Final Report: Identifying relationships between invasive species and species of greatest conservation need in the Northeast region

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Background

Exotic invasive species pose a significant threat to species of greatest conservation need (SGCN) throughout the Northeast in a number of ways. Impacts may be direct (affecting individual health or productivity) or indirect (affecting habitat and/or ecosystem processes) or both.

State wildlife action plans (SWAP) have identified wildlife species within each state that warrant some level of management concern. Causes for concern vary by species and typically loss of habitat, pollution, and other stressors are listed as contributors to population decreases. In some cases, invasive species have been specifically identified as impacting subsets of SGCNs within states but to date, there has been no assessment of the invasive species posing the greatest potential threat to SGCNs at the regional level.

The original goal of this project was to produce a list of invasive species that posed the most significant threat to SGCNs in the Northeast Region. However, during the process of completing the project it became evident that the true value in this effort lies in the data assembled and the ability for future users to customize it for their specific needs. Therefore, the goal of this project was amended to focus on the provision of these data tables and a process for modifying them to allow users to modify them and generate lists reflecting their own importance criterion. This report will provide background information on how these data tables were developed and how they should be interpreted for prioritizing and ranking invasive species threats to SGCNs.

This report will provide background information on how the lists of SGCNs and invasive species were compiled and attributed. We will also provide an example of how this information can be used to generate specific ranked lists of invasive species.

Methods

Our general approach was to utilize existing information provided in SWAPs and in available lists of invasive species for each state in the region. Information was gathered from websites and available reports. We generated a list of SGCNs and invasive species for the project area. We then assigned a habitat-based score derived from characteristics identified for each invasive species, scored potential interactions using key assumptions, and an interaction applicability matrix.

SGCNs

No regional list of SGCNs was available for this work. To create an integrated regional list we consulted the SWAPs for each state in the Northeast Region (Figure 1). While the general format for reporting and analysis was similar in each state, the taxonomic groups included differed. In some cases, states chose to include extirpated species (e.g., eastern timber wolf) or subspecies (e.g., Appalachian yellow-bellied sapsucker) in their assessments. Some states included invertebrates and/or marine species while others did not.

In order to generate lists with regional applicability, we attempted to standardize the state lists as much as possible. We elected to include only those groups that were represented in each of these states; namely fish, amphibians, reptiles, birds, and mammals). These lists were consolidated into a single Microsoft (MS) Excel spreadsheet that listed each species and the states that included it in their respective SWAP. We sorted this list alphabetically by scientific name and noted instances where subspecies were identified. If the subspecies was listed as the species level by other states in the region, the subspecies record was folded into the species level record (and the state added to that record). If a subspecies was identified for only one instance (e.g., *Microtus pennsylvanicus provectus* in Rhode Island) it was retained. We documented all of the subspecies that were rolled into the species-level records for reference (Appendix A).

Each of the SGCNs identified in this table were assigned habitat classification values. We developed a general habitat classification and assigned presence (1) and absence (0) values for each SGCN and invasive species for each class based on information taken from publically available internet databases. The general habitat classes used were selected in order to provide sufficient differentiation at the species level and to permit "cross-walking" to other systems used by various natural resource management agencies in the region.[1] A more detailed description of the habitat classes used is provided in (Table 1).

We identified the subset of species that were attributed exclusively to open water marine environments and removed them from the dataset. These species present a suite of complications our study is not designed to accommodate (e.g., habitat specificity, jurisdictional representation, etc.)

In all, we included 667 SGCNs in our analysis (Figure 2). Very few of the SGCNs were listed in 7 or more states (16%; Table 2; Appendix A), with over 65% of the species identified as SGCN in 3, or fewer, states. However, this pattern was not consistent across all the taxa. Over 30% of bird SGCNs were listed in 7 or more states whereas less than 6% of amphibian SGCNs were as commonly listed (Table 2).

A simple examination of SGCNs by habitat showed that the habitat type with the most SGCNs (fish included) were freshwater rivers and wetlands (Table 3). The general habitat type with the most non-fish SGCN was freshwater wetland (153).

