Wildlife Action Plan 2015 Revision Process
White Paper[1]

Ranking Criteria for Prioritizing Wildlife Species for Conservation and Management

Introduction

States use federal funds generated by excise taxes provided by the Wildlife Restoration Act (Pittman-Robertson), Sport Fisheries Restoration Act (Dingell-Johnson), and the Wallop-Breaux Act to support the conservation and management of game fish and wildlife species. The State Wildlife Grants (SWG) program was established by the U.S. Congress to provide funding for nongame species not traditionally covered under most previous federal funding programs. The U.S. Fish & Wildlife Service (USFWS) has oversight of the SWG program and gives states the authority to determine how they identify these priority species.

To qualify for SWG funds, each state is mandated to develop conservation strategies with a focus on *Species of Greatest Conservation Need* (SGCN). In North Carolina, SGCN have been defined as species that are currently rare or have been designated as at-risk of extinction; those for which we have knowledge deficiencies; and those that have not received adequate conservation attention in the past. In addition to SGCN, species that may be vulnerable to local threats; species of recreational, commercial, or tribal importance that are vulnerable; species for which we are unable to determine true status in the state; and those identified as management concerns are referred to as *priority species*. Work related to priority species may be funded from sources other than the SWG program; however, eligibility for SWG funds is restricted to SGCN.

2005 Prioritization Process

The need for an iterative process to identify species conservation priorities was acknowledged during development of the 2005 North Carolina Wildlife Action Plan (WAP). To meet the need, a Technical Team comprised of North Carolina Wildlife Resources Commission (NCWRC) biologists considered a number of different planning and prioritization efforts in order to evaluate the utility of using a pre-existing methodology versus developing a new process. Criteria included consideration for species that are currently rare or designated as at-risk, those for which we have knowledge deficiencies, and those that have not received adequate conservation attention in the past.

The USFWS, NatureServe, Partners In Flight, American Fisheries Society, and numerous other organizations regularly generate lists of species for which they have conservation concern or which warrant levels of protection. It would be easy to use one or more of these lists as a means of identifying priority species, but the varying methodologies were considered

[1] Developed by Wildlife Action Plan Revision Technical Team Ranking Criteria Work Group (D. H. Allen, S. K. Anderson, C. S. Carr, J. C. Fuller, R. B. Nichols, V. F. Stancil, K. C. Weeks)

insufficient for identifying vulnerable taxa at a scale relevant to North Carolina (Breininger *et al*. 1998). Following the 2005 review team's evaluation, it was determined that an independent prioritization process would best meet the goals for identifying North Carolina's SGCN and priority species. The following requirements were used to develop the SGCN and priority species list:

- consider all species within each taxon (regardless of status or threat) at the start of the process,
- collect information not previously measured in existing prioritization efforts (*e.g*., degree of knowledge about a species), and
- develop a process that reflects the NCWRC's mission and goals since the agency carries responsibility and authority for managing the state's wildlife resources.

The 2005 ranking evaluations focused on eight taxonomic groups based on jurisdictional and traditional programmatic boundaries. The groups were amphibians, birds, crayfish, freshwater fish, freshwater snails, freshwater mussels, mammals, and reptiles. Teams of species experts (Taxa Teams) were convened to evaluate taxonomic groups using review criteria that considered conservation concern and knowledge for each species. Taxa Team member responses to the review criteria resulted in ranking scores for each species that were used to develop a prioritized species list. Chapter 2 in the 2005 WAP more fully describes the prioritization review process and provides lists of SGCN and priority species by taxa group (NCWAP 2005).

Following publication of the 2005 WAP, members of the Technical and Taxa Teams reviewed the ranking criteria and prioritization process and recommended future iterations include a reevaluation of the criteria and methodology. It was recommended that conservation plans, prioritization methodologies, and species groups that were not considered for the first edition be evaluated for inclusion in the WAP during future updates and revisions (NCWAP 2005).

Review and Revision of the 2005 Prioritization Process

In mid-2012, an Association of Fish and Wildlife Agencies (AFWA) Teaming With Wildlife (TWW) work group developed voluntary best-practice guidance for use by states during revision of their WAPs (AFWA 2012). The AFWA-TWW guidance includes a recommendation to use clearly defined procedures for assessing conservation status and setting conservation priorities (AFWA 2012). The guidance suggests using formal ranking methods such as the International Union of Conservation Networks (IUCN) Red List Categories and Criteria (IUCN 2001, 2010), Florida Fish and Wildlife Conservation Commission's taxa ranking system (Millsap *et al.* 1990), and the NatureServe conservation status evaluation tool (NatureServe 2012a, Master *et al.* 2012, Faber-Langendoen *et al.* 2012). Benefits of using more uniform methods include consistency of the information and the ability to share data across organizations (Salafsky *et al*. 2008).

Following recommendations from the 2005 WAP Review Team as well as AFWA-TWW's best practice guidance, the 2015 WAP Revision Technical Team formed a Ranking Criteria Work

Group (Work Group) to review and evaluate ranking metrics and prioritization tools. The Work Group was comprised of biologists from the NCWRC and were tasked with developing recommendations for a method to identify SGCN and to prioritize conservation efforts on behalf of species. In addition to reviewing the evaluation methods recommended by AFWA-TWW (noted above), the Work Group also considered methods described by the Convention on International Trade in Endangered Species (CITES 2011), American Fisheries Society (Deacon *et al.* 1979, Jelks *et al.* 2008), Partners In Flight Species Assessment Process (Beissinger *et al.* 2000), and an assessment of various categorization systems conducted by deGrammont and Cuaron (2006) and Arponen (2012).

Based on the results of their review and assessment, the Work Group members determined that adopting and modifying selected ranking criteria and scoring metrics described by IUCN, Millsap (*et al.* 1990), and NatureServe combined with creation of original criteria and metrics to capture knowledge gaps and management concerns, would best meet North Carolina's WAP goals for identifying SGCN and prioritizing conservation efforts. The Work Group also adopted the 10-point scoring system as described in Millsap (*et al.* 1990) because the application of this method is similar to the ranking criteria proposed in this white paper and a statistical analysis conducted by Millsap (*et al.* 1990) of their results indicated the metrics and scoring system were robust and selection bias was minimal.

