, SA, RW, Trappers
3	4.8.4	Develop an Anti-Poaching/Collection Strategy	All Populations	<5 yrs	ES, SWA	LE, AI, NGO
3	4.8.5	Train Law Enforcement on the turtle collection threat and abatement measures	All Populations	Ongoing	ES, SWA	LE, NGO, EC, AI
3	4.7.4	Perform Population Management	Use Population Management Decision Tree	5-10 yrs (if needed)	ES, SWA	Zoos, AI
NA	4.8.2	Perform Beaver Control	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO

*CP=Conservation Plan

† These actions should periodically be re-evaluated

IX.**MECHANISM FOR REPORTING AND/OR UPDATING THE PLANS**

The Conservation Plan should be reviewed and updated every 5-10 years. It is recommended that the Conservation Plan be updated just prior to USFWS 5-year reviews.

X.**LIST OF RECOVERY UNIT MEETING PARTICIPANTS**

In 2017 a group of Bog Turtle experts, professionals who work in the Hudson-Housatonic Recovery Unit, gathered to participate in expert surveys to determine the top threats and limiting factors negatively affecting Bog Turtle populations in this recovery unit. They also ranked conservation strategies to provide insights on the most needed actions for the recovery of the species in the Hudson-Housatonic Recovery Unit.

October 5, 2017 Meeting Participants

<i>Participant Name</i>	<i>Affiliation</i>
Elaina Burns	New York Department of Environmental and Conservation
Ashley Gocha	New York Department of Environmental and Conservation
Brian Hess	Connecticut Department of Energy and Environmental Protection
Michael Jones	Massachusetts Division of Fisheries and Wildlife
Erik Kiviat	Hudsonia
Lisa Masi	New York Department of Environmental and Conservation
Kathleen O'Brien	New York Department of Environmental and Conservation
William Pitts	New Jersey Department of Environmental Protection
Alicia Protus	U.S. Fish and Wildlife Service
Noelle Rayman-Metcalf	U.S. Fish and Wildlife Service
Angela Sirois-Pitel	The Nature Conservancy
Timothy Watson	New York Department of Environmental and Conservation
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APPENDIX C: OUTER COASTAL PLAIN RECOVERY UNIT ACTION PLAN

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I. DEFINITIONS

Core Habitat – A wetland that meets Bog Turtle suitable habitat requirements where turtles are most frequently found. Multiple Core Habitat areas may be found within a single delineated wetland but may cross multiple parcels.

Extant Population – Populations where there has been a turtle observation in appropriate habitat in the past 30 yrs.

Extirpated Population – Population where the habitat was destroyed and no habitat remains.

Historical Population – Populations where habitat is present, no turtles were observed in the past 30 yrs or a full Phase 2 survey occurred (since turtles were last found within 30 years) and no turtles were found

Metapopulation - Populations with genetic exchange feasible through occasional dispersal events. Populations are close enough to each other to allow occasional movements within one generation time (10-40 years) of an individual: < 3 km of contiguous wetland, < 2 km of intermediate or mosaic upland-wetland habitat, or < 1.5 km undeveloped upland habitat.

Population - A functionally reproductive group of individuals (e.g. at least one individual from each sex or evidence of reproduction such as presence of a hatchling or juvenile) using one or more Core Habitat areas, which are within 300 m of each other with no major barriers between them. Movement between Core Habitat patches likely occurs every 1-10 years.

Unknown Population – Locations where there has been a turtle observation in past 30 yrs, a full Phase II survey has NOT been completed, and one or more of the following is true:

- Historical observation, but no survey work occurred and habitat exists
- Recent road observation, no surveys occurred, and habitat exists within 30 m
- Recent observation resulting from environmental review project, survey stopped as soon as a turtle was found, no further surveys were performed, and habitat exists.

II. INTRODUCTION

2.1. ACTION PLAN USE AND PURPOSE

This document is for use by state and federal partners to guide their conservation efforts over the next 5-10 years, for the Bog Turtle in the Outer Coastal Plain Recovery Unit. This Action Plan summarizes the most prominent threats and limiting factors, describes the status of the species within this recovery unit, and identifies and prioritizes specific strategies needed for recovery of the species. It also provides an implementation schedule with a timeline for completing these actions. This Recovery Unit Action Plan identifies specific recovery unit priorities and should be used in conjunction with the Conservation Plan (2019), which identifies regional level priorities across all recovery units in the Northern population range (Figure 1). Data resulting from Bog Turtle expert surveys provides the basis for these recommendations. This living document should periodically be re-evaluated and updated.

2.2. OUTER COASTAL PLAIN RECOVERY UNIT

The Outer Coastal Plain Recovery Unit is along the southeastern edge of the Northern population range (Fig. 1). It extends from Cape May north along the coast to Monmouth County New Jersey. This recovery unit does not have subunits.

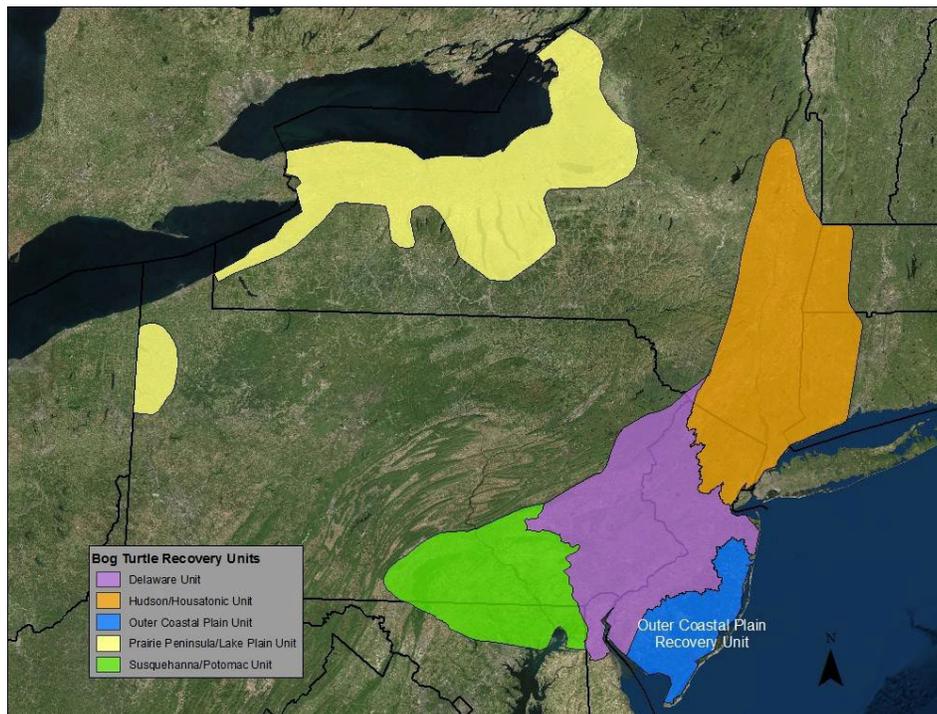


Figure 1. Map showing the Northern population range of the Bog Turtle, separated into 5 recovery units. The Outer Coastal Plain Recovery Unit (blue) is along the southeastern edge of the Northern population range.

2.3. POPULATION STATUS

Some information exists on the current status of populations in the northeast. Below we summarize data on range changes, the number of newly discovered populations (since time of federal listing), number of extant populations, and population viability based on a recent assessment.

- **Range changes:** Historical and current (within past 30 years) Bog Turtle observation data were used to create historical and current range maps. The historical range maps were delineated by creating a 10 km buffer off all HUC12 sub-watersheds containing historically and/or current turtle observations. A current range map was similarly created using only the HUC12 sub-watershed with current observations. Based on these data the species' range has contracted by 79% in the Outer Coastal Plain Recovery Unit, with 1,003,531 ac of the habitat having been lost. However, this is certainly an overestimate due to the patchiness of likely suitable bog habitat. Much of this RU is made up of Pine Barren ecosystem. The historical range includes all observations of the species (historical, extirpated, extant, and unknown) whereas the current range only included the range for extant populations.
- **Number of populations in the recovery unit discovered since 1997 (time of federal listing):** No New Jersey populations have been discovered since 1997.
- **Number of Extant Populations, Metapopulations and Core Habitats:** The number of each is listed by state in Table 1.

Table 1. Number of extant populations, extant metapopulations and extant core habitats identified by state biologists in New Jersey's Outer Coastal Plain Recovery Unit.

	<i># Extant Pops</i>	<i># Extant Metapops</i>	<i># Extant Core Habitats</i>
New Jersey*	5	0	5

*Additional extant populations, extant metapopulations and core habitats are found in New Jersey – see Delaware and Hudson-Housatonic Recovery Unit Action Plans.

- **Extant Population Viability Ranking:** Below is a breakdown of the rankings of populations in the Outer Coastal Plain Recovery Unit (Table 2). For information on the methodology used to rank populations, see section 4.2.2 of the Conservation Plan.

Table 2. The number of populations that were ranked as Good, Fair, and Poor for their potential to be viable over the long term in New Jersey's Outer Coastal Plain Recovery Unit.

	<i>Good</i>	<i>Fair</i>	<i>Poor</i>
New Jersey	0	0	5

III. THREATS AND LIMITING FACTORS

This section identifies and ranks threats and limiting factors affecting the status and recovery of the Bog Turtle. A list of threats and limiting factors was developed for the Recovery Plan and elaborated upon during a species recovery meeting in 2011 (see list below). Using this updated list, threats were identified for each extant population in the Outer Coastal Plain Recovery Unit.

List of Primary Threats to Bog Turtle within the Northern Population Range.

- Roads (direct and indirect effects)
- Agriculture
- American Beaver
- Altered Hydrology
- Invasive Plants
- Development (direct and indirect effects)
- Succession
- Predation
- Utility ROW
- Oil Spills
- Illegal Collection

3.1. THREATS

Using this list (above), the top threats were identified by experts in this recovery unit for each population (Table 3). Top recovery unit-wide threats include Roads, Altered Hydrology, Succession and Development.

Table 3. Current threats are listed for populations in the Outer Coastal Plain Recovery Unit. Threats are ordered by degree of influence on the population, starting with the greatest threat to the population.

Population	Threats
018.1	Roads, Development, Altered Hydrology
021.1	Altered Hydrology, Roads, Succession
023.1	Succession, Altered Hydrology, Development, Roads
028.1	Altered Hydrology, Development, Succession
058.1	Invasive Plants, Altered Hydrology, Succession

State lead biologists compiled historical and current observational data, which was entered into a centralized regional database developed by USFWS. For each population, they provided information (to the best of their knowledge) on current habitat conditions for hydrology and percent of invasive plants and succession. The state biologist also noted any depredation events and/or poaching events that were known or likely to have occurred at any time in the past. Information extracted from this regional database also provides some insights on threats although these numbers are almost certainly underestimations of the true values:

- Disturbance to Hydrology: This was noted for 3 extant NJ populations.
- Succession: There was one populations with >41% coverage of the Core Habitat in NJ populations.
- Development Pressure: Exists in the Core Habitat or both the Core Habitat and the 300ft Buffer in 1 NJ populations.
- Depredation: This was unknown to occur at any of the 5 extant NJ populations.
- Poaching: This likely occurred in up to 4 of the extant NJ population.

3.2. LIMITING FACTORS TO RECOVERY

Experts ranked Limiting Factors that limit recovery of a species beyond threats (Table 4). A list of limiting factors was developed during a Bog Turtle Recovery meeting in 2011 (see below). This list was used to identify top limiting factors affecting the Outer Coastal Plain Recovery Unit and individual populations within the recovery unit. Connectivity is of concern but biologically meaningful connectivity between known populations is likely not attainable except perhaps between two populations. Top limiting factors identified include Lack of distributional knowledge, lack of connectivity, and low habitat quality.

List of Primary Limiting Factors to Recovery of the Bog Turtle within the Northern Population Range.

- Lack of Distributional Knowledge
- Lack of Understanding Predation
- Lack of Understanding Disease
- Lack of Habitat Protection
- Need for Landowner Outreach
- Low Habitat Quality
- Lack of Recruitment
- Lack of Habitat Quantity
- Lack of Connectivity
- Need for Prioritization of Populations for Habitat Management
- Need for Prioritization of Populations for Habitat Protection

Table 4. Limiting Factor for recovery of the Bog Turtle are listed for the Outer Coastal Plain Recovery Unit and individual populations within the unit. Limiting Factors are ordered by degree of influence on the population, starting with the greatest impact to the population.

Population	Limiting Factors
<i>Recovery Unit Wide</i>	Lack of Distributional Knowledge, Lack of Connectivity
<i>018.1</i>	Lack of Distributional Knowledge, Lack Habitat Quantity, Lack of Connectivity
<i>021.1</i>	Lack of Distributional Knowledge, Lack of Connectivity
<i>023.1</i>	Lack of Distributional Knowledge, Lack of Connectivity
<i>028.1</i>	Lack of Distributional Knowledge, Low Habitat Quality, Lack of Connectivity
<i>058.1</i>	Lack of Distributional Knowledge, Low Habitat Quality, Lack of Connectivity

IV.

PROGRESS

The data presented below were compiled using information from the multi-state regional database for all years. The health assessments did not begin until 2001 and the regional population and habitat monitoring did not begin until 2014.

4.1. PROGRESS TOWARDS RECOVERY

Considerable effort has gone into discovering new populations, better understanding population abundance and recruitment of known populations, protecting habitat, improving habitat quality, and understanding demographics of populations and site-specific habitat use. The values below are for all actions noted for all years data is present.

4.1.1. POPULATION SURVEYS

Various types of surveys have been conducted over the years (Table 5). Regional sampling occurred in recent years for tracking of population trends (survey protocols can be found in Section 4.2.5 and 4.2.6 of the Conservation Plan). Phase 1, 2, 3 surveys are designed to determine presence/absence of Bog Turtle in wetlands and are typically performed in response to a development project proposal (see USFWS 2018 for more details). No health assessments have occurred for populations in the Outer Coastal Plain Recovery Unit.

Table 5. The type of survey and number of populations where each survey type was performed in the New Jersey's Outer Coastal Plain Recovery Unit. This is based on all available data in the state's database. Negative data as not been tracked.

<i>Type of Survey</i>	<i>NJ</i>
<i>Regional Population Monitoring: Rapid Assessments</i>	0
<i>Regional Population Monitoring: Intensive Sampling</i>	0
<i>Regional Habitat Monitoring: Random Sampling</i>	0
<i>Regional Habitat Monitoring: Targeted Sampling</i>	0
<i>Phase 1 surveys</i>	4
<i>Phase 2 surveys</i>	0
<i>Phase 3 surveys</i>	0
<i>Opportunistic surveys</i>	4
<i>Health Assessments</i>	0

4.1.2. HABITAT PROTECTION

Habitat protection here includes properties purchased for conservation purposes and properties with an easement (conservation or agricultural).

Table 6. Different levels of habitat protection and the number of populations with each type of protection level for New Jersey populations in the in the Outer Coastal Plain Recovery Unit.

<i>Type and Location of Protection</i>	<i>NJ</i>
<i>Full permanent protection of the Core Habitat</i>	1
<i>Partial permanent protection of the Core Habitat</i>	1
<i>Full permanent protection of the 300 ft Buffer</i>	1
<i>Partial permanent protection of the 300 ft Buffer</i>	2
<i>Partial temporary protection</i>	0

4.1.3. HABITAT MANAGEMENT

Habitat management to remove woody and invasive plants has been a key conservation measure used in previous years. Below is a rough summary (based on what information exists) of prior management actions.

- Habitat Management Projects: No populations have had management.
- Habitat Management Plans: No site-specific habitat management plans have been drafted for populations in this recovery unit.

4.1.4. DEMOGRAPHIC AND HABITAT USE DATA

Site-specific demographics and habitat use can provide insight on critical habitat features and inform habitat management actions. Several such studies have occurred since the species was listed. Below is a rough summary (based on what information exists) of prior research in this area of study.

- There are no core habitats with demographic research since the 1970/early 80s.
- There are no core habitats with site-specific habitat use (tracking) data.

V.

CONSERVATION APPROACH

The following sections identify and prioritize conservation strategies to be implemented, populations and important habitat corridors to target for these conservation actions, and lay out an implementation plan and benchmarks recommended for the Outer Coastal Plain Recovery Unit. This approach is based on both a broad-scale perspective and local perspective, which is important to obtain recovery of the species across the Northern range. Priorities outlined here should be used to determine actions to propose for grants and other funding opportunities. As funding and resources become available conservation partners should use this action plan to address the highest priority actions, not yet completed, in the Outer Coastal Plain Recovery Unit and use these priority population lists to maintain and recover populations. However, lower priority conservation actions or actions at lower priority populations may still be warranted based on opportunities that arise and other agency priorities. Non-prioritized conservation actions for particular populations or innovative new ideas may also help with recovery of the Bog Turtle.

VI.

RANKING CONSERVATION STRATEGIES

Experts in the Outer Coastal Plan Recovery Unit ranked conservation strategies in order of effectiveness and/or need. A list of conservation strategies was developed for the Recovery Plan and elaborated upon during a species recovery meeting in 2011. In 2019, experts ranked these strategies based on the risk level or degree of positive influence each has on the Bog Turtle populations in this recovery unit. Conservation strategies for this recovery unit were ranked from 1-3 with 1 being very important for the recovery of the species and 3 being less important. These ranks identified priority actions (Table 14).

6.1. CONSERVATION STRATEGIES PRIORITY LEVEL DESCRIPTION

Priority 1: Strategies that experts within the Outer Coastal Plain Recovery Unit deemed to be the most urgent and effective for recovery. These actions should be completed before all other conservation strategies. Some of these actions have already been completed, are currently being implemented, or are planned for implementation in the next few years.

Priority 2: Strategies that should be implemented after priority 1 strategies are underway or have been completed.

Priority 3: Strategies that are of lowest priority for implementation. However, these strategies have been identified as being useful for the recovery of Bog Turtles. While these measures are considered to be of lesser need, they may prove to be valuable in particular circumstances. In general, these actions should only be implemented after priority 1 and 2 strategies are underway or have been completed.

VII.

PRIORITY POPULATIONS AND IMPORTANT HABITAT CORRIDORS

7.1. POPULATIONS VIABILITY POTENTIAL

Bog Turtle experts from across the Northern range developed a population-ranking methodology to categorize populations in terms of their potential to be viable over the long-term. Populations were ranked using 3 population quality parameters and 5 habitat quality parameters. Experts determined a weighted average for each parameter and based on overall population scores (including both the population and habitat quality parameters) populations were grouped into 3 categories: Good, Fair, and Poor. A full table of the results was sent to the state leads and the USFWS federal coordinator for Bog Turtle. For details on the ranking methodology, see section 4.2.2 in the Conservation Plan. These ranking results and/or particular ranking parameters were used to identify priority populations for specific conservation actions such as habitat protection, habitat management, and specific research projects. Resulting population priority lists are provided below.

7.2. POPULATION PRIORITY LEVEL DESCRIPTION

Priority 1: Populations that experts within the Outer Coastal Plain Recovery Unit deemed to be of highest priority for specific conservation actions as described below.

Priority 2: Populations that should be of next highest priority after conservation actions at priority 1 populations are underway or have been completed.

Priority 3: Populations that should be of next highest priority after conservation actions at priority 2 populations are underway or have been completed.

Priority 4: Populations that are of lowest priority for conservation actions. However, all populations are of importance for the recovery of Bog Turtles. While conservation measures are considered to be of lesser need at these populations due to the perceived likelihood of their effectiveness at recovering the species, they may prove to be valuable in particular

circumstances. In general, Priority 4 populations should only be a target for conservation strategies when all other populations are considered stable or increasing, unless opportunities arise for conservation actions that will benefit these sites without affecting efforts on higher priority sites.

7.3. POPULATION PRIORITIZATION FOR HABITAT PROTECTION

Within the Outer Coastal Plain Recovery Unit, populations were ranked according to the effectiveness of habitat protection measure for the recovery of the species across the Northern range (Table 7). Below are the criteria used to prioritize populations for habitat protection. One population is fully protected and the other three populations do not meet these criteria and have poor potential for viability. See section 4.2.3 in the Conservation Plan for more information.

Priority 1:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 2-4 OR
- Populations ranked as having “Good” population quality and “Good” or “Fair” habitat quality and a habitat protection score of 2-4

Priority 2:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 1 OR
- Populations ranked as having “Good” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1 OR
- Populations ranked as having “Fair” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1-4

Priority 3*: “Poor” population quality rank and “Fair” habitat quality rank and a habitat protection score of 1-4.

Priority 4: All other populations

Table 7. Priority level for habitat protection measures and a list of populations that fall into each priority level in New Jersey within the Outer Coastal Plain Recovery Unit.

	<i>New Jersey</i>
Priority 1	None
Priority 2	None
Priority 3	021.1, 028.1

*Priority 3 was modified from what is listed in the Conservation Plan for this recovery unit.

7.4. POPULATION PRIORITIZATION FOR HABITAT MANAGEMENT

Populations were ranked within this recovery unit according to the effectiveness of habitat management measure for the recovery of the species across the Northern range (Table 8). Below

are the criteria used to prioritize populations for habitat management actions. See section 4.2.3 in the Conservation Plan for more information.

Priority 1:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 3-5 OR
- Populations ranked as having “Good” population quality and “Good” or “Fair” habitat quality and a habitat protection score of 3-5

Priority 2:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 1-2 OR
- Populations ranked as having “Good” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1-2 OR
- Populations ranked as having “Fair” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 2-5

Priority 3*: “Fair” or “Poor” population quality rank and a habitat protection score of 1

Priority 4: All other populations

*Priority 3 was modified from what is listed in the Conservation Plan for this recovery unit.

Table 8. Priority level for habitat management actions and a list of populations that fall into each priority level in New Jersey within the Outer Coastal Plain Recovery Unit.

<i>New Jersey</i>	
Priority 1	None
Priority 2	None
Priority 3	021.1, 028.1

7.5. POPULATION PRIORITIZATION FOR POPULATION MONITORING, HABITAT MONITORING, AND INVENTORY/GAP SURVEYS

Extant populations were ranked for their potential to be viable over the long-term. Ranking metrics included parameters associated with population quality (e.g., population size and recruitment) and other for habitat quality (e.g., percent succession and road density within and adjacent to Core Habitat). Each population was given a score for each metric and metric scores were summed for an overall population score. An expert group ranked the importance of each metric for determining a population’s ability to remain stable. Results from the survey were used to determine the weighting of each metric in the overall population score. For more details, see Section 4.2.2 of the Conservation Plan.

7.5.1. POPULATION PRIORITIZATION FOR POPULATION MONITORING

Populations with a population size score of 4 or 5 (Table 9) and where landowner access is granted.

Table 9. Priority populations in the Outer Coastal Plain Recovery Unit for population and habitat monitoring.

<i>Priority Populations for Population and Habitat Monitoring</i>	
New Jersey	None

7.5.2. POPULATION PRIORITIZATION FOR HABITAT MONITORING

Random habitat sampling should occur in Core Habitats where the population size score was 4-5 (Table 9) and landowner permission to access is granted. Targeted habitat monitoring should occur at locations where habitat management is planned, including pre- and post-management assessments, and landowner permission to access is granted.

7.5.3. POPULATION PRIORITIZATION FOR INVENTORY/GAP SURVEYS

Populations to target for inventory/gap survey are populations of unknown occupancy (see definitions in section 1), or extant populations with a population size score of 2 (unknown due to insufficient survey effort; Table 10). In addition, historical habitat and potential habitat patches (of unknown occupancy) should be targeted, particularly within the important habitat corridors and outside the current species' range.

Table 10. Extant populations in the Outer Coastal Plain Recovery Unit with unknown population size due to a lack of survey effort. These are priority sites for inventory/gap surveys in addition to site of unknown occupancy, historical, and potential habitats.

<i>Priority Populations for Inventory/Gap Surveys</i>	
New Jersey	021.1, 023.1

7.6. POPULATION PRIORITIZATION FOR POPULATION MANAGEMENT

Implementation of population management actions (i.e., captive management) have been identified as of low priority, but evaluation and identification of the most efficient and effective population management techniques were considered a Priority 1 action for the Northern population. Therefore, we identify a set of priority populations as potential recipient and donor populations.

7.6.1. PRIORITY RECIPIENT POPULATIONS

Priority recipient Populations are populations that ranked "Poor" for population quality and "Good" for habitat quality based on results from the population viability-ranking project (Table 11).

There are no priority populations for population management actions in the Outer Coastal Plain Recovery Unit.

Table 11. A list of priority populations for population management actions in New Jersey’s Outer Coastal Plain Recovery Unit.

<i>Priority Recipient Populations</i>	
<i>New Jersey</i>	None

7.6.2. PRIORITY DONOR POPULATIONS

Priority Donor Populations are populations that scored a 5 for both population size and recruitment, and ranked as “Good” for both Habitat Quality and Population Viability (Table 12). It is also recommended that population viability analysis modeling be used to determine what impact removals will have on donor populations, specifically determine what number by sex and age class can be removed without causing negative population trend. No donor populations were identified for this recovery unit. Therefore, donor will have to come from outside this recovery unit should population management occur.

Table 12. A list of potential donor populations for population management actions to recover populations in need (listed in table 9) in the Outer Coastal Plain Recovery Unit.

<i>Priority Donor Populations</i>	
<i>New Jersey</i>	None

7.7. IMPORTANT HABITAT CORRIDORS

Important habitat corridors were identified and mapped for the purpose of improving or maintaining metapopulation dynamics. Results from geospatial analyses and evaluation of observational and population data were used to identify the most important habitat corridors between top-ranking Core Habitats throughout the Northeastern range. Using New Jersey Department of Environmental Protection, Division of Fish and Wildlife CHANJ (Connecting Habitat Across New Jersey) tools, potential habitat corridors may exist between populations 023.1, 021.1, and 058.1. Significant land protection, habitat restoration, and road mitigation efforts would be necessary to create functional connectivity between these populations, but the potential exists.

VIII. IMPLEMENTATION PLAN

This implementation plan should be used to identify top priority strategies needed for the recovery of populations in the Outer Coastal Plain Recovery Unit. Table 14 below identifies actions needed, a rough target timeline benchmarks for completing each action, and identifies the responsible organization and potential partners to assist with each strategy.

Table 13. A list of agencies that are potential partners for one or more conservation strategy and their abbreviation code. These codes are found in Table 12.

<i>Code</i>	<i>Agency</i>
AI	Academic Institutions
BZOO	Baltimore Zoo
COE	U.S. Army Corps of Engineers
DOD	U.S. Department of Defense
DOT	Federal or State Departments of Transportation
EC	Environmental Consultants
EPA	U.S. Environmental Protection Agency
ES	USFWS, Ecological Services
LE	Federal or State Law Enforcement
LG	Local and Municipal Agencies
NGO	Nongovernmental Organizations
NRCS	USDA, Natural Resource Conservation Service
NWR	USFWS, National Wildlife Refuges
PFW	USFWS, Partners for Fish and Wildlife
PL	Private Landowners
SA	State Agencies, other than the wildlife agencies
SL	State Legislature
SWA	State Wildlife Agencies
USFWS	USFWS, other programs
USGS	U.S. Geological Survey

8.1. IMPLEMENTATION TABLE

Table 14. Conservation Strategy descriptions, their priority level of implementation, the location in the Conservation Plan (CP Section) where specific actions are outlined, priority populations to target for each strategy, the timeline for action, organizations responsible for implementation and potential partners to complete the work.