Invasive Species

The term "invasive species" has a liberal definition across geopolitical boundaries which can make standardization difficult. For this study, we elected to follow the guidelines for categorizing invasive species set forth by the National Invasive Species Council (2006)[2]. In this document, invasive species are defined as "… a

[1] The habitat classification developed for the northeast by The Nature Conservancy was not available during this phase of the project.
[2] National Invasive Species Council. 2006. Invasive species definition clarification and guidance white paper.

non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human, animal, or plant health."

For this study, species were identified as "non-native" if the best available expert opinion suggested that the species was not native to the states comprising the northeast region study area. Further those species that have been introduced for specific natural resource management purposes (e.g., small mouthed bass) are not considered as invasive species for this study. Further, those species that are native to the immediate region but are expanding (e.g., brown-headed cowbird, Canada goose) were also excluded. Feral populations of domesticated species were included as they both exist beyond immediate management and are clearly detrimental to native species and habitats. We also excluded invasive species considered to be internal parasites on specific hosts.

The invasive species list used for this project were primarily derived from two sources; aquatic species listed by the USGS Non- indigenous Aquatic Species (NAS) database[3], and plants listed as invasive by NatureServe[4]. In both cases, the databases were queried by state to produce candidate lists of invasive species. These lists were then concatenated and duplicate entries were removed. We reviewed each of the aquatic species (i.e., those listed in NAS) to determine if the species had established populations in the region and removed those species that were listed as "native" and those listed for "marine" habitats. Records that were likely to be the result of single observations in time and space (e.g., aquarium releases) were also removed. We also removed species that had no supporting information with their record which primarily resulted in the removal of poorly understood, geographically limited instances of microorganisms and bacteria. Plant records were similarly distilled by including only those species listed as either "High" or "Medium" risk by NatureServe's I-rank system. We also removed species of plants that are native to the northeastern US (per the definition outlined above) even though they may be presently invasive (e.g., black locust).

These lists were supplemented with terrestrial species appearing on various state lists where they were available and contained additional species. These included feral populations of domesticated animals (e.g., goats) and other higher-order vertebrates (e.g., cattle egret).

The invasive species list includes representatives from multiple taxonomic groups, including birds, mammals, fish, crustaceans, mollusks, insects, pathogens, and plants. The creation of a comprehensive list of invasive species for the northeastern US was beyond the scope of this project, so the list created does not include every possible invasive. However, it does provide a good cross-section representing multiple levels of infestation and threat to SGCNs.

As with the SGCN, we assigned general habitat classification values to each of the invasive species based on available information. These assignments were made conservatively to ensure that potential habitat use was not omitted. In other words, we tended to include species in habitats when there was some level of uncertainty rather than exclude them. Habitat information came primarily from the NAS, NatureServe and the Global Invasive Species Database sites with occasional input from other sites available on the Internet.

We included 238 invasive species (Figure 3) from 12 groups. This is not a complete list of invasive species for the northeast. The majority of the species included are plants (68%). The majority of these species occurred in 7 or more states (58%; Table 4). There were 71 (30%) invasive species common to all states in the northeast (Table 4, Appendix B). We obtained 162 species from NatureServe (i.e., plants), 62 from NAS, and 14 from other sources.

[3] US Geological Survey Website http://nas.er.usgs.gov/.
[4] NatureServe Explorer website http://www.natureserve.org/explorer

The general habitat class with the greatest number of invasive species was "forest edge" with 115 species (48%; Table 3) followed by pasture and grassland with 94 and 86 species respectively (39% and 36%).

Invasive Species Threat Assessment

We combined all the species lists into a single, master invasive species list for use in the analysis. In addition to the state distribution, we also recorded basic information for each invasive species that included the invasive characteristics likely to impact SGCNs (either directly or indirectly) at several levels. The invasive characteristics levels used were:

SGCN level	Interaction results in the displacement of one or more SGCNs either through direct competition or negative interaction (e.g., predation)
Habitat Level	The presence of the invasive species likely results in an overall reduction in the quality of habitat for one or more SGCN usually by displacing a native species (of prey, cover, etc.), draining limited resources (e.g., prey organisms), or changing a structural component
Ecosystem Level	The invasive species in some way permanently alters the functional attributes in the location as to change the community composition and diminish quality (e.g., increase turbidity)