Members of the Work Group coordinated with biologists at the NC Natural Heritage Program (NCNHP) to determine whether any information used in the NatureServe evaluation tool would be compatible with the proposed ranking criteria. It was determined this information is not uniformly available across all taxa groups or for species that are not tracked for reporting to NatureServe. However, the NCNHP will provide data for those species which are tracked in their database system. The NCNHP requested that the metrics be designed in a way that ranking criteria data can augment information used in designating state-level rankings as reported by NatureServe. As a result of these coordination efforts, the Work Group adopted answer scales that utilize the NatureServe evaluation tool for several metrics that address conservation concerns (NatureServe 2012a).

Other coordination efforts include a request to faculty and staff of the North Carolina Cooperative Fish & Wildlife Research Unit and staff of the Biodiversity and Spatial Information Center at NC State University (NCSU) for review of the draft ranking criteria metrics. The request asked for comments on whether statistical analysis would be needed to reduce bias in the evaluation process. Their recommendations include

- displaying answer scales without the associated scores as a means of reducing reviewer bias for selecting answers based on a preferred score outcome,
- calculating average scores for each metric that are then totaled within each evaluation category for each species, and
- using a Bayesian style analysis of the relationship between a threat's scope and severity.

Members of the Nongame Wildlife Advisory Committee (NWAC) were also asked to review and provide comments on the proposed ranking criteria. Responses were limited and comments were restricted to minor revisions, which have been incorporated into the metrics.

2015 Prioritization Process

The revised ranking criteria are represented by metrics developed by the Work Group and are described in this white paper report. The criteria will be used to evaluate all wildlife in the amphibian, bird, crayfish, freshwater fish, freshwater mussel, mammal, reptile, and snail taxa groups found in North Carolina in order to identify SGCN and priority species. The results of this ranking process will be used to prioritize conservation efforts (including research needs), and identify species of management concern. As with the 2005 SGCN evaluation, the Work Group recommendation calls for all game species (those that are hunted, fished, or trapped) to be included in the ranking process so species experts and peer reviewers can consider the broad interrelationships between species and their habitats (Wells *et al*. 2010, Tear *et al.* 2005). Including game species also allows consideration of how the variability of likely climate change impacts, as currently understood, may affect the state's wildlife species during the next decade.

The ranking criteria metrics were developed to be a robust measure of our understanding about the status, trends, and risks of species in the state. Overall, we want the evaluation process to be one that can be applied consistently when used by different people and that will facilitate an evaluation and comparison of extinction risks among different taxa. To accomplish this goal, the evaluation is divided into three review categories: Conservation Need, Knowledge Gap, and Management Concern. While the Conservation Need metrics consider the status of species both within the state and where they occur elsewhere, the Knowledge Gap and Management Concern metrics consider only the occurrences in North Carolina.

Species Ranking. The ranking process used to identify SGCN and priority species is intended to be both transparent and collaborative, with partners representing numerous state and federal agencies, education and research organizations, and private citizens knowledgeable about the taxa contributing to the process. Teams of species experts and research scientists will complete the ranking evaluation for the species they are knowledgeable about. Their knowledge may be directly related to their own work or indirectly related through access to current research data. A peer-review analysis of the ranking results will be conducted once the Taxa Teams have completed their reviews.

Each Taxa Team considered whether adjustments to the method for calculating the Conservation Concern ranking scores would be appropriate for the taxon. The Taxa Teams that made scoring adjustments are:

- Amphibians and Reptiles (Herps): The Conservation Concern score calculation was adjusted for the Metric 9 threat assessment categories by multiplying the evaluation score by 0.25 and adding the adjusted score to the cumulative score.

- Birds: The cumulative total Conservation Concern score was calculated by using the full score for Metrics 1 through 4 and Metric 6 and adjusted scores for remaining metrics in this category. The adjustments included multiplying the Metric 5 score by 0.5 in order to address the effect of different life histories and carrying capacities of this diverse taxon. The Metric 7 score was calculated by multiplying the results by 1.5 for each species in order to emphasize the effect of population trends in North Carolina. The Metric 8 score

was adjusted by multiplying the results by 0.5 in order to reduce the effect of coastal species life histories. The threat assessment score from Metric 9 was calculated as the maximum score reported from the evaluation categories, with 10 points being the maximum added to the cumulative score. Additionally, the Taxa Team added consideration for those species where non-breeding, breeding, or both populations occurred in North Carolina by adding 6, 8, or 10 points (respectively) to the Conservation Concern cumulative total.

- Freshwater Fish: The threat assessment score from Metric 9 was calculated as the maximum score reported from the evaluation categories, with 10 points being the maximum added to the cumulative score.

Ranking Scores. Taxa Team members and peer-reviewers will select the appropriate response for each metric as part of the ranking process. Responses will be entered into an organized, relational database developed for the NCWRC's Portal Access to Wildlife Systems (PAWS) web site. The database will be available through the internet and each reviewer will be assigned unique security access. Each metric's answer scale represents empirical responses that will be recorded from the reviewer's responses and will be used to calculate numeric ranking scores.

Scores will be averaged and a total calculated by the PAWS database for each of the review categories. Taxa Teams will use the Conservation Concern and Knowledge Gap scores in the species prioritization process that will identify SGCN. Ranking scores from all three review categories will be used to recommend priority species. The steps involved in completing the species ranking and scoring process are described below.

1. Each Taxa Team member will review the ranking criteria metrics and evaluate species for which they are knowledgeable. Responses for each metric will be entered by Team members into the PAWS database.
2. Taxa Teams will be convened to review the metric responses submitted by their Team members. The metric responses will be compiled in a preliminary report automatically generated by the PAWS database. For each species where a metric response varies, Taxa Team members will collaboratively review the responses to determine whether calculation of an average score based on the range of responses is appropriate or if a final response should be designated.
3. Final ranking scores will be automatically calculated by the PAWS database using the results of the Taxa Team review of the metric responses. Taxa Team members will review ranking scores for all species in their taxa group and will recommend minimum Conservation Concern and Knowledge Gap scores for a species to be designated SGCN.
4. The Taxa Teams will review ranking scores from each of the three review categories and recommend minimum scores for a species to be considered a priority species.
5. Peer-reviewers will be asked to review the metric responses and recommendations for SGCN and priority species. Peer-reviewers may submit recommendations to modify the ranking evaluations. Recommendations to modify a ranking evaluation must be supported with appropriate citations or references to substantiating research.