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.5.2	Conduct Inventory/Gap Surveys to identify populations and improve our understanding of the species distribution	N/A	Ongoing	ES, SWA	NGO, AI, EC, PL
1	4.4.1	Conduct succession/Invasive Plant Management	Use the Habitat Management	Ongoing	ES, SWA	All Partners except LE

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
			Priority List			and SL
1	4.2.8	Develop a Communication Strategy	Not Applicable	<5 yrs	ES, SWA	All Partners
1	4.5.1	Research the Effectiveness of Habitat Management to evaluate specific techniques and compare results among techniques	Use the Habitat Management Priority List	<5 yrs	ES, SWA	NRCS, AI, NGO, EC
1	4.2.5, 4.2.6	Implement Population and Habitat Monitoring	Extant Populations with Pop Size Score of ≥3	Ongoing	ES, SWA	EC, NGO
1	4.3.1	Connect Fragmented Habitat	Within Important Habitat corridors	5-10 yrs	ES, SWA	NGO, LG, SA, USFWS
1	4.9.1, App. F	Draft BMPs to Improve Road Passageways near Bog Turtle habitat and protective measures during construction	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, AI, EC
1	4.5.3	Research the Effects of Agriculture, Pesticides, and Herbicides on Core Habitat quality	Extant Population Adjacent to Agriculture; Populations with “Poor” Population Quality and “Good” Habitat Quality and Reference Populations*	<5 yrs	ES, SWA	NRCS, AI, EC, NGO
1	4.9.3	Draft BMPs to Reduce Impacts from Development Projects	Extant Populations	<5 yrs	ES, SWA	NGO, AI,

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.2.2	Rank Populations for Viability , their potential to be viable	Extant Populations	Completed†	ES, SWA	NGO, AI, EC
1	4.2.4	Map Important Habitat Corridors	Between Populations with “Good” or “Fair” viability and within 3 km of each other	Completed†	ES, SWA	NGO, AI
1	4.4.2	Restore Hydrology within Core Habitat	Populations with “Good” or “Fair” Population Quality and “Fair” Habitat Quality due to disturbed hydrology	<5 yrs	ES, SWA, NRCS	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA, USFWS, USGS
1	4.8.1	Protect Nests from predators	Populations with “Fair” Population Quality and “Good” Habitat Quality	Ongoing (as needed)	ES, SWA	NGO, EC, AI
1	4.7.1	Identify Best Population Management Techniques to recover Bog Turtle populations	Use Population Management Priority List	<5 yrs	ES, SWA	AI, Zoos
1	4.5.4	Research Hydrology and Water Chemistry at Bog Turtle sites including the collection of baseline data	Opportunistic ally	<5 yrs	ES, SWA	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA, NRCS, USFWS, USGS, AI
1	4.8.5	Train Law Enforcement on the turtle collection threat and abatement	All Populations	Ongoing	ES, SWA	LE, NGO, EC, AI

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
measures						
1	4.9.2	Draft BMPs to Reduce Impacts from Roadside Mowing Practices	Extant Populations	Ongoing	ES, SWA	DOT, LG, NGO
1	4.6.4	Implement Regional Survey Protocols for Consultants	Not Applicable	Ongoing	ES, SWA	EC
1	4.2.7	Create a Standardized Regional Database	All Populations	Ongoing	ES, SWA	NGO, AI, EC
1	4.6.3	Require Surveyor Qualifications	Not Applicable	Completed†	ES, SWA	EC
1	4.6.2	Revise the Recovery Plan and Re-evaluated the Recovery Criteria	Not Applicable	<5 yrs	ES, SWA	EC, AI, NGO
1	4.7.2	Draft a Population Management Decision Tree , proactive and reactive versions	Not Applicable	Completed	ES, SWA	NGO
1	4.7.3	Draft Guidelines for Population Management	Extant Populations	<5 yrs	ES, SWA	Zoos (particularly TN Zoo and WCS), NGOs
1	4.5.13	Evaluate Population Genetics and Develop a Genetic Library	Extant Populations	5-10 yrs or <5 yrs if done in conjunction with other genetic projects	ES, SWA	AI, EC, NGO
1	4.5.9	Conduct Health Assessments	Populations were disease is suspected and a subset of Pops with “Good” and	Ongoing	ES, SWA	WCS, BZOO, Veterinarians, Animal Health

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
			"Fair" viability			Research Laboratori es
2	4.2.5	Seek Max Penalties on Violations of the ESA	N/A	5-10 yrs	ES, SWA	LE, SL
2	4.2.1	Obtain Funding to support conservation actions	Extant Populations	Ongoing	ES, SWA	All Partners
2	4.3.2	Engage in Landowner Outreach for Habitat Protection	Use the Habitat Protection Priority List	Ongoing	ES, SWA	NRCS, PFW, RW, NGO, LG, EC, PL
2	4.2.3	Prioritize Populations for Habitat Protection	Extant Populations	Completed [†]	ES, SWA	NGO, AI, EC
2	4.2.3	Prioritize Populations for Habitat Management	Use the Habitat Management Priority List	Completed [†]	ES, SWA	NGO, AI, EC
2	4.4.3	Engage in Landowner Outreach for Habitat Management	Use the Habitat Management Priority List	Ongoing	ES, SWA	All Partners except LE and SL
2	4.5.5	Research the Effects of Development on Core Habitat quality	Populations pre- and post-development or affected populations and reference populations*	<5 yrs	ES, SWA	AI, NGO, EC
2	4.2.9	Monitor Progress of Conservation Actions	All Populations	Ongoing	ES, SWA	None
2	4.9.4, App. I	Draft BMPs to Reduce Impacts from Stream Restoration, Culvert, and Bridge Projects	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, EC, AI
2	4.5.7	Develop and Evaluate eDNA techniques	Not Applicable	Completed; some continued research	ES, SWA	AI, NGO

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
				possible		
2	4.8.1	Perform Predator Control	As the need arises	Ongoing (as needed)	ES, SWA	NRCS, USFWS, SA, RW, Trappers
2	4.9.5	Draft BMPs to Reduce Impacts from Pipeline Projects	Extant Populations	<5 yrs	ES, SWA	EC, AI, NGO
2	4.6.6	Revise Regulations to Improve Protection for the Bog Turtle	Not Applicable	5-10 yrs	ES, SWA	EC, NGO, AI
2	4.3.5	Conduct Staff Trainings for state and federal partners as well as non-governmental conservation organizations.	Not Applicable	<5 yrs	ES, SWA	NGO, EC, RW
2	4.5.8	Research the Effects of Roads on Bog Turtles and their habitat	Populations with "Poor" Population Quality and "Good" Habitat Quality and Reference Populations*	<5 yrs	ES, SWA	DOT, EC, AI, NGO, COE, EPA, LG
2	4.3.4	Develop a Stewardship Program(s)	Opportunistically	5-10 yrs	ES, SWA	NRCS, PL, EC, NGO, AI
2	4.4.4	Restore Relic Bogs	Historic Populations ≤1.5 km from an Extant Population with "Good" Viability	5-10 yrs (opportunistically)	ES, SWA	COE, USGS, EPA
2	4.9.7	Draft BMPs for Controlling Predators	Extant Populations	5-10 yrs	ES, SWA	NRCS, USFWS, SA, RW,

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
						Trappers
2	4.8.4	Develop an Anti-Poaching/Collection Strategy	All Populations	<5 yrs	ES, SWA	LE, AI, NGO
2	4.7.4	Perform Population Management	Use Population Management Decision Tree	5-10 yrs (if needed)	ES, SWA	Zoos, AI
2	4.2.10	Develop a Climate change Strategy	All Populations	5-10 yrs or <5 yrs if done in conjunction with other related projects	ES, SWA	AI, USFWS, SA, USGS, EC, NGO
2	4.5.10	Research the Effects of Depredation	As the need arises	5-10 yrs (if needed)	ES, SWA	AI, NGO
2	4.5.11	Evaluate PIT Tagging Techniques	Not Applicable	5-10 yrs	ES, SWA	AI, EC, NGO
2	4.9.6	Draft BMPs for Radio-telemetry Research	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO
2	4.5.12	Research the Effects of Beaver on Bog Turtles and their habitat	As the need arises	5-10 yrs	ES, SWA	AI, EC, NGO
2	4.9.8	Draft BMPs for Beaver Management, particularly for the Hudson-Housatonic Recovery Unit	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.6.5	Draft Guidelines to Reduce Adverse Effects	Not Applicable	5-10 yrs	ES, SWA	EC, AI, NGO
3	4.6.7	Improve Environmental Review Tools	Not Applicable	Ongoing	ES, SWA	EC

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
3	4.3.3	<i>Engage in Mitigation Banking to Protect Habitat</i>	Population with “Good” viability or “Good” Population Quality and Fair Habitat Quality	<5 yrs	ES, SWA	LG, NGO, EC
3	4.5.14	<i>Research Life History Traits</i>	As the need arises	Ongoing (if needed)	ES, SWA	AI, EC, NGO
3	4.5.6	<i>Research Macro and Microhabitat Use</i>	As the need arises	Ongoing (as needed)	ES, SWA	AI, NGO
3	4.2.11	<i>Compile a Bibliography of Bog Turtle Literature</i>	Not Applicable	Ongoing	ES, SWA	None

*CP=Conservation Plan

† These actions should periodically be re-evaluated

IX. MECHANISM FOR REPORTING AND/OR UPDATING THE PLANS

The Conservation Plan should be reviewed and updated every 5-10 years. It is recommended that the Conservation Plan be updated just prior to USFWS 5-year reviews.

APPENDIX D: PRAIRIE PENINSULA-LAKE PLAIN RECOVERY UNIT ACTION PLAN

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I. DEFINITIONS

Core Habitat – A wetland that meets Bog Turtle suitable habitat requirements where turtles are most frequently found. Multiple Core Habitat areas may be found within a single delineated wetland but may cross multiple parcels.

Extant Population – Populations where there has been a turtle observation in appropriate habitat in the past 30 yrs.

Extirpated Population – Population where the habitat was destroyed and no habitat remains.

Historical Population – Populations where habitat is present, no turtles were observed in the past 30 yrs or a full Phase 2 survey occurred (since turtles were last found within 30 years) and no turtles were found

Metapopulation - Populations with genetic exchange feasible through occasional dispersal events. Populations are close enough to each other to allow occasional movements within one generation time (10-40 years) of an individual: < 3 km of contiguous wetland, < 2 km of intermediate or mosaic upland-wetland habitat, or < 1.5 km undeveloped upland habitat.

Population - A functionally reproductive group of individuals (e.g. at least one individual from each sex or evidence of reproduction such as presence of a hatchling or juvenile) using one or more Core Habitat areas, which are within 300 m of each other with no major barriers between them. Movement between Core Habitat patches likely occurs every 1-10 years.

Unknown Population – Locations where there has been a turtle observation in past 30 yrs, a full Phase II survey has NOT been completed, and one or more of the following is true:

- Historical observation, but no survey work occurred and habitat exists
- Recent road observation, no surveys occurred, and habitat exists within 30 m
- Recent observation resulting from environmental review project, survey stopped as soon as a turtle was found, no further surveys were performed, and habitat exists.

II. INTRODUCTION

2.1. ACTION PLAN USE AND PURPOSE

This document is for use by state and federal partners to guide their conservation efforts over the next 5-10 years, for the Bog Turtle in the Prairie Peninsula-Lake Plain Recovery Unit. This Action Plan summarizes the most prominent threats and limiting factors, describes the status of the species within this recovery unit, and identifies and prioritizes specific strategies needed for recovery of the species. It also provides an implementation schedule with a timeline for completing these actions. This Recovery Unit Action Plan identifies specific recovery unit priorities and should be used in conjunction with the Conservation Plan (2019), which identifies regional level priorities across all recovery units in the Northern population range (Figure 1). Data resulting from Bog Turtle expert surveys provides the basis for these recommendations. This is a living document that should periodically be re-evaluated and updated.

2.2. PRAIRIE PENINSULA-LAKE PLAIN RECOVERY UNIT

The Prairie Peninsula-Lake Plain Recovery Unit is a disjunct group of Bog Turtle populations in the northwestern edge of the Northern population range (Fig. 1). It extends from Mercer and Crawford Counties in Pennsylvania along the Great Lakes north through Oswego County New York. This recovery unit has three subunits; the Pennsylvania, New York West, and New York East subunits (Fig. 2). There are no known extant populations in the Pennsylvania or the New York East subunits. Therefore, all information reported in this action plan will be focused on the extant populations in the New York West subunit (i.e., Central New York).

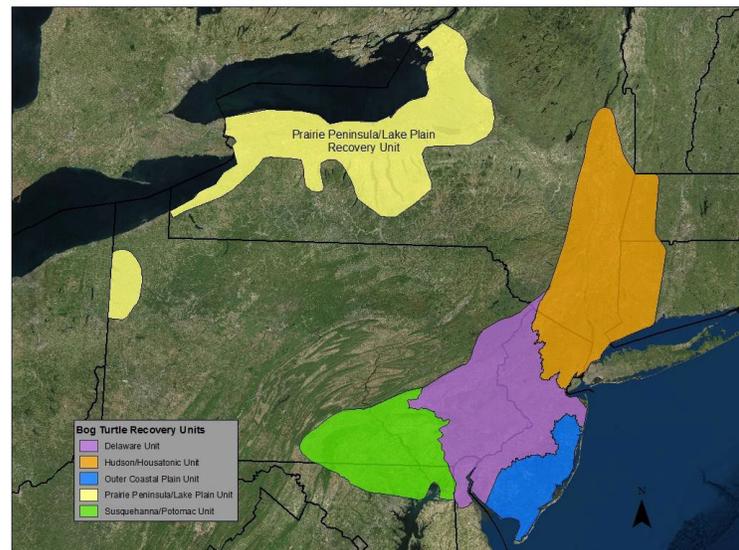


Figure 1. Map showing the Northern population range of the Bog Turtle as 5 recovery units. The Prairie Peninsula-Lake Plain Recovery Unit (yellow) is along the northwestern edge.

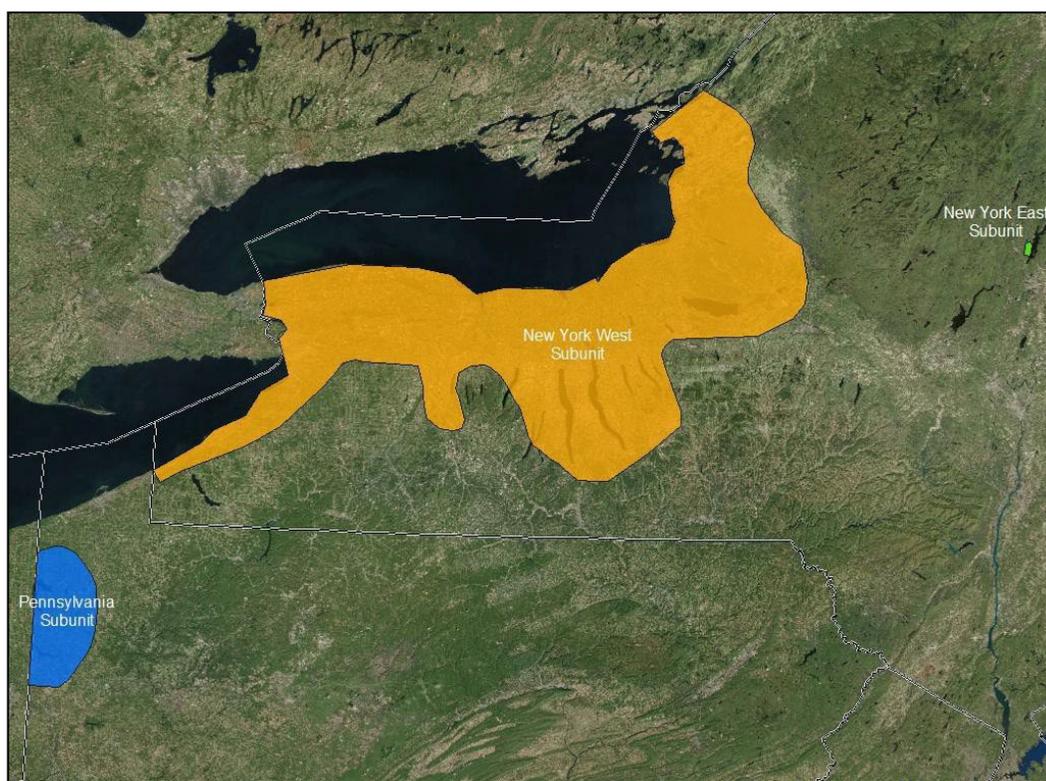


Figure 2. Map showing the Bog Turtle Prairie Peninsula-Lake Plain Recovery Unit and its three subunits. The Pennsylvania subunit (blue), New York West subunit (orange), and New York East subunit (green). Only the New York West subunit still has extant populations.

2.3. POPULATION STATUS

Considerable information exists on the current status of populations in the northeast. Below we summarize data on range changes, the number of newly discovered populations (since time of federal listing), number of extant populations, and population viability based on a recent assessment.

- **Range changes:** Historical and current (within past 30 years) Bog Turtle observation data were used to create historical and current range maps. The historical range map was delineated by creating a 10 km buffer off all HUC12 sub-watersheds (USGS 12-digit hydrologic units) containing historically and/or current turtle observations. A current range map was similarly created using only the HUC12 sub-watersheds with current observations. Based on these data the species' range has contracted by 68% in the Prairie Peninsula-Lake Plain Recovery Unit, with 1,996,186 acres of habitat having been lost. The historical range includes all observations of the species (historical, extirpated, extant, and unknown) whereas the current range only includes the range for extant populations.

- Number of populations in the recovery unit discovered since 1997 (time of federal listing): Two New York populations have been discovered since 1997, site 38-04 was discovered in 2000. An observation was made at a historic site (59-04) in 2004. A third population (38-03) was discovered in 1997.
- Number of Extant Populations, Metapopulations and Core Habitats: Five extant populations are present in the PPLP RU in New York, none of which are close enough to be part of a metapopulation (Table 1). One of the New York Populations has only had one observation despite multiple trapping efforts over a 10-yr period, but we are considering it a population in this Action Plan. The other four populations appear to be relatively robust. No extant populations are known in Pennsylvania at this time.

Table 1. Number of extant populations, extant metapopulations and extant core habitats in the Prairie Peninsula-Lake Plain Recovery Unit.

	<i># Extant Pops</i>	<i># Extant Metapops</i>	<i># Extant Core Habitats</i>
<i>New York*</i>	5	0	5

Additional extant populations, extant metapopulations and core habitats are found in Pennsylvania and New York – see Susquehanna-Potomac, Delaware, and Hudson-Housatonic Recovery Unit Action Plans.

- Extant Population Viability Ranking: Below is a breakdown of the rankings of populations in the Prairie Peninsula-Lake Plain Recovery Unit (Table 2). Populations 59-04 and 38-02 were ranked as having “Fair” potential viability over the long term and the other three populations were ranked as having “Good” potential for viability. For additional information on the methodology used to rank populations, see section 4.2.2 of the Conservation Plan.

Table 2. The number of population that were ranked as Good, Fair, and Poor for their potential to be viable over the long term in the New York Prairie Peninsula-Lake Plain Recovery Unit.

	<i>Good</i>	<i>Fair</i>	<i>Poor</i>
<i>New York</i>	3	2	0

III. **THREATS AND LIMITING FACTORS**

This section identifies and ranks current threats and limiting factors affecting the status and recovery of the Bog Turtle. A list of threats and limiting factors was developed for the Recovery Plan and expanded during a species recovery meeting in 2011 (see list below). Using this updated list, threats were identified for each extant population in the Prairie Peninsula-Lake Plain Recovery Unit.

List of Primary Threats to Bog Turtle within the Northern Population Range.

- Roads (direct and indirect effects)
- Agriculture
- American Beaver
- Altered Hydrology

- Invasive Plants
- Development (direct and indirect effects)
- Succession
- Predation
- Utility ROW
- Oil Spills
- Illegal Collection

3.1. THREATS

A list of threats was developed and experts used this list to identify threats effecting each population within the Prairie Peninsula-Lake Plain Recovery Unit (Table 3). The top threats include invasive plants, development, altered hydrology, and agriculture.

Table 3. Current threats are listed for populations in the Prairie Peninsula-Lake Plain Recovery Unit. Threats are ordered by degree of influence on the population, starting with the greatest threat to the population.

Population	Threats
38-02	Development, altered hydrology, roads, invasive plants, predation
38-03	Development, altered hydrology, invasive plants, predation
38-04	Altered hydrology, roads
50-01	Roads, American Beaver, altered hydrology, invasive plants, development, and illegal collection, predation
59-04	Altered hydrology, agriculture, invasive plants, succession

State lead biologists and recovery unit experts compiled historical and current observational data, which was entered into a centralized regional database developed by USFWS. For each population, they provided information (to the best of their knowledge) on current habitat conditions for hydrology and percent of invasive plants and succession. The state biologist also noted any depredation events and/or poaching events that were known or likely to have occurred at any time in the past. Information extracted from this regional database also provides some insights on threats although these numbers are almost certainly underestimations of the true values:

- Disturbance to Hydrology: This was noted for 4 extant NY populations.
- Invasive Plants and Succession: While some habitat management is needed, no populations have tree/shrub covering >60% of the Core Habitat.
- Development Pressure: Exists in the Core Habitat or both the Core Habitat and the 300ft Buffer in 3 NY populations.
- Depredation: This likely occurred in at least 1 extant NY population between 2017 and 2018.
- Poaching: This likely occurred in 1 extant NY population.

3.2. LIMITING FACTORS TO RECOVERY

Experts ranked Limiting Factors that limit recovery of a species beyond threats (Table 4). A list of limiting factors was developed during a Bog Turtle Recovery meeting in 2011 (see below). This list was used to identify top limiting factors affecting the Prairie Peninsula-Lake Plain Recovery Unit and individual populations within the Recovery Unit. Distributional knowledge is good in this recovery unit. Over 100 wetlands in Oswego County and 130 in Wayne/Cayuga Counties have been surveyed by Dr. Rosenbaum and Dr. Nelson, professors at SUNY-Oswego (Rosenbaum and Nelson unpublished reports; Rosenbaum 2019). Connectivity is of concern but biologically meaningful connectivity between known populations is not attainable. Populations are too far apart (15 miles or more) for turtles to migrate from one population to another. The top limiting factors include lack of connectivity, and lack of knowledge of recruitment. Hatchlings and juveniles have been observed at many of these sites but additional population assessments would be valuable to better understand population demographics.

List of Primary Limiting Factors to Recovery of the Bog Turtle within the Northern Population Range.

- Lack of Distributional Knowledge
- Lack of Understanding Predation
- Lack of Understanding Disease
- Lack of Habitat Protection
- Need for Landowner Outreach
- Low Habitat Quality
- Lack of Recruitment
- Lack Habitat Quantity
- Lack of Connectivity
- Need for Prioritization of Populations for Habitat Management
- Need for Prioritization of Populations for Habitat Protection

Table 4. Limiting Factors on recovery of the Bog Turtle are listed for the Prairie Peninsula-Lake Plain Recovery Unit and individual populations within the unit. Limiting Factors are ordered by degree of influence on the population, starting with the greatest impact to the population to the least.

Population	Limiting Factors
Recovery Unit Wide	Connectivity
38-02	Lack of understanding predation and disease, lack of knowledge on recruitment
38-03	None at this time
38-04	Lack of understanding predation and disease, lack of knowledge on recruitment
50-01	Lack of understanding predation and disease, lack of knowledge on recruitment, Low habitat quality
59-04	Lack of understanding predation and disease, lack of knowledge on recruitment

IV.

PROGRESS

The data presented below were compiled using information from the multi-state regional database for all years. The health assessments did not begin until 2001 and the regional population and habitat monitoring did not begin until 2014. The values below only represent partial data for the 2018 field season.

4.1. PROGRESS TOWARDS RECOVERY

Considerable effort has gone into discovering new populations, better understanding population abundance and recruitment of known populations, protecting habitat, improving habitat quality, and understanding demographics of populations and site-specific habitat use. The values below are for all actions noted for all years data is present.

4.1.1. POPULATION SURVEYS

Various types of surveys have been conducted over the years (Table 5), primarily Dr. Rosenbaum and Dr. Nelson. Rosenbaum and Nelson surveyed (Phase 1 and Phase 2 surveys depending on the site) over 90 “bogs” (fens) in Oswego County looking for potential bog turtle habitat as defined by known and historic LPPP sites (Rosenbaum and Nelson unpublished reports, see Rosenbaum 2019). A subset of what were considered high potential sites were trapped (phase 3 surveys) resulting in the discovery of three previously unknown sites in Oswego County. Vegetation surveys were performed at occupied sites. Additionally Phase 1 surveys were conducted on another 130 wetlands in Wayne and Cayuga Counties (see Rosenbaum 2019).

Regional sampling occurred in recent years for tracking of population trends (survey protocols can be found in Section 4.2.5 and 4.2.6 of the Conservation Plan). Phase 1, 2, 3 surveys are designed to determine presence/absence of Bog Turtle in wetlands and are typically performed in response to a development project proposal (see USFWS 2018 for more details). Health assessments have also been completed for numerous populations in the Prairie Peninsula-Lake Plain Recovery Unit.

Table 5. The type of survey and number of populations where each survey type was performed in New York’s Prairie Peninsula-Lake Plain Recovery Unit. This is based on all available data in the state’s database. Negative data have not been tracked well in most states including New York.

<i>Type of Survey</i>	<i>NY</i>
<i>Regional Population Monitoring: Rapid Assessments</i>	2
<i>Regional Population Monitoring: Intensive Sampling</i>	2
<i>Regional Habitat Monitoring: Random Sampling</i>	1
<i>Regional Habitat Monitoring: Targeted Sampling</i>	0
<i>Phase 1 surveys</i>	130+
<i>Phase 2 surveys</i>	90
<i>Phase 3 surveys</i>	5+
<i>Health Assessments</i>	1

4.1.2. HABITAT PROTECTION

Type of habitat protection is indicated in Table 6 and includes properties purchased for conservation purposes and properties with an easement (conservation or agricultural).

Table 6. Different levels of habitat protection and the number of populations with each type of protection level for New York populations in the in the Prairie Peninsula-Lake Plain Recovery Unit.

<i>Type and Location of Protection</i>	<i>NY</i>
<i>Full permanent protection of the Core Habitat</i>	5
<i>Partial permanent protection of the Core Habitat</i>	0
<i>Full permanent protection of the 300 ft Buffer</i>	3
<i>Partial permanent protection of the 300 ft Buffer</i>	2
<i>Partial temporary protection</i>	1

4.1.3. HABITAT MANAGEMENT

Habitat management to remove woody and invasive plants has been a key conservation measure used in previous year. Below is a rough summary (based on what information exists) of prior management actions.

- Habitat Management Projects: This occurred and/or continues for 3 NY populations.
- Habitat Management Plans: Three populations have informal habitat management plans and the drafting of a detailed site management plan is planned for one of these populations.

4.1.4. DEMOGRAPHIC AND HABITAT USE DATA

Site-specific demographics and habitat use can provide insight on critical habitat features and inform habitat management actions. Several such studies have occurred since the species was listed. Below is a rough summary (based on existing information) of prior research on this subject. Rosenbaum, and Rosenbaum and Nelson have conducted various telemetry studies to identify patterns of seasonal movements, characterize their habitat and habitat use, and breeding ecology (see Rosenbaum 2019).

- Two populations have had substantial demographic research.
- Two populations have had substantial site-specific habitat use (tracking) research.

V.

CONSERVATION APPROACH

The following sections identify and prioritize conservation strategies to be implemented, populations and important habitat corridors to target for these conservation actions, and lays out an implementation plan and benchmarks recommended for the Prairie Peninsula-Lake Plain Recovery Unit. This approach is based on a broad-scale perspective as well as a local perspective, which is important to obtain recovery of the species across the Northern range. Priorities outlined here should be used to determine actions to propose for grants and other funding opportunities. As funding and resources become available conservation partners should use this action plan to

address the highest priority actions, not yet completed, in the Prairie Peninsula-Lake Plain Recovery Unit and use these priority population lists to maintain and recover populations. However, lower priority conservation actions or actions at lower priority populations may still be warranted based on opportunities that arise and other agency priorities. Non-prioritized conservation actions for particular populations or innovative new ideas may also help with recovery of the Bog Turtle. Researchers working in this recovery unit are also strongly encouraged to consult the Conservation Management Plan for the Bog Turtle in the Central New York Portion of the Prairie Peninsula Lake Plains Recovery Unit of New York State (Rosenbaum 2019)

VI.

RANKING CONSERVATION STRATEGIES

Dr. Rosenbaum (pers. comm. 2019) ranked conservation strategies in order of effectiveness and/or need. A list of conservation strategies was developed for the Recovery Plan and expanded during a species recovery meeting in 2011. In 2019, Dr. Rosenbaum ranked these strategies based on the risk level or degree of positive influence each has on the Bog Turtle populations in this recovery unit. Conservation strategies for this recovery unit were ranked from 1-3 with 1 being very important for the recovery of the species and 3 being less important. These ranks identified priority actions (Table 12).

6.1. CONSERVATION STRATEGIES PRIORITY LEVEL DESCRIPTION

Priority 1: Strategies that experts within the Prairie Peninsula-Lake Plain Recovery Unit deemed to be the most urgent and effective for recovery. These actions should be completed before all other conservation strategies. Some of these actions have already been completed, are currently being implemented, or are planned for implementation in <5 yrs.

Priority 2: Strategies that should be implemented after priority 1 strategies are underway or have been completed.

Priority 3: Strategies that are of lowest priority for implementation. However, these strategies have been identified as being useful for the recovery of Bog Turtles. While these measures are considered to be of lesser need, they may prove to be valuable in particular circumstances. In general, these actions should only be implemented after priority 1 and 2 strategies are underway or have been completed.

VII.

PRIORITY POPULATIONS

7.1. POPULATIONS VIABILITY POTENTIAL

Bog Turtle experts from across the Northern range developed population-ranking methodology to categorize populations in terms of their potential to be viable over the long-term (see Section IV of the Conservation Plan and Section X of the Recovery Unit Action Plans (Appendix A-E)). Populations were ranked using 3 population quality parameters and 5 habitat quality parameters. Experts determined a weighted average for each parameter and based on overall population scores (including both the population and habitat quality parameters) populations were grouped into 3

categories: Good, Fair, and Poor. A full table of the results was sent to the state leads and the USFWS federal coordinator for Bog Turtle. For details on the ranking methodology, see section 4.2.2 in the Conservation Plan. These ranking results and/or particular ranking parameters were used to identify priority populations for specific conservation actions such as habitat protection, habitat management, and specific research projects. Resulting population priority lists are provided below.

7.2. POPULATION PRIORITY LEVEL DESCRIPTION

Priority 1: Populations that experts within the Prairie Peninsula-Lake Plain Recovery Unit deemed to be of highest priority for specific conservation actions as described below.

Priority 2: Populations that should be of next highest priority after conservation actions at priority 1 populations are underway or have been completed.

Priority 3: Populations that should be of next highest priority after conservation actions at priority 2 populations are underway or have been completed.

Priority 4: Populations that are of lowest priority for conservation actions. However, all populations are of importance for the recovery of Bog Turtles. While conservation measures are considered to be of lesser need at these populations due to the perceived likelihood of their effectiveness at recovering the species (based on population viability ranking), they may prove to be valuable in particular circumstances. In general, Priority 4 populations should only be a target for conservation strategies when all other populations are considered stable or increasing, unless opportunities arise for conservation actions that will benefit these sites without affecting efforts on higher priority sites.

7.3. POPULATION PRIORITIZATION FOR HABITAT PROTECTION

Three populations in this recovery unit are already protected. The other two extant populations, 38-02 and 59-04, are priority sites for habitat protection of both the full Core Habitat and at least a 300 ft buffer area surrounding the Core Habitat.

7.4. POPULATION PRIORITIZATION FOR HABITAT MANAGEMENT

Populations were ranked within this recovery unit according to the effectiveness of habitat management measure for the recovery of the species across the Northern range. Below are the criteria used to prioritize populations for habitat management actions in the Prairie Peninsula-Lake Plain Recovery Unit and results are shown in Table 7.

Priority 1:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 3-5 OR
- Populations ranked as having “Good” population quality and “Good” or “Fair” habitat quality and a habitat protection score of 3-5

Priority 2*: All other extant populations in this recovery unit

Table 7. Priority level for habitat management actions and a list of extant populations that fall into each priority level in the Prairie Peninsula-Lake Plain Recovery Unit.

<i>New York</i>	
Priority 1	38-03, 38-04, 50-01
Priority 2	38-02, 59-04

*Priority 2 was modified from what is listed in the Conservation Plan for this recovery unit.

7.5. POPULATION PRIORITIZATION FOR POPULATION MONITORING, HABITAT MONITORING, AND INVENTORY/GAP SURVEYS

Extant populations were ranked for their potential to be viable over the long-term. Ranking metrics included parameters associated with population quality (e.g., population size and recruitment) and other for habitat quality (e.g., percent success and road density within and adjacent to Core Habitat). Each population was given a score for each metric and metric scores were summed for an overall population score. An expert group ranked the importance of each metric for determining a population’s ability to remain stable. Results from the survey were used to determine the weighting of each metric in the overall population score. For more details, see Section 4.2.2 of the Conservation Plan.

7.5.1. POPULATION PRIORITIZATION FOR POPULATION MONITORING

Priority populations for population monitoring are those with a population size score of 3-5 based on the population-ranking project (Table 8) and where landowner access is granted. This includes 4 of the 5 extant populations in this recovery unit. Since there are only 5 populations we also recommend management action take place at site 50-04.

Table 8. Priority populations in the Prairie Peninsula-Lake Plain Recovery Unit for population and habitat monitoring.

<i>Priority Populations for Population and Habitat Monitoring</i>	
New York	38-02, 38-03, 38-04, 50-01

7.5.2. POPULATION PRIORITIZATION FOR HABITAT MONITORING

Random habitat sampling should occur in Core Habitats where the population size score was 3-5 (Table 6) and landowner permission to access is granted. Targeted habitat monitoring should occur at locations where habitat management is planned, including pre- and post-management assessments, and landowner permission to access is granted.