All decisions on invasive characteristics were informed by consulting information available online; primarily the NAS and/or Global Invasive Species Database for animals and NatureServe for plants. Invasive species could receive a value of 1 or 0 for any one of these characteristics. These values were assigned by determining how each invasive species was likely to impact SGCNs identified in this project only, therefore impacts to other organisms (e.g., native plant species diversity) were not considered. When assignments were questionable or debatable, we elected to assign a 1 rather than a 0 to ensure that potential invasive threats were included and the results were conservative.

We also included values representing the realized and potential impacts of the invasive species. Realized impacts are those that are presently observed or expected, and potential impacts are informed extrapolations of presumed impacts given a number of future scenarios. In both cases, assignments of these values were made by reviewing available information. These were assigned based geographic distribution and impact. These are used together resulting in 4 values; limited distribution – low impact (1), limited distribution – high impact (2), wide distribution – low impact (3), or wide distribution – high impact (4). We also assigned a 0 if there was no evidence (or likelihood) of impacts by that species over the project area.

Development of the SGCN-invasive species interaction criteria

Once the lists of SGCN and potential invasive species were created, we developed a database of potential interaction for all SGCN-invasive species pairs. Given the large number of potential interactions, it was

impossible to complete a thorough literature review for each specific combination. Instead, we chose to take a habitat based approach based on several general assumptions.

Assumption 1:
Invasive species and SGCNs would have to share habitat "space" in order for interactions to take place. Unless both a SGCN and invasive species utilized the same general habitat there would be no impact. This is true regardless of present geographic distributions for either SGCNs or invasive species.

Assumption 2:
In all cases where SGCNs and invasive species co-exist the relationship is fundamentally negative, and that negative impacts to SGCN would increase with increasing numbers of invasive species. Also, invasive species that affect a SGCN in several habitats results in added threat. Admittedly, this is an oversimplification of SGCN-invasive species interaction but one that we had to accept in order to develop an unbiased evaluation technique for the region.

Assumption 3:
Interactions between SGCNs and invasives are not compounded by additional invasive species or other conditions.

We made no attempt to match present distributions of invasive species and SGCNs at the state level or below. Therefore, interactions between invasives and SGCNs can occur throughout the region in habitats utilized by both regardless of whether they are known to occur within the same state or area. Spatial differentiation at this spatial level was beyond the scope of this project. Using these assumptions, we went through a series of steps to develop an impact score for each invasive species.

We developed a simple algorithm to calculate a "habitat score" for each pair of SGCN and invasive species based on the general habitat classifications of each. This score quantifies the potential interaction between species sharing the same habitats. SGCNs that share habitats with invasive species are assumed to experience potential threat from those species either directly or indirectly. Thus, where individual SGCNs share multiple habitats with an invasive species, the cumulative impact will be greater since there would be less opportunity for the SGCN to "escape" to alternate habitat. The score is calculated by multiplying the values for the SGCN and the invasive species in the same habitat then summing across all habitats (see example).

These two species share only one habitat, thus the habitat score is determined by the sum of the interactions (in this case 1). We assume that negative impacts increase as score increases (see assumption 2 above).

	Habitat 1	Habitat 2	Habitat 3	Habitat 4	Habitat 5	Habitat 6	Habitat 7	Habitat 8	Habitat 9	Habitat 10	Habitat 11	Habitat 12	Habitat 13	Habitat 14	Habitat 15
SGCN								1					1		
Invasive sp.			1								1		1	1	
	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Example calculations of habitat score for a SGCN-Invasive Species pair. Each column is a different general habitat class.

However it should be noted that SGCN that occurs in several habitat types along with an invasive species would result in a higher score compared to an SGCN found in only one type. So drawing conclusions regarding relative impacts using the habitat score alone should be done carefully. We could assume that such a generalist SGCN sharing multiple habitats with an invasive species would constitute a greater threat to that species and thus a higher score.