6. Taxa Team members will evaluate all recommendations submitted by peer-reviewers to determine merit of the responses. Each Taxa Team will collaboratively determine whether to incorporate recommended changes and modify a species ranking or to retain the original ranking recommendation.
7. Final ranking recommendations made by the Taxa Teams will be published in the 2015 WAP as a list of SGCN and priority species within each taxa group. The final metric responses and ranking criteria scores will be made available in spreadsheet format for public access through a website download.

The Technical Team and Ranking Criteria Work Group recommends that all species be periodically reevaluated using the ranking criteria. Future modifications to the metrics may be required to accommodate new findings and incorporate best practice recommendations.

Conclusion and Acknowledgements

Members of the Technical and Taxa Teams reviewed the ranking process used to identify SGCN and priority species for the 2005 WAP and made a recommendation to revise the process during the next WAP revision cycle. The 2015 WAP Revision Technical Team formed a Ranking Criteria Work Group to develop recommendations for a new species prioritization process. This Work Group reviewed several existing ranking processes over the course of nine months and worked collaboratively to develop a draft prioritization process and ranking criteria that considers the status of Conservation Concerns, Knowledge Gaps, and Management Concerns for all species in North Carolina.

Peer-review and technical input was sought from technical and species experts from the Cooperative Fish and Wildlife Unit at NCSU, NWAC, NCNHP, NCWRC, and the 2015 WAP Revision Steering Committee. The Technical Team and Ranking Criteria Work Group recommend these proposed ranking criteria be used to evaluate and prioritize species for publication in the 2015 revision of the WAP.

NCWRC staff involved in development of the ranking criteria and the technical and species experts and peer-review participants providing input include the following:

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2015 Ranking Criteria Metrics

The ranking criteria metrics were developed to assist with the prioritization process that will identify SGCN and are divided into three categories: Conservation Need, Knowledge Gap, and Management Concern. The answer scale of each metric was designed to represent empirical data that can be applied to the different taxa groups. While the Conservation Need metrics consider the status of species both within the state and where they occur elsewhere, the Knowledge Gap and Management Concern metrics consider only the occurrences in North Carolina.

A. Conservation Need Category

The Conservation Need category is designed to evaluate biological vulnerability by considering the global and regional status and trends of a species (wherever it occurs) as well as its local status (wherever it occurs in North Carolina). Many species found in North Carolina have resident as well as migratory populations that range across a wide area outside the state. Metrics that consider the global and regional status of a species can help identify those at risk globally or regionally so we can prioritize conservation efforts to secure local populations and protect biodiversity (Wells *et al.* 2010).

1. Conservation Protection Status. This metric represents the current federal or state listed status of a species. Both federal and state listing processes use scientifically-based evaluation and ranking methods to develop listing recommendations. In many cases, continuing species-specific conservation efforts will be required to maintain viable populations of these species (Scott *et al.* 2010). It is important that these species remain a priority for conservation efforts statewide. Scores have been assigned based on the highest protection status currently applied to the species.

What is the current conservation protection status? (This information will be provided and reviewers will not need to make a selection.)

(a) Federal <u>and</u> State Listed as Endangered (E) or Threatened (T)
(b) State Listed Endangered (E)
(c) State Listed Threatened (T)
(d) Federal Candidate Species (C)
(e) State Special Concern (SC)
(f) None

Global and Regional Status

Metrics 2 through 4 consider global and regional status that in many cases will extend beyond the state's boundaries. If a species is endemic to the state, we consider its range-wide distribution to be North Carolina.

2. Population Size, Range Wide. For our use in this evaluation, range is considered to be a geographic area represented by the outermost boundaries that encompass where a species occurs naturally (Suring *et al.* 2011). Efforts to evaluate a species' rarity can include measurements of population size as represented by geographic distribution and abundance (Manne and Pimm 2006, Witte and Torfs 2003, Kunin 1998). Considering population size range-wide provides a comparison of how well a species population is doing overall when compared with populations within the state (Crain *et al.* 2011). The answer scale is adopted from the NatureServe evaluation tool (NatureServe 2012a).

This metric recognizes the importance of a species where it has overall low population sizes in other parts of its range (global or regional) but it may have a larger population within the state. For example, populations occurring within the state may be relatively large and represent a significant portion of the total known population for a species which has a range beyond North Carolina and may be experiencing declines or have low numbers in those areas (*e.g.*, Eastern hellbenders, sanderlings). The opposite may also be true – the population size in North Carolina may be small, but the overall population is large. For example, eastern coral snake populations in North Carolina are considered critically imperiled, but it is common in parts of its range outside the state and does not appear to be significantly threated elsewhere (NatureServe 2012b). Scores are assigned based on the estimated number of adults throughout the species' range.

What is the *estimated* number of adults within the species' range?

(a) 1 – 50 individuals
(b) 50 - 250 individuals
(c) 250 - 1,000 individuals
(d) 1,000 - 2,500 individuals
(e) 2,500 - 10,000 individuals
(f) 10,000 - 100,000 individuals
(g) 100,000 - 1,000,000 individuals
(h) >1,000,000 individuals

3. Range Size. As noted for population size, geographic distribution is an important measurement of a species' rarity (Manne and Pimm 2006, Witte and Torfs 2003, Kunin 1998). Range size considers the most restricted area over which the species is distributed, including areas where it occurs outside NC. The intent in using this metric is to recognize the importance of species with small range sizes because they may be more at risk of extinction (Breininger *et al.* 1998). Where a species has distinct breeding and nonbreeding ranges (*e.g.*, migratory birds, anadramous fish), the smaller range size should be considered during this evaluation.