7.5.3. POPULATION PRIORITIZATION FOR INVENTORY/GAP SURVEYS

Populations to target for inventory/gap survey are populations of unknown occupancy (see definitions in section 1), historical habitat, and potential habitat patches (of unknown occupancy). This action is not a priority for the PPLP RU.

7.6. POPULATION PRIORITIZATION FOR POPULATION MANAGEMENT

Implementation of population management actions (i.e., captive management) have been identified as of low priority, but evaluation and identification of the most efficient and effective population management techniques were considered a Priority 1 action for the Northern population. Therefore, we identify a set of priority populations as potential recipient and donor populations.

7.6.1. PRIORITY RECIPIENT POPULATIONS

Priority recipient populations are populations that ranked “Poor” for population quality and “Good” for habitat quality based on results from the population viability-ranking project (Table 9).

Table 9. A list of priority populations for population management actions in New York’s Prairie Peninsula-Lake Plain Recovery Unit.

<i>Priority Recipient Populations</i>	
New York	59-04

7.6.2. PRIORITY DONOR POPULATIONS

Priority Donor Populations are populations that scored a 5 for both population size and recruitment, and ranked as “Good” for both Habitat Quality and Population Viability (Table 10). It is also recommended that population viability analysis modeling be used to determine what impact removals will have on donor populations, specifically determine what number by sex and age class can be removed without causing negative population trend.

Table 10. A list of potential donor populations for population management actions to recover Bog Turtle populations in need (listed in table 9) in the Prairie Peninsula-Lake Plain Recovery Unit.

<i>Priority Donor Populations</i>	
New York	38-03

VIII.

IMPLEMENTATION PLAN

This implementation plan should be used to identify top priority strategies needed for the recovery of populations in the Prairie Peninsula-Lake Plain Recovery Unit. It identifies populations where specific actions are most needed, a rough target timeline benchmarks for completing each action,

identifies the responsible organization (also see Table 11) and potential partners to assist with each strategy. Academic institutions that have been strong partners in this RU include SUNY-Oswego, SUNY-ESF, Syracuse University, and Cornell University.

Table 11. A list of agencies that are potential partners for one or more conservation strategy and their abbreviation code. These codes are found in Table 12.

<i>Code</i>	<i>Agency</i>
AI	Academic Institutions
BZOO	Baltimore Zoo
COE	U.S. Army Corps of Engineers
DOD	U.S Department of Defense
DOT	Federal or State Departments of Transportation
EC	Environmental Consultants
EPA	U.S. Environmental Protection Agency
ES	USFWS, Ecological Services
LE	Federal or State Law Enforcement
LG	Local and Municipal Agencies
NGO	Nongovernmental Organizations
NRCS	USDA, Natural Resource Conservation Service
NWR	USFWS, National Wildlife Refuges
PFW	USFWS, Partners for Fish and Wildlife
PL	Private Landowners
SA	State Agencies, other than the wildlife agencies
SL	State Legislature
SWA	State Wildlife Agencies
USFWS	USFWS, other programs
USGS	U.S. Geological Survey

8.1. IMPLEMENTATION TABLE

Table 12. Conservation Strategy descriptions, their priority level of implementation, the location in the Conservation Plan (CP Section) where specific actions are outlined, priority populations to target for each strategy, the timeline for action, organizations responsible for implementation and potential partners to complete the work.

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.3.4	Develop a Stewardship Program(s)	Opportunistic ally	5-10 yrs	ES, SWA, AI	NRCS, PL, EC, NGO
1	4.2.1	Obtain Funding to support conservation actions	Extant Populations	Ongoing	ES, SWA	All Partners

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.3.2	Engage in Landowner Outreach for Habitat Protection	Use the Habitat Protection Priority List	Ongoing	ES, SWA, AI	NRCS, PFW, RW, NGO, LG, EC, PL
1	4.4.3	Engage in Landowner Outreach for Habitat Management	Use the Habitat Management Priority List	Ongoing	ES, SWA	All Partners except LE and SL
1	4.4.1	Conduct succession/Invasive Plant Management	Use the Habitat Management Priority List	Ongoing	ES, SWA	All Partners except LE and SL
1	4.2.3	Prioritize Populations for Habitat Protection	Extant Populations	Completed [†]	ES, SWA	NGO, AI, EC
1	4.2.3	Prioritize Populations for Habitat Management	Use the Habitat Management Priority List	Completed [†]	ES, SWA	NGO, AI, EC
1	4.2.8	Develop a Communication Strategy	Not Applicable	<5 yrs	ES, SWA	All Partners
1	4.5.1	Research the Effectiveness of Habitat Management to evaluate specific techniques and compare results among techniques	Use the Habitat Management Priority List	<5 yrs	ES, SWA	NRCS, AI, NGO, EC
1	4.2.5, 4.2.6	Implement Population and Habitat Monitoring	Extant Populations with Pop Size Score of ≥ 3	Ongoing	ES, SWA	EC, NGO
1	4.2.5	Seek Max Penalties on Violations of the ESA	N/A	5-10 yrs	ES, SWA	LE, SL
1	4.5.5	Research the Effects of Development on Core Habitat quality	Populations pre- and post-development or affected populations and reference populations*	<5 yrs	ES, SWA	AI, NGO, EC
1	4.5.4	Research Hydrology and Water Chemistry at Bog Turtle sites including the collection of baseline data	Opportunistically	<5 yrs	ES, SWA	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA,

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
						NRCS, USFWS, USGS, AI
1	4.5.3	Research the Effects of Agriculture, Pesticides, and Herbicides on Core Habitat quality	Extant Populations Adjacent to Agriculture; Populations with “Poor” Population Quality and “Good” Habitat Quality and Reference Populations*	<5 yrs	ES, SWA	NRCS, AI, EC, NGO
1	4.9.3	Draft BMPs to Reduce Impacts from Development Projects	Extant Populations	<5 yrs	ES, SWA	NGO, AI,
1	4.8.5	Train Law Enforcement on the turtle collection threat and abatement measures	All Populations	Ongoing	ES, SWA	LE, NGO, EC, AI
1	4.2.2	Rank Populations for Viability , their potential to be viable	Extant Populations	Completed†	ES, SWA	NGO, AI, EC
1	4.2.9	Monitor Progress of Conservation Actions	All Populations	Ongoing	ES, SWA	None
1	4.6.4	Implement Regional Survey Protocols for Consultants	All Populations	Ongoing	ES, SWA	EC
1	4.6.3	Require Surveyor Qualifications	Not Applicable	Completed†	ES, SWA	EC
1	4.6.2	Revise the Recovery Plan and Re-evaluated the Recovery Criteria	Not Applicable	<5 yrs	ES, SWA	EC, AI, NGO
1	4.7.2	Draft a Population Management Decision Tree , proactive and reactive versions	Not Applicable	Completed	ES, SWA	NGO
1	4.7.3	Draft Guidelines for Population Management	Extant Populations	<5 yrs	ES, SWA	Zoos (particularly TN Zoo and WCS), NGOs

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.8.4	Develop an Anti-Poaching/Collection Strategy	All Populations	<5 yrs	ES, SWA	LE, AI, NGO
2	4.9.1, App. F	Draft BMPs to Improve Road Passageways near Bog Turtle habitat and protective measures during construction	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, AI, EC
2	4.4.2	Restore Hydrology within Core Habitat	Populations with “Good” or “Fair” Population Quality and “Fair” Habitat Quality due to disturbed hydrology	<5 yrs	ES, SWA, NRCS	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA, USFWS, USGS
2	4.7.1	Identify Best Population Management Techniques to recover Bog Turtle populations	Use Population Management Priority List	<5 yrs	ES, SWA	AI, Zoos
2	4.8.1	Perform Predator Control	As the need arises	Ongoing (as needed)	ES, SWA	NRCS, USFWS, SA, RW, Trappers
2	4.6.6	Revise Regulations to Improve Protection for the Bog Turtle	All Populations	5-10 yrs	ES, SWA	EC, NGO, AI
2	4.2.7	Create a Standardized Regional Database	All Populations	Ongoing	ES, SWA	NGO, AI, EC
2	4.6.7	Improve Environmental Review Tools	Not Applicable	Ongoing	ES, SWA	EC
2	4.5.9	Conduct Health Assessments	Populations where disease is suspected and a subset of Pops with “Good” and “Fair” viability	Ongoing	ES, SWA	WCS, BZOO, Veterinarians, Animal Health Research Laboratories, AI

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
2	4.6.5	Draft Guidelines to Reduce Adverse Effects	Not Applicable	5-10 yrs	ES, SWA	EC, AI, NGO
2	4.5.6	Research Macro and Microhabitat Use	As the need arises	Ongoing (as needed)	ES, SWA	AI, NGO
2	4.5.14	Research Life History Traits	As the need arises	Ongoing (if needed)	ES, SWA	AI, EC, NGO
2	4.5.13	Evaluate Population Genetics and Develop a Genetic Library	Extant Populations	5-10 yrs or <5 yrs if done in conjunction with other genetic projects	ES, SWA	AI, EC, NGO
2	4.5.11	Evaluate PIT Tagging Techniques	Not Applicable	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.9.7	Draft BMPs for Controlling Predators	Extant Populations	5-10 yrs	ES, SWA	NRCS, USFWS, SA, RW, Trappers
3	4.5.10	Research the Effects of Depredation	As the need arises	5-10 yrs (if needed)	ES, SWA	AI, NGO
3	4.9.6	Draft BMPs for Radio-telemetry Research	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.2.11	Compile a Bibliography of Bog Turtle Literature	Not Applicable	Ongoing	ES, SWA	None
3	4.8.1	Protect Nests from predators	Populations with "Fair" Population Quality and "Good" Habitat Quality	Ongoing (as needed)	ES, SWA	NGO, EC, AI
3	4.5.12	Research the Effects of Beaver on Bog Turtles and their habitat	As the need arises	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.9.8	Draft BMPs for Beaver Management , particularly for the Hudson-Housatonic Recovery Unit	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.7.4	Perform Population Management	Use Population Management Decision Tree	5-10 yrs (if needed)	ES, SWA	Zoos, AI

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
3	4.2.10	Develop a Climate Change Strategy	All Populations	5-10 yrs or <5 yrs if done in conjunction with other related projects	ES, SWA	AI, USFWS, SA, USGS, EC, NGO
3	4.5.7	Develop and Evaluate eDNA techniques	Not Applicable	Completed; some continued research possible	ES, SWA	AI, NGO
3	4.4.4	Restore Relic Fens	Historic Populations ≤1.5 km from an Extant Population with “Good” Viability	5-10 yrs (opportunistically)	ES, SWA	COE, USGS, EPA
3	4.3.3	Engage in Mitigation Banking to Protect Habitat	Population with “Good” viability or “Good” Population Quality and Fair Habitat Quality	<5 yrs	ES, SWA	LG, NGO, EC
3	4.3.5	Conduct Staff Trainings for state and federal partners as well as non-governmental conservation organizations.	Not Applicable	<5 yrs	ES, SWA	NGO, EC, RW
3	4.5.8	Research the Effects of Roads on Bog Turtles and their habitat	Populations with “Poor” Population Quality and “Good” Habitat Quality and Reference Populations*	<5 yrs	ES, SWA	DOT, EC, AI, NGO, COE, EPA, LG
3	4.9.4, App. I	Draft BMPs to Reduce Impacts from Stream Restoration, Culvert, and Bridge Projects	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, EC, AI

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
3	4.9.5	Draft BMPs to Reduce Impacts from Pipeline Projects	Extant Populations	<5 yrs	ES, SWA	EC, AI, NGO
3	4.9.2	Draft BMPs to Reduce Impacts from Roadside Mowing Practices	Extant Populations	Ongoing	ES, SWA	DOT, LG, NGO
3	4.2.4	Map Important Habitat Corridors	Between Populations with “Good” or “Fair” viability and within 3 km of each other	Completed†	ES, SWA	NGO, AI
3	4.3.1	Connect Fragmented Habitat	Within Important Habitat corridors	5-10 yrs	ES, SWA	NGO, LG, SA, USFWS
3	4.5.2	Conduct Inventory/Gap Surveys to identify populations and improve our understanding of the species distribution	N/A	Completed†	ES, SWA	NGO, AI, EC, PL

*CP=Conservation Plan

† These actions should periodically be re-evaluated

IX. MECHANISM FOR REPORTING AND/OR UPDATING THE PLANS

The Conservation Plan should be reviewed and updated every 5-10 years. It is recommended that the Conservation Plan be updated just prior to USFWS 5-year reviews.

X. LIST OF RECOVERY UNIT MEETING PARTICIPANTS

In 2017 a group of Bog Turtle experts, professionals who work in the Prairie Peninsula-Lake Plain Recovery Unit gathered to participate in a Prairie Peninsula-Lake Plain Recovery Unit meeting and discussed threats and conservation strategies need in this recovery unit.

October 4, 2017 Meeting Participants

<i>Participant Name</i>	<i>Affiliation</i>
John Adamski	Seneca Park Zoo
Bernie Carr	Central New York Land Trust
Sandra Doran	U.S. Fish and Wildlife Service

Jim Eckler	New York Department of Environmental and Conservation
Sarah Piecuch	New York Department of Transportation
Noelle Rayman-Metcalf	U.S. Fish and Wildlife Service
Peter A. Rosenbaum	State University of New York at Oswego

XI.

REFERENCES

Rosenbaum, Peter A. 2019. Conservation management plan for the Bog Turtle in Central New York portion of the Prairie Peninsula lake plains recovery unit of New York State. A report drafted for the New York Field Office USFWS, NY.

APPENDIX E: SUSQUEHANNA-POTOMAC RECOVERY UNIT ACTION PLAN

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I. DEFINITIONS

Core Habitat – A wetland that meets Bog Turtle suitable habitat requirements where turtles are most frequently found. Multiple Core Habitat areas may be found within a single delineated wetland but may cross multiple parcels.

Extant Population – Populations where there has been a turtle observation in appropriate habitat in the past 30 yrs.

Extirpated Population – Population where the habitat was destroyed and no habitat remains.

Historical Population – Populations where habitat is present, no turtles were observed in the past 30 yrs or a full Phase 2 survey occurred (since turtles were last found within 30 years) and no turtles were found

Metapopulation - Populations with genetic exchange feasible through occasional dispersal events. Populations are close enough to each other to allow occasional movements within one generation time (10-40 years) of an individual: < 3 km of contiguous wetland, < 2 km of intermediate or mosaic upland-wetland habitat, or < 1.5 km undeveloped upland habitat.

Population - A functionally reproductive group of individuals (e.g. at least one individual from each sex or evidence of reproduction such as presence of a hatchling or juvenile) using one or more Core Habitat areas, which are within 300 m of each other with no major barriers between them. Movement between Core Habitat patches likely occurs every 1-10 years.

Unknown Population – Locations where there has been a turtle observation in past 30 yrs, a full Phase II survey has NOT been completed, and one or more of the following is true:

- Historical observation, but no survey work occurred and habitat exists
- Recent road observation, no surveys occurred, and habitat exists within 30 m
- Recent observation resulting from environmental review project, survey stopped as soon as a turtle was found, no further surveys were performed, and habitat exists.

II. INTRODUCTION

2.1. ACTION PLAN USE AND PURPOSE

This document is for use by state and federal partners to guide their conservation efforts over the next 5-10 years, for the Bog Turtle in the Susquehanna-Potomac Recovery Unit (SP RU). This Action Plan summarizes the most prominent threats and limiting factors, describes the status of the species within this recovery unit, and identifies and prioritizes specific strategies needed for recovery of the species. It also provides an implementation schedule with a timeline for completing these actions. This Recovery Unit Action Plan identifies specific recovery unit priorities and should be used in conjunction with the Conservation Plan (2019), which identifies regional level priorities across all recovery units in the Northern population range (Figure 1). Data resulting from Bog Turtle expert surveys provides the basis for these recommendations. This living document should periodically be re-evaluated and updated.

2.2. SUSQUEHANNA-POTOMAC RECOVERY UNIT

The Susquehanna-Potomac Recovery Unit is located along the southwestern edge of the Northern population range (Fig. 1). It extends from Adams County Pennsylvania and Carroll County Maryland east to Lancaster County Pennsylvania and Cecil County Maryland and has three sub-units (Fig. 2).

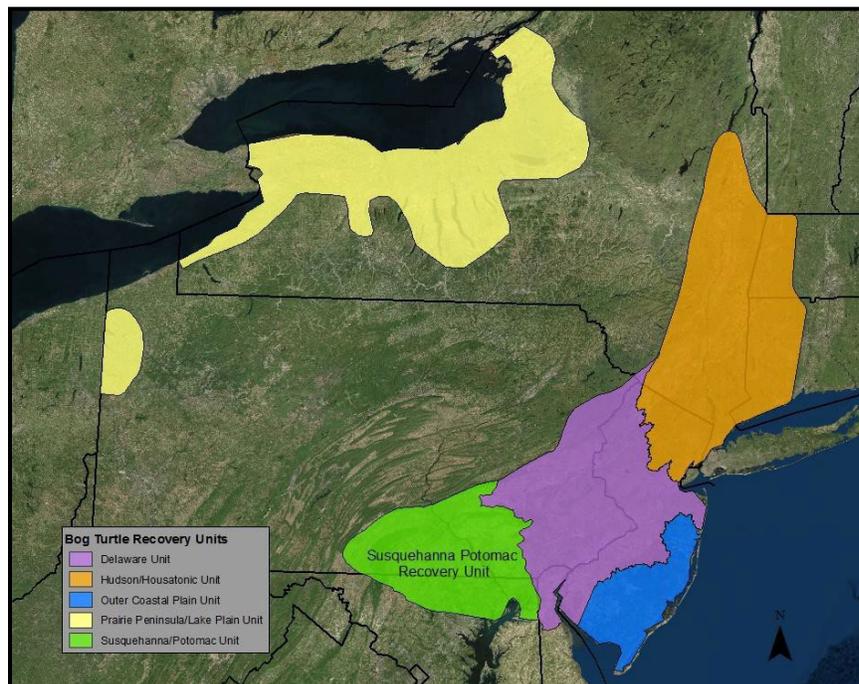


Figure 1. Map showing the Northern population range of the Bog Turtle, separated into 5 recovery units. The Susquehanna Potomac Unit (green) is along the southern edge of the range.

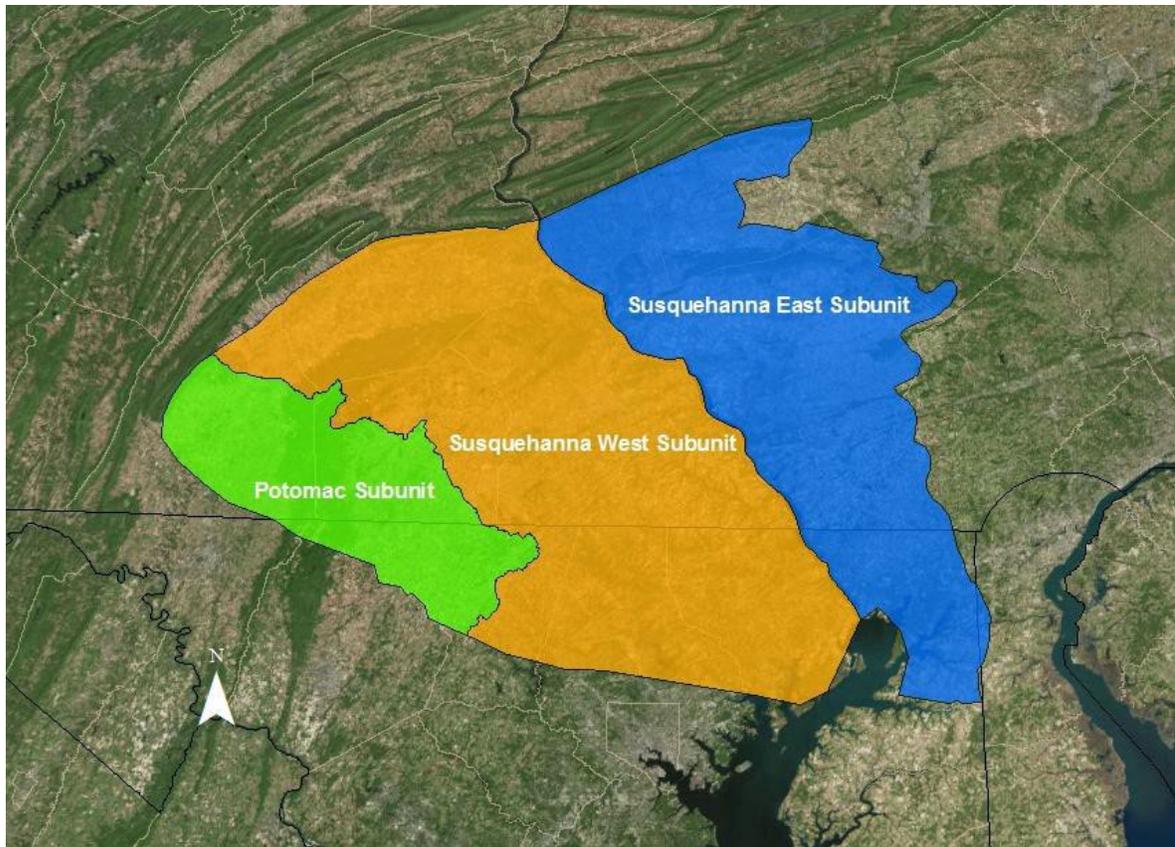


Figure 2. Map showing the Bog Turtle Susquehanna-Potomac Recovery Unit and its three subunits.

2.3. POPULATION STATUS

- Range changes: Historical and current (within past 30 years) Bog Turtle observation data were used to create historical and current range maps. The historical range map was delineated by creating a 10 km buffer off all HUC12 sub-watersheds containing historically and/or current turtle observations. A current range map was similarly created using only the HUC12 sub-watersheds with current observations. Based on these data the species' range has largely been maintained in the Susquehanna-Potomac Recovery Unit, with only 4% (138,564 ac) of the habitat being lost. This is less than in any other recovery unit. The historical range includes all observations of the species (historical, extirpated, extant, and unknown) whereas the current range only includes the range for extant populations.
- Number of populations in the recovery unit discovered since 1997 (time of federal listing): Seven MD populations and 46 PA populations.
- Number of Extant Populations, Metapopulations and Core Habitats: Number of each is listed by state in Table 1.

Table 1. Number of extant populations, extant metapopulations and extant core habitats identified by state biologists in Maryland and Pennsylvania, which make up the Susquehanna-Potomac Recovery Unit.

	<i># Extant Pops</i>	<i># Extant Metapops</i>	<i># Extant Core Habitats</i>
<i>Maryland</i>	92	21	124
<i>Pennsylvania*</i>	53	6	61

*Additional extant populations, extant metapopulations and core habitats are found in Pennsylvania – see Delaware Recovery Unit Action Plan.

- **Extant Population Viability Ranking:** Below is a breakdown of the rankings of populations in the Susquehanna-Potomac Recovery Unit (Table 2). For information on the methodology used to rank populations, see section 4.2.2 of the Conservation Plan.

Table 2. The number of population that were ranked as Good, Fair, and Poor for their potential to be viable over the long term in Maryland and Pennsylvania in the Susquehanna-Potomac Recovery Unit.

	<i>Good</i>	<i>Fair</i>	<i>Poor</i>
<i>Maryland</i>	19	38	35
<i>Pennsylvania</i>	5	15	33

III.

THREATS AND LIMITING FACTORS

This section identifies and ranks threats and limiting factors affecting the status and recovery of the Bog Turtle. A list of threats and limiting factors was developed for the Recovery Plan and was expanded during a species recovery meeting in 2011. In 2017-2018, experts in each of the recovery units participated in ranking these threats and limiting factors based on the risk level or degree of negative influence each has on the Bog Turtle populations in that recovery unit. Threats were ranked as high (3 points), moderate (2 points), low (1 point), or unknown risk (no points) and limiting factors were ranked as very limiting (3 points), somewhat limiting (2 points), not limiting (1 point) and Unknown (no points). Mean scores were calculated and used in a relative comparison (Fig. 3 and 5).

3.1. THREATS

The top current threats identified by experts in this recovery unit included habitat degradation due to direct and indirect effects of increased development, proliferation of invasive plants, altered hydrology, ecological succession, and agricultural activities (Fig. 3). Roads also ranked fairly high. Ranking of threats were similar among the sub-units (Fig. 4) with one notable exception. Hydrology was determined to be less impacted in the Potomac sub-unit, with fewer populations affected by development pressure. For more details see the Species Status Assessment (currently in development). There were also some differences in the order of these threats among the subunits, with development ranking highest in Susquehanna West and East, and ecological succession

ranking highest in the Potomac subunit (Fig. 3). A high degree of uncertainty was associated with disease, contaminants, oil spills, and beaver.

State lead biologists compiled historical and current observational data, which was entered into a centralized regional database developed by USFWS. For each population, they provided information (to the best of their knowledge) on current habitat conditions for hydrology and percent of invasive plants and succession. The state biologist also noted any depredation events and/or poaching events that were known or likely to have occurred at any time in the past. These data extracted from the regional database also provide some insights on threats although these numbers are almost certainly underestimations of the true values:

- Disturbance to Hydrology: This was noted for 100 MD populations and 29 PA populations.
- Invasive Plants and Succession: Cover >60% of the Core Habitat in 33 MD populations and 12 PA populations.
- Development Pressure: Exists for all but 6 populations in this recovery unit. Is present in the Core Habitat or both the Core Habitat and the 300ft Buffer in 27 MD populations and 11 PA populations.
- Depredation: This occurred in 8 extant MD populations between 1999 and 2017, and likely occurred at another MD population in 1997.
- Poaching: This occurred in 9 extant MD populations between the years 1990 and 2004 and likely occurred in another MD population in 1980.
-

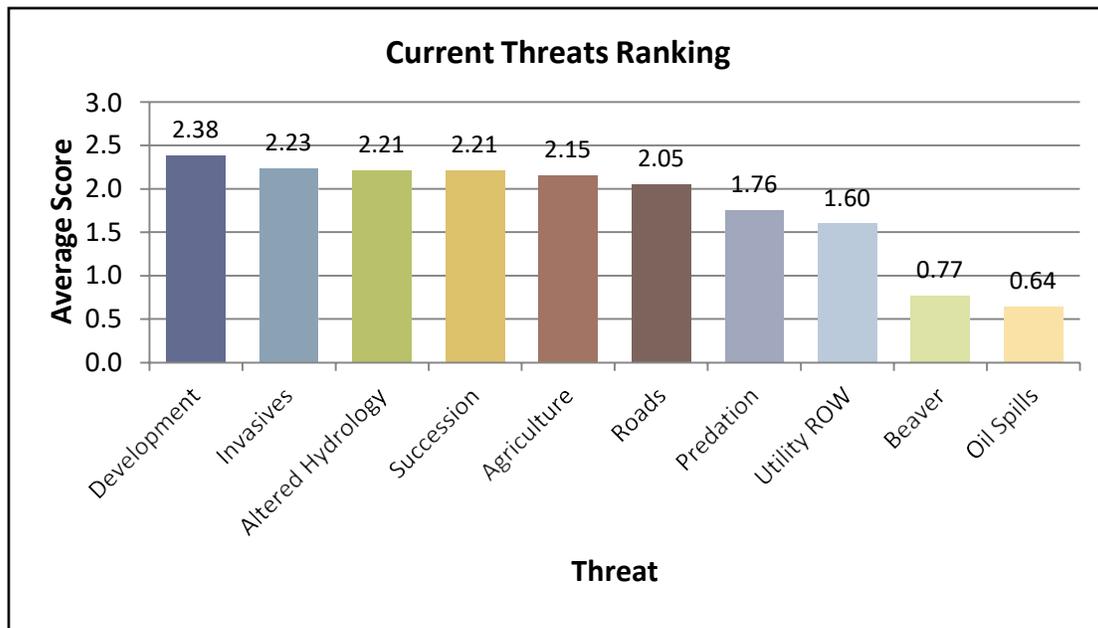


Figure 3. Threats to the Bog Turtle ranked in order of degree of their effect on populations within the Susquehanna-Potomac Recovery Unit. Higher average scores indicate threats of greater effect.

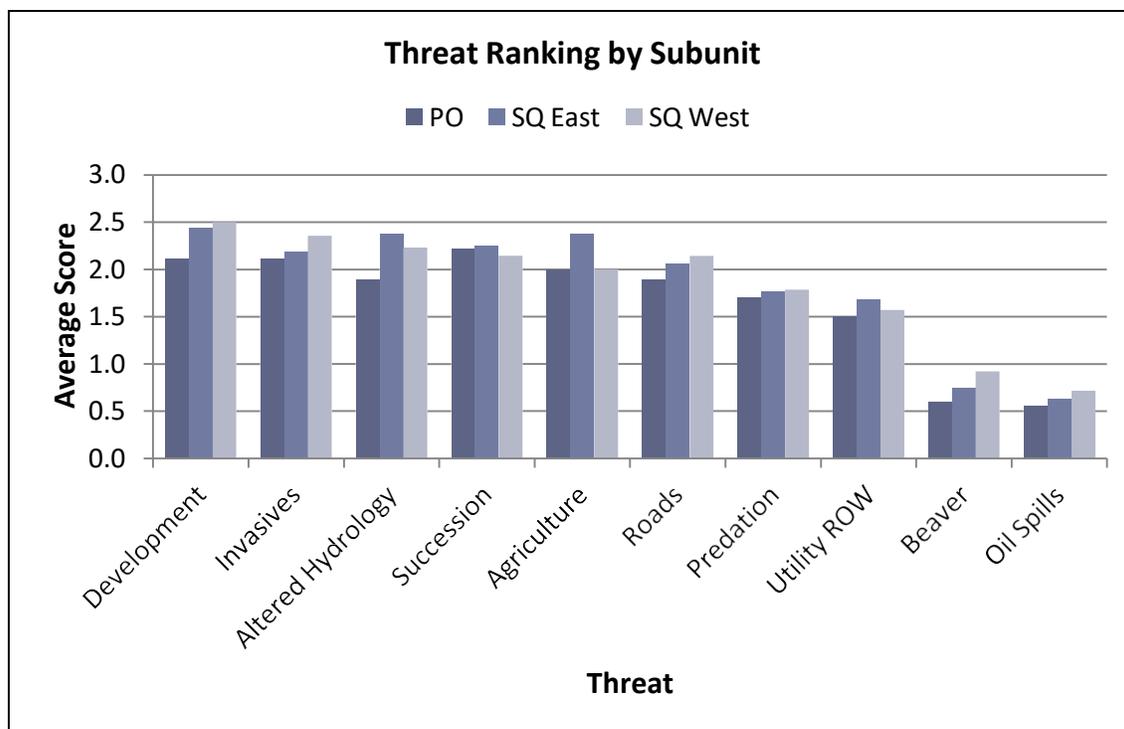


Figure 4. A comparison of the degree of effect of threats among sub-units of the Susquehanna-Potomac Recovery Unit, including the Potomac (PO), Susquehanna East (SQ East), and Susquehanna West (SQ West) subunits.