To address this issue, we also calculated the ratio of habitats shared by the SGCN-invasive species pair relative to the total number of habitats of the SGCN. The higher the value, the higher the threat score. In the example above the Habitat Ratio would be 0.5 since only 1 of the 2 habitat classes occupied by the SGCN is threatened by this invasive species.

A comprehensive table containing all general habitat assignments for SGCNs and invasive species is provided (Appendix A and B respectively). The table containing the habitat scores and habitat ratio for each SGCN-invasive species pair is also provided (Appendix C).

Applicability Matrix

Clearly the SGCN-invasive habitat matrix alone would be insufficient to capture interactions appropriately. For example, while mute swans are known to compete with other waterfowl for nesting space and food, they do not pose a direct threat to non-avian species found in the same wetlands. Therefore, interactions between mute swan and southern bog lemming based solely on habitat are not real or likely insignificant.

To ensure that we were not inflating habitat interaction scores with unlikely or unreasonable interactions, we developed an applicability matrix for each of the invasive species and SGCNs. Applicability was determined by a set of rules developed for each invasive species applied to the SGCN list. For example, if an invasive species was expected to only impact waterfowl, then all non-waterfowl species would be assigned a value of 0 in the matrix and all waterfowl a 1. This process was repeated for all the invasive species (usually by group, but at the species level when appropriate) and SGCN combinations (Appendix B).

Final Habitat Score and Habitat Ratio

The applicability matrix was multiplied by the matrix of habitat scores to calculate a final habitat score. Where applicability values were 0, the result would be 0 and no interaction would be expected. The remaining values represented potential interactions between SGCNs and invasive species at the general habitat level (Appendix C).

We did not consider state distributions for SGCNs and invasives when calculating the final ranking or applicability. We assumed that all interactions were possible even if an SGCN and/or an invasive species were found in the same state or not. This assumption allowed us to evaluate each invasive as a “regional threat” regardless of known distribution. However, this will result in increases the overall habitat interaction score for invasive-SGCN combinations.

The habitat interaction scores were determined for all invasive species-SGCN combinations (158,746 unique combinations). The total number of SGCNs that each invasive species potentially impacts was determined by counting all of the cells where the interaction score was greater than 0 (full tabular data are supplied in

Appendix C). Approximately 66% of all the possible interactions were zero (i.e., no impact was expected). The maximum number of SGCNs potentially impacted by a single invasive species observed was 503 (marsh thistle). The mean number of SGCN impacted was 225 species (std. dev = 112 species).

The observed habitat interaction scores for invasive species-SGCN pairs ranged from 0 – 6 (maximum observed between Fowler's toad and multiple invasives including marsh thistle and feral cat). The observed habitat interaction scores totals ranged from 0 – 786 (maximum observed for marsh thistle) with a mean interaction score of 172.

Evaluation Criteria Calculations

There are a number of different ways to evaluate the impacts of invasives. These metrics can be as simple as the number of SGCNs impacted by each invasive, or can be more complex incorporating invasive characteristics, impacts, or weighting values. We compiled several metrics that could provide users with a way to develop ranked lists either taken individually or used together (e.g., sum of ranks). Users should understand how each metric is calculated and what information is included in order to use the most appropriate metric for their needs. Of course the metrics can be easily modified in MS Excel to produce custom values for specific needs.

Total Number/Proportion of SGCN Impacted

This information is contained in the Final Habitat Matrix. We can simply use "=COUNTIF(COL, ">0")" function for each column (i.e., invasive species) to determine the number of pairings that resulted in any impact (regardless of total). This number can be transformed to a proportion by dividing by the total number of invasive species in the analysis (in this case 238).

$$S1 = \frac{\#\ of\ SGCN\ impacted}{Total\ \#\ of\ SGCN}$$

This will produce a value between 0 and 1. This is the simplest criteria for ranking the invasive species. However, this factor does not include any sort of modification on the presumed severity of the impact the invasive species has on the SGCN.