The answer scale is adopted from the NatureServe evaluation tool (NatureServe 2012a). Scores are assigned based on the area over which the taxon is distributed, including watershed size for aquatic species.

What is the *estimated* area of distribution (range size)?

(a) < 100 km^2 (< about 40 mi^2)
(b) 100 - 250 km^2
(c) 250-1,000 km^2
(d) 1,000-5,000 km^2
(e) 5,000-20,000 km^2
(f) 20,000-200,000 km^2 [North Carolina has 125,919.81 km^2]
(g) 200,000-2,500,000 km^2
(h) >2,500,000 km^2 [The US has about 6.8 million km^2]
(i) Unknown

4. Distribution Trend (long-term). A species may be more vulnerable to extinction when its range becomes fragmented or too small to support its population. The persistence of rare species may be more limited when habitat impacts are long-term and the fragmentation leads to increased local competition between species for reduced resources (Hanski 2008, Wahlberg *et al*. 1996, Millsap *et al.* 1990). This evaluation considers changes to distribution because of habitat loss or change that may have occurred from European settlement up to recent historical periods more than 20 years ago.

For example, the fragmentation and reduction of longleaf pine acreage that began with European settlers using the forests as a resource for military naval stores (Frost 1993) has resulted in significant impacts to distribution of wildlife species adapted to this community type, especially red-cockaded woodpecker and gopher frog. Conversely, some species have adapted and thrive in urban/suburban settings (*e.g.*, raccoon, gray squirrel) and are expanding. Another example is the frequent availability of early successional habitat associated with harvest rotations on timber plantations. This land use practice may allow larger populations of prairie warblers to occur in these areas than would have occurred historically with natural landscapes.

The answer scale is adopted from the NatureServe evaluation tool (NatureServe 2012a). Scores are assigned based on the estimated % change in area occupied by the species.

What is the estimated % change in area occupied by the species?

(a) Decrease of >90%
(b) Decrease of 80 - 90%
(c) Decrease of 70 - 80%
(d) Decrease of 50 - 70%
(e) Decrease of 30 - 50%
(f) Decrease of 10 - 30%
(g) Relatively Stable (≤ 10% increase or decrease)
(h) Increasing (≥ 10% increase)

North Carolina Status

Metrics 5 through 9 focus on a species' status in North Carolina.

5. Population Size in North Carolina. Species that become rare locally may serve as early warnings for declines over broader areas that are likely to occur for numerous reasons, including threatened habitats or genetic decline (Wells *et al*. 2010). In addition, North Carolina has numerous endemic species and some have single or small populations found only in discrete locations. Endemic species may have low reproductive potential that will contribute to small populations (Kunin and Gaston 1998). Burlakova *et al*. (2010) noted there is typically a high rate of endemism associated with freshwater habitats because many species have evolved within small geographic ranges (reviewed in Strayer and Dudgeon 2010).

There are some species (*e.g.,* birds, anadromous fish) with different breeding and non-breeding populations in North Carolina or the populations may be short-term transients during migratory stop overs. For these species, separate evaluations should be done for breeding and non-breeding populations; transient populations should be included in the non-breeding category. The answer scale is adopted from the NatureServe evaluation tool (NatureServe 2012a). Scores are assigned based on the estimated total number of adults found in North Carolina.

What is the estimated number of adults within North Carolina?

(a) 1 – 50 individuals
(b) 50 - 250 individuals
(c) 250 - 1,000 individuals
(d) 1,000 - 2,500 individuals
(e) 2,500 - 10,000 individuals
(f) 10,000 - 100,000 individuals
(g) 100,000 - 1,000,000 individuals
(h) >1,000,000 individuals

6. Range Size in North Carolina. A species may be widespread and secure within its total range, but populations in NC can be imperiled. This metric is intended to help differentiate the degree of imperilment for populations occurring within the state.

Range size is the most restricted area within NC over which the species is distributed and can be measured by the number of counties where the species occurs. Range size can include counties where suitable habitat is considered to be available but surveys have not been recently conducted. If a species has distinct breeding and non-breeding ranges in NC, use the smaller range to determine a score. Some species, particularly freshwater fish species, may be native to certain river basins but are considered nonnative or invasive when introduced to river basins where they would not normally be found. For aquatic species, range size is based on the number of river basins where the species is found and is native.

Assign scores based on the most restricted area (range) within NC over which the species is distributed (number of counties or river basins) or where it is expected to occur based on habitat availability. Historical occurrence is not considered if appropriate habitat is no longer available.

What is the estimated range size for the species in North Carolina?

(a) Terrestrial: 1 – 2 counties – or –
Fish, Mussels, Crayfish: 1 – 36 HUCs (12-digit)
(b) Terrestrial: 3 – 5 counties – or –
Fish, Mussels, Crayfish: 37 – 90 HUCs (12-digit)
(c) Terrestrial: 6 – 10 counties – or –
Fish, Mussels, Crayfish: 91 – 180 HUCs (12-digit)
(d) Terrestrial: 11 – 25 counties – or –
Fish, Mussels, Crayfish: 181 – 450 HUCs (12-digit)
(e) Terrestrial: 26 – 50 counties – or –
Fish, Mussels, Crayfish: 451 - 900 HUCs (12-digit)
(f) Terrestrial: More than 50 counties (or statewide) – or –
Fish, Mussels, Crayfish: More than 900 HUCs (12-digit)

7. Population Trend (short-term). Long-term distribution trends for a species may document an overall decline in population; however, more recent data may indicate the population is stable or increasing in North Carolina. The short-term trend in number of individuals throughout the range in North Carolina will recognize declining NC populations without regard to the species' population status across its entire range. Annual recruitment may not be sufficient to sustain population size or result in population growth because sexually mature adults are not able or have diminished capacity to reproduce, and/or particular age classes have abnormally low survival rates.

Examples of short-term trends that have been noted for conservation concern in the past include population declines of box turtles, long-tailed weasels, and grasshopper sparrows. Other short-term trends can represent population growth (*e.g.*, white-tailed deer, wild turkey) or populations that have stabilized after past declines (*e.g*. red-cockaded woodpecker). Scores are assigned based on recent trends within the last 20 years that relate to the number of individuals throughout the species' range in NC (Millsap *et al.* 1990). Base the evaluation on the most restricted area (range) within NC over which the species is distributed (number of counties or river basins or HUC12s) or where it is expected to occur based on habitat availability.