3.2. LIMITING FACTORS TO RECOVERY

Experts ranked current Limiting Factors that limit recovery of a species beyond threats. Top limiting factors for the Susquehanna-Potomac Recovery Unit include prioritizing population for habitat management, prioritizing populations for habitat protection, both requiring region-wide action. Followed by habitat quality and quantity, habitat protection and distribution knowledge (Fig. 5). Ranking of limiting factors were similar among the sub-units (Fig. 6) with one notable exception: habitat quality scored higher in the Potomac sub-unit, with fewer populations needing habitat management. For more details, see the Species Status Assessment (currently in development).

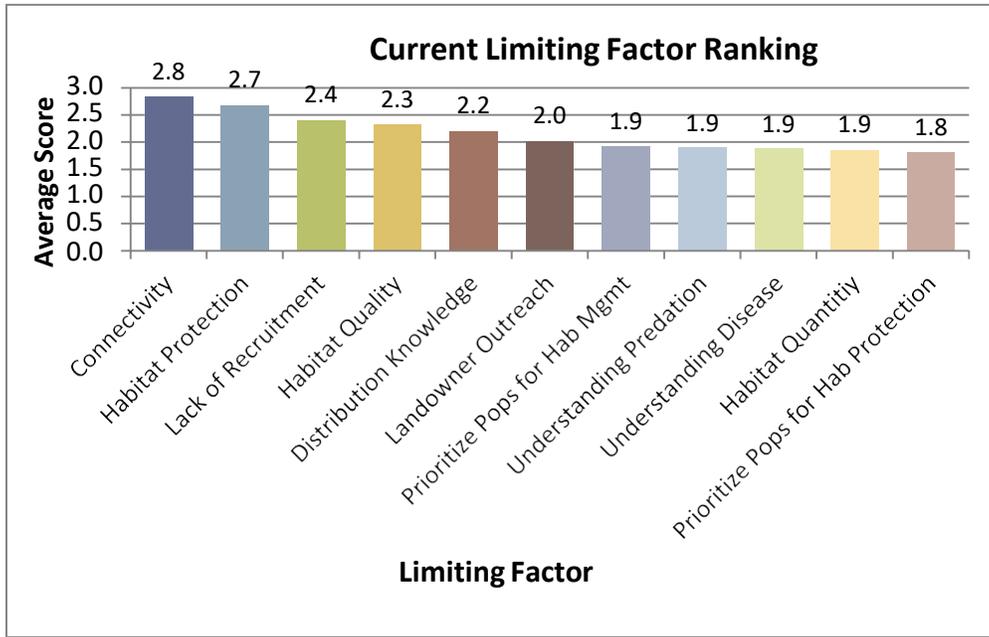


Figure 5. Limiting factors ranked in order of the degree of effect on population in the Susquehanna-Potomac Recovery Unit. Higher scores indicate threats of greater effect.

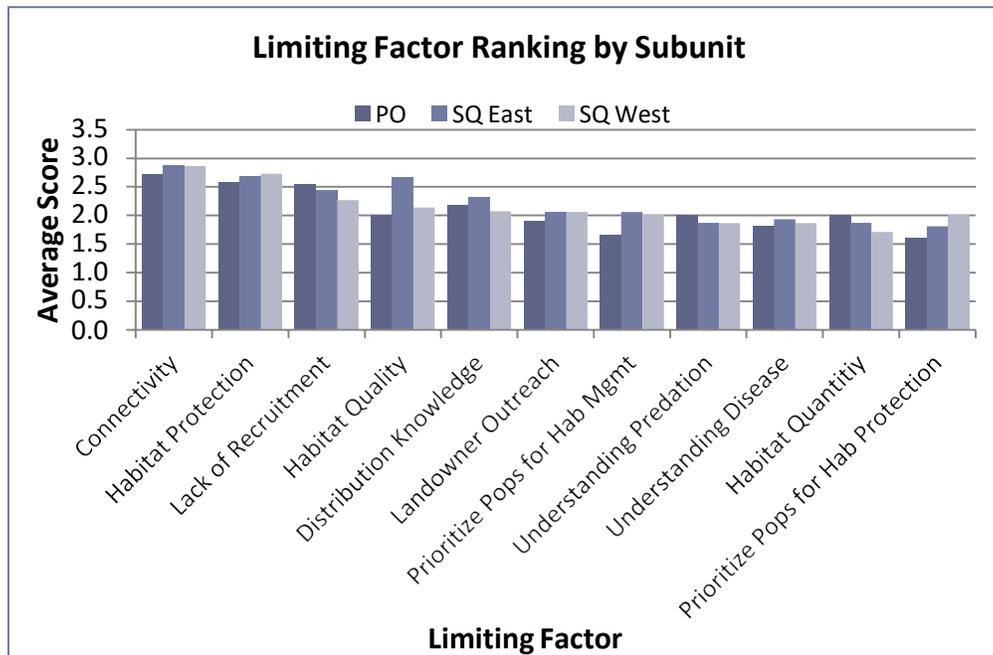


Figure 6. A comparison of the degree of effect of limiting factors among subunits of the Susquehanna-Potomac Recovery Unit.

IV.

PROGRESS

The data presented below were compiled using information from the multi-state regional database for all years. The health assessments did not begin until 2001 and the regional population and habitat monitoring did not begin until 2014. The values below only represent partial data for the 2018 field season.

4.1. PROGRESS TOWARDS RECOVERY

Considerable effort has gone into discovering new populations, better understanding population abundance and recruitment of known populations, protecting habitat, improving habitat quality, and understanding demographics of populations and site-specific habitat use. The values below are for all actions noted for all years data is present.

4.1.1. POPULATION SURVEYS

Various types of surveys have been conducted over the years (Table 3). Regional sampling occurred in recent years for tracking of population trends (survey protocols can be found in Section 4.2.5 and 4.2.6 of the Conservation Plan). Phase 1, 2, 3 surveys are designed to determine presence/absence of Bog Turtle in wetlands and are typically performed in response to a development project proposal (see USFWS 2018 for more details). Health assessments have also been completed for numerous populations in the Susquehanna-Potomac Recovery Unit.

Table 3. The type of survey and number of populations where each survey type was performed in Maryland and Pennsylvania for populations in the Susquehanna-Potomac Recovery Unit. This is based on all available data in the state's database. Negative survey data has not been tracked in most states.

<i>Type of Survey</i>	<i>MD</i>	<i>PA</i>
<i>Regional Population Monitoring: Rapid Assessments</i>	11	16
<i>Regional Population Monitoring: Intensive Sampling</i>	5	3
<i>Regional Habitat Monitoring: Random Sampling</i>	4	5
<i>Regional Habitat Monitoring: Targeted Sampling</i>	8	4
<i>Phase 1 surveys</i>	91	46
<i>Phase 2 surveys</i>	92	47
<i>Phase 3 surveys</i>	10	13
<i>Health Assessments</i>	11	0

4.1.2. HABITAT PROTECTION

Habitat protection here includes properties purchased for conservation purposes and properties with an easement (conservation or agricultural; Table 4).

Table 4. Different levels of habitat protection and the number of populations with each type of protection level for Maryland and Pennsylvania populations in the in the Susquehanna-Potomac Recovery Unit.

<i>Type and Location of Protection</i>	<i>MD</i>	<i>PA</i>
<i>Full permanent protection of the Core Habitat</i>	15	11
<i>Partial permanent protection of the Core Habitat</i>	33	10
<i>Full permanent protection of the 300 ft Buffer</i>	4	3
<i>Partial permanent protection of the 300 ft Buffer</i>	62	21
<i>Partial temporary protection</i>	0	1

4.1.3. HABITAT MANAGEMENT

Habitat management to remove woody and invasive plants has been a key conservation measure used in previous years. Below is a rough summary (based on what information exists) of prior management actions.

- Habitat Management Projects: 25 MD populations and 22 PA populations have had management.
- Habitat Management Plans: Data should be added for the number of site-specific habitat management plans.

4.1.4. DEMOGRAPHIC AND HABITAT USE DATA

- Maryland has collected enough long-term demographic data from 1992-2018 to develop population tables for 24 localities. Pennsylvania conducted trapping efforts for environmental review projects and research providing some knowledge of the demographics of 19 populations.
- Maryland have had 20 radio-telemetry studies conducted from 1996-2017 at 12 sites. A total of 246 Bog Turtles have yielded 3681 radiolocation records. Pennsylvania conducted radio telemetry and/or trapping efforts for environmental review projects and research providing some habitat use information for 14 populations.

V.

CONSERVATION APPROACH

The following sections identify and prioritize conservation strategies to be implemented, populations and important habitat corridors to target for these conservation actions, and lay out an implementation plan and benchmarks recommended for the Susquehanna-Potomac Recovery Unit. This approach is based on a broad-scale perspective, which is important to obtain recovery of the species across the Northern range. Priorities outlined here should be used to determine actions to propose for grants and other funding opportunities. As funding and resources become available conservation partners should use this action plan to address the highest priority actions, not yet completed, in the Susquehanna-Potomac Recovery Unit and use these priority population lists to maintain and recover populations. However, lower priority conservation actions or actions at lower priority populations may still be warranted based on opportunities that arise and other agency

priorities. Non-prioritized conservation actions for particular populations or innovative new ideas may also help with recovery of the Bog Turtle.

VI.

RANKING CONSERVATION STRATEGIES

Bog Turtle expert surveys were used to rank conservation strategies in order of effectiveness and/or need. Experts that work in the Susquehanna-Potomac Recovery Unit were polled to determine what conservation strategies would be most effective and are in greatest need for the recovery of the species in this region. A list of conservation strategies was developed during a species recovery meeting in 2011. In 2017-2018, experts in each of the recovery units participated in ranking these strategies based on the risk level or degree of positive influence each has on the Bog Turtle populations in that recovery unit. Conservation strategies were ranked from 1-5 with 5 being very important for the recovery of the species and 1 being less important. Mean scores were calculated and used to identify priority actions (Table 5) and strategies were grouped into categories (Table 6).

6.1. CONSERVATION STRATEGIES PRIORITY LEVEL DESCRIPTION

Priority 1: Strategies that experts within the Susquehanna-Potomac Recovery Unit deemed to be the most urgent and effective for recovery. These actions should be completed before all other conservation strategies. Some of these actions have already been completed, are currently being implemented, or are planned for implementation in the next few years.

Priority 2: Strategies that should be implemented after priority 1 strategies are underway or have been completed.

Priority 3: Strategies that are of lowest priority for implementation. However, these strategies have been identified as being useful for the recovery of Bog Turtles. While these measures are considered to be of lesser need, they may prove to be valuable in particular circumstances. In general, these actions should only be implemented after priority 1 and 2 strategies are underway or have been completed.

6.2. CONSERVATION STRATEGIES PRIORITIZATION

Bog Turtle experts that work in the Susquehanna-Potomac Recovery Unit ranked conservation strategies for the Susquehanna-Potomac Recovery Unit (Table 6). Survey results are shown below with the conservation strategies organized from those deemed of greatest importance (or most effective for achieving recovery of the Bog Turtle) in this recovery unit to those that were considered least important. However, all conservation strategies listed were identified as needs for the Bog Turtle. This information should be used to prioritize conservation efforts in the Susquehanna-Potomac Recovery Unit, to determine which strategies should be implemented first, and to justify funding for related projects. Ranking categories are as follows: strategies that scored ≥ 3.80 are ranked as Priority 1, 3.50-3.79 are Priority 2, and ≤ 3.50 are Priority 3.

Table 5. A list of abbreviations for categories of conservation strategies used to recover the Bog Turtle.

<i>Abbreviation</i>	<i>Conservation Strategy Category</i>
<i>BMPs</i>	Best Management Practices
<i>BSC</i>	Broad Scale Conservation
<i>HM</i>	Habitat Management
<i>HP</i>	Habitat Protection
<i>LR</i>	Laws and Regulations
<i>PBC</i>	Predators and Beaver Control
<i>PM</i>	Population Management
<i>RN</i>	Research Needs

Table 6. Conservation strategies for the Northern population of the Bog Turtle. Strategies are listed in order of their expected benefit to the recovery of the Bog Turtle based on Susquehanna-Potomac Recovery Unit expert survey scores. Conservation strategies are grouped into categories (e.g., habitat protection or laws and regulations) and the Conservation Plan section is provided (CP Section).

<i>Conservation Strategy</i>	<i>Strategy Category</i>	<i>RU Mean Score</i>	<i>Priority Level</i>
<i>Seek Max Penalties on Violations of the ESA</i>	LR	4.69	1
<i>Conduct Inventory/Gap Surveys</i>	RN	4.62	1
<i>Obtain Funding</i>	BSC	4.62	1
<i>Engage in Landowner Outreach for Habitat Protection</i>	HP	4.54	1
<i>Research the Effectiveness of Habitat Management</i>	RN	4.46	1
<i>Conduct Succession/Invasive Plant Management</i>	HM	4.46	1
<i>Prioritize Populations for Habitat Protection and Management</i>	BSC	4.46	1
<i>Develop a Communication Strategy</i>	BSC	4.46	1
<i>Connect Fragmented Habitat</i>	HP	4.38	1
<i>Implement Population and Habitat Monitoring</i>	BSC	4.38	1
<i>Research the Effects of Agriculture, Pesticides, and Herbicides</i>	RN	4.31	1
<i>Engage in Landowner Outreach for Habitat Management</i>	HM	4.31	1
<i>Draft BMPs to Improve Road Passageways</i>	BMP	4.31	1
<i>Draft BMPs to Reduce Impacts from Development Projects</i>	BMP	4.31	1

<i>Conservation Strategy</i>	<i>Strategy Category</i>	<i>RU Mean Score</i>	<i>Priority Level</i>
<i>Research the Effects of Development</i>	RN	4.23	1
<i>Restore Hydrology</i>	HM	4.23	1
<i>Map Important Habitat Corridors</i>	BSC	4.23	1
<i>Rank Populations for Viability</i>	BSC	4.23	1
<i>Protect Nests and Perform Predator Control</i>	PBC	4.15	1
<i>Identify Best Population Management Techniques</i>	PM	4.15	1
<i>Research Hydrology and Water Chemistry</i>	RN	4.08	1
<i>Draft BMPs to Reduce Impacts from Stream Restoration, Culvert, or Bridge Projects</i>	BMPs	4.08	1
<i>Monitor Progress of Conservation Actions</i>	BSC	4.08	1
<i>Develop and Evaluate eDNA Techniques</i>	RN	4.00	2
<i>Train Law Enforcement</i>	PBC	4.00	2
<i>Draft BMPs to Reduce Impacts from Roadside Mowing Practices</i>	BMP	3.92	2
<i>Draft BMPs to Reduce Impacts from Pipeline Projects</i>	BMP	3.92	2
<i>Revise Regulations to Improve Protection</i>	LR	3.92	2
<i>Implement USFWS Survey Protocols</i>	LR	3.86	2
<i>Research the Effects of Roads</i>	RN	3.85	2
<i>Create a Standardized Regional Database</i>	BSC	3.85	2
<i>Revise the Recovery Plan and Re-evaluate the Recovery Criteria</i>	LR	3.85	2
<i>Require Surveyor Qualifications</i>	LR	3.85	2
<i>Conduct Staff Trainings</i>	HP	3.85	2
<i>Draft Guidelines for Population Management</i>	PM	3.77	2
<i>Develop a Stewardship Program(s)</i>	HP	3.77	2
<i>Draft Guidelines to Reduce Adverse Effects</i>	LR	3.77	2
<i>Research Macro and Microhabitat Use</i>	RN	3.77	2

<i>Conservation Strategy</i>	<i>Strategy Category</i>	<i>RU Mean Score</i>	<i>Priority Level</i>
<i>Engage in Mitigation Banking to Protect Habitat</i>	HP	3.75	2
<i>Restore Relic Fens</i>	HM	3.69	2
<i>Draft a Population Management Decision Tree</i>	PM	3.62	2
<i>Draft BMPs for Controlling Predators</i>	BMP	3.54	2
<i>Research Life History Traits</i>	RN	3.46	3
<i>Develop an Anti-poaching/Collection Strategy</i>	PBC	3.46	3
<i>Perform Population Management</i>	PM	3.46	3
<i>Research the Effects of Depredation</i>	RN	3.38	3
<i>Compile a Bibliography of Bog Turtle Literature</i>	BSC	3.38	3
<i>Develop a Climate Change Strategy</i>	BSC	3.38	3
<i>Evaluate Population Genetics and Develop a Genetic Library</i>	RN	3.31	3
<i>Improve Environmental Review Tools</i>	LR	3.23	3
<i>Conduct Health Assessments</i>	RN	3.15	3
<i>Evaluate PIT Tagging Techniques</i>	RN	3.08	3
<i>Draft BMPs for Radio-telemetry Research</i>	BMP	3.00	3
<i>Research the Effects of Beaver</i>	RN	2.93	3
<i>Draft BMPs for Beaver Management</i>	BMP	2.23	3
<i>Perform Beaver Control</i>	PBC	NA	NA

VII. PRIORITY POPULATIONS AND IMPORTANT HABITAT CORRIDORS

7.1. POPULATION VIABILITY POTENTIAL

Bog Turtle experts from across the Northern range developed population-ranking methodology to categorize populations in terms of their potential to be viable over the long-term. Populations were ranked using 3 population quality parameters and 5 habitat quality parameters. Experts determined a weighted average for each parameter and based on overall population scores (including both the population and habitat quality parameters) populations were grouped into 3 categories: Good, Fair, and Poor. A full table of the results was sent to the state leads and the USFWS federal coordinator for Bog Turtle. For details on the ranking methodology, see section 4.2.2 in the Conservation Plan. These ranking results and/or particular ranking parameters were used to identify priority populations for specific conservation actions such as habitat protection, habitat management, and specific research projects. Resulting population priority lists are provided below.

7.2. POPULATION PRIORITY LEVEL DESCRIPTION

Priority 1: Populations that experts within the Susquehanna-Potomac Recovery Unit deemed to be of highest priority for specific conservation actions as described below.

Priority 2: Populations that should be of next highest priority after conservation actions at priority 1 populations are underway or have been completed.

Priority 3: Populations that should be of next highest priority after conservation actions at priority 2 populations are underway or have been completed.

Priority 4: Populations that are of lowest priority for conservation actions. However, all populations are of importance for the recovery of Bog Turtles. While conservation measures are considered to be of lesser need at these populations due to the perceived likelihood of their effectiveness at recovering the species, they may prove to be valuable in particular circumstances. In general, Priority 4 populations should only be a target for conservation strategies when all other populations are considered stable or increasing, unless opportunities arise for conservation actions that will benefit these sites without affecting efforts on higher priority sites.

7.3. POPULATION PRIORITIZATION FOR HABITAT PROTECTION

Within the Susquehanna-Potomac Recovery Unit, populations were ranked according to the effectiveness of habitat protection measure for the recovery of the species across the Northern range (Table 7). Below are the criteria used to prioritize populations for habitat protection. See section 4.2.3 in the Conservation Plan for more information.

Priority 1:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 2-4 OR
- Populations ranked as having “Good” population quality and “Good” or “Fair” habitat quality and a habitat protection score of 2-4

Priority 2:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 1 OR
- Populations ranked as having “Good” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1 OR
- Populations ranked as having “Fair” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1-4

Priority 3: “Good” or “Fair” population quality rank and “Poor” habitat quality rank and a habitat protection score of 1-4

Priority 4: All other populations

Table 7. Priority level for habitat protection measures and a list of populations that fall into each priority level in Maryland and Pennsylvania within the Susquehanna-Potomac Recovery Unit.

	<i>Maryland</i>	<i>Pennsylvania</i>
Priority 1	MD-374, MD-506, MD-115, MD-787, MD-1466, MD-1899, MD-2496, MD-4387, MD-4763, MD-4858, MD-5398, MD-5792, MD-6793, MD-6817, MD-7179, MD-7454, MD-7621, MD-7825, MD-9819	BERK-01, CHES-36, LANC-01, LANC-07
Priority 2	MD-114, MD-227, MD-729, MD-786, MD-1198, MD-1410, MD-1602, MD-1608, MD-1717, MD-1738, MD-2412, MD-3091, MD-3624, MD-3656, MD-4000, MD-4651, MD-5243, MD-6243, MD-6451, MD-6549, MD-6794, MD-7836, MD-8117, MD-9795	LANC-04, LANC-06, LANC-13, LANC-18, LEBA-14, YORK-12, YORK-13
Priority 3	MD-1602, MD-2647, MD-3074, MD-4363, MD-4929, MD-6532, MD-6533, MD-6991, MD-9780, MD-9788, MD-9803, MD-9809	ADAM-01, LANC-02, LANC-29, LEBA-13, YORK-01, YORK-17

7.4. POPULATION PRIORITIZATION FOR HABITAT MANAGEMENT

Populations were ranked within this recovery unit according to the effectiveness of habitat management measure for the recovery of the species across the Northern range (Table 8). Below are the criteria used to prioritize populations for habitat management actions. See section 4.2.3 in the Conservation Plan for more information.

Priority 1:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 3-5 OR
- Populations ranked as having “Good” population quality and “Good” or “Fair” habitat quality and a habitat protection score of 3-5

Priority 2:

- Populations ranked as having “Good” potential for viability over the long-term and a habitat protection score of 1-2 OR
- Populations ranked as having “Good” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 1-2 OR
- Populations ranked as having “Fair” population quality score and “Good or “Fair” habitat quality score and a habitat protection score of 2-5

Priority 3: “Fair” population quality rank and a habitat protection score of 1

Priority 4: All other populations

Table 8. Priority level for habitat management actions and a list of populations that fall into each priority level in Maryland and Pennsylvania within the Susquehanna-Potomac Recovery Unit.

	<i>Maryland</i>	<i>Pennsylvania</i>
Priority 1	MD-24, MD-115, MD-374, MD-506, MD-787, MD-1116, MD-1466, MD-1899, MD-2311, MD-2496, MD-3472, MD-3597, MD-3821, MD-4387, MD-4763, MD-4858, MD-5398, MD-5792, MD-6793, MD-6817, MD-7179, MD-7454, MD-7621, MD-7825, MD-9815, MD-9819	BERK-01, CHES-36, LANC-01, LANC-07
Priority 2	MD-227, MD-729, MD-786, MD-1112, MD-114, MD-1198, MD-1181, MD-1410, MD-1602, MD-1717, MD-3091, MD-3656, MD-4000, MD-4651, MD-6098, MD-6451, MD-6549, MD-6794, MD-7836, MD-8117, MD-9801	ADAM-03, ADAM-06, CUMB-01, LANC-04, LANC-13, LANC-15, LEBA-14, YORK-03
Priority 3	MD-1608, MD-1738, MD-2412, MD-2647, MD-3074, MD-3624, MD-4363, MD-4929, MD-5243, MD-6243, MD-6532, MD-6533, MD-6991, MD-9788, MD-9795, MD-9803, MD-9809	LANC-06, LANC-18, LEBA-13, YORK-01, YORK-12, YORK-13, YORK-17

7.5. POPULATION PRIORITIZATION FOR POPULATION MONITORING, HABITAT MONITORING, AND INVENTORY/GAP SURVEYS

Extant populations were ranked for their potential to be viable over the long-term. Ranking metrics included parameters associated with population quality (e.g., population size and recruitment) and other for habitat quality (e.g., percent success and road density within and adjacent to Core Habitat). Each population was given a score for each metric and metric scores were summed for an overall population score. An expert group ranked the importance of each metric for determining a population’s ability to remain stable. Results from the survey were used to determine the weighting of each metric in the overall population score. For more details, see Section 4.2.2 of the Conservation Plan.

7.5.1. POPULATION PRIORITIZATION FOR POPULATION MONITORING

Populations with a population size score of 4 or 5 (Table 9) and where landowner access is granted.

Table 9. Priority populations in the Susquehanna-Potomac Recovery Unit for population and habitat monitoring.

<i>Priority Populations for Population and Habitat Monitoring</i>	
Maryland	MD-374, MD-506, MD-729, MD-1116, MD-1466, MD-2311, MD-3472, MD-3597, MD-3821, MD-4858, MD-5398, MD-7179, MD-7454, MD-7621, MD-7825
Pennsylvania	ADAM-01, BERK-01, CHES-36, LANC-01, LANC-13, LANC-29

7.5.2. POPULATION PRIORITIZATION FOR HABITAT MONITORING

Random habitat sampling should occur in Core Habitats where the population size score was 4-5 (Table 9) and landowner permission to access is granted. Targeted habitat monitoring should occur at locations where habitat management is planned, including pre- and post-management assessments, and landowner permission to access is granted.

7.5.3. POPULATION PRIORITIZATION FOR INVENTORY/GAP SURVEYS

Populations to target for inventory/gap survey are populations of Unknown occupancy (see definitions in section 1), or Extant populations with a population size score of 2 (unknown due to insufficient survey effort; Table 10). In addition, historical habitat and potential habitat patches (of unknown occupancy) should be targeted, particularly within the important habitat corridors and outside the current species' range.

Table 10. Extant populations in the Susquehanna-Potomac Recovery Unit with unknown population size due to a lack of survey effort. These are priority sites for inventory/gap surveys in addition to site of unknown occupancy, historical, and potential habitats.

<i>Priority Populations for Inventory/Gap Surveys</i>	
Maryland	MD-23, MD-227, MD-114, MD-115, MD-1112, MD-1181, MD-1198, MD-1341, MD-1342, MD-1410, MD-1601, MD-1608, MD-1717, MD-1738, MD-1746, MD-1871, MD-1899, MD-2412, MD-2647, MD-2896, MD-3074, MD-3188, MD-3382, MD-3624, MD-3656, MD-4000, MD-4363, MD-4387, MD-4651, MD-4712, MD-4929, MD-5243, MD-5708, MD-6098, MD-6243, MD-6451, MD-6532, MD-6533, MD-6549, MD-6793, MD-6794, MD-6991, MD-7180, MD-7244, MD-7835, MD-7836, MD-8117, MD-9780, MD-9788, MD-9795, MD-9801, MD-9803, MD-9809, MD-9819
Pennsylvania	ADAM-03, ADAM-05, LANC-02, LANC-19, LANC-23, LEBA-13, LEBA-14, YORK-02, YORK-04, YORK-11, YORK-12, YORK-14

7.6. POPULATION PRIORITIZATION FOR POPULATION MANAGEMENT

Implementation of population management actions (i.e., captive management) have been identified as of low priority, but evaluation and identification of the most efficient and effective population management techniques were considered a Priority 1 action. Therefore, we identify a set of priority populations as potential recipient and donor populations.

7.6.1. PRIORITY RECIPIENT POPULATIONS

Priority Recipient Populations are populations that ranked “Poor” for population quality and “Good” for habitat quality based on results from the population viability-ranking project (Table 11). There are no priority populations for population management actions in the Susquehanna-Potomac Recovery Unit.

Table 11. A list of priority population for population management actions in Maryland and Pennsylvania for the Susquehanna-Potomac Recovery Unit.

<i>Priority Recipient Populations</i>	
Maryland	None
Pennsylvania	None

7.6.2. PRIORITY DONOR POPULATIONS

Priority Donor Populations are populations that scored a 5 for both population size and recruitment, and ranked as “Good” for both Habitat Quality and Population Viability (Table 12). It is also recommended that population viability analysis modeling be used to determine what impact removals will have on donor populations, specifically determine what number by sex and age class can be removed without causing negative population trend.

Table 12. A list of potential donor populations for population management actions to recover populations in need (listed in table 9) in the Susquehanna-Potomac Recovery Unit.

<i>Priority Donor Populations</i>	
Maryland	MD-1116, MD-3472, MD-3821
Pennsylvania	None in this recovery unit

7.7. IMPORTANT HABITAT CORRIDORS

Important habitat corridors were identified and mapped for the purpose of improving or maintaining metapopulation dynamics. Results from geospatial analyses and evaluation of observational and population data were used to identify the most important habitat corridors between top-ranking Core Habitats throughout the Northeastern range. Corridors were ranked in

order of importance for habitat protection and management actions. Below are the criteria used to prioritize populations for habitat management actions. Spatial data were provided to the state leads and the regional federal coordinator for Bog Turtle conservation. See section 4.2.4 in the Conservation Plan for more information.

Priority 1: Habitat between all extant populations within a single Metapopulation and with ≥ 1 population that ranked as “Good” for viability. These locations are of highest priority for habitat protection and management actions. These are also important locations for locating and surveying other potential wetland habitat.

Priority 2: Habitat between all extant populations (and Core Habitats within each population) within a single Metapopulation and with ≥ 1 population that ranked as “Fair” for viability.

Priority 3: Habitat between all extant populations (and Core Habitats within each population) within a single Metapopulations and with only populations that ranked as “Poor” for viability.

Priority 4: Linkages between two or more populations that ranked as “Good” for viability and are not currently part of the same metapopulation (based on the mapping guidelines), are within 2 km of each other, and are not separated by a 4-lane highway or multiple high traffic state roads.

VIII.

IMPLEMENTATION PLAN

This implementation plan should be used to identify top priority strategies needed for the recovery of populations in the Susquehanna-Potomac Recovery Unit (Table 14). It identifies populations where specific actions are most needed, a rough target timeline benchmarks for completing each action, identifies the responsible organization (Table 13) and potential partners to assist with each strategy.

Table 13. A list of agencies that are potential partners for one or more conservation strategy and their abbreviation code. These codes are found in Table 12.

<i>Code</i>	<i>Agency</i>
AI	Academic Institutions
BZOO	Baltimore Zoo
COE	U.S. Army Corps of Engineers
DOD	U.S Department of Defense
DOT	Federal or State Departments of Transportation
EC	Environmental Consultants
EPA	U.S. Environmental Protection Agency
ES	USFWS, Ecological Services
LE	Federal or State Law Enforcement
LG	Local and Municipal Agencies
NGO	Nongovernmental Organizations

NRCS	USDA, Natural Resource Conservation Service
NWR	USFWS, National Wildlife Refuges
PFW	USFWS, Partners for Fish and Wildlife
PL	Private Landowners
SA	State Agencies, other than the wildlife agencies
SL	State Legislature
SWA	State Wildlife Agencies
USFWS	USFWS, other programs
USGS	U.S. Geological Survey

8.1. IMPLEMENTATION TABLE

An implementation table was constructed to help guide conservation partners to address the most pressing conservation needs (Table 14). The formal establishment of a working group for the Susquehanna-Potomac Recovery Unit would be beneficial. It is recommended that this group is created by the end of 2020 and that at a minimum the group holds annual meetings to discuss progress on conservation actions and planned activities for the following year.

Table 14. Conservation Strategy descriptions, their priority level of implementation, the location in the Conservation Plan (CP Section) where specific actions are outlined, priority populations to target for each strategy, the timeline for action, organizations responsible for implementation and potential partners to complete the work.