Total Final Habitat Score

The Total Final Habitat Score is a sum of all the individual pairwise scores for each invasive species summed across each SGCN. This value would account for situations where an invasive species and SGCN share multiple habitats and thus have a higher score. Essentially, this accounts for each SGCN-invasive pair across each habitat type.

$$S2 = \sum_{N=1}^{667} Final\ Habitat\ Score$$

Modified Final Habitat Score

Another metric we provide is the modified Final Habitat Score. This value is simply the Final Habitat Scores for each invasive species-SGCN pairing multiplied by the Final Habitat Ratio value and summed across all SGCN.

$$S3 = \sum_{n=1}^{667} (Final\ Habitat\ Score\ (invasive\ n) * Final\ Habitat\ Ratio(invasive\ n))$$

This value reduces the Final Habitat Score to reflect available habitat refugia for the SGCN for each invasive species. For example if an SGCN is found in 3 habitat types and shares only 2 of those with a specific invasive species, then there is 1 habitat type where the SGCN will not be impacted and the habitat threat is reduced. In this example, the Final Habitat Score would be 2 and the Final Habitat Matrix would be 0.67. So, the modified Final Habitat Score would be 1.34.

Invasive Characteristics Score

Invasive species can impact SGCNs at multiple levels. To capture these impacts, we developed an Invasive Characteristics Score that can incorporate one or more characteristics into a single metric for ranking. The metric is based on the assumption that species impacting SGCNs at multiple levels (i.e., species, habitat, and system) will be more threatening than those interacting at a single level. The worst possible scenario for an invasive species would be to impact all SGCN at the species, habitat, and system levels.

The metric is calculated by multiplying each of the invasive characteristics value (1 or 0) by the total proportion of species impacted (see above) and summing across all characteristics.

$$S4 = \sum_{n=1}^{3} (\%\ of\ SGCN\ impacted * Invasive\ Characteristic\ n)$$

Characteristics exhibited by the invasive species modified by the total number of SGCNs impacted by the species. This is determined by summing the value obtained by multiplying the proportion of SGCN impacted by the invasive by each of the three invasive characteristics. The theoretical maximum value for this score is 3.

This metric could be further modified by weighting the invasive characteristics according to the user specifications. For example, invasives that impact system processes may be considered to be more important than others and could be weighted twice as much as the other characteristics. In this case the maximum score value would be 4 (e.g., 1 * 1* (2*1) = 4). Users could also include other factor in this basic equation such as impact values or state distributions (e.g., invasives presently occurring within a state are weighted higher than others).

Creating Ranked Lists

Any of the above metrics can be used to create a sorted, ranked list using tools provided in MS Excel such as RANK and copy/paste special functions. Several scoring metrics could be ranked separately and a “final” list created by summing the ranks across each metric. Those with the lowest total score could be considered the most threatening based on the criteria used.

Discussion

The purpose of the project was to collect and present information that would allow others to generate ranked lists of invasive species for their area of interest within the Northeast region. The information presented here is useful when used appropriately. Any potential user should be aware of the assumptions and limitations before applying results to any decision making process.

The SGCN lists included represent species from each of the 13 states in the Northeast without any additional caveats on importance. Each SGCN is equally weighted as presented. There are a number of ways that species could be assigned differing importance values in order to customize the analysis.

The invasive species lists are not complete, nor contain detailed information on the distribution of the species in the Northeast. We also refrained from assigning any sort of weighting criteria on these species in our information however we attempted to include specific information on how the invasive species was expected to impact SGCNs and on the realized and potential impacts at the regional level. The study does not include species of plants (e.g., black locust) or animals (e.g., brown-headed cowbird) that are known to impact SGCNs and are expanding in the Northeast. Their exclusion for this study is semantic and these species are certainly important to consider when determining which species pose the greatest threats to SGCN conservation.

The inclusion of information related to invasive species management/mitigation was beyond the scope of this project but would be important information to include. If such information were compiled, it could be added to the data presented here to further modify importance and rankings.

Both SGCN and invasive species were assigned to generalized habitats based on available information. The classes were necessarily general and more geographically specific applications of this information could warrant modification to these values to gain the most accurate results. We suggest that users assign habitats liberally to avoid errors of omission when considering invasive species and their impacts. Also, clearly the critical habitat of some species of SGCN and invasive species may not have been well represented by this general habitat classification system (e.g., cave dwelling species). Users can simply apply new classes (or whole new systems) to improve the dataset and achieve their specific goals; however each SGCN and invasive species in the analysis should be updated to the new classification system.

