Integrating Climate Change Into Invasive Species Management: a Risk Assessment Survey Analysis to Identify Species of Concern

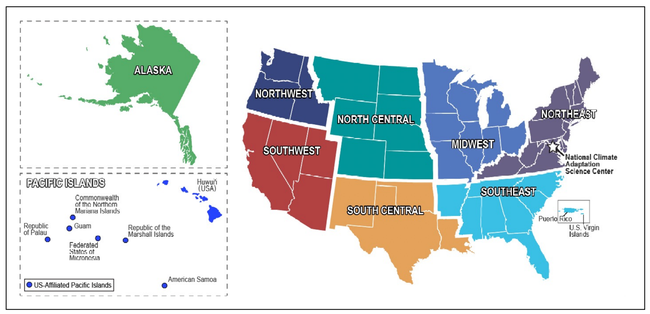
Nicole Read[1], Annette Evans[2], Carrie Brown-Lima[2,3], Rachel Gregg[4], Deah Lieurance[5], R. Chelsea Nagy[6], Lindsey Thurman[7], Toni Lyn Morelli[2]

[1]Duke University, [2]USGS Northeast Climate Adaptation Science Center, [3]New York Invasive Species Research Institute at Cornell University, [4]Environmental Science Associates, [5]Department of Ecosystem Science and Management, The Pennsylvania State University, [6]Earth Lab and ESIIL, Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado Boulder, [7]USGS Northwest Climate Adaptation Science Center

Abstract

Climate change is expected to influence the frequency and severity of biological invasions in a variety of ways, including creating novel introduction pathways, decreasing the resilience of native habitats, inducing range shifts and expansions, and altering phenologies. As such, it is important to gain a better understanding of how invasive species managers incorporate climate change in their management strategies and identify the invasive species that are expected to pose the greatest threat under climate change. To address these questions, the Regional Invasive Species and Climate Change Management Network surveyed invasive species researchers and managers across four regions of the continental U.S. (the Northeast, Southeast, North Central, and Northwest) to determine the invasive species of greatest concern. This analysis will identify and compare the invasive species most frequently reported by researchers and managers for each region and describe their ecologies.

Background



The Regional Invasive Species and Climate Change (RISCC) Management Network was founded in 2016 by staff and faculty at the New York Invasive Species Research Institute, the University of Massachusetts, and the Northeast Climate Adaptation Science Center in response to requests from invasive species managers for more guidance on managing invasive species in the face of climate change. The RISCC Management Network aims to provide this guidance by synthesizing relevant science, sharing the needs and knowledge of managers, strengthening the connection between researchers and managers, and conducting priority research. Since its founding in the Northeast, five other RISCC regions have been established across North America based on this successful model.

To assess research needs and priorities regarding climate-adaptive invasive species management, the different RISCC Networks distributed surveys to managers throughout their regions. The survey included questions addressing the background and demographics of respondents, the incorporation of climate change in their invasive species management strategies, and potential barriers to success. This analysis focuses on a specific survey question that asks respondents to reflect on which invasive species pose the greatest threat to their management goals both currently and 10-20 years in the future. This is significant as it can help inform managers in developing proactive and tailored management approaches.

Methodology

- **Survey Data Collection:** Surveys were collected in 4 regions across the continental U.S. (the Northeast, Northwest, North Central, and Southeast) using Qualtrics software; invitations to participate in the survey were sent by email to several Listservs, which vary by region. The survey question asking respondents to submit the invasive species that they feel pose the greatest threat to their management goals currently and 10-20 years in the future was a fill in the blank question. 208 respondents answered this question in the Northeast, 172 in the Northwest, 42 in the North Central, and 127 in the Southeast.
- **Data Analysis:** Many respondents listed more than one species of concern, and responses that were above the genus level were excluded from the analysis, so the total number of species reported was 4987. All analyses regarding the proportion of taxa and the most frequently reported species were performed in RStudio 2023.06.2+561.

Proportions of Taxa Reported