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.2.5	Seek Max Penalties on Violations of the ESA	N/A	5-10 yrs	ES, SWA	LE, SL
1	4.2.1	Obtain Funding to support conservation actions	Extant Populations	Ongoing	ES, SWA	All Partners
1	4.5.2	Conduct Inventory/Gap Surveys to identify populations and improve our understanding of the species distribution	N/A	Ongoing	ES, SWA	NGO, AI, EC, PL
1	4.3.2	Engage in Landowner Outreach for Habitat Protection	Use the Habitat Protection Priority List	Ongoing	ES, SWA	NRCS, PFW, RW, NGO, LG, EC, PL
1	4.2.3	Prioritize Populations for Habitat Protection	Extant Populations	Completed ⁺	ES, SWA	NGO, AI, EC
1	4.2.3	Prioritize Populations for Habitat Management	Use the Habitat Management Priority List	Completed ⁺	ES, SWA	NGO, AI, EC

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.4.1	Conduct succession/Invasive Plant Management	Use the Habitat Management Priority List	Ongoing	ES, SWA	All Partners except LE and SL
1	4.2.8	Develop a Communication Strategy	Not Applicable	<5 yrs	ES, SWA	All Partners
1	4.5.1	Research the Effectiveness of Habitat Management to evaluate specific techniques and compare results among techniques	Use the Habitat Management Priority List	<5 yrs	ES, SWA	NRCS, AI, NGO, EC
1	4.2.5, 4.2.6	Implement Population and Habitat Monitoring	Extant Populations with Pop Size Score of ≥ 3	Ongoing	ES, SWA	EC, NGO
1	4.3.1	Connect Fragmented Habitat	Within Important Habitat corridors	5-10 yrs	ES, SWA	NGO, LG, SA, USFWS
1	4.4.3	Engage in Landowner Outreach for Habitat Management	Use the Habitat Management Priority List	Ongoing	ES, SWA	All Partners except LE and SL
1	4.9.1, App. F	Draft BMPs to Improve Road Passageways near Bog Turtle habitat and protective measures during construction	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, AI, EC
1	4.9.3	Draft BMPs to Reduce Impacts from Development Projects	Extant Populations	<5 yrs	ES, SWA	NGO, AI,
1	4.2.2	Rank Populations for Viability , their potential to be viable	Extant Populations	Completed†	ES, SWA	NGO, AI, EC
1	4.2.4	Map Important Habitat Corridors	Between Populations with “Good” or “Fair” viability and within 3 km of each other	Completed†	ES, SWA	NGO, AI

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
1	4.5.5	Research the Effects of Development on Core Habitat quality	Populations pre- and post-development or affected populations and reference populations*	<5 yrs	ES, SWA	AI, NGO, EC
1	4.4.2	Restore Hydrology within Core Habitat	Populations with “Good” or “Fair” Population Quality and “Fair” Habitat Quality due to disturbed hydrology	<5 yrs	ES, SWA, NRCS	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA, USFWS, USGS
1	4.8.1	Protect Nests from predators	Populations with “Fair” Population Quality and “Good” Habitat Quality	Ongoing (as needed)	ES, SWA	NGO, EC, AI
1	4.7.1	Identify Best Population Management Techniques to recover Bog Turtle populations	Use Population Management Priority List	<5 yrs	ES, SWA	AI, Zoos
1	4.2.9	Monitor Progress of Conservation Actions	All Populations	Ongoing	ES, SWA	None
1	4.5.4	Research Hydrology and Water Chemistry at Bog Turtle sites including the collection of baseline data	Opportunistically	<5 yrs	ES, SWA	COE, DOT, EC, EPA, LG, NGO, PFW, PL, RW, SA, NRCS, USFWS, USGS, AI
1	4.9.4, App. I	Draft BMPs to Reduce Impacts from Stream Restoration, Culvert, and Bridge Projects	Extant Populations	<5 yrs	ES, SWA	DOT, NGO, EC, AI
2	4.5.7	Develop and Evaluate eDNA techniques	Not Applicable	Completed; some continued research possible	ES, SWA	AI, NGO

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
2	4.8.1	Perform Predator Control	As the need arises	Ongoing (as needed)	ES, SWA	NRCS, USFWS, SA, RW, Trappers
2	4.8.5	Train Law Enforcement on the turtle collection threat and abatement measures	All Populations	Ongoing	ES, SWA	LE, NGO, EC, AI
2	4.9.2	Draft BMPs to Reduce Impacts from Roadside Mowing Practices	Extant Populations	Ongoing	ES, SWA	DOT, LG, NGO
2	4.9.5	Draft BMPs to Reduce Impacts from Pipeline Projects	Extant Populations	<5 yrs	ES, SWA	EC, AI, NGO
2	4.6.6	Revise Regulations to Improve Protection for the Bog Turtle	Not Applicable	5-10 yrs	ES, SWA	EC, NGO, AI
2	4.6.4	Implement Regional Survey Protocols for Consultants	Not Applicable	Ongoing	ES, SWA	EC
2	4.2.7	Create a Standardized Regional Database	All Populations	Ongoing	ES, SWA	NGO, AI, EC
2	4.6.3	Require Surveyor Qualifications	Not Applicable	Completed†	ES, SWA	EC
2	4.6.2	Revise the Recovery Plan and Re-evaluated the Recovery Criteria	Not Applicable	<5 yrs	ES, SWA	EC, AI, NGO
2	4.3.5	Conduct Staff Trainings for state and federal partners as well as non-governmental conservation organizations.	Not Applicable	<5 yrs	ES, SWA	NGO, EC, RW
2	4.5.8	Research the Effects of Roads on Bog Turtles and their habitat	Populations with “Poor” Population Quality and “Good” Habitat Quality and Reference Populations*	<5 yrs	ES, SWA	DOT, EC, AI, NGO, COE, EPA, LG
2	4.6.5	Draft Guidelines to Reduce Adverse Effects	Not Applicable	5-10 yrs	ES, SWA	EC, AI, NGO
2	4.5.6	Research Macro and Microhabitat Use	As the need arises	Ongoing (as needed)	ES, SWA	AI, NGO

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
2	4.3.4	Develop a Stewardship Program(s)	Opportunistically	5-10 yrs	ES, SWA	NRCS, PL, EC, NGO, AI
2	4.3.3	Engage in Mitigation Banking to Protect Habitat	Population with "Good" viability or "Good" Population Quality and Fair Habitat Quality	<5 yrs	ES, SWA	LG, NGO, EC
2	4.4.4	Restore Relic Fens	Historic Populations ≤1.5 km from an Extant Population with "Good" Viability	5-10 yrs (opportunistically)	ES, SWA	COE, USGS, EPA
2	4.7.2	Draft a Population Management Decision Tree , proactive and reactive versions	Not Applicable	Completed	ES, SWA	NGO
2	4.7.3	Draft Guidelines for Population Management	Extant Populations	<5 yrs	ES, SWA	Zoos (particularly TN Zoo and WCS), NGOs
2	4.9.7	Draft BMPs for Controlling Predators	Extant Populations	5-10 yrs	ES, SWA	NRCS, USFWS, SA, RW, Trappers
3	4.8.4	Develop an Anti-Poaching/Collection Strategy	All Populations	<5 yrs	ES, SWA	LE, AI, NGO
3	4.5.14	Research Life History Traits	As the need arises	Ongoing (if needed)	ES, SWA	AI, EC, NGO
3	4.7.4	Perform Population Management	Use Population Management Decision Tree	5-10 yrs (if needed)	ES, SWA	Zoos, AI
3	4.2.11	Compile a Bibliography of Bog Turtle Literature	Not Applicable	Ongoing	ES, SWA	None

Priority	CP* Section	Conservation Strategy Description	Priority Populations	Timeline	Responsible Organizations	Potential Partners
3	4.2.10	Develop a Climate change Strategy	All Populations	5-10 yrs or <5 yrs if done in conjunction with other related projects	ES, SWA	AI, USFWS, SA, USGS, EC, NGO
3	4.5.10	Research the Effects of Depredation	As the need arises	5-10 yrs (if needed)	ES, SWA	AI, NGO
3	4.5.13	Evaluate Population Genetics and Develop a Genetic Library	Extant Populations	5-10 yrs or <5 yrs if done in conjunction with other genetic projects	ES, SWA	AI, EC, NGO
3	4.6.7	Improve Environmental Review Tools	Not Applicable	Ongoing	ES, SWA	EC
3	4.5.9	Conduct Health Assessments	Populations were disease is suspected and a subset of Pops with “Good” and “Fair” viability	Ongoing	ES, SWA	WCS, BZOO, Veterinari ans, Animal Health Research Laboratori es
3	4.5.11	Evaluate PIT Tagging Techniques	Not Applicable	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.9.6	Draft BMPs for Radio- telemetry Research	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.5.12	Research the Effects of Beaver on Bog Turtles and their habitat	As the need arises	5-10 yrs	ES, SWA	AI, EC, NGO
3	4.9.8	Draft BMPs for Beaver Management, particularly for the Hudson-Housatonic Recovery Unit	Extant Populations	5-10 yrs	ES, SWA	AI, EC, NGO

*CP=Conservation Plan

† These actions should periodically be re-evaluated

IX.**MECHANISM FOR REPORTING AND/OR UPDATING THE PLANS**

The Conservation Plan should be reviewed and updated every 5-10 years. It is recommended that the Conservation Plan be updated just prior to USFWS 5-year reviews.

X.**LIST OF RECOVERY UNIT MEETING PARTICIPANTS**

In both 2016 and 2017 a group of Bog Turtle experts, professionals who work in the Susquehanna-Potomac Recovery Unit, gathered to participate in expert surveys to determine the top threats and limiting factors negatively affecting Bog Turtle populations in this recovery unit. They also ranked conservation strategies to provide insights on the most needed actions for the recovery of the species in the Susquehanna-Potomac Recovery Unit.

December 19, 2016 Meeting Participants

<i>Participant Name</i>	<i>Affiliation</i>
Robert Anderson	U.S. Fish and Wildlife Service
Ben Berra	Skelly and Loy, Inc.
Quillyn Bickley	Herpetological Associates
Andrew Brookens	Skelly and Loy, Inc.
Bob Bull	WHM Group
Bonnie Dershem	U.S. Fish and Wildlife Service
Lori Erb	Mid-Atlantic Center for Herpetology and Conservation
Kathy Gipe	Pennsylvania Fish and Boat Commission
Amy Nazdrowicz	Landmark Science and Engineering
Nate Nazdrowicz	Independent
Craig Patterson Nein	Johnson, Mirmiran and Thompson, Inc.
Noelle Rayman- Metcalf	U.S. Fish and Wildlife Service
Brandon Ruhe	Mid-Atlantic Center for Herpetology and Conservation
Brian Scoffield	U.S. Fish and Wildlife Service
Julie Slacum	U.S. Fish and Wildlife Service
Scott Smith	Maryland Department of Natural Resources
David Smith	Coastal Resources, Inc.
Chris Urban	Pennsylvania Fish and Boat Commission
Robert Zappalorti	Herpetological Associates

December 19, 2017 Meeting Participants.

<i>Participant Name</i>	<i>Affiliation</i>
Robert Anderson	U.S. Fish and Wildlife Service
Ben Berra	Skelly and Loy, Inc.
Andrew Brookens	Skelly and Loy, Inc.
Bonnie Dershem	U.S. Fish and Wildlife Service
Lori Erb	Mid-Atlantic Center for Herpetology and Conservation
Kathy Gipe	Pennsylvania Fish and Boat Commission
Nate Jones	AECOM
Nate Nazdrowicz	Independent
Craig Patterson Nein	Johnson, Mirmiran and Thompson, Inc.
Tom Pluto	PEC
Gian Rocco	Sole Proprietor
Noelle Rayman- Metcalf	U.S. Fish and Wildlife Service
Brandon Ruhe	Mid-Atlantic Center for Herpetology and Conservation
Beth Schlimm	Maryland Department of Natural Resources
Julie Slacum	U.S. Fish and Wildlife Service
Scott Smith	Maryland Department of Natural Resources
Chris Urban	Pennsylvania Fish and Boat Commission

APPENDIX F: BEST MANAGEMENT PRACTICES FOR ROAD CROSSING STRUCTURES FOR BOG TURTLES

Many Bog Turtle populations are small and isolated. Maintaining and improving connectivity among Core Habitats within the same population or metapopulation is desirable. We currently only have 82 extant metapopulations in the Northern range. The Important Habitat Corridor spatial data identifies these locations of greatest importance to protect for connectivity (see Section 4.2.4). Within these areas, roads should be identified where improved turtle passageways are most needed. In addition, these areas should be protected from new roads unless they include adequate turtle passageways. Guidelines or BMPs are needed on passageways design recommendations, ways to retrofit or improve existing culverts and bridges, and recommendation for maintaining these structures over time. Brian Zarate of the New Jersey Department of Environmental Protection and several members of the NEPARC Roads Working Groups drafted the following guidelines. They have been slightly modified so that the recommendations are more specific for Bog Turtles. Additional work is needed to finalize these guidelines for use throughout the Northern range.

General Guidelines

- Review the Important Habitat Corridors to identify good candidate locations for Bog Turtle passageway installation.
 - There should be suitable habitat on either side of the crossing structure and with Core Habitat within 1.5 km on each side of the road and no other major barriers between the Core Habitats.
 - Ideally, the habitat on both sides of the road should have a protected status to ensure the prolonged benefit of wildlife crossing installation. For sites where habitat on both sides of the road does *not* have protection status, state natural resource agencies should be contacted to discuss the potential for habitat protection measures.
- When creating new roadways, include Bog Turtle crossings and habitat connectivity considerations early in the planning process.
- Construction and maintenance disturbance to habitat on either side of the road should be kept to a minimum.
- Attempt to include wildlife crossing structure BMPs for as broad an array of wildlife as possible.
- Consider human behavior when implementing wildlife crossing BMPs
 - Wildlife crossing signs can be effective at increasing driver alertness within high-volume wildlife road crossing areas. These can have flashing lights and/or be periodically closed (folded) or moved to gain driver attention. Such measures should be carefully considered prior to use in areas that may be vulnerable to poaching or targeting.
 - Enforce strict speeding restrictions and other road safety laws.
 - Engage in public outreach to educate drivers on wildlife crossing safety measures.
 - Minimize human use of wildlife crossing structures (trails, sidewalks, etc.), at least at the times of highest use by wildlife (at night, during annual migrations, etc.).
- Improve driver line of sight and discourage Bog Turtles (and other wildlife) from approaching road by altering vegetation within road right-of-way.

- Vegetation maintenance strategies can balance roadside aesthetics with habitat creation and driver-wildlife visibility. Successful roadside vegetation management is site-specific and requires an understanding of Bog Turtle ecology and behavior, as well as planning to minimize unintended consequences for other wildlife (ex. the creation of open habitat may be a deterrent to smaller animals such as birds and butterflies, increasing the barrier effect of roads for these animals).
- Other techniques besides traditional vegetation maintenance (mowing, etc.) include planting unpalatable roadside vegetation for Bog Turtle and planting low-growing vegetation to allow driver-wildlife sightline (upland grasses) while providing suitable habitat leading to passageways.
- On-going maintenance, local conditions, and the behavior of the Bog Turtle are key components to the success of roadside vegetation measures.
- Practice BMPs to avoid the spread of invasive plants.
 - Incorporate invasive plant prevention measures into all engineering and road maintenance projects (e.g., cleaning equipment prior to starting construction at the site).
 - Implement appropriate prevention practices to reduce the introduction, establishment and spread of invasive plants during road construction, decommissioning, and maintenance activities.
 - Reduce the introduction and establishment of invasive plants and seed via the use of infested material.
- Consider the Bog Turtle when constructing or modifying associated road structures.
 - Use gently sloped curbing rather than traditional vertical curbing.
 - Consider seasonal adaptations for storm drains, like wire meshing to capture migrating hatchlings that fall into storm drains.
 - Install barriers along highways with one-way openings at the bottom that allow wildlife to escape the roadway and return to the adjacent habitat. Preferred barrier designs would allow turtles to get off the roadway into habitat but *not* allow turtles to get onto the highway from the adjacent habitat. These one-way openings are recommended to be 8 inches high and 18 inches wide to accommodate passage of all turtle species, and can be installed on a variety of barrier structures (e.g., noise barriers, Jersey barriers, etc.)
- Consider general BMPs when constructing wildlife crossing structures.
 - Minimize the impacts of construction work within habitat.
 - Follow proper disinfection protocols as well as protocols to minimize the spread of invasive plant species (i.e., equipment cleaning) when construction occurs within habitat.
 - Conduct any required state and federal agency coordination regarding potential project impacts to threatened and endangered species and other wildlife of concern.
 - Several restrictions may exist between March 1 and September 30 based on construction/maintenance activity (mowing, herbicide use, motorized equipment use, etc.). Consult with state biologists for specific regulations.
 - During periods where Bog Turtles will be active, have a qualified Bog Turtle surveyor on site to exclude turtles and other species of concern from work area before construction begins. Consult with state biologists for lists of experienced personnel.

Crossing Structure

Types of crossing structures

- **Box Tunnel**
 - Traditionally used for drainage, but also increasingly being placed and modified specifically for amphibian and reptile passage.
 - Tunnels up to 10 feet wide or high typically made from precast concrete.
 - Variations include open-top or open-grate, open-bottom or variations of these (both recommended where possible).
 - Straight walls may be perceived by Bog Turtle as increased openness.
 - Provide more cross-sectional area or openness than round or elliptical culverts with the same width.
- **Arch Tunnel**
 - Recommended for tunnels greater than or equal to 5 feet in diameter.
 - Round tunnels work well in aquatic conditions for most turtles.
 - In terrestrial conditions, round tunnels should be filled >6 inches deep with local soil/debris to create a level crossing surface while maintaining minimum height (see chart below).
 - Terrestrial pathways alongside stream or creek beds are possible with additional structural width.
 - Recommended design specifications for arch tunnels are slightly larger than box tunnels to compensate for the loss of openness as a result of tunnel shape.
- **Large Underpass or Wildlife Overpass**
 - Larger multi-species crossing structures greater than 10 feet such as tunnels and bridges, viaducts or overpasses that are generally not prefabricated or precast.
 - Possible to maintain natural landscape if road is tunneled or elevated (ex., viaduct).

Size of structures

Larger sub-surface crossing structures provide greater airflow and natural light conditions; however, smaller structures with grated tops can be effective. Grated structures are placed flush with the road surface.

TURTLE ROAD CROSSING STRUCTURES - RECOMMENDED DIMENSIONS*

	<i>Recommended</i>	<i>Maximum</i>	<i>Minimum</i>
<i>Internal Width</i>	4 feet	No maximum	3 feet
<i>Internal Height</i>	4 feet	No maximum	3 feet
<i>Length</i>	≤40 feet	125 feet	Road width
<i>Spacing*</i>	500 feet	1,000 feet	No minimum

*Dimensions will vary if the structure accommodates an active channel of waterflow. Numbers provided in table refer to wildlife pathway alongside active channel. Spacing refers to distance along roadway between wildlife crossing structures when installing multiple structures within a larger area of habitat.

Design considerations

- Maximize continuity of native soils adjacent to and within the structure, if possible. Avoid importation of soils from outside the project area and soils with invasive plant material.
- Open bottom structures are preferred to maintain continuity of substrate (box or arch culvert).
 - In non-aquatic environments, four-sided, circular, or elliptical culverts should be backfilled with native substrate (>6 inches deep), while maintaining minimum height. Polymer culverts and some plastic surfaces may be suitable for wildlife passage without backfill.
 - If the structure is located in an aquatic environment, evaluate whether substrate will be stable or if there is potential for erosion.
 - Maintain a moist environment in terrestrial crossings to accommodate moisture-sensitive species. This can be accomplished through maintaining appropriate tunnel substrate and providing cover objects throughout the interior of the crossing structure.
- Tunnels should be as open as possible to maximize airflow and light inside the tunnel. This may be achieved by designing tunnels with larger (typically wider) openings, using two structures when a median is present or with an open-top or partial open-top tunnel. When using two structures separated by a median, fencing should direct turtles/wildlife between the structures and restrict access onto the roadway.
- Minimize the intensity of noise and light coming from the road and traffic when possible.
 - Ensure artificial night lighting does not affect nocturnal animals by placing roadway lighting away from wildlife crossing structures.
 - Use noise barriers, tree plantings, or other techniques to reduce road noise and vibration. Careful consideration should be given to these mitigation measures to avoid unintended consequences, such as attracting wildlife to road edges by creating habitat through tree plantings.
- Riprap should not be placed in front of or on the slopes adjacent to a passageway. If riprap is required, then it should be buried, back-filled with smaller rock and topsoil, and planted with native vegetation.
- Animals approaching a crossing structure should be able to see through it to suitable habitat on the opposite side of the road.
- Tunnels should be completely level or with minimal grading (up to 3%), at the entrances and within the tunnel.
- Design drainage features so flooding does not occur within structures. Runoff from roadways near crossing structures should not be directed to the tunnel.
- Water in aquatic tunnels should be standing or have low flow rates. Aquatic crossing structures should never be fully submerged.
- When possible, include wildlife crossing BMPs for multiple species/groups.
 - To facilitate passage by both aquatic and terrestrial species, structure should be wide enough to provide dry passage with an elevated ledge or dry ground

(accomplished by ensuring a structure width that is at least 1.2x the stream bank's full width) on one or both sides of the structure. Dry passage width should be at least 12 inches wide.

Location/Spacing

- Site crossings near or along known migration corridors where turtles will likely crossroads to access necessary habitat. When available, use existing data on turtle crossing activity to plan locations of crossing structures.
- When roads bisect large expanses of continuous habitat (e.g., complex wetland), crossing structures should generally be spaced 300 yards apart for Bog Turtles and other small animals depending on species, budget, and site-specific engineering and ecological considerations.
- Integrate the crossing structures with the natural landscape. For example, take advantage of valleys for crossings under roads and incorporating fencing into natural landscape features, such as existing steep rock faces.

Replacing or Retrofitting Existing Crossing Structures

- When replacing a culvert, consider implementing a tunnel-fencing system with specifications for the Bog Turtle and other target species.
- A retrofitting decision-making guideline is available from the Maine Audubon Terrestrial Survey Report (Appendix B: Passage Assessment System).
- There are several ways to retrofit existing culverts and fencing for Bog Turtle crossing:
 - Remove obstacles at the entrances, within, or in approaching the crossing structure (ex. debris, vegetation, garbage, etc.);
 - Fill in voids between large rocks/riprap with smaller material to prevent turtles from getting trapped;
 - Modify to facilitate turtle/wildlife movement through crossing structures (e.g., install grating to existing culverts to allow light into crossing structure, cover riprap to create smooth pathway, etc.);
 - Reduce intimidation associated with crossing structure (e.g., reduce road noise, increase light exposure, provide cover objects within crossing structure, maintain consistent sediment and environmental conditions within and outside of tunnel, etc.);
 - Enhance appeal of approach to structures to encourage turtle/wildlife to use crossing structures (ex. maintain vegetation in front of crossing structure, avoid using erosion netting around crossing structure in which small animals like snakes and turtles can become trapped, etc.);
 - Address the fencing and barriers to encourage turtles/wildlife to use crossing structures and avoid movement on the road (ex. add fencing for wildlife, tie in existing fencing to crossing structures); and
 - Add or adjust structural features that may inhibit Bog Turtles from using the crossing structure (ex. add ramps to perched culvert outlets; add dry shelves to fully aquatic passages, etc.).

Fencing

- Wing walls should angle out from each end of the structure at approximately 25-45 degrees to encourage animals to move into the tunnel, and to orient turtles that move away from the tunnel toward the natural environment.
- Fencing should extend on either side of the structure the entire length of suitable habitat or just beyond a natural break in a Bog Turtle's ability to traverse the landscape (e.g. steep terrain, change in habitat or land use) and guide them to the structure.
- Cattle guards or small culverts may be used in cases where fencing needs to allow for a driveway or other access road. Fencing can be tied directly into the structure to allow turtles to continue moving along the fence beneath the driveway.
- To prevent breaching by climbing species, fence designs that top angle or curve away from the roadway are recommended.
- Guiding wall/fence should tie into the structure entrance, with no gaps, and avoid any surface irregularities that might impede or distract movement toward the tunnel entrance.
- Fencing should be at least 2 feet above ground (higher to protect larger species like snapping turtles) and be made of hardware cloth, concrete, aluminum, vinyl, prefabricated plastic, or welded wire-mesh. To accommodate smaller herpetofauna, especially snakes, mesh openings of $\frac{1}{4}$ inch x $\frac{1}{4}$ inch are recommended. Smaller sizes ($\frac{1}{8}$ inch x $\frac{1}{8}$ inch) may also be used for snakes. Mesh openings of $\frac{1}{2}$ inch x $\frac{1}{2}$ inch are the maximum recommended for turtles. Use higher fencing than necessary where possible, to account for the buildup of dead vegetation.
- Opaque material is generally better for turtles, reducing stress of repetitive attempts to reach visible habitat on the opposite side.
- Guiding wall/fence should be buried below ground 6-10 inches to prevent animals from digging under the fence material.
- Fencing design should allow animals that do get on the roadway a means of getting off of the roadway safely. Hinged doors or one-way passages ($\frac{1}{2}$ PVC piping placed perpendicular to an inclining slope with the top sloping away from the road) can be placed onto the roadway side of the fence to allow turtles that become trapped on the road to escape, without allowing animals to enter onto the road.

Maintenance

- If the turtle/wildlife underpass/culvert is not being monitored on a regular basis, periodic visits should be made to ensure that there are no obstacles, foreign matter, or overgrowth of vegetation in or near the structure that might affect wildlife use.
- Fencing should be checked, maintained and repaired periodically (minimum once per year just prior to the target animals' seasonal movements or peak activity period if applicable. In most cases, fences should be checked on a more frequent basis).
- Fencing should be placed as far as possible from the road edge to minimize impacts from snow removal, mowing or other road-side maintenance practices.
- Eliminate vegetation and materials that would allow Bog Turtles and other animals to climb over the fence and onto the roadway.

- Follow BMPs for restrictions on roadside maintenance near wildlife crossing structures (April 1- September 30 for most species, but dates will vary depending on target species, see [Table X](#))
- Consider target species and other at-risk herpetofaunal species, as well as other wildlife species of concern, when planning crossing structure maintenance activities.

Monitoring

- Monitoring is critical to evaluate the effectiveness of structures in passing Bog Turtles safely. Monitoring should include both evaluation of wildlife use of the structure as well as the amount and species composition of roadkill within the road segment of interest. For example, documenting locations of roadkill post-construction may provide critical information on gaps in fencing or areas where fencing may need to be extended to cover additional areas.
- Additional technologies may be used to increase the effectiveness of monitoring activities (e.g., wildlife camera systems, PIT tag and radio-telemetry arrays, GPS tags).
- Up to at least three years of monitoring before (1 year) and after (2 years) a road mitigation project is recommended to allow researchers to measure changes in the ecological response (e.g. population size or road mortality rate) of the target species and reduce the influence of random, one-time events. The appropriate time-frame will depend on the ecological response and target species characteristics (e.g. longer-term monitoring for species that have longer generation times).

APPENDIX G: BEST MANAGEMENT PRACTICES TO REDUCE IMPACTS FROM STREAM RESTORATION, ROAD CULVERT, OR BRIDGE PROJECTS

Stream restoration projects to improve stream conditions can have temporary impacts to Bog Turtles and their habitat. These projects may cause direct mortality to turtle by disturbing or dislodging turtles out of their hibernacula. Large machinery can damage Bog Turtle wetland habitat. The recommendations below were drafted by Scott Smith of the Maryland Department of Natural Resources, Wildlife and Heritage Service and are in use in Maryland. The effect of winter work on turtle behavior is under investigation. Based on the result of ongoing research the timing of the winter work may be modified. These guidelines should be evaluated, and revised as appropriate, for use among all state in the Northern range.

Introduction

These recommendations are for any stream restoration projects adjacent to known or potentially occupied Bog Turtle habitat, or for stream restoration for stream reaches located between known occupied habitats. These could also be applied to road culvert and bridge repair and replacement projects in Bog Turtle watersheds. The concern for projects depends on the distance from the nearest known or potential site and population characteristics of one or more of these sites, as well as if there has been documented turtle movement between sites (Figs. 1 and 2). Any project within 300 feet (Zone 2 in Federal Recovery Plan (USFWS 2001)) of known or potential Bog Turtle habitat must include avoidance and minimization measures. These will need to be reviewed by DNR on a project-by-project basis. In general, stream restoration projects should be good for overall watershed health and thus beneficial for Bog Turtles, so this document provides avoidance and minimization measures that should be incorporated into a project description to help streamline the project review process.

Prefer work be conducted during turtle hibernation: Nov. 1 - Feb. 28/29

These dates can be adjusted a bit depending on temperatures. Most turtles are in hibernacula by Oct. 15 and in some years by the end of September. Conversely, general emergence from hibernacula is usually not until after March 15, so if needed this work period could be adjusted somewhat but would need to be approved by DNR.

Justification:

Bog Turtles are sedentary during the winter dormancy period, moving at most a few meters. They will overwinter in both typical fen/wetland habitat (under root mats, submerged rock crevices, under tussocks and sphagnum mats), but also under stream banks. Turtles overwintering under stream banks are most “at risk” to this activity during this time period.

Reducing likelihood of “take”:

- A **Qualified Bog Turtle Surveyor** (QBTS) should be employed to ensure “take” does not occur.

- **Silt fences** (standard type) will need to be placed delineating limits-of-disturbance (LODs) and these will need to be provided on maps in the project description. Prior to any heavy equipment movement into the LOD, the QBTS will conduct a sweep through the area to remove any Bog Turtles. This will need to occur the morning of each work day.
- **Turtle release sites** need to be identified prior to any work being done to ensure turtle survival should any be captured (more likely during active season work vs winter dormancy). Captured turtles should be measured, marked (DNR will provide marking scheme) and photographically documented by the QBTS.
- For in-stream work the **QBTS will need to survey under-bank areas** as best as possible during each day in that day's LOD area. If the stream has ice cover it will need to be broken to allow this to be surveyed. The QBTS will also need to **check silt fences** several times per day to ensure no fleeing turtles "woken up" by machinery vibrations are on the move. The QBTS will also need to be **closely monitoring earth-moving equipment**, excavators in particular, for any turtles in the soil being moved.
- The QBTS needs to have the **authority to signal for an immediate temporary stop to equipment operation** if it looks like there are turtles in the area where work is occurring. This authority and the QBTS role should be communicated to the work crew during a **site meeting prior to work commencing** (DNR also in attendance).
- If these guidelines are followed and "take" still does occur, an **"incident report"** should be prepared so we can learn from the incident. If the QBTS is ignored by work crew and "take" occurs than DNR and USFWS may consider legal recourse.
- **No soil disturbance should be allowed within Bog Turtle wetlands, nor any excavation or other activities that could impact wetland hydrology** (either draining or ponding water). Any excavated areas adjacent to the wetlands should be restored to their original condition (graded and seeded) to prevent sedimentation from occurring near the wetland.