What is the estimated short-term population trend for the species in North Carolina?

(a) Decline of >90%
(b) Decline of 80 - 90%
(c) Decline of 70 - 80%
(d) Decline of 50 - 70%
(e) Decline of 30 - 50%
(f) Decline of 10 - 30%
(g) Relatively Stable (≤ 10% increase or decrease)
(h) Increasing (≥ 10% increase)

8. Population Concentration. Some species tend to concentrate or aggregate at one or a few locations, especially during breeding seasons or migratory periods. These species may be at greater risk of extinction due to factors or events that can impact an entire population (Millsap *et al.* 1990). This is most recently evident from the extensive loss of bat populations affected by white-nosed syndrome. A species may congregate or aggregate seasonally or daily at specific locations in North Carolina (*e.g.*, hibernacula, breeding sites, migration focal points, communal roosting, etc.) or may use the habitat year-round. Aquatic species concentrations may be based on occurrence within a single watershed or because the species tends to congregate during spawning. Populations that are so rare they are restricted to small areas can be considered aggregations.

Migratory waterfowl that use Coastal Plain communities for stop-over or wintering habitat and amphibians that breed in isolated pools are examples of populations with life histories that require they concentrate in specific areas. Wood storks that breed in a few locations and have eggs or young on the nest could be at considerable risk from catastrophic events such as storms or fire. The reproductive success of a gopher frog population breeding in one location would be at risk if drought caused the pond or wetland to dry up before young matured. Another example would be the bog turtle, which uses discrete wetlands that are often small concentrated patches within a larger landscape.

Is the species known or suspected to concentrate (or aggregate) in North Carolina?

(a) majority concentrates at single location or stream reach in NC
(b) majority concentrates at 2 – 10 terrestrial locations or stream reaches in NC
(c) majority concentrates at 11 – 25 terrestrial locations or stream reaches in NC
(d) majority concentrates at > 25 terrestrial locations or stream reaches in NC
(e) the species does not congregate or aggregate in NC

9. Threats. Following a best practice guide recommendation (AFWA 2012), a list of the 11 most likely threats that will impact wildlife are considered in this assessment. The list is based primarily on the definitions and hierarchical classification scheme published by Salafsky *et al.* (2008) and adopted by the IUCN Conservation Measures Partnership (IUCN 2012), with modifications. The threat of geologic events (volcanic, earthquake, and avalanches) was eliminated based on an expectation these events will have little to no impact at this time on wildlife in North Carolina.

Threats are evaluated based on the anticipated impact to a species. The list of threats to be considered is provided in Table 1. Sub-categories (1.1, 1.2, 1.3, etc.) for threat categories 1 through 10 are described by Salafsky *et al.* (2008) and were included as examples to help define the threat categories and are not scored individually. A threat category for wildlife disease was added because impacts from the spread of infectious disease (*e.g.,* white-nosed syndrome) can pose a significant threat to some species. Threat category 11 (Disease & Pathogens) and the sub-categories for this threat were developed by the Work Group.

Table 2 describes the scope and severity of impact that each threat is likely to have on wildlife. The scope and severity descriptions are based on the scales outlined in NatureServe's evaluation assessment report (see Tables 6 and 7 in Master *et al.* 2012).

The evaluation uses the Bayesian style analysis shown in Figure 1 to characterize the relationship between scope and severity of the threat. The relationship between scope and severity of the impact is used to assign an overall risk category of very high, high, medium, low, or not a threat. A score will be assigned to each of these risk categories and the final threats score will reflect a calculated average for each of the 11 threats listed in Table 1.

Table 1. The most likely threats to impact wildlife.	
Threat Category	
1	**Residential & commercial development**
	Threats are from human settlements or other nonagricultural land uses with a substantial footprint. Includes housing and urban areas; commercial and industrial areas; and tourism and recreation areas.
2	**Agriculture & aquaculture**
	Threats are from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture. Includes annual and perennial nontimber crops; wood and pulp plantations; and livestock farming and ranching.
3	**Energy production & mining**
	Threats are from production of nonbiological resources, exploring for, developing, and producing petroleum and other liquid hydrocarbons. Includes: oil and gas drilling; mining and quarrying; and renewable energy.
4	**Transportation & service corridors**
	Threats are from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality. Includes roads and railroads; utility and service lines; shipping lines; and flight paths.
5	**Biological resource use**
	Threats are from Consumptive use of “wild” biological resources including deliberate and unintentional harvesting effects; also persecution or control of specific species. Includes hunting and collecting terrestrial animals; gathering terrestrial plants; logging and wood harvesting; and fishing and harvesting aquatic resources.
6	**Human intrusions & disturbance**
	Threats are from human activities that alter, destroy and disturb habitats and species associated with nonconsumptive uses of biological resources. Includes all recreational activities; military exercises; work and other activities (research, vandalism, law enforcement, illegal activities).
7	**Natural system modifications**
	Threats are from actions that convert or degrade habitat in service of “managing” natural or seminatural systems, often to improve human welfare. Includes fire and fire suppression; man-made dams and water management/use; other ecosystem modifications (land reclamation; shoreline hardening; beach reconstruction, snag removal from streams, etc.).
8	**Invasive & other problematic species & genes**
	Threats from non-native and native plants, animals, pathogens/ microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance. Includes invasive non-native/alien species; problematic native species (e.g., beavers); introduced genetic material (e.g., genetically modified insects; hatchery or aquaculture raised species).
9	**Pollution**
	Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources. Includes household sewage and urban waste water; industrial and military effluents; agricultural and forestry effluents; garbage and solid waste; air-borne pollutants; and excess energy (e.g., ambient noise, sonar, cold or hot water from power plants, beach lights, etc.).
10	**Climate change & severe weather**
	Long-term climatic changes that may be linked to global warming and other severe climatic or weather events outside the natural range of variation that could wipe out a vulnerable species or habitat. Includes habitat shifting and alteration; droughts; temperature extremes; storms and flooding.
11	**Disease & Pathogens**
	Threats are from bacteria, viruses, protozoa, fungi, and parasites. This category includes exotic or introduced pathogens, prion (non-viral, non-bacterial) disease, and zoonotic diseases. Wildlife species may act as hosts or reservoirs.
Classification of Threats (1 - 10) adopted from Salafsky *et al.* (2008).	