Applicability values were included to further capture real relationships between SGCNs and invasive species pairs at the species level that were not captured at the habitat or system level. Again, we tended to be inclusive in our analysis but more specific applications would necessarily require a reevaluation of some of the assignments.

The suite of metrics that can be used to rank the importance of invasive species is nearly endless. While we have included several metrics that can be used to rank invasive species they may not capture the entire range of characteristics necessary for specific application of the dataset. However, we feel the accompanying data will permit users to design and calculate metrics that meet their needs with little modification.

Summary

Invasive plants and animals threaten SGCNs across the region either as direct competitors, or by degrading natural habitats. The severity of threat to SGCNs varies according to a number of factors. The data that are provided with this report may be used by managers and decision makers to answer more specific questions

relating to the severity and importance of individual invasive species or SGCNs. This information, if used along with additional information such as invasive species management options, can contribute to effective decision making for targeted invasive species mitigation and threat assessment.

Table 1. Descriptions of general habitat classes used for both SGCNs and invasive species.

General Habitat Class	Description
Freshwater – Lake	Open water bodies with little or no flow. Includes use of shoreline, near-shore areas, and open water
Freshwater – River	Flowing water bodies of all sizes. Includes shoreline and immediately adjacent riparian areas
Freshwater - Wetland	Areas characterized by seasonally or temporarily wet soils and standing water along with woody and/or herbaceous vegetation.
Marine – Open	Deep water saline coastal areas
Marine – Intertidal	Areas affected by daily tidal fluctuation typified by beach-ocean interface. Usually sparsely vegetated.
Marine – Marsh	Coastal wetlands characterized by herbaceous vegetation and subject to regular tidal inundation.
Marine – Beach	Sparsely vegetated sand areas immediately adjacent to ocean or estuaries.
Forest – Deciduous	Areas dominated by mature, or maturing, deciduous trees species with > 50% canopy closure. May include riparian areas immediately adjacent to water bodies.
Forest – Coniferous (hemlock/mesic)	Areas dominated by mature eastern hemlock and/or white pine in natural occurrences. Typically located adjacent to high-gradient streams.
Forest – Coniferous (other)	Areas dominated by mature, or maturing, coniferous trees species with > 50% canopy closure. Includes plantations of coniferous trees.
Forest - Mixed	Areas dominated by a combination of mature, or maturing, deciduous and coniferous trees species with > 50% canopy closure. May include riparian areas immediately adjacent to water bodies.
Forest – early successional	Any area dominated by early-stage tree species (predominantly deciduous). Typically the result of recent timber harvest activity or natural disturbance.
Shrub land	Upland areas dominated by woody shrub species. Likely to remain for longer periods of time than early successional forest.
Grassland	Areas dominated by herbaceous species that are not impacted by frequent agricultural practice. Includes fallow agricultural lands as well as managed grass stands.
Forest edge	Applies to “edge” habitats associated with forest-herbaceous interface. Often includes tree, shrub, and herbaceous components in linear arrangements on the landscape.
Woodland	Areas with sparse tree overstory (< 50% canopy closure) with significant herbaceous or shrub understory. Overstory

	may be comprised of either deciduous or coniferous species, or both.
Pasture	Herbaceous areas frequently disturbed by active livestock grazing and related management (e.g., mowing). Vegetation height uniform and less then 0.5m. May contain sparsely arrayed trees or shrubs.
Agriculture	Areas under active and frequent disturbance from plowing, mowing, planting, or other activities. Includes row crops and grass crops (i.e., hay) production.
Cliff/Rock	Sparsely vegetated areas comprised of exposed rock or talus. Typically on steep slopes.

Table 2. Summary of the number of state distribution of SGCNs by taxa.