Work conducted during Bog Turtle active season (least preferred): March 1-Oct. 31

If this is unavoidable due to other DNR TOY restrictions (Use III, etc.) then the potential for "take" is dramatically increased as turtles will be moving around, particularly from spring emergence (mid-March through mid-April), through mating (April-mid-June) and nesting (late May to early July) seasons. Bog Turtles are generally sedentary during the heat of summer (aestivation) and, then in preparation for and movement to hibernation, become more active in September to early October (especially on rainy days), before winter dormancy in mid-October.

Justification:

This time period should only be used if winter work is logistically impossible, the job is so large that it will require >1 season to complete, or other DNR TOY restrictions conflict. **Avoidance of work during this period should be the norm.**

Reducing likelihood of "take":

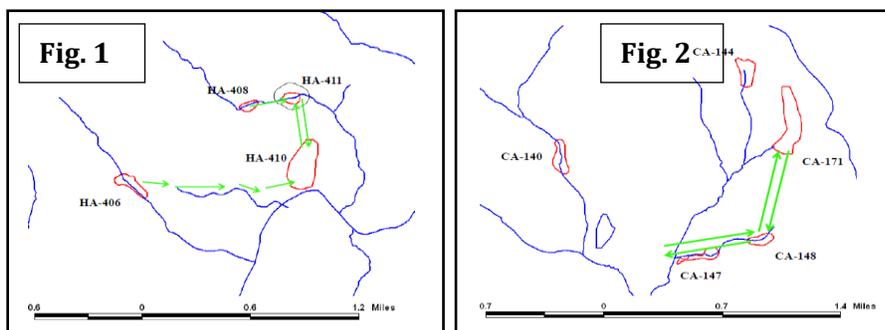
- A **Qualified Bog Turtle Surveyor** (QBTS) should be employed to ensure "take" does not occur.
- **Silt fences** will need to be placed delineating LODs, but depending on site and project these **may need to be super, heavy duty, double standard** or single standard silt fence but very

stringent attention will be needed to ensure they remain functioning during entire project implementation.

- **Turtle release sites** need to be identified prior to any work being done to ensure turtle survival should any be captured. Captured turtles should be measured, marked (DNR will provide marking scheme), and photographically documented by the QBTS.
- The **QBTS will conduct a sweep through the area to remove any Bog Turtles prior to any heavy equipment movement into the LOD.** This will need to occur **the morning of each work day.** For in-stream work the QBTS will need to **survey the entire stream bottom and under-bank areas** as best as possible. The QBTS (and/or assistants) will also need to **check silt fences** (both sides) many times per day to ensure no turtles are trapped in the work zone and crushed. The QBTS will also need to be **closely monitoring earth-moving equipment**, excavators in particular, for any turtles in the soil being moved.
- The **QBTS needs to have the authority to signal for an immediate temporary stop to equipment operation** if there looks like there are turtles in the area where work is occurring. This authority and the QBTS role should be communicated to the work crew during a **site meeting prior to work commencing** (DNR also in attendance).
- If these guidelines are followed and “take” still does occur, **an “incident report”** should be prepared so we can learn from the incident. If the QBTS is ignored by work crew and “take” occurs than DNR and USFWS may consider legal recourse.
- **No soil disturbance should be allowed within Bog Turtle wetlands, nor any excavation or other activities that could impact wetland hydrology** (either draining or ponding water). Any excavated areas adjacent to the wetlands should be restored to their original condition (graded and seeded) to prevent sedimentation from occurring near the wetland.

Project Report

Regardless of the time of year of the project, **the QBTS should prepare a short report for DNR** on the project and their activities performed to reduce “take” (dates on the job, animals removed by number and species; photos, etc.), including documentation of any Bog Turtles moved out of the LOD. They can also include recommendations on additional minimization measures that could be implemented, ways to make the process more efficient, and any problems they encountered during the project.



Figures 1 and 2. Examples of Bog Turtle movements between occupied wetlands, derived from mark-recapture and telemetry data. Additional movements between the sites in Fig. 2 are likely (e.g., CA-140 to CA-147, CA-144 to CA-171).

APPENDIX H: CONSERVATION STRATEGIES AND THE TOP THREAT AND LIMITING FACTORS THEY ADDRESS

Table 1. The top 25 Conservation Strategies and threats they address.

Top Conservation Strategies	Top Threats					
	<i>Development</i>	<i>Invasive Plants</i>	<i>Altered Hydrology</i>	<i>Succession</i>	<i>Agriculture</i>	<i>Roads</i>
<i>Obtain Funding</i>	X	X	X	X	X	X
<i>Conduct Succession/Invasive Plant Management</i>		X		X		
<i>Rank Populations for Viability</i>	X	X	X	X	X	X
<i>Research the Effectiveness of Habitat Management</i>		X		X	X	
<i>Implement Population and Habitat Monitoring</i>		X	X	X		
<i>Prioritize Populations for Habitat Protection and Management</i>	X	X	X	X	X	X
<i>Seek Max Penalties on Violations of the ESA</i>	X		X		X	X
<i>Restore Hydrology</i>			X		X	X
<i>Connect Fragmented Habitat</i>	X		X			X
<i>Map Important Habitat Corridors</i>	X		X			X
<i>Develop a Communication Strategy</i>	X	X	X	X	X	X
<i>Prioritize Populations for Habitat Management</i>		X		X		
<i>Conduct Inventory/Gap surveys</i>	X		X		X	X
<i>Engage in Landowner Outreach for Habitat Protection</i>	X	X	X	X	X	X
<i>Research the Effects of Agriculture</i>		X	X	X	X	
<i>Require Surveyor Qualifications</i>	X					

<i>Research Hydrology & Water Chemistry</i>	X		X		X	X
<i>Monitor Progress on Conservation Actions</i>	X	X	X	X	X	X
<i>Engage in Landowner Outreach for Habitat Management</i>		X	X	X	X	
<i>Identify the Best Population Management Techniques</i>						
<i>Revise the Recovery Plan</i>						
<i>Research the Effects of Development</i>	X		X			X
<i>Draft BMP for Road Passageways</i>		X	X			X
<i>Re-evaluate the Recovery Criteria</i>						

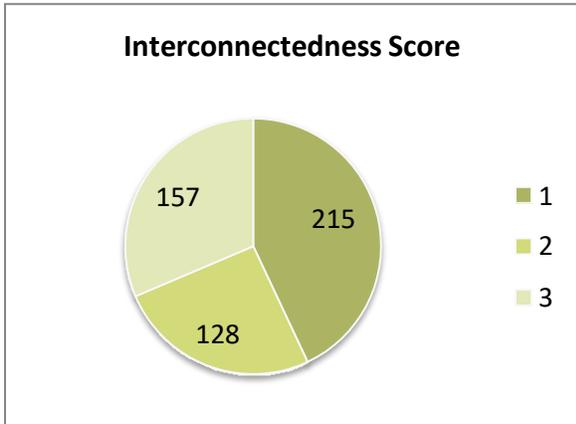
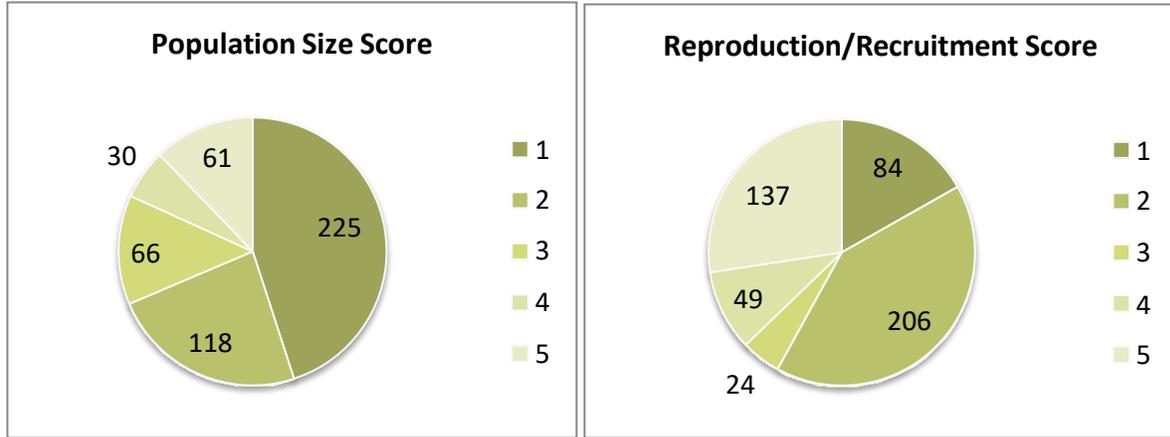
Table 2. The top 25 Conservation Strategies and the limiting factors they address.

Top Conservation Strategies	Top Limiting Factors					
	Connectivity	Habitat Protection	Lack of Recruitment	Habitat Quality	Distribution Knowledge	Landowner Outreach
<i>Obtain Funding</i>	X	X		X	X	X
<i>Conduct Succession/Invasive Plant Management</i>	X		X	X		
<i>Rank Populations for Viability</i>		X				
<i>Research the Effectiveness of Habitat Management</i>	X			X		
<i>Implement Population and Habitat Monitoring</i>			X	X		X
<i>Prioritized Populations for Habitat Protection</i>		X		X		
<i>Seek Max Penalties on Violations of the ESA</i>		X		X		
<i>Restore Hydrology</i>			X	X		
<i>Connect Fragmented Habitat</i>	X			X		
<i>Map Important Habitat Corridors</i>	X	X				X
<i>Develop a</i>		X		X	X	X

<i>Communication Strategy</i>						
<i>Prioritize Populations for Habitat Management</i>				X	X	
<i>Conduct Inventory/Gap surveys</i>	X	X			X	X
<i>Engage in Landowner Outreach for Habitat Protection</i>	X	X		X		X
<i>Effects of Agriculture</i>				X		
<i>Require Surveyor Qualifications</i>		X				
<i>Research Hydrology & Water Chemistry</i>		X		X	X	
<i>Monitor Progress on Conservation Actions</i>	X	X	X	X	X	X
<i>Engage in Landowner Outreach for Habitat Management</i>	X		X	X		X
<i>Identify Best Population Management Techniques</i>			X			
<i>Revise the Recovery Plan</i>						
<i>Research the Effects of Development</i>		X		X		
<i>Draft BMP for Road Passageways</i>	X			X		
<i>Re-evaluate the Recovery Criteria</i>						

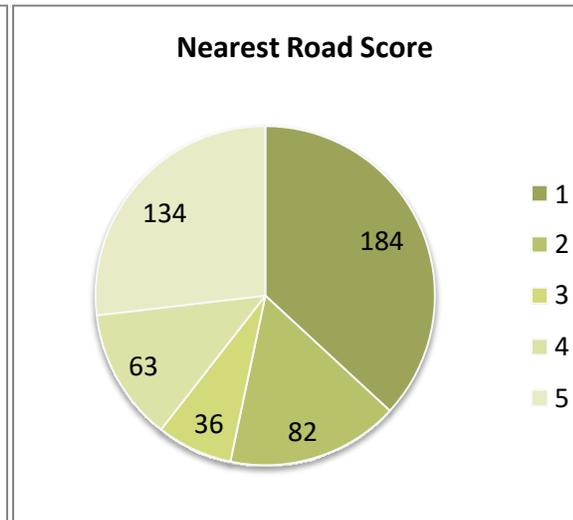
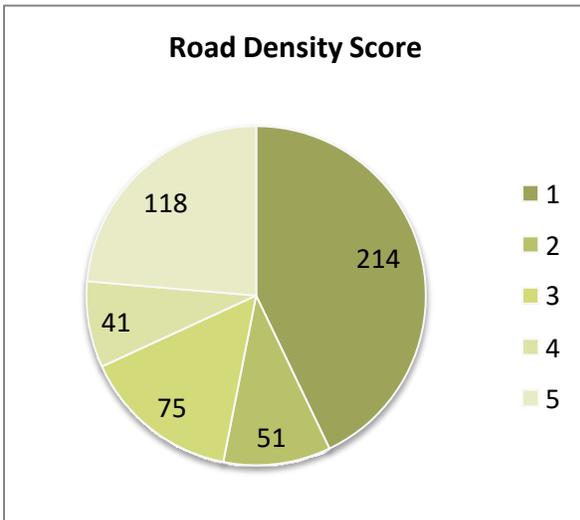
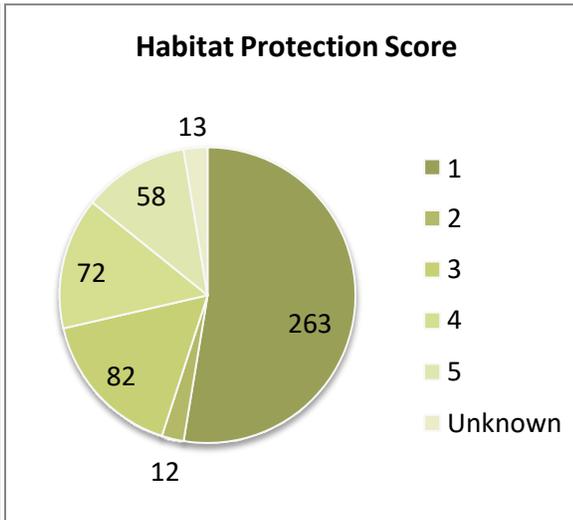
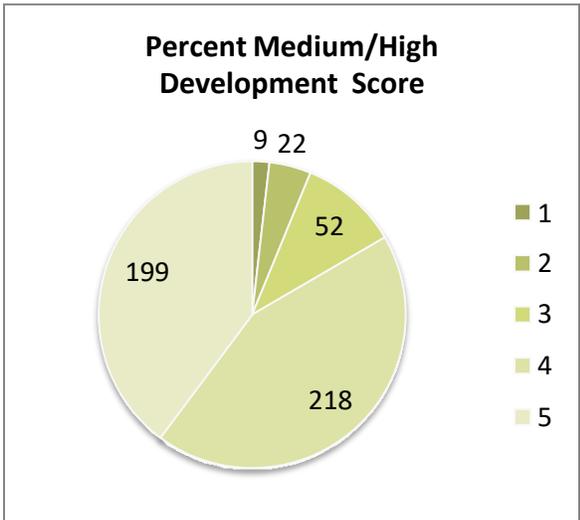
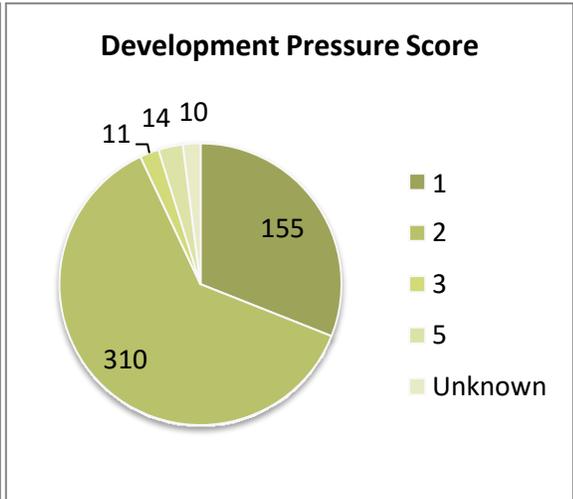
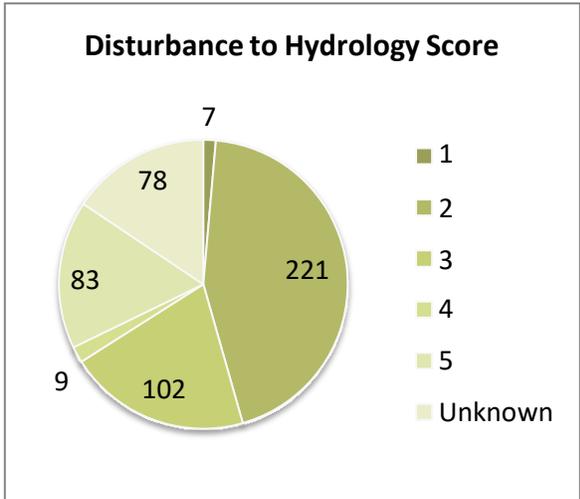
APPENDIX I: POPULATION VIABILITY RANKING RESULTS FOR INDIVIDUAL METRICS

Population Quality Metric Results



Habitat Quality Metric Results





APPENDIX J: POPULATION MONITORING INSTRUCTIONS

A. Site Identifiers, Date and Start Time, and Surveyors

1. **Monitoring Site ID** is the two digit RU initials–two digit state initials–two digit monitoring site ID/code (e.g. for a site in the Delaware RU in Pennsylvania, first site may be DE-PA-01).

- Delaware Unit = DE; Hudson/Housatonic Unit = HH; Susquehanna/Potomac Unit = SP; Lake Plain Unit = LP

Site Name is the nickname for the Core Habitat.

Town is the town where the Core Habitat is located (can be multiple towns).

2. **Core Habitat Area (ac)** is the number of acres the Core Habitat area includes.
Survey Area is the number of acres of the survey area if smaller than the Core Habitat.
3. **Survey Date** is the date the survey took place.
Required Survey Time is the amount of time the survey should take given the number of surveyors and the size of the survey area (2-person hrs/acre). See Table 1 on the last page of this document.
4. **Site visit Number** is to identify whether the survey is the first, second, or third survey of the season at a given site.
5. **Lead Surveyor(s)** is the surveyor or surveyors that are leading the survey and have been identified by the State Project Lead as a “lead surveyor” for this project.
Assistant Surveyor(s) are all other surveyors regardless of level of experience.

B. Environmental Factors and Number of Surveyors

6. **Start Conditions:**

Start Time is the time you start actively searching for turtles.

Rain is the amount of precipitation at the start of the survey period. Categories include n=no rain; l=light rain; i=intermittent rain; and h=heavy rain.

Air Temp is the air temperature in the shade at the beginning of the survey period.

Temperature can be recorded in C or °F.

Wind Speed is the wind speed at the beginning of the survey time period. Use the percentage categories in the Beaufort Wind Scale (on the data sheet) for a description of the wind condition categories.

Cloud Cover is the amount of cloud cover at the beginning of the survey period. Use the following cloud cover categories: c=clear; p=partly cloudy; or o=overcast.

Number of Surveyors is the number of both lead and assistant surveys actively searching for turtles at the beginning of the survey.

7. **End Conditions**

End Time is the time you stop actively searching for turtles.

Rain is the amount of precipitation at the end of the survey period. Categories include n=no rain; l=light rain; i=intermittent rain; and h=heavy rain.

Air Temp is the air temperature in the shade at the end of the survey period. Temperature can be recorded in C or °F.

Wind is the wind speed at the end of the survey time period. Use the percentage categories in the Beaufort Wind Scale (on the data sheet) for a description of the wind condition categories.

Cloud Cover is the amount of cloud cover at the end of the survey period. Use the following cloud cover categories: c=clear; p=partly cloudy; or o=overcast.

Num of Surveyors is the number of both lead and assistant surveys actively searching for turtles at the end of the survey.

8. **Stopped Searching (min)** the number of person minutes (or person hrs, see #9 below) your survey team was not actively searching for turtles, between the survey start and end time recorded. For example, if you all stopped to look at and photograph the first turtle captured or one person was processing turtle the entire time those person minutes would be subtracted.
9. **Effort Hrs** is the person-hours (number of surveyors/search time) spent actively searching divided by the number of acres searched (survey area).
10. **Other Turtle Species Observed** is where you record the name of any turtle species found other than the Bog Turtle, such as spotted or wood turtles.
11. **Herpetofauna Species Observed** is where you record a list of the names of other herpetofauna found during the survey.
12. **# Live Bog Turtles Captured During the Survey Time** is the number of individual Bog Turtles you captured within the pre-determined survey period. Please also provide a breakdown of the number of adult males, adult females, and juveniles (<70 mm straight line plastron length).
13. **# Live Bog Turtles Captured After the Survey Time** is the number of individual turtles captured outside of the allotted time, when surveyors decide to continue searching for turtles after the monitoring survey is done. In these cases the survey time was extend longer then the predetermined 2-person hours/acre. In such cases, the entire survey area should still be searched during the predetermined time.
14. **# Dead Bog Turtles** is the number of individual Bog Turtle carcasses that were found at any time during your site visit (before, during or after the survey time).
15. **Signs of Bog Turtles (y/n)** is where you note yes if you observed any tracks, shells or other signs that Bog Turtles may be present at the site.

16. Comments on any other important information, such as new beaver impoundment within your survey area, other alterations to the habitat, etc.

Turtle Processing Guidelines

- Prior to surveys, all lead surveyors should coordinate with their state project lead to acquire appropriate permits and to determine if turtles will be marked and if so how (notching scheme, numbers to use and exact methods).
- Complete a *Bog Turtle Capture Form (or an equivalent capture form)* for each turtle found.
- Turtles found on or near the survey site before/after the actual survey period should be processed, but please note this on the *Capture Form*. Also, collect GPS location information for deceased turtles (shells, DOR).
- GPS coordinates (lat, long) for turtle capture locations should be obtained. Record all coordinates as **NAD83 decimal degrees**.
- Process all turtles including taking measurements and photographs (carapace, plastron, and neck patch if possible); unless you are sure the turtle was captured during a previous survey in the same year.
- When a turtle has an irregular number of marginal scutes (e.g., 11 or 13) on one or both sides of the carapace, make sure that you note the appropriate turtle ID. Prior to the field season check with your state project lead to determine the appropriate way to determine the turtle ID in these cases.
- Coordinate with your the state project lead to determine if data should be collected on other species observed (e.g., wood turtles or other state-listed species).
- Coordinate with the state project lead prior to surveys to determine what to do if you find sick or injured turtles. In addition, the USFWS Health Bulletin guidelines should be followed for injured or sick Bog Turtles.
- If transmitters are used, transmitters and affixing material (e.g. epoxy) combined should not exceed 7% of the body weight of the turtle. Surveyors should also follow any state-specific requirements for this work.

Survey Steps for Rapid Assessment (Visual/Tactile) Surveys

Presurvey

- 1) Contact landowners for permission to survey the site.
- 2) State project leads create a list of qualified surveyors and determine which sites each surveyor will sample.
- 3) Provide a training session to lead surveyors.
- 4) Create and print a site map with ortho imagery background and delineated Core Habitat area (and the Survey area boundary if different from the Core Habitat).
- 5) Disinfect waders/footwear, turtle processing equipment

Survey

- 6) The lead surveyor(s) should clearly define (describe and/or show) the survey area boundaries to all surveyors.

- 7) Record site info, date and start time, surveyor's names, and weather conditions at the beginning of the survey.
- 8) Briskly walk the survey area looking for turtles on the surface.
- 9) Perform a more thorough search of the best habitat within the Core Habitat, probing in the mud, searching in puddles, along the edge of tussock sedge, and under dead vegetation.
- 10) Record stop time, surveyor's names, weather conditions at the end of the survey period.
- 11) Process Turtles (may occur during the survey, but keep track of the time surveyors are not actively searching to deduct this time before calculating the effort hours).
- 12) The transcriber should put their initials at the top of the data sheet(s).
- 13) Have a second person review the data sheet(s) for completeness and initial the top of the form.

Equipment List

- GPS unit
- Camera
- Calipers
- Scale
- Clipboard
- Pens/pencils
- Site map that identifies the survey area/Core Habitat
- Data sheets (turtle survey form, turtle capture forms)
- Monitoring Instructions document
- Watch/Clock
- Turtle notching numbers (if marking turtles)
- Turtle notching schematic (if marking turtles)
- Waders
- Disinfectant, brush, rinse water, and containers/sprayer

Primary Sources

- How to develop survey protocols: a handbook (USFWS 2013).
- Demography and population genetics of the Bog Turtle (*Glyptemys muhlenbergii*): implications for regional conservation planning in New York State (Shoemaker 2011)
- Guidelines for Bog Turtle surveys (Phase 2 and 3 Turtle Surveys; USFWS 2006)
- A role of trapping in detection of a small Bog Turtle (*Glyptemys muhlenbergii*) population. (Somers and Mansfield-Jones 2008)
- Monitoring of Bog Turtle colonies at sites in immediate proximity to development in Southeastern Pennsylvania (PFBC 2008)
- Massachusetts eastern box turtle monitoring protocol (Erb and Willey 2010)
- Coordinated monitoring strategy for wood turtles (*Glyptemys insculpta*) in the Northeastern United States (Jones et al. 2013)
- Coordinated regional monitoring strategy for Blanding's turtle in the Northeastern United States (Jones et al. 2012)
- Revised Recovery Plan for the Mojave population of the desert tortoise (*Gopherus agassizii*) (USFWS 2011)

Table 1. Survey time chart to calculate 2-person hours/acre of effort given the number of surveyors and the size of the area to be surveyed.

Survey Time by Site Size and Number of Surveyors

Size of Site in Acres	Number of Surveyors																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.25	30	15	10	8	6	5	4	4	3	3	3	3	2	2	2	2	2	2	2	2
0.5	60	30	20	15	12	10	9	8	7	6	5	5	5	4	4	4	4	3	3	3
0.75	90	45	30	23	18	15	13	11	10	9	8	8	7	6	6	6	5	5	5	5
1	120	60	40	30	24	20	17	15	13	12	11	10	9	9	8	8	7	7	6	6
1.25	150	75	50	38	30	25	21	19	17	15	14	13	12	11	10	9	9	8	8	8
1.5	180	90	60	45	36	30	26	23	20	18	16	15	14	13	12	11	11	10	9	9
1.75	210	105	70	53	42	35	30	26	23	21	19	18	16	15	14	13	12	12	11	11
2	240	120	80	60	48	40	34	30	27	24	22	20	18	17	16	15	14	13	13	12
2.25	270	135	90	68	54	45	39	34	30	27	25	23	21	19	18	17	16	15	14	14
2.5	300	150	100	75	60	50	43	38	33	30	27	25	23	21	20	19	18	17	16	15
2.75	330	165	110	83	66	55	47	41	37	33	30	28	25	24	22	21	19	18	17	17
3	360	180	120	90	72	60	51	45	40	36	33	30	28	26	24	23	21	20	19	18
3.25	390	195	130	98	78	65	56	49	43	39	35	33	30	28	26	24	23	22	21	20
3.5	420	210	140	105	84	70	60	53	47	42	38	35	32	30	28	26	25	23	22	21
3.75	450	225	150	113	90	75	64	56	50	45	41	38	35	32	30	28	26	25	24	23
4	480	240	160	120	96	80	69	60	53	48	44	40	37	34	32	30	28	27	25	24
4.25	510	255	170	128	102	85	73	64	57	51	46	43	39	36	34	32	30	28	27	26
4.5	540	270	180	135	108	90	77	68	60	54	49	45	42	39	36	34	32	30	28	27
4.75	570	285	190	143	114	95	81	71	63	57	52	48	44	41	38	36	34	32	30	29
5	600	300	200	150	120	100	86	75	67	60	55	50	46	43	40	38	35	33	32	30
5.25	630	315	210	158	126	105	90	79	70	63	57	53	48	45	42	39	37	35	33	32
5.5	660	330	220	165	132	110	94	83	73	66	60	55	51	47	44	41	39	37	35	33
5.75	690	345	230	173	138	115	99	86	77	69	63	58	53	49	46	43	41	38	36	35
6	720	360	240	180	144	120	103	90	80	72	65	60	55	51	48	45	42	40	38	36
6.25	750	375	250	188	150	125	107	94	83	75	68	63	58	54	50	47	44	42	39	38
6.5	780	390	260	195	156	130	111	98	87	78	71	65	60	56	52	49	46	43	41	39
6.75	810	405	270	203	162	135	116	101	90	81	74	68	62	58	54	51	48	45	43	41
7	840	420	280	210	168	140	120	105	93	84	76	70	65	60	56	53	49	47	44	42
7.25	870	435	290	218	174	145	124	109	97	87	79	73	67	62	58	54	51	48	46	44
7.5	900	450	300	225	180	150	129	113	100	90	82	75	69	64	60	56	53	50	47	45

Grayed cells represent surveys outside the recommended effort hours/acre

APPENDIX K: HABITAT MONITORING INSTRUCTIONS

Initial Set up of Habitat Monitoring Plots

Monitoring station(s) will be permanently marked at two corners of a 4 m x 4 m square plot (Fig. 2). The northeast and southwest corners should be marked with rebar, PVC, stamped fencing post or some other long-lasting material and the marker locations recorded with GPS technology for future sampling.

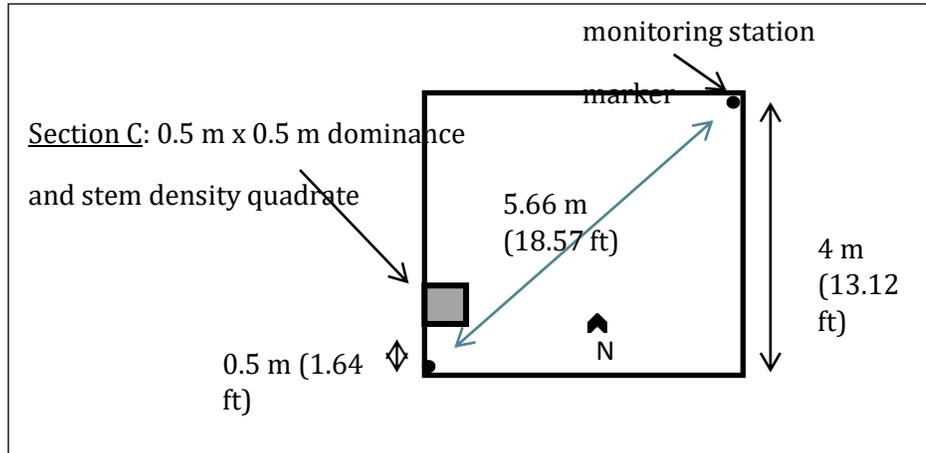


Figure 2. Diagram of 4 m x 4 m square plot monitoring plot, 0.5 m x 0.5 m quadrat, and permanent monitoring station markers.

C. Site and Plot Identifiers, Surveyors, and Date and Time

17. Monitoring Site ID is the two digit RU initials–two digit state initials–two digit monitoring site ID/code (e.g. for a site in the Delaware RU in Pennsylvania, first site may be DE-PA-01).
Site Name is the nickname for the Core Habitat.

Town is the town where the Core Habitat is located (can be multiple towns)

18. Plot # is the plot number within that Core Habitat.

Plot GPS Coordinates (NE corner) is the decimal degrees for the lat long at the Northeastern corner of the plot. If for some reason the northeast corner is not used, describe what location was used and why

GPS Accuracy is the accuracy distance reading from the GPS at the time the location was recorded.

19. Lead Surveyor(s) is the surveyor or surveyors that are leading the survey and have been identified by the State Project Lead as a “lead surveyor” for this project.

Assistant Surveyor(s) are all other surveyors regardless of level of experience.