Table 2. Threat Scope and Severity.

THREAT - SCOPE		THREAT - SEVERITY	
(a) Pervasive	Affects all or most (71-100%) of the total population or occurrences	*(a) Extreme*	Likely to destroy or eliminate occurrences, or reduce the population 71-100%
(b) Large	Affects much (31-70%) of the total population or occurrences	*(b) Serious*	Likely to seriously degrade/reduce affected occurrences or habitat or reduce the population 31-70%
(c) Restricted	Affects some (11-30%) of the total population or occurrences	*(c) Moderate*	Likely to moderately degrade/reduce affected occurrences or habitat or reduce the population 11-30%
(d) Small	Affects a small (1-10%) proportion of the total population or occurrences	*(d) Slight*	Likely to only slightly degrade/reduce affected occurrences or habitat, or reduce the population 1-10%
(e) Unknown	There is insufficient information to determine the scope of threats	*(e) Unknown*	There is insufficient information to determine the severity of threats
(f) None		*(f) None*	

Figure 1. Scope and severity risk categories used for assigning threat scores.

Severity \ Scope	Pervasive	Large	Restricted	Small	*Unknown*
Extreme	Very High	High	Medium	Low	Medium
Serious	High	High	Medium	Low	Medium
Moderate	Medium	Medium	Low	Low	Low
Slight	Low	Low	Low	Low	Low
Unknown	Medium	Medium	Low	Low	

B. Knowledge Gap Category

One of the obstacles to wildlife conservation and management is often a lack of scientific information about a species or taxa group. A lack of information inhibits the ability to assess a species' risk of extinction based on its distribution, population status, or other metric (IUCN 2012). Changes that occur over long time periods may be hard to detect or the reasons for a species' decline may be difficult to discern when data are insufficient. The lack of long-term data coupled with a need to develop policies that are often short-term responses can contribute to inefficient and ineffective conservation measures (Mace and Purvis 2008). Identifying where information is lacking or where uncertainty exists about the information available will improve decisions made about conservation needs and actions.

The Knowledge Gap category is similar in scope to the 'Research Needed' classification scheme outlined in the IUCN Red List Categories and Criteria (IUCN 2001). This category was developed to identify and prioritize survey, monitoring, and research needs of species in North Carolina. While it could be justified to rank every species at the highest priority there are not sufficient resources to implement and achieve this level of effort. Reviewers should evaluate the needs of each species based on what can be achieved under existing programs or given available resources to develop new programs over the next 10 years. Survey, monitoring, and research data are needed before we can develop conservation actions that benefit species and preserve biodiversity and ecosystem services (Arponen 2012). Conversely, a lack of data can also preclude preventative measures that protect a species or result in failure to restrict actions that will have a negative consequence for a species.

10. Statewide Distribution (survey priorities). This metric is an assessment of the knowledge base of a species' distribution in North Carolina and represents new and continuing survey needs. As noted in Metric 6 (Range Size in NC), suitable habitat may be available for a species but surveys have not been conducted to determine their presence. The lack of information, both current and historic, about many species affects our ability to design or implement proactive or responsive conservation or management programs. The lack of knowledge about distribution can prevent development of monitoring programs and future conservation recommendations. Scores are assigned based on the availability of data or knowledge about a species' distribution in North Carolina.

What is the level of knowledge about statewide distribution?

(a) Distribution is uncertain, has been extrapolated from a few locations, or knowledge about distribution is limited to general range maps.
(b) Broad range limits or habitat associations are known but local occurrence cannot be predicted accurately.
(c) Distribution can be easily predicted based on known locations or known habitat associations have been documented throughout the state.

11. Statewide Population Trends (monitoring priorities). Monitoring programs can be developed after sufficient survey information is collected and statewide distribution is better understood for a species (Millsap *et al.* 1990). Data collected through population monitoring can be used to evaluate a species' abundance and detect population trends. Global and regional population trends can be different from what is happening in North Carolina and monitoring program data can help detect trends for both declining and increasing populations. Scores are assigned based on the availability of data or knowledge about trends in a species' abundance or population in North Carolina.

What is the status of monitoring statewide population trends?

(a) Not currently monitored.
(b) Populations in discrete locations are monitored.
(c) Monitored statewide but no statistical sensitivity.
(d) Monitored statewide with statistical sensitivity or nearly complete census.

12. Population Limitations (research priorities). When monitoring program results indicate a species is declining in North Carolina, research is likely needed to understand how and why these populations have changed (IUCN 2001, Millsap *et al*. 1990). Research programs can be used to investigate when declines may be related to existing or new threats, specific limiting factors, competitive forces, natural processes, or result from multiple factors that are not easily defined.

The intent of this metric is to measure the extent of what is known about factors that affect a species' population or distribution within the state. For example, marsh birds such as rails and bitterns are secretive and hard to observe; this may result in a lack of research data to document their life history in North Carolina. Scores are assigned based on the availability of research data or a body of knowledge about statewide population limitations:

What is the level of knowledge about factors that affect a species' population size or distribution in the state?

(a) There is little to no knowledge about factors affecting a species' population size or distribution.
(b) There is some knowledge, but numerous factors affecting a species' population size or distribution are unknown.
(c) There is general understanding of most factors affecting a species' population or distribution but one or more major factors are unknown.
(d) All major factors affecting a species' population size and distribution are known.

13. Population Size (survey, monitoring, and research priorities). Some populations are naturally dynamic because of life history strategies (r- versus k-selected species) while others may fluctuate on a generational, seasonal, or periodic basis depending on various environmental or biodiversity factors. Multiple strategies may be needed to understand the dynamics of a species' population size so this metric will help prioritize the survey, monitoring

or research needs to understand a species' population size. Scores are assigned based on the availability of data or knowledge about statewide population size.