No. of States	amphibian		bird		fish		mammals		reptile		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	38	58%	41	16%	122	54%	25	37%	19	34%	245	37%
2	6	9%	39	15%	47	21%	9	13%	9	16%	110	16%
3	6	9%	30	12%	25	11%	11	16%	5	9%	77	12%
4	5	8%	28	11%	14	6%	7	10%	9	16%	63	9%
5	3	5%	24	10%	7	3%	4	6%	5	9%	43	6%
6	4	6%	12	5%	3	1%	2	3%	1	2%	22	3%
7	1	2%	18	7%	1	0%	3	4%	1	2%	24	4%
8			15	6%	1	0%			1	2%	17	3%
9	1	2%	10	4%	3	1%	1	1%			15	2%
10	1	2%	10	4%	1	0%			1	2%	13	2%
11			12	5%	3	1%	4	6%	3	5%	22	3%
12			7	3%					2	4%	9	1%
13			6	2%			1	1%			7	1%
Total	**65**	**100%**	**252**	**100%**	**227**	**100%**	**67**	**100%**	**56**	**100%**	**667**	**100%**

Table 3. Total numbers of SGCN and invasives found in each general habitat class.

General Habitat Class	All SGCN		All Invasives	
	#	%	#	%
Freshwater				
Lake	124	19%	76	32%
River	258	39%	59	25%
Wetland	206	31%	62	26%
Marine				
Intertidal	27	4%	6	3%
marsh	73	11%	17	7%
Beach	42	6%	12	5%
Forest				
Deciduous	43	6%	23	10%
Coniferous (Hemlock)	7	1%	10	4%
Coniferous other	41	6%	9	4%
Mixed	50	7%	15	6%
Young Forest	14	2%	37	16%
Other				
Shrubland	56	8%	58	24%
Grassland	66	10%	86	36%
Border/edge	29	4%	115	48%
Woodland	96	14%	77	32%
Pasture	46	7%	94	39%
Agriculture	43	6%	61	26%
Rock/Cliff	20	3%	5	2%

Table 4. Summary of the number of invasive species distribution by group.

No. of States	All Invasives	
	Total Spp.	%
1	44	18%
2	19	8%
3	13	5%
4	9	4%
5	10	4%
6	4	2%
7	6	3%
8	11	5%
9	8	3%
10	17	7%
11	12	5%
12	14	6%
13	71	30%