20. Survey Date is the date the survey took place.

Survey Start Time is the time surveyors actively start to set up or evaluating the first plot.

D. **Guidance Information** is meant to provide a visual guide for the initial set up of the plots and for identifying the location where assessments are to occur by section on the field form.

E. **Abundant Species and Woody Stem Density (0.5 m x 0.5 m Quadrat)**

21. Species Abundance

- Within the 0.5 m x 0.5 m (1.64 x 1.64 ft) quadrat, determine the three most dominant species. List the species name and percent cover (of both live and dead plants) using the percent cover categories below. Abundant species are those that are most prominent in the plot and have the highest percent of coverage compared to other species.

Table 2. Categories of percent cover for abundant species

% Cover
≤20
21-40
41-60
61-80
>80

Woody stem density

- Within the 0.5 m x 0.5 m quadrat estimate woody stem density using the following density classifications (also see Fig. 3):

- 0 = no woody stems
- 1 = very few woody stems
- 2 = few woody stems
- 3 = moderate number of woody stems
- 4 = dense woody stems

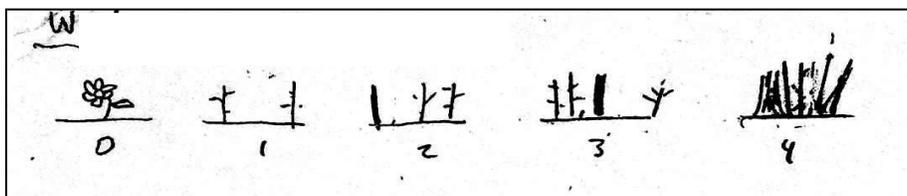


Figure 3. A graphic example of density classification categories.

F. Canopy Cover (4 m x 4 m Plot)

22. Percent Cover by Height Class

- Within the 4 m x 4m square plot estimate the total percent vegetation in the following vegetative height classes using the percent cover categories in Table 3 and 4. Vertically place a 2 m long staff gage, resting at substrate or water surface level, within the plot to help define height classes. Do not set gage on tussock or clumps of vegetation. A PVC pipe can be used to create a staff gage (Fig. 4). This parameter is largely meant to capture the degree of canopy cover and shading of the habitat. You should include overhanging vegetation even if the basal area is outside the monitoring plot. For class 1 (below 0.5 m), record both the percentage of live and dead vegetation.

Table 3. Vegetation height classes

Class	Height (m)
1	<0.5
2	0.5 – 1.0
3	1.1 – 2.0
4	> 2

Table 4. Categories of percent cover

% Cover
0
≤5
6-20
21-40
41-60
>60

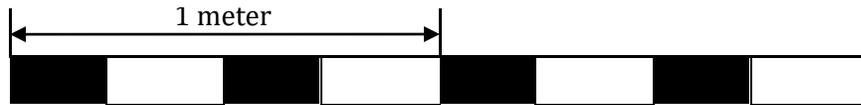


Figure 4. Diagram of staff gage made of PVC piping. Each 25 cm of length will be alternated between white and black.

G. Photographic Monitoring (4 m x 4 m Plot)

23. Photographic Monitoring by taking two photographs for future reference and comparison.

- 1) Standing near, but outside the western edge of the 4 m x 4 m square plot, photograph the vegetation within the plot. Take the photograph from eye height point to the ground at the southwestern edge of the plot. The plot should fill the picture frame. If your view from the western edge is obstructed you may take the photo from another location along the plot edge, but make sure you note the location on your data sheet so that it can be repeated in the future. This photo is just for your reference in the future.
- 2) Standing just outside (adjacent to) the Northeastern marker, and with the 2 m staff gage at the southwestern marker, take a photograph from eye height and with the 1 m mark

on the gage as the center point (see Hall 2001a and 2001b for more details). This photo is to estimate percent of different vegetation cover types.

Notes:

- As per Hall 2002 “A photo monitoring field notebook is recommended for carrying the original photos and some intervening photographs into the field. If previous photographs were done by different people, you may discover some disorientation of subsequent views. For that reason, a copy of the original photograph is very important. Re-photograph from the original and not from any misoriented intervening views.”
- As per Hall 2002 “If camera locations and photo points were not marked, they may be approximated by the following triangulation procedure. Align items in the original photograph. Start in the center of the photograph to orient the direction of the picture” and envision a line from you through the center to the top of the image to align features. The “find items on the sides of the picture to triangulate the location.”
- Photographs should be named as follows: Monitoring Site ID.Plot Num.Photo Num.Year (e.g., for site 23, plot 2, first photo in 2014 = 23.2.1.2014)
- The same camera and lens, or an equivalent match (e.g. 55 mm lens with a digital camera), should be used each time.
- Check photos to make sure they came out (e.g., not obscured by sunburst or poor exposure).
- Record the type of camera equipment used (camera, focal length of lens, and lens and exposure settings).

H. Species Composition (4 m x 4 m Plot)

Within the 4 m x 4 m square plot, estimate the percent cover of the following groupings (see Fig.5 for a visual guide to estimating percent cover; the total can exceed 100% due to overlapping structural layers).

24. Basal Woody Vegetation:

(use these categories: 0, ≤10%, 11-25, 26-40%, 41-60%, >60%)

- Total Percent Basal Woody Vegetation
- % Downed Woody (dead branches on the ground)
- % Short woody (tree or shrub <2m in height)
- % Tall woody (tree or shrub ≥2 m in height)
- Name of the most abundant short woody species
- Name of the most abundant tall woody species
- Percent Cinquefoil (only applicable for Northern NJ and New England Sites)

25. Herbaceous Vegetation

(use these categories: 0, ≤10%, 11-25, 26-40%, 41-60%, >60%)

- Total Percent Live Herbaceous Vegetation
- Total Percent Dead Herbaceous Vegetation
- % Nesting habitat: in example, tussock sedge, soft bulrush, moss and hummocks or other unvegetated, slightly raised surfaces (<8” above the substrate or water surface). For this parameter, you are really looking for

the appropriate microtopography. Please also record appropriate nesting habitat under canopy cover (under % Shaded).

- % Other Graminoids (e.g., grasses and/or non-tussock sedge and rush)
- % Forbs (i.e., flowering plants), ferns
- % unvegetated, visible saturated soil
- % visible shallow surface water (<0.5 m deep)

26. Non-native Invasive Vegetation

(use these categories: 0, ≤10%, 11-25, 26-40%, 41-60%, >60%)

- Total Percent Non-native Invasive Vegetation
- % Multiflora rose
- % Common reed (phragmites)
- % Reed canary grass
- % Japanese stiltgrass
- % Mile-a-minute
- % Purple Loosestrife
- Other invasives (Name and percent category)

27. Potentially Invasive Native Species

- % Sweetflag
- % Skunk cabbage
- % Cattail

I. Hydrology and Soil Condition (4 m x 4 m Plot)

28. Hydrology

Within each 4 m x 4 m square plot determine the state of the surface water (check one):

- 1 - Flowing water visible, water appears oxygenated
- 2 - Still or very slow water movement that appears oxygenated
- 3 - Still or very slow water movement, and doesn't appear oxygenated
- 4 - None

(Use sight, smell and temperature to determine oxygenation. Visible movement and/or cold water temperature generally indicates oxygenation. Conversely, no movement, warm water temperature and bad smelling water (sulfur) generally indicate non-oxygenated water)

29. Soils

Within each 4 m x 4 m square plot estimate the percent coverage and average depth of saturated soil. Use a ruler to record depth of saturated (mucky) soil one arm length in from each of the four corners. The measurement may be moved slightly (approx. 6") to avoid tops of tussock, tree roots, and other obstructions. Use gentle pressure to press the measuring stick into the mud until it hits resistance.

- Percent of area with, vegetated or unvegetated, saturated (mucky) soil

- Use these categories: >60%, 41-60%, 26-40%, 11-25%, ≤10%, 0
- Record the range in depth of saturated soils (four measurements described above)
- Record the average depth of saturated soils (four measurements described above). This can be calculated later in the office.

J. Meander Survey (Entire Core Habitat and a 300 ft Buffer Area)

30. Meander Survey:

The following estimates should be made for the entire Core Habitat AND/OR the 300 ft buffer area surrounding the Core Habitat. This should include the areas of direct impact (not secondary impacts). Surveyors should perform a timed meander walk through the entire Core Habitat (approx. 8 min/acre of Core Habitat and a maximum of 60 minutes for the largest sites)

- Percent of Invasive plants within the Core Habitat (*use these categories: 0, ≤10%, 11-25%, 26-40%, 41-60%, >60%*)
 - Name the most abundant species
- Percent of Success of woody plants greater than 1 m in height within the Core Habitat (*Use these categories: 0, ≤10%, 11-25%, 26-40%, 41-60%, >60%*)
 - Name the most abundant species

K. Disturbance and Land Use (Entire Core Habitat and a 300 ft Buffer Area)

31. Disturbance to Hydrology within the Core Habitat (Zone 1; direct impact area). This could include flooding, drainage ditches, tile drainages, berms, roads, and/or culverts.

- Estimate the percent of the Core Habitat where the hydrology has been altered using percent categories in Table 5.
- Determine type of disturbance (identify all that apply) and estimated date installed using year categories in Table 6.
 - Types of disturbances: Ditching/drain tiles, Berms, roads, or culverts, Sedimentation, Beaver impoundment, Ponding, Other

Table 5. Percent Categories

Percent
0
≤10%
11-25%
26-40%
41-60%
>60%

Table 6. Year Categories

Time Period
≤5
6-10
11-20
>20

32. Disturbance to Vegetation within the Core Habitat (check the one that best fits). Check mowing or grazing if it occurs sometime within the same year as the habitat monitoring assessment.

- Amount of Disturbance

- 1- Light to moderate (e.g., light grazing (1-3 animals/acre) or mowing during the inactive season; vegetation of 6" or greater present)
- 2 - No grazing or mowing
- 3 - Moderate to high (e.g., overgrazing where vegetation is under 6")
- 4 - Mowing during the turtle's active season
- Is the disturbance to the vegetation related to habitat management? Y/N
 - If Yes explain

33. General Site and Disturbance Comments is where you note any disturbances related comments, particularly ones that would not have been noted during the plot evaluations (i.e., a large patch of Phragmites not in the plots) and any other general site related comments.

34. Disturbance to stream and buffer habitat.

- Percent undisturbed stream bank and vegetated buffer within the Core Habitat and 300 ft (90 m) upstream and downstream of Core Habitat:
 - Use these percent categories: No Stream, 0, ≤40%, 41-60%, 61-80, >80%
 - Record the most common type of disturbance if there is disturbance
- Percent undisturbed buffer out 300 ft (90 m) from the Core Habitat:
 - Use these percent categories: 0, ≤40%, 41-60%, 61-80%, >80%
 - Record the most common type of disturbance if there is disturbance

Equipment and Supply List

- | | |
|--|--|
| <ul style="list-style-type: none"> ○ Rebar or other material for permanently marking the monitoring station ○ 0.5 m x 0.5 m quadrat ○ 4 m x 4 m square plot frame (pvc pipes) ○ Staff gage ○ Ruler ○ Camera ○ GPS unit ○ Compass (or use the GPS unit) ○ Waders ○ Disinfectant | <ul style="list-style-type: none"> ○ Data sheets ○ Hammer ○ Plastic yardstick (or other measuring device for mud depth) ○ Transect tape (optional) ○ Past habitat photos ○ Site map ○ Monitoring Instructions ○ Coordinated for the habitat plots (include extra random locations for the initial set up of plots) |
|--|--|

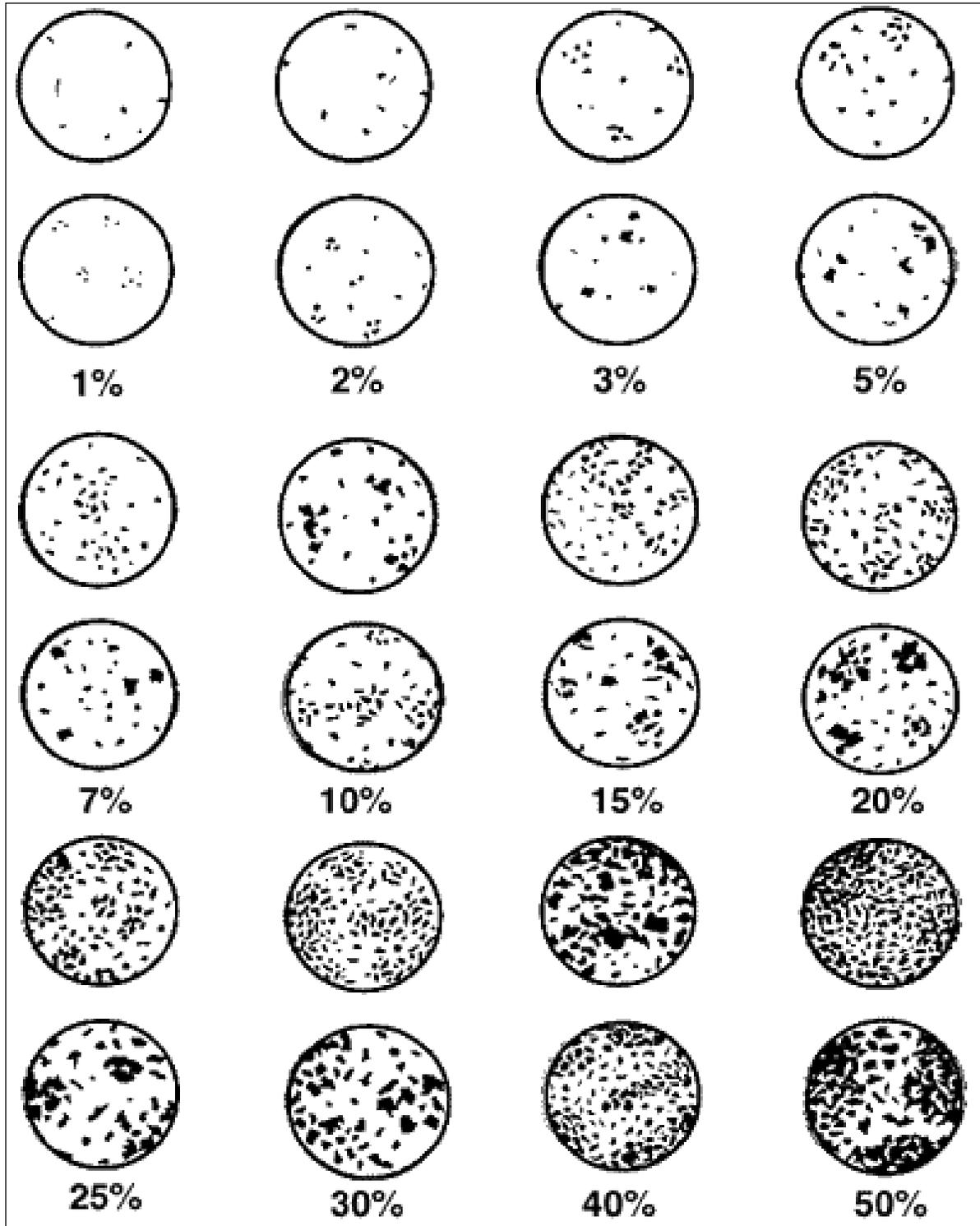


Figure 5. Graphical guide for visually estimating percent cover (after Terry and Chilingar 1955).

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APPENDIX L: REGIONAL BOG TURTLE DATABASE FIELDS AND DOMAINS

Database Fields

Table 1: Township

Name	Type	Length	Domain
Township	String	255	
Township_FIPSCode	Integer	4	
County	String	255	
County_FIPSCode	SmallInteger	2	
State	String	2	
State_FIPSCode	SmallInteger	2	
State_Name	String	50	

Table 2: County

Name	Type	Length	Domain
County	String	255	
County_FIPSCode	SmallInteger	2	
State	String	2	
State_Name	String	50	
State_FIPSCode	SmallInteger	2	

Table 3: State

Name	Type	Length	Domain
State	String	2	
State_Name	String	50	
State_FIPSCode	SmallInteger	2	

Table 4: Recovery Unit

Name	Type	Length	Domain
Recovery_Unit	String	50	
Recovery_Subunit	String	50	

Table 5: RI Core Habitat

Name	Type	Length	Domain
Core_Habitat_ID	String	50	
Core_Habitat_Name	String	255	
Core_Habitat_Link	String	50	
First_Turtle_Obs	Date	8	
Last_Turtle_Obs	Date	8	
Occupancy_Type	String	15	Occupancy_Type
Poaching	String	20	Occurrence
Poaching_Years	String	100	
Predation	String	20	Occurrence
Most_Recent_Year_Of_Predation	SmallInteger	2	
Invasive_Plants	String	10	0_10_60
Succession	String	10	0_10_60
Disturbance_To_Hydrology	String	10	Disturbance_To_Hydrology
Type_Of_Disturbance	String	20	Disturbance_Type
Development_Pressure	String	20	Development_Pressure
Type_Of_Development	String	25	Development_Type
Permanent_Land_Protection_Core	String	10	Full_Partial
Permanent_Land_Protection_Buff	String	10	Full_Partial
Temporary_Land_Protection_Core	String	10	Full_Partial
Temporary_Land_Protection_Buff	String	10	Full_Partial
BT_In_Core_Protection_Doc	String	5	Yes_No
BT_In_Buffer_Protection_Doc	String	5	Yes_No
Year_Protection_Ends_In_Core	SmallInteger	2	
Year_Protection_Ends_In_Buffer	SmallInteger	2	
Type_Of_Management_Actions	String	20	Management_Action_Type
Most_Recent_Yr_Mgmt_Actions	SmallInteger	2	
Most_Recent_Yr_Phase_1_Complete	SmallInteger	2	
Most_Recent_Yr_Phase_2_Complete	SmallInteger	2	
Most_Recent_Yr_Phase_3_Complete	SmallInteger	2	
Most_Recent_Yr_Health_Assmt	SmallInteger	2	
Comments	String	2000	
Area_Acres	Single	4	
Centroid_Lat	Single	4	
Centroid_Long	Single	4	
PopulationID	String	50	
First_Turtle_Obs_Verbatim	String	50	
Last_Turtle_Obs_Verbatim	String	50	
First_Turtle_Obs_Exact	String	5	Yes_No
Last_Turtle_Obs_Exact	String	5	Yes_No

Name	Type	Length	Domain
QC_Reviewed	String	5	Yes_No
Pop_Size	String	255	0_5
Pop_Recruitment	String	255	0_5
Pop_Interconnectedness	String	255	0_5
Pop_Quality	Single	4	
Pop_Quality_Rank	String	5	Poor_Fair_Good
Pop_Acres	String	255	0_5
Pop_Succession	String	255	0_5
Pop_Hydrology	String	255	0_5
Pop_Development_Score	String	255	0_5
Pop_Development_Percent	Single	4	
Pop_Habitat_Protection	String	255	0_5
Pop_Road_Density	String	255	0_5
Pop_Nearest_Road	String	255	0_5
Pop_Habitat_Quality_Score	Single	4	
Pop_Habitat_Quality_Rank	String	5	Poor_Fair_Good
Pop_Prelim_Rank	String	20	Poor_Fair_Good_Mix
Pop_Final_Rank	String	5	Poor_Fair_Good
Pop_True_Metapop	String	5	Yes_No

Table 6: RI Disease Management

Name	Type	Length	Domain
Core_Habitat_ID	String	50	
Core_Habitat_Name	String	255	
Start_Date	Date	8	
End_Date	Date	8	
Lead_Agency_Organization	String	100	Agency_Organization
Management_Plan	String	5	Yes_No
Disease_Management_Type	String	50	Disease_Management_Type
Lab	String	500	
Report_ID	String	255	
Results	String	25	Disease_Management_Results
Number_Turtles_Sampled	SmallInteger	2	
Sampled_Turtles_IDs	String	255	
Sample_Type	String	100	
Number_Turtles_Treated	SmallInteger	2	
Treated_Turtles_IDs	String	100	
Turtles_Released_Back_To_Site	String	5	Yes_No
Turtle_Release_Dates	String	255	
Comments	String	255	

Name	Type	Length	Domain
Disease_Management_ID	String	50	
QC_Reviewed	String	5	Yes_No
Excel_GUID	String	50	
Survey123_GUID	String	50	

Table 7: RI Habitat Management

Name	Type	Length	Domain
Core_Habitat_ID	String	50	
Core_Habitat_Name	String	255	
Start_Date	Date	8	
End_Date	Date	8	
Lead_Agency_Organization	String	100	Agency_Organization
Biologists	String	255	
Management_Plan	String	5	Yes_No
Total_Treatment_Area_Acres	Single	4	
Funding_Source	String	255	
Funding_Year	SmallInteger	2	
Funding_Start_Date	Date	8	
Funding_End_Date	Date	8	
Cut_Woody_Acres	Single	4	
Cut_Woody_Type	String	50	
Light_Equipment_Type	String	100	
Heavy_Equipment_Make_Model	String	100	
Wetland_Heavy_Equipment_Psi	Single	4	
Herbicide_Treatment_Acres	Single	4	
Herbicide_Type	String	25	Herbicide_Type
Surfactant_Used	String	5	Yes_No
Surfactant_Type	String	100	
Herbicide_Amount	Single	4	
Herbicide_Amount_Units	String	10	Herbicide_Amount_Units
Herbicide_Application_Method	String	50	Herbicide_Application_Method
Herbicide_Damage_Non_Target_Veg	String	5	Yes_No
Burned_Acres	Single	4	
Mowed_Acres	Single	4	
Mower_Make_Model	String	100	
Mower_Psi	Single	4	
Mower_Blade_Height	String	25	
Mowing_Purpose	String	50	Mowing_Purpose
Mowing_On_ROW_Wetland	String	5	Yes_No
Mower_Treatment_Company	String	255	

Name	Type	Length	Domain
Cattail_Control_Acres	Single	4	
Phragmites_Control_Acres	Single	4	
Fence_Length_Meters	Single	4	
Fence_Installation_Year	SmallInteger	2	
Grazing_Acres	Single	4	
Grazing_Restoration_By_BO	String	5	Yes_No
Grazing_Maintenance_By_BO	String	5	Yes_No
Animal_Type	String	20	Animal_Type
Animal_Density	Single	4	
Grazing_Schedule	String	255	
Biological_Control	String	5	Yes_No
Other_Management	String	5	Yes_No
Targeted_Vegetation	String	255	
Damage_Non_Targeted_Vegetation	String	5	Yes_No
Determination	String	500	
Take_Observed	String	5	Yes_No
Follow_Up_Monitoring_Needed	String	5	Yes_No
Comments	String	2000	
QC_Reviewed	String	5	Yes_No
Excel_GUID	String	50	
Survey123_GUID	String	50	

Table 8: RI Habitat Survey

Name	Type	Length	Domain
Core_Habitat_ID	String	50	
Core_Habitat_Name	String	255	
Survey_Date	Date	8	
Lead_Surveyors	String	255	
Assistant_Surveyors	String	255	
Recorders	String	100	
Plot_Number	String	10	
Survey_Area_Acres	Single	4	
Longitude	Double	8	
Latitude	Double	8	
GPS_Accuracy_Meters	SmallInteger	2	
Survey_Type	String	25	Habitat_Survey_Type
Species_1	String	50	
Species_1_Live	String	5	0_20_80
Species_1_Dead	String	5	0_20_80
Species_2	String	50	

Name	Type	Length	Domain
Species_2_Live	String	5	0_20_80
Species_2_Dead	String	5	0_20_80
Species_3	String	50	
Species_3_Live	String	5	0_20_80
Species_3_Dead	String	5	0_20_80
Woody_Stem_Density	SmallInteger	2	0_4
Height_Cover_Class_1_Live	String	5	0_5_60
Height_Cover_Class_1_Dead	String	5	0_5_60
Height_Cover_Class_2	String	5	0_5_60
Height_Cover_Class_3	String	5	0_5_60
Height_Cover_Class_4	String	5	0_5_60
Recent_Management	String	5	Yes_No
Picture_Numbers	String	255	
Camera_Make_Model	String	255	
Lens_Length_And_Setting	String	255	
Total_Woody	String	10	0_10_60
Downed_Woody	String	10	0_10_60
Short_Woody	String	10	0_10_60
Tall_Woody	String	10	0_10_60
Shrubby_Cinquefoil	String	10	0_10_60
Most_Abundant_Short_Woody	String	50	
Most_Abundant_Tall_Woody	String	50	
Herbaceous_Total_Live	String	10	0_10_60
Herbaceous_Total_Dead	String	10	0_10_60
Herbaceous_Nest_Habitat	String	10	0_10_60
Herbaceous_Shaded_Nest_Habitat	String	10	0_10_60
Herbaceous_Other_Graminoids	String	10	0_10_60
Herbaceous_Forbs_And_Ferns	String	10	0_10_60
Visible_Saturated_Soil	String	10	0_10_60
Visible_Shallow_Soil	String	10	0_10_60
Total_Invasives	String	10	0_10_60
Total_Multiflora	String	10	0_10_60
Total_Common_Reed	String	10	0_10_60
Total_Reed_Canary_Grass	String	10	0_10_60
Total_Japanese_Stiltgrass	String	10	0_10_60
Total_Mile_A_Minute	String	10	0_10_60
Total_Loosestrife	String	10	0_10_60
Other_Invasive_1_Name	String	50	
Other_Invasive_1	String	10	0_10_60
Other_Invasive_2_Name	String	50	

Name	Type	Length	Domain
Other_Invasive_2	String	10	0_10_60
Other_Invasive_3_Name	String	50	
Other_Invasive_3	String	10	0_10_60
Sweetflag	String	10	0_10_60
Skunk_Cabbage	String	10	0_10_60
Cattail	String	10	0_10_60
Hydrology	SmallInteger	2	0_4
Saturated_Soil	String	10	0_10_60
Soil_Depth_1	Single	4	
Soil_Depth_2	Single	4	
Soil_Depth_3	Single	4	
Soil_Depth_4	Single	4	
Soil_Depth_Range	String	10	
Soil_Average_Depth	Single	4	
Invasives_In_Core	String	10	0_10_60
Most_Abundant_Invasive_In_Core	String	50	
Hydrology_Area_Altered	String	10	0_10_60
Ditching_Tiles	String	5	Yes_No
Ditching_Tiles_Installed	String	5	1_20
Berms	String	5	Yes_No
Berms_Installed	String	5	1_20
Roads	String	5	Yes_No
Roads_Installed	String	5	1_20
Culverts	String	5	Yes_No
Culverts_Installed	String	5	1_20
Sedimentation	String	5	Yes_No
Sedimentation_Installed	String	5	1_20
Beaver_Impoundment	String	5	Yes_No
Beaver_Impoundment_Installed	String	5	1_20
Ponding	String	5	Yes_No
Ponding_Installed	String	5	1_20
Hydrology_Disturbance_Other	String	255	
Veg_Disturbance_Related_To_Mgmt	String	5	Yes_No
Disturbance_To_Vegetation_Scale	SmallInteger	2	
Veg_Disturbance_Mgmt_Explain	String	500	
Stream_Bank_In_Habitat	String	5	Yes_No
Stream_Bank_Undisturbed	String	5	0_40_80
Stream_Most_Common_Disturbance	String	255	
Core_Habitat_Buffer_Undisturbed	String	5	0_40_80
CH_Buff_Most_Common_Disturbance	String	255	

Name	Type	Length	Domain
NonHerp_SGCN_Species_Obs	String	500	
General_Site_Comments	String	2000	
QC_Reviewed	String	5	Yes_No
Excel_GUID	String	50	
Survey123_GUID	String	50	

Table 9: RI Landowner Info

Name	Type	Length	Domain
Landowner_ID	Integer	4	
Landowner_First_Name	String	50	
Landowner_Last_Name	String	50	
Landowner_Organization	String	255	
Comments	String	2000	
ParcelID	String	50	
QC_Reviewed	String	5	Yes_No

Table 10: RI Metapopulation

Name	Type	Length	Domain
Metapopulation_ID	String	50	
Metapopulation_Link	String	50	
State	String	2	
County	String	255	
Township	String	255	
Recovery_Unit	String	50	
Recovery_Subunit	String	50	
QC_Reviewed	String	5	Yes_No

Table 11: RI Parcel

Name	Type	Length	Domain
Parcel_ID	Integer	4	
Parcel_Name	String	255	
Parcel_Link	String	255	
Latitude	Double	8	
Longitude	Double	8	
Coordinate_Source	String	255	Coordinate_Source
Data_Source	String	255	

Name	Type	Length	Domain
First_Contact_Date	Date	8	
First_Contact_Name	String	255	
Last_Contact_Date	Date	8	
Last_Contact_Name	String	255	
Communication_Attempted_No_Response	String	5	Yes_No
Communication_No_Interest_Stay_Off	String	5	Yes_No
Site_Visit_Agreed	String	5	Yes_No
Site_Visit_Conducted	String	5	Yes_No
Survey_Conducted	String	5	Yes_No
Habitat_Management_Needed	String	5	Yes_No
Habitat_Management_Conducted	String	5	Yes_No
Follow_Up_Needed	String	5	Yes_No
Initial_Call	String	5	Yes_No
Follow_Up_Call_For_Initial_Visit	String	5	Yes_No
Follow_Up_For_Turtle_Survey_Pre_Post_Management	String	5	Yes_No
Follow_Up_Habitat_Survey_For_Pre_Post_Management	String	5	Yes_No
Land_Protection_Plan	String	5	Yes_No
Acres_Owned_By_Conservation_Grp	Single	4	
Acres_In_WRP	Single	4	
Acres_In_Conservation_Easement	Single	4	
Acres_In_Other	Single	4	
Conservation_Plan	String	5	Yes_No
Conservation_Plan_Status	String	50	Conservation_Plan_Status
Conservation_Plan_Start_Date	Date	8	
Conservation_Plan_End_Date	Date	8	
Conservation_Plan_Written_By	String	255	
Comments	String	2000	
QC_Reviewed	String	5	Yes_No
CoreHabitatID	String	50	

Table 12: RI Photo Monitoring Plot

Name	Type	Length	Domain
Core_Habitat_ID	String	50	
Core_Habitat_Name	String	255	
Photo_Plot_ID	String	255	
Photo_Plot_Name	String	255	
Date	Date	8	
Comments	String	2000	
QC_Reviewed	String	5	Yes_No

Name	Type	Length	Domain
Survey123_GUID	String	50	

Table 13: RI Population

Name	Type	Length	Domain
Population_ID	String	50	
Population_Link	String	50	
Inventory_Needs	String	5	Yes_No
Management_Needs	String	5	Yes_No
Research_Needs	String	5	Yes_No
Inventory_Needs_Comments	String	2000	
Management_Needs_Comments	String	2000	
Research_Needs_Comments	String	2000	
State	String	2	
Comments	String	2000	
Directions	String	2000	
EO_Rank	String	5	EO_Rank
EO_Rank_Date	Date	8	
EO_Rank_Comments	String	2000	
EO_Rank_Comments_Date	Date	8	
EO_Rank_Comments_By	String	50	
Site_Name	String	255	
General_Habitat_Description	String	5000	
MetapopulationID	String	50	
QC_Reviewed	String	5	Yes_No