What is the level of knowledge about the species' population size in North Carolina?

(a) Population size is uncertain.
(b) Population size somewhat known but estimates are expected to have high variance.
(c) Population size somewhat known but estimates are expected to have low to moderate variance.
(d) Population size is well known.

14. Threats Assessment (research priorities). This metric is to independently prioritize each threat described in Metric 9 (see Conservation Concern category) for importance as a research topic for the species. The maximum concern could be assigned to all threats but it would be unrealistic to expect adequate resources could be assigned or that it would be feasible to conduct research on all of the topics. A more reasonable approach is to consider how likely each threat category is to contribute to the extinction risk for a species over the next 10-year planning horizon. This time period correlates with the minimum requirement to reevaluate and revise the Wildlife Action Plan on a 10-year cycle.

Each of the 11 threat categories will be ranked for priority as a research subject using a scale of 1 – 11 depending on the expected likelihood it will impact the species, with 1 representing the lowest priority and 11 representing the highest priority. For example, pollution may be considered a high threat to a mussel species and be ranked 8 because some research is already available into the effects of pollution on mussel species. In comparison, biological resource use may be less likely to threaten a mussel species and be ranked 1 to indicate it is a low research priority.

The evaluation will result in a high (9 – 11), medium (5 – 8), or low (1 – 4) priority ranking based on the need for research. The frequency of the scores will be reported for each threat as a means of evaluating and prioritizing research needs.

Metric 14 Threat Categories (see also Conservation Concern Metric 9)	
1	Residential & commercial development
2	Agriculture & aquaculture
3	Energy production & mining
4	Transportation & service corridors
5	Biological resource use
6	Human intrusions & disturbance
7	Natural system modifications
8	Invasive & other problematic species & genes
9	Pollution
10	Climate change & severe weather
11	Disease & pathogens
Classification of Threats (1 - 10) adopted from Salafsky *et al.* (2008).	

C. Management Concerns Category

The Wildlife Resources Commission has jurisdictional authority and stewardship responsibility for all wildlife as defined in G.S. 113-129 and other North Carolina statutes. Game animals and sport fish are known to be economically and culturally important in North Carolina, but it is also important to consider their role in wider biodiversity conservation issues (Arponent 2012). Conservation objectives that result in opposing recommendations for game and nongame species can minimize effectiveness of the conservation measures. The Management Concerns category was developed to assist with setting priorities for managing all wildlife species in North Carolina.

Ranking scores developed for this category can be used to identify and highlight population sustainability issues and areas where management action may be needed to mitigate impacts on both game and nongame species. While these ranking scores may be used to inform conservation priorities for game species, such as harvest limits, land management activities, and species management activities, consideration of the scores developed in all three categories of the ranking criteria can help set objectives and inform decisions that support diverse ecosystem services and biodiversity (Arponen 2012).

15. Disease Vector Concerns. Because of their ability to trigger sudden epidemics and their potential for rapid evolution, infectious agents, parasites, prions, and diseases (pathogens) are important concerns in conservation biology (Altizer *et al*. 2003, Lafferty and Gerber 2002, Daszak *et al.* 2000, Harvell *et al.* 1999). Pathogens can influence ecosystem diversity by impacting genetic diversity and species composition within natural communities (Altizer *et al.* 2003) and wildlife can be an important host or transmission vector for many different pathogens. In this metric, a vector is defined as a species that transmits a pathogen whether it is among wildlife species, between wildlife and domestic animals, or between wildlife and humans. Examples of pathogens that can be transmitted through wildlife vectors include whirling disease, rabies, canine distemper virus, West Nile virus, and bovine tuberculosis.

When a population is exposed to a pathogen, depending on an interaction of factors involving the host, agent, and environment, the population may be resistant to infection or may become a host. According to Rhyan and Spraker (2010) there are three types of hosts.

- A *dead-end host* is not able to maintain the infection/disease without an external source
- A *spillover host* is able to maintain the infection/disease for a time but requires periodic input from another source
- A *maintenance host* is able to maintain infection without further transmission from another species.

While dead-end and spillover hosts may become disease vectors, transmitting infection to other species, the most epidemiologically significant species are maintenance hosts capable of interspecific disease transmission. Scores are assigned based on whether a species is involved in the maintenance or transmission of pathogens to other wildlife species, domestic animals, or humans.

Does this species pose a threat as a disease vector toward other wildlife species, domestic animals, or humans?

(a) High threat, known to be a maintenance host and a source of pathogen transmission that could have significant and negative impacts to other wildlife, domestic animals, or humans. Management actions may be required to control transmission of the pathogen.
(b) May be a spill-over host, able to maintain the pathogen for a time but requires periodic re-exposure from another source. Impacts to domestic animals and humans may not be significant. Management may not be required if transmission is naturally controlled.
(c) May be a dead-end host, not able to maintain the pathogen without an external source of re-exposure. Management may not be required because transmission may be naturally controlled.
(d) Unknown at this time.
(e) Not a vector.

16. Invasive Concerns. Natural ecosystem functions reflect the interrelationships of the native species that have evolved in that system; introduced species can change community composition in ways that alter ecosystem function (Gurevitch and Padilla 2004). Often the mechanisms for this change are through competition that displaces native species or the ability of a species to exploit disturbances caused by other sources (*e.g.,* development, pollution) (Scott *et al.* 2012, Didham *et al.* 2005). Some introduced species, such as feral swine, nutria, flathead catfish, and Asian clam, can be invasive and have considerable negative effects because of their widespread distribution in the state. Others may not be as widely invasive or they may be native species that have population concentrations that can exert competitive pressures on surrounding communities (*e.g.,* white-tailed deer, resident Canada geese, tundra swans).

For the purposes of this metric, the term invasive species means those species that are either nonnative or introduced. In addition, a native species that is highly concentrated to the point that they affect ecosystem function may create impacts from competitive pressures similar to an invasive species and should be considered under this metric. Quantifying the effects of invasive species can be difficult because there may also be economic gains associated with their intentional introduction or value as a harvestable species (Lapointe *et al.* 2011). This metric is intended to identify and evaluate whether a species is considered invasive or a pest as related to ecosystem function without regard to the economic effects (positive or negative) of their presence. Scores are assigned based on whether a species is considered invasive and creates a threat to native populations.