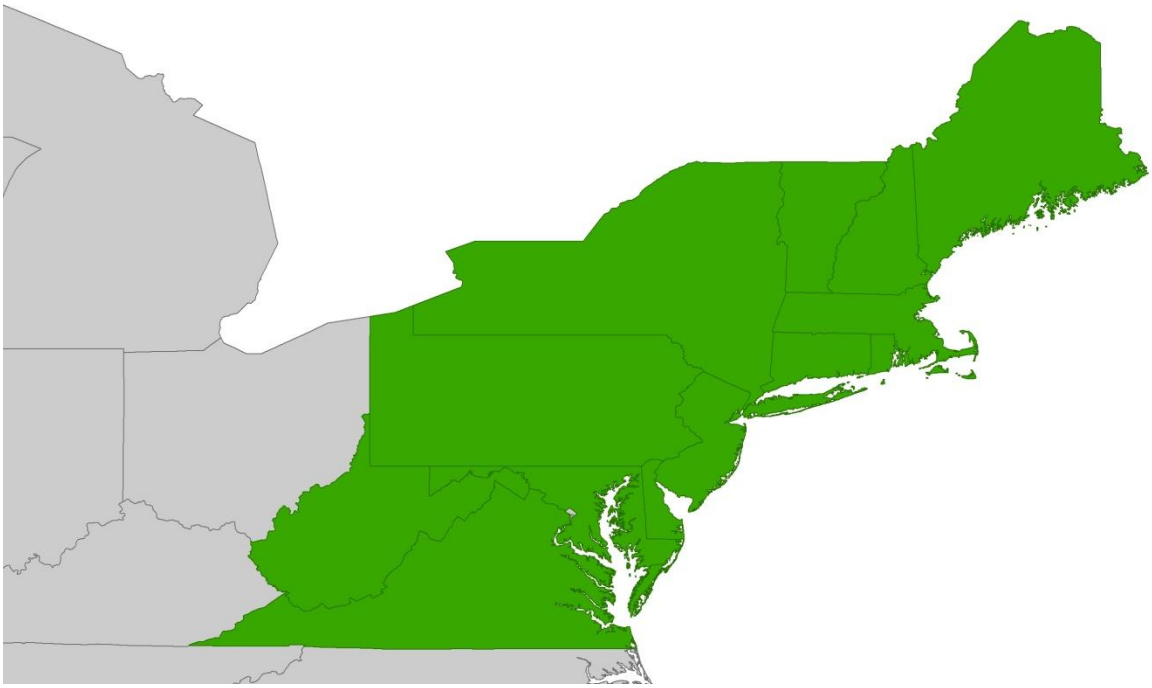

Figure 1. States comprising the Northeast region. Project did not include the District of Columbia.

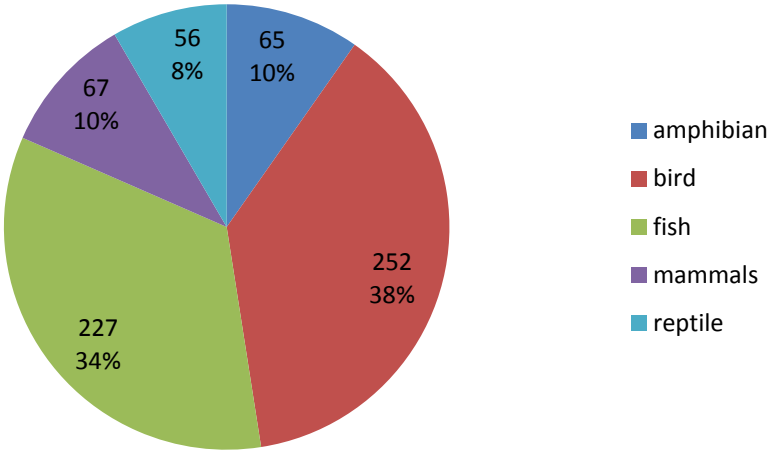

Figure 2. Distribution of SGCNs used in this analysis by group.

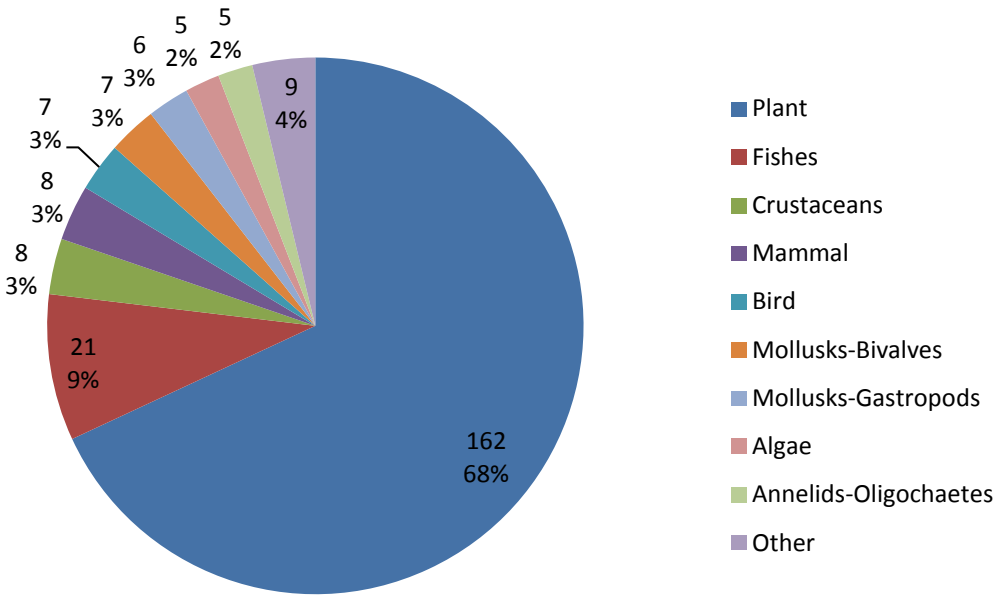

Figure 3. Distribution of invasive species used in this analysis by group. The other category includes protozoans (4), Coelenterates (3), a frog, and an arthropod.