Table 14: RI Population Management

Name	Type	Length	Domain
Population_ID	String	255	
Core_Habitat_ID	String	50	
Core_Habitat_Name	String	255	
Start_Date	Date	8	
End_Date	Date	8	
Lead_Agency_Organization	String	100	Agency_Organization
Management_Plan	String	5	Yes_No
Funding_Source	String	100	
Funding_Year	SmallInteger	2	
Nest_Protection	String	5	Yes_No
Nest_Protection_Method	String	25	Nest_Protection_Method
Number_Of_Nests_Caged	SmallInteger	2	

Name	Type	Length	Domain
Number_Of_Nests_Found	SmallInteger	2	
Number_Of_Eggs_In_Caged_Nests	SmallInteger	2	
Number_Of_Eggs_In_Uncaged_Nests	SmallInteger	2	
Number_Hatched_Caged_Nests	SmallInteger	2	
Number_Hatched_Uncaged_Nests	SmallInteger	2	
Number_Hatched_Unknown_Nests	SmallInteger	2	
Number_Caged_Nests_Predated	SmallInteger	2	
Number_Uncaged_Nests_Predated	SmallInteger	2	
Nest_Protection_Comments	String	500	
Predator_Pest_Control	String	5	Yes_No
Target_Species	String	20	Target_Species
Number_Of_Trap_Nights	SmallInteger	2	
Number_Of_Shooting_Nights	SmallInteger	2	
Number_Removed	SmallInteger	2	
Predator_Pest_Control_Comments	String	500	
Headstart	String	5	Yes_No
Headstart_Method	String	25	Headstart_Method
Headstart_Source_Site_ID	String	255	
Headstart_Number_Started	SmallInteger	2	
Headstart_Number_Released	SmallInteger	2	
Headstart_Number_Transmitted	SmallInteger	2	
Headstart_Comments	String	500	
Translocation	String	5	Yes_No
Translocation_Source_Site_ID	String	255	
Translocation_Release_Site_ID	String	255	
Translocation_Number_Of_Turtles	SmallInteger	2	
Translocation_Num_Transmitted	SmallInteger	2	
Translocation_Comments	String	500	
QC_Reviewed	String	5	Yes_No
Excel_GUID	String	50	
Survey123_GUID	String	50	

Table 15: RI Turtle Data

Name	Type	Length	Domain
Core_Habitat_ID	String	50	
Core_Habitat_Name	String	255	
Turtle_ID	String	50	
Capture_Date	Date	8	
Capture_Time	String	5	
Capture_Type	String	25	Capture_Type

Name	Type	Length	Domain
Found_On_Road	String	5	Yes_No
Observers	String	255	
Processors	String	255	
Recorders	String	100	
Latitude	Double	8	
Longitude	Double	8	
Accuracy	SmallInteger	2	
Coordinate_Source	String	50	Coordinate_Source
Previously_Marked	String	5	Yes_No
Age_Class	String	10	Age_Class
Sex	String	10	Sex
Gravid	String	5	Yes_No
Behavior	String	255	
Behavior_Other_Description	String	255	
Location_Dominant_Microhabitat	String	255	
Notching_Scheme	String	50	Notching_Scheme
Notch_Type	String	50	Notch_Type
ML1	String	5	Marginal_Condition
ML2	String	5	Marginal_Condition
ML3	String	5	Marginal_Condition
ML4	String	5	Marginal_Condition
ML5	String	5	Marginal_Condition
ML6	String	5	Marginal_Condition
ML7	String	5	Marginal_Condition
ML8	String	5	Marginal_Condition
ML9	String	5	Marginal_Condition
ML10	String	5	Marginal_Condition
ML11	String	5	Marginal_Condition
ML12	String	5	Marginal_Condition
ML13	String	5	Marginal_Condition
MR1	String	5	Marginal_Condition
MR2	String	5	Marginal_Condition
MR3	String	5	Marginal_Condition
MR4	String	5	Marginal_Condition
MR5	String	5	Marginal_Condition
MR6	String	5	Marginal_Condition
MR7	String	5	Marginal_Condition
MR8	String	5	Marginal_Condition
MR9	String	5	Marginal_Condition
MR10	String	5	Marginal_Condition

Name	Type	Length	Domain
MR11	String	5	Marginal_Condition
MR12	String	5	Marginal_Condition
MR13	String	5	Marginal_Condition
Marginals_Summary	String	50	
Notch_ID	String	50	
Manual_ID	String	50	
PL1	String	5	Plastron_Condition
PL2	String	5	Plastron_Condition
PL3	String	5	Plastron_Condition
PL4	String	5	Plastron_Condition
PL5	String	5	Plastron_Condition
PL6	String	5	Plastron_Condition
PR1	String	5	Plastron_Condition
PR2	String	5	Plastron_Condition
PR3	String	5	Plastron_Condition
PR4	String	5	Plastron_Condition
PR5	String	5	Plastron_Condition
PR6	String	5	Plastron_Condition
Scute_Morphology	String	10	Scute_Morphology
Scute_Morphology_Comments	String	255	
Visible_Annuli	SmallInteger	2	
Greater_50_Percent_Worn	String	5	Yes_No
PIT_Tagged	String	5	Yes_No
PIT_Tag_ID	String	25	
Transmitted	String	5	Yes_No
Transmitter_Frequency	Double	8	
Healthy	String	5	Yes_No
Eyes_Look_Good	String	5	Yes_No
Injuries	String	5	Yes_No
Discharge_URT	String	5	Yes_No
Scute_Loss_Or_Lesions	String	5	Yes_No
Loss_Of_Skin_Pigment	String	5	Yes_No
Lethargy	String	5	Yes_No
Tail_Intact	String	5	Yes_No
Limbs_Intact	String	5	Yes_No
Bite_Marks_On_Shell	String	5	Yes_No
Cracked_Damaged_Shell	String	5	Yes_No
Deformed_Shell	String	5	Yes_No
Ectoparasites	String	5	Yes_No
Other_Problems	String	2000	

Name	Type	Length	Domain
Health_Comments	String	2000	
Carapace_Length	Single	4	
Carapace_Width	Single	4	
Carapace_Width_Location	String	25	Carapace_Width_Location
Plastron_Length	Single	4	
Plastron_Width	Single	4	
Plastron_Width_Location	String	25	Plastron_Width_Location
Shell_Height	Single	4	
Weight	Single	4	
Weight_With_Transmitter	Single	4	
Other_Photos	String	5	Yes_No
Photo_Owners	String	500	
Blood_Collected	String	5	Yes_No
Blood_Sample_ID	String	50	
Blood_Sample_Destination	String	500	
Nail_Sample_Collected	String	5	Yes_No
Skin_Sample_Collected	String	5	Yes_No
Shell_Sample_Collected	String	5	Yes_No
Samples_Sent_To	String	500	
Dead	String	5	Yes_No
Remains_Type	String	50	Remains_Type
Remains_Tissue_Sample_Collected	String	5	Yes_No
Disease_Management_ID	String	255	
Suspected_Cause_Of_Death	String	2000	Cause_Of_Death
Final_Storage_Of_Carcass	String	500	Final_Storage
Mortality_Comments	String	2000	
General_Comments	String	2000	
TurtleSurveyID	Integer	4	
Capture_Date_Verbatim	String	50	
Capture_Date_Exact	String	5	Yes_No
QC_Reviewed	String	5	Yes_No
Excel_GUID	String	50	
Survey123_GUID	String	50	

Table 16: RI Turtle Survey

Name	Type	Length	Domain
Core_Habitat_ID	String	50	
Core_Habitat_Name	String	255	
Survey_Date	Date	8	
Lead_Surveyors	String	255	

Name	Type	Length	Domain
Assistant_Surveyors	String	255	
Recorders	String	100	
Survey_Type	String	20	Survey_Type
Survey_Area_Acres	Single	4	
Person_Hours_Per_Acre	Single	4	
Site_Visit_Number	SmallInteger	2	
Start_Number_Surveyors	SmallInteger	2	
Start_Time	String	5	
Start_Rain	String	25	Rain
Start_Cloud_Cover	String	10	Cloud_Cover
Start_Wind	SmallInteger	2	Beaufort_Scale
Start_Air_Temperature	SmallInteger	2	
Start_Air_Temperature_Scale	String	10	Temperature_Scale
Start_Water_Temperature	SmallInteger	2	
Start_Water_Temperature_Scale	String	10	Temperature_Scale
Date_Traps_Set	Date	8	
Date_Traps_Pulled	Date	8	
Number_Of_Traps_Set	SmallInteger	2	
Number_Of_Trap_Nights_Fahey	SmallInteger	2	
Number_Of_Trap_Nights_Eel	SmallInteger	2	
Number_Of_Trap_Nights_Other	SmallInteger	2	
Number_Traps_With_Drift_Fences	SmallInteger	2	
Total_Number_Of_Trap_Nights	SmallInteger	2	
Turtles_Found	String	5	Yes_No
Signs_Of_GLMU	String	5	Yes_No
GLMU_Nest	SmallInteger	2	
GLMU_Egg	SmallInteger	2	
GLMU_Adult_Female	SmallInteger	2	
GLMU_Adult_Male	SmallInteger	2	
GLMU_Juvenile_Hatchling	SmallInteger	2	
GLMU_Unknown	SmallInteger	2	
GLMU_Total	SmallInteger	2	
Number_Live_GLMU_During_Survey	SmallInteger	2	
Number_Live_GLMU_After_Survey	SmallInteger	2	
Number_Dead_GLMU	SmallInteger	2	
Search_End_Time	String	5	
CHPI_Total	SmallInteger	2	
CHSE_Total	SmallInteger	2	
CLGU_Total	SmallInteger	2	
GLIN_Total	SmallInteger	2	

Name	Type	Length	Domain
KISU_Total	SmallInteger	2	
STOD_Total	SmallInteger	2	
TECA_Total	SmallInteger	2	
Other_Herptofauna_Obs	String	500	
NonHerp_SGCN_Species_Obs	String	500	
Comments	String	2000	
End_Number_Surveyors	SmallInteger	2	
End_Time	String	5	
End_Rain	String	25	Rain
End_Cloud_Cover	String	10	Cloud_Cover
End_Wind	SmallInteger	2	Beaufort_Scale
End_Air_Temperature	SmallInteger	2	
End_Air_Temperature_Scale	String	10	Temperature_Scale
End_Water_Temperature	SmallInteger	2	
End_Water_Temperature_Scale	String	10	Temperature_Scale
Turtle_Survey_ID	Single	4	
Survey_Date_Exact	String	5	Yes_No
Survey_Date_Verbatim	String	50	
QC_Reviewed	String	5	Yes_No
Excel_GUID	String	50	
Survey123_GUID	String	50	

Database Domains

Table 1: 0_4

Code	Name
0	0
1	1
2	2
3	3
4	4

Table 2: 0_5

Code	Name
0	0
1	1
2	2
3	3

Code	Name
4	4
5	5

Table 3: 0_5_60

Code	Name
0	0
1-5	1-5
6-20	6-20
21-40	21-40
41-60	41-60
>60	>60

Table 4: 0_10_60

Code	Name
0	0
1-10	1-10
11-25	11-25
26-40	26-40
41-60	41-60
>60	>60
Unknown	Unknown

Table 5: 0_20_80

Code	Name
0	0
1-20	1-20
21-40	21-40
41-60	41-60
61-80	61-80
>80	>80

Table 6: 0_40_80

Code	Name
0	0
1-40	1-40
41-60	41-60
61-80	61-80

Code	Name
>80	>80

Table 7: 1 20

Code	Name
1-5	1-5
6-10	6-10
11-20	11-20
>20	>20

Table 8: Age Class

Code	Name
Adult	Adult
Eggs	Eggs
Hatchlings	Hatchlings
Juvenile	Juvenile

Table 9: Agency Organization

Code	Name
Connecticut DEEP	Connecticut DEEP
Delaware DFW	Delaware DFW
Maryland DNR	Maryland DNR
Massachusetts DFW	Massachusetts DFW
New Jersey DFW	New Jersey DFW
New York DEC	New York DEC
Pennsylvania GC	Pennsylvania GC
The Nature Conservancy	The Nature Conservancy
US Fish and Wildlife Service	US Fish and Wildlife Service

Table 10: Animal Type

Code	Name
Cows	Cows
Goats	Goats
Horses	Horses
Other	Other
Sheep	Sheep

Table 11: Beaufort Scale

Code	Name
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Table 12: Behavior

Code	Name
Basking in Open	Basking in Open
Cryptic Basking	Cryptic Basking
Feeding	Feeding
Hibernating	Hibernating
Mating	Mating
Moving	Moving
Nesting	Nesting
Other	Other
Unknown	Unknown

Table 13: Capture Type

Code	Name
Incidental	Incidental
Nesting	Nesting
Photo Video	Photo Video
Radio Telemetry	Radio Telemetry
Trapping	Trapping
Visual Probing	Visual Probing

Table 14: Carapace Width Location

Code	Name
Bridge	Bridge
Widest Point	Widest Point

Table 15: Cause Of Death

Code	Name
Disease	Disease
Old Age	Old Age
Predation	Predation
Road	Road
Unknown	Unknown

Table 16: Cloud Cover

Code	Name
Clear	Clear
Overcast	Overcast
Partly	Partly

Table 17: Conservation Plan Status

Code	Name
Finalized	Finalized
In Draft	In Draft

Table 18: Coordinate Source

Code	Name
Core Habitat Centroid	Core Habitat Centroid
Digital Imagery	Digital Imagery
Geopoint Map	Geopoint Map
Google Maps	Google Maps
GPS Unit	GPS Unit
Other	Other
Road Atlas	Road Atlas

Table 19: Development Pressure

Code	Name
Both	Both
In 300 Foot Buffer	In 300 Foot Buffer
In Wetland	In Wetland

Code	Name
None	None

Table 20: Development Type

Code	Name
Agriculture	Agriculture
Industrial Commercial	Industrial Commercial
Man-made Ponds	Man-made Ponds
Multiple Types	Multiple Types
Residential	Residential
Roads	Roads

Table 21: Disease Management Results

Code	Name
Confirmed	Confirmed
No Disease	No Disease
Suspected	Suspected

Table 22: Disease Management Type

Code	Name
Health Assessment	Health Assessment
Symptomatic Assessment	Symptomatic Assessment

Table 23: Disturbance To Hydrology

Code	Name
Full	Full
None	None
Partial	Partial
Unknown	Unknown

Table 24: Disturbance Type

Code	Name
Beaver Impoundment	Beaver Impoundment
Ditching	Ditching
Drain Tiles Berms	Drain Tiles Berms
Man-made Ponding	Man-made Ponding

Code	Name
Multiple Types	Multiple Types
Other	Other
Roads Culverts	Roads Culverts
Sedimentation	Sedimentation

Table 25: EO Rank

Code	Name
A	A
AB	AB
B	B
BC	BC
C	C
CD	CD
D	D
E	E
F	F
H	H
U	U
X	X
X?	X?

Table 26: Final Storage

Code	Name
Destroyed	Destroyed
Lab	Lab
Left In Field	Left In Field
Museum	Museum
Office	Office

Table 27: Full Partial

Code	Name
Full	Full
None	None
Partial	Partial

Table 28: Habitat Survey Type

Code	Name
Random Survey	Random Survey
Targeted Survey	Targeted Survey

Table 29: Headstart Method

Code	Name
Artificial Incubation	Artificial Incubation
Release Young	Release Young

Table 30: Herbicide Amount Units

Code	Name
Gallons	Gallons
Ounces	Ounces

Table 31: Herbicide Application Method

Code	Name
Back Pack	Back Pack
Basal Bark	Basal Bark
Cut Drip	Cut Drip
Cut Stem	Cut Stem
Foliar	Foliar
High Pressure	High Pressure

Table 32: Herbicide Type

Code	Name
Glyphosate	Glyphosate
Imazapyr	Imazapyr
Triclopyr	Triclopyr

Table 33: Management Action Type

Code	Name
Cutting	Cutting
Grazing	Grazing
Herbicide	Herbicide
Mowing	Mowing
Multiple Types	Multiple Types
None	None

Table 34: Marginal Condition

Code	Name
A	A
D	D

Code	Name
N	N
N1	N1
N2	N2

Table 35: Microhabitat

Code	Name
Broadleaf Vegetation	Broadleaf Vegetation
Cattail	Cattail
Dead Vegetation	Dead Vegetation
Invasive Species	Invasive Species
Low Grass Sedge	Low Grass Sedge
Mud	Mud
Other	Other
Rivulet Puddle	Rivulet Puddle
Shrub	Shrub
Tall Vegetation	Tall Vegetation
Tunnel	Tunnel
Tussock	Tussock
Underground	Underground
Upland	Upland
Water	Water

Table 36: Mowing Purpose

Code	Name
Cattail Phragmites Control	Cattail Phragmites Control
Routine Maintenance	Routine Maintenance

Table 37: Nest Protection Method

Code	Name
Cage At Substrate	Cage At Substrate
Cage Below Substrate	Cage Below Substrate

Table 38: Notch Type

Code	Name
Broken	Broken
Circular	Circular

Code	Name
Drill Hole	Drill Hole
Other	Other
Square File	Square File
Triangle File	Triangle File

Table 39: Notching Scheme

Code	Name
Cagle Ernst Combo	Cagle Ernst Combo
Ernst et al 1974	Ernst et al 1974
Honegger 1979	Honegger 1979
Modified Cagle 1939	Modified Cagle 1939
Modified Honegger 1979	Modified Honegger 1979
Other	Other
Taylor et al 1984	Taylor et al 1984
Unknown	Unknown

Table 40: Occupancy Type

Code	Name
Extant	Extant
Extirpated	Extirpated
Historical	Historical
Potential	Potential
Unknown	Unknown

Table 41: Occurrence

Code	Name
Likely Occured	Likely Occured
Occured	Occured
Unknown	Unknown

Table 42: Plastron Condition

Code	Name
A	A
D	D
N	N
X	X

Table 43: Plastron Width Location

Code	Name
Behind Bridge	Behind Bridge
Y Notch Bridge	Y Notch Bridge

Table 44: Poor Fair Good

Code	Name
Fair	Fair
Good	Good
Poor	Poor

Table 45: Poor Fair Good Mix

Code	Name
Fair	Fair
Fair or Good	Fair or Good
Fair or Poor	Fair or Poor
Good	Good
Poor	Poor

Table 46: Rain

Code	Name
Heavy	Heavy
Intermittent	Intermittent
Light	Light
None	None

Table 47: Remains Type

Code	Name
Partial Shell And Tissue	Partial Shell And Tissue
Partial Shell No Tissue	Partial Shell No Tissue
Whole Shell And Tissue	Whole Shell And Tissue
Whole Shell No Tissue	Whole Shell No Tissue

Table 48: Scute Morphology

Code	Name
Irregular	Irregular
Regular	Regular

Table 49: Sex

Code	Name
Female	Female
Male	Male
Unknown	Unknown

Table 50: Survey Type

Code	Name
Intensive Monitoring	Intensive Monitoring
Opportunistic	Opportunistic
Phase 2	Phase 2
Radio Telemetry	Radio Telemetry
Rapid Monitoring	Rapid Monitoring
Trapping	Trapping

Table 51: Target Species

Code	Name
Ants	Ants
Beaver	Beaver
Bird	Bird
Fox	Fox
Mink	Mink
Possum	Possum
Raccoon	Raccoon
Skunk	Skunk
Unknown Rodent	Unknown Rodent

Table 52: Temperature Scale

Code	Name
Celcius	Celcius
Fahrenheit	Fahrenheit

Table 53: Yes No

Code	Name
No	No
Yes	Yes

APPENDIX M: BLOOD COLLECTION PROTOCOL FOR BOG TURTLES

Last updated 6/28/2017

BACKGROUND

The following guidelines are for collecting blood samples from Bog Turtles for the purpose of developing a genetic library to assist with the development of eDNA technology for detecting Bog Turtles from water samples. Guidelines may vary if blood collection is for some other purpose. For example, the blood volume collected for disease screening tests may be higher than the amounts recommended in this document.

SUPPLIES AND MATERIALS

- Tubes with buffer (size and buffer to be determined by Hyatt or sample processing lead)
- 25, 26, 27 or 30 gauge bevel-tip needles (shorter is better)
- 0.5 or 1.0 ml syringe (small diameter is better)
- Sharps (used needle) disposal container
- Alcohol wipes (purchased at drug store)
- Fine permanent black marker
- Storage container for samples (e.g., lunch box with ice packs)
- Dishtowels/small rags (optional)

Note 1: Tubes with buffer, needles, and syringes will be provided by SUNY ESF.

Note 2: In a pinch, most drug stores carry needles and syringes. For example, 1.0ml (1cc) volume syringes are available and 29 gauge or smaller needles.

TURTLE CRITERIA AND BLOOD VOLUME

Due to the small size of Bog Turtles, it is very important to pre-determine which turtles are heavy enough to be safely bled and the upper limit of how much blood can be collected from an individual based on its weight to avoid endangering the turtle. It is generally accepted that you can safely collect up to 10% of the total blood volume of a healthy animal (Huge 2010). Blood is 4-8 percent of the body weight of a chelonian (Huge 2010). The Wildlife Conservation Society's guidelines for collecting blood from Bog Turtles for disease-screening tests recommend collecting no more than 0.8 ml per 100 grams of body mass (Raphael 2016). The amounts below are relatively conservative based on these data:

- No turtle under 100 g in weight should be bled
- No turtle that appear ill, injured, or weak should be bled, but should be taken to a veterinarian for a health evaluation and testing.
- 0.40 ml of blood can be collected for every 100 g of turtle
 - 100 g Bog Turtle \leq 0.40 ml limit
 - 125 g Bog Turtle \leq 0.50 ml limit
 - 150 g Bog Turtle \leq 0.60 ml limit
 - 175 g Bog Turtle \leq 0.70 ml limit

- 200 g Bog Turtle \leq 0.80 ml limit
- Modifications are needed for the Prairie Peninsula and Lake Plain Recovery Unit due to the small size of adults, which are rarely over 100 g. We recommend the following blood collection volume guidelines for this recovery unit:
 - 100 g Bog Turtle \leq 0.40 ml limit
 - 75 g Bog Turtle \leq 0.30 ml limit
 - 50 g Bog Turtle \leq 0.20 ml limit
 - 25 g Bog Turtle \leq 0.10 ml limit
 - No turtles under 25 g should be bled

BLEEDING DIRECTIONS

Two methods for collecting blood are described below, tail bleeding and subcarapacial bleeding. Only one sample is needed from an individual turtle. Repeat bleedings may be harmful even if done on different days/visits within the same season. Each sample should only contain blood from one turtle and caution should be taken to avoid cross-contamination between samples.

A. TAIL BLEEDING DIRECTIONS (preferred method)

Preparation

- 1) Assemble the needle and syringe if separate.
 - a. Remove needle from packaging (keep the needle cap on).
 - b. Remove the syringe from packaging.
 - c. Insert the needle firmly onto the syringe.
- 2) Loosen the needle cap but do not remove.
- 3) Prime the syringe plunger by pulling and pushing on the plunger several times.
- 4) Have two alcohol swabs handy (but not open).
- 5) Have a sample tube with EDTA buffer handy and loosen the cap
- 6) Stabilize the turtle.
 - a. You can use a dishtowel to wrap the front half of the turtle to control head and limb movement (optional).
 - b. Place the turtle between your knees with the tail facing toward you and the body slightly angled (with the tail up and anterior end down).
- 7) Clean the tail.
 - a. Grip the tail and remove any mud or water.
 - b. Swab the top of the tail with an alcohol swab.

Collecting Blood

- 1) Hold the syringe in your dominant hand.
- 2) Firmly grip the sides of the tail tip with the other hand, between the forefinger and thumb, gently stretching the tail lengthwise (with the turtle held tightly between your knees). The back of your hand should be toward the ground and your fingertips pointing upward (Fig. 1).

- 3) Rest the syringe across the first three fingers of your dominant hand, with the third one on under the end of the plunger and place your thumb on the top of the syringe. The pinky can be used to push the plunger back in if needed.
- 4) Turn the needle so that the bevel is facing up.
- 5) Rest the bottom of your dominant hand on the other hand (or your leg) for added stability.
- 6) Place the needle and syringe at approximately a 45-degree angle up from the tail, with the needle tip touching the tail approximately halfway down the length of the tail.
- 7) Gently probe the needle into the centerline of the tail (towards the vertebral bones), part way up the tail. You are targeting the space between two vertebrae. Only very small movements are necessary. Be careful not to insert the needle more than about ¼", particularly if you are near the base of the tail (near the cloacal opening).
- 8) When you think you are in the correct spot gently pull the plunger out with your third finger, just enough to feel some pressure. If blood does not begin to flow very gently move the needle in and/or out a little (very slight movements) to see if you hit the vein OR twist the needle to change the position of the bevel.
- 9) If you do not hit the vein on the first try you can withdrawal the needle and try another location along the tail. Be careful not to go too high towards the carapace where you could risk puncturing the lining of the cloacae or digestive tract or any vital nerves. Do not try more than three times on any individual.
- 10) Once blood begins to flow, maintain your position and keep pressure on the plunger until you have the desired amount of blood. Make sure you do not draw more blood volume than what is recommended above.
- 11) Once you have the full amount of blood remove the syringe and empty the contents into the buffer solution in the sample tube.
- 12) Firmly put the cap on the tube and invert several times to mix the buffer and blood.
- 13) Label the sample tube with the state initials and a unique sample number (e.g., PA-01). Note the sample number used on your turtle processing data sheet.
- 14) Swab the tail with an alcohol swab to clean the injection area(s).
- 15) Put the needle cap firmly back on and remove the needle from the syringe, placing it in a sharps container. Place the syringe in a trash bag kept separate from the samples and clean syringes and needles.



Figure 1. Tail Bleeding Example (photo from an online document by David Perpnan of Loro Parque Foundation).

B. SUBCARAPACIAL BLEEDING DIRECTIONS

Preparation

- 1) Assemble the needle and syringe if separate.
 - a. Remove needle from packaging (keep the needle cap on).
 - b. Remove the syringe from packaging.
 - c. Insert the needle firmly onto the syringe.
- 2) Loosen the needle cap but do not remove.
- 3) Prime the syringe plunger by pulling and pushing on the plunger several times.
- 4) Have two alcohol swabs handy (but not open).
- 5) Have a sample tube with EDTA buffer handy and loosen the cap
- 6) Stabilize the turtle.
 - a. You can use a dishtowel to wrap the turtle in, leaving the head end exposed, to control limb movement (optional).
 - b. Place the turtle between your knees with the head facing toward you and the body slightly angled (with the anterior end up and posterior down).
- 7) Clean the injection site with an alcohol swab if possible.

Collecting Blood

- 1) Hold the syringe in your dominant hand.
- 2) Gently push the snout of the turtle into the shell with your finger or a small instrument (e.g. triangle file or pen).
- 3) Rest the syringe across the first three fingers of your dominant hand, with the third one on under the end of the plunger and place your thumb on the top of the syringe (Fig. 2). The pinky can be used to push the plunger back in if needed.
- 4) Turn the needle so that the bevel is facing up.
- 5) Rest the bottom of your dominant hand on the other hand (or leg) for added stability.
- 6) Place the needle and syringe at an angle parallel to the slope of the carapace, with the needle tip touching the site where the base of the neck attaches to the shell (See figure below).
- 7) Gently probe the needle into the skin and upward towards the shell along the midline area.
- 8) When you think you are in the correct spot gently pull the plunger out with your third finger, just enough to feel some pressure. If blood does not begin to flow very gently move the needle in and/or out a little (very slight movements) to see if you hit the vein OR twist the needle to change the position of the bevel.
- 9) If you do not hit the vein on the first try, you can withdrawal the needle and try one more time. Be careful not to insert the needle to far back into the body. Do not try more than two times on any individual as nerve damage has been reported as a result of multiple insertions.
- 10) Once blood begins to flow, maintain your position and keep pressure on the plunger until you have the desired amount of blood. Make sure you do not draw more blood volume than what is recommended above.

- 11) Once you have the full amount of blood remove the syringe and empty the contents into the buffer solution in the sample tube.
- 12) Firmly put the cap on the tube and invert several times to mix the buffer and blood.
- 13) Label the sample tube with the state initials and a unique sample number (e.g., PA-01). Note the sample number used on your turtle processing data sheet.
- 14) Swab the injection area(s) with an alcohol swab.
- 15) Put the needle cap firmly back on and remove the needle from the syringe, placing it in a sharps container. Place the syringe in a trash bag kept separate from the samples and clean syringes and needles.



Figure 2. Subcarapacial bleeding Example (photo by Lori Erb).

TISSUE SAMPLES

Blood samples are preferred but opportunistic tissue samples from deceased Bog Turtles are also welcome.

- Cut a relatively clean 0.5 - 1 cm piece of tissue sample from the carcass. Use latex gloves, clean forceps and scissors.
- Place the tissue in a tube with EDTA buffer solution.
- Place cap on the tube and invert the tube to cover the tissue with buffer.
- Label the sample tube with the state initials and a unique sample number (e.g., PA-01). Note the sample number used on your turtle processing data sheet.
- If the carcass is stored for any amount of time before placing tissue in a sample tube, place the carcass on ice or in a freezer until the sample is prepared.
- Alternatively, the entire carcass could be shipped to SUNY ESF (shipping directions are below).

TOENAIL CLIPPINGS

It is recommended that you also collect toenail clippings on turtles that are not bled. For example if you capture 30 Bog Turtles at a monitoring site, you would collect blood on the first 12 and then collect toenail clippings from the remaining turtles. This is to opportunistically collect additional

genetic samples for future use in building a genetic library for the species. This is also recommended for sites where you are not collecting blood and tend to capture many turtles.

- Using feline toenail clippers to clip the tip of several toenails up to the cuticle but not beyond.
- Place toenail clippings in a tube with 95% ethanol buffer (95% ethyl alcohol is fine)
- Label the sample tube with the date, RU-state initials-site number, and turtle number.
- Swab the injection area(s) with an alcohol swab.
- Wipe the toenail clippers with an alcohol swab to remove any remaining clippings or DNA.

SAMPLE STORAGE

Store samples on ice as soon as possible while in the field. Upon return from the field put samples in a freezer (preferably kept at -20°C) until shipping to SUNY ESF. Ship samples as soon as possible, but avoid sending them over a weekend when the university is closed. Samples should be shipped Monday – Thursday overnight mail.

LITERATURE REVIEWED

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APPENDIX N: DRAFT BIBLIOGRAPHY OF *GLYPTEMYS MUHLENBERGII* (BOG TURTLE) LITERATURE

This summary of Bog Turtle literature listed below is a DRAFT and should not be considered a complete list.

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