What is the invasive species threat concern for the species?

(a) High threat, known to have a direct impact on native species.
(b) Moderate threat, suspected to have a direct or indirect impact on native species.
(c) Unknown at this time.
(d) Low threat, suspected to have only indirect or minimal impact on native species.
(e) Has no impact on native species.

17. **Economic Influence in NC.** Hunting, fishing, wildlife viewing, and other wildlife related activities have an important economic influence in North Carolina. The perception of a species' economic influence, either as a single species or as part of a group of species, can be subjective and difficult to measure because both positive and negative economic influences are associated with the species. The economic influence may be broad and hard to quantify because economic value can be generated in numerous ways and associated with wildlife in general. For instance, purchasing a hunting license could result in additional expenditures for ammunition, clothing, equipment, and travel expenses for lodging, meals, and fuel, but these purchases may also be related to other recreational activities. An individual bird species may not be associated with economic influence, but bird watching as an industry has an economic influence as demonstrated by revenues that are tracked and reported by several different interest groups. Other economic influences that may be difficult to measure include the ecosystem services provided by wildlife species, such as water filtering by mussel species that contributes to higher surface water quality thereby reducing regulatory requirements associated with impaired waters.

Depredation of crops by a pest species may have a negative economic influence on a landowner or the agriculture industry, but the need to control the pest species creates a positive economic influence on the wildlife damage control industry and may create hunting opportunities. Vehicle collisions with wildlife may be a negative economic influence on vehicle owners and insurance companies, but the need to repair or purchase a replacement vehicle contributes positively to auto towing and repair businesses and dealerships. The presence of a rare or listed species may trigger a requirement for additional environmental coordination and more stringent design standards for a construction project, which may be viewed as a negative economic influence, but the requirements support an environmental and engineering design consulting services industry. Scores for this metric are assigned based on best professional judgment about the highest level of economic influence of the species (either individually or as part of a group) without regard to whether it is positive, negative, or both.

What is the highest level of economic influence of the species in North Carolina?

(a) This species individually has a high economic influence in NC.
(b) This species is part of a group that collectively has a high economic influence in NC.
(c) This species (individually or as part of a group) has a moderate economic influence in NC.
(d) Unknown.
(e) This species (individually or as part of a group) has a low to no economic influence in NC.

18. Cultural Value. While somewhat subjective, wildlife species can have important cultural values that may be difficult to measure, such as those associated with watchable wildlife activities, depiction in art, or cultural significance. Knowledge that a species exists and is viable or that future generations will be able to enjoy a species is a value. Another example would be of the ecosystem services wildlife can provide because they are an integral part of biological communities and ecosystems (*e.g.,* contribution to clean water, provide pest control). They can

be culturally significant because of their iconic nature, a value they represent, or their importance to Native American culture. For instance, the bald eagle is emblematic of the United States and American freedom as well as an important symbol to most Native American tribes.

Other cultural values are evidenced by festivals and special events that highlight the species (Groundhog Day, East Carolina Wildlife Arts Festival, New Year's Eve Possum Drop). Scores are assigned based on whether there is a cultural value associated with a species. However, a cultural value or significance based solely on the economic value of a species is not the intent of this metric.

What is the cultural value of the species?

(a) Recognized nationally or high cultural values.
(b) Recognized statewide or moderate cultural values.
(c) May be recognized locally or have low cultural values.
(d) None.

19. Period of Occurrence. Application of management or conservation actions on behalf of a wildlife may need to take into account the degree to which a species is available by considering when it occurs in our state. In many cases, land protection measures such as fee-simple acquisition or conservation easement purchases may be the most likely action for conservation of transient species. Other measures on behalf of short-term migrants and species that infrequently occur in North Carolina may be more difficult to execute and ineffective, either because our state is a short stop-over along a migration route or the species' range does not normally extend into North Carolina.

In addition to land protection measures, other management activities and conservation actions may be planned and implemented more readily for year-round resident species and for migratory species that occur annually for more than short periods. Scores are assigned based on a species' period of occurrence in North Carolina.

When does the species occur in the state?

(a) Permanent resident species.
(b) Resident during breeding season.
(c) Resident during winter or non-breeding season.
(d) Migrates through.
(e) Transient or rare occurrence.

20. Management for Sustainability and Species Subject to Exploitation. Designing and implementing measures to conserve biological diversity is a complex problem. In addition to the need for scientific data to make informed decisions, the planning process is also subject to prioritization as well as the availability of budget and resources (Arponen 2012, Tear *et al*. 2005). Given these limitations and constraints it is important to direct efforts toward those species with the greatest need rather than focusing a majority of resources on species that will persist without

conservation efforts (Arponen 2012). Populations that are most at risk of extinction will likely have the greatest management need to maintain the potential for recovery or to preserve genetic diversity of the species.

Conceptually, the sustainable use of wildlife does not lead to the long-term decline of biological diversity and maintains present and future uses of the resource (Weinbaum *et al*. 2013). Measures can be taken to support sustainable harvests or protect populations, including management for sustainable yields, restoration of habitats to benefit the species, propagation to supplement populations intended for harvest or collection, and targeted law enforcement oversight to detect illegal harvest or take. Species subject to exploitation through harvest are game animals and sport fish. Nongame species may be exploited through permits that allow limited collection for scientific study or for business or personal uses. Illegal taking of animals for exportation, pet trade, or food is another source of exploitation. Ranking scores are assigned based on the extent to which management efforts are needed for conservation of at-risk populations or to sustain harvestable populations.

Is management needed and are current levels of action sufficient to maintain populations?

(a) Current high management needs and current levels of action are <u>not</u> sufficient to maintain long-term viable populations.
(b) Low to moderate management needs but current levels of action are <u>not</u> sufficient to maintain long-term viable populations.
(c) High management needs and current levels are sufficient to maintain viable populations.
(d) Low to moderate management needs and current levels are sufficient to maintain viable populations.
(e) Management needs are unknown.
(f) Management is not needed.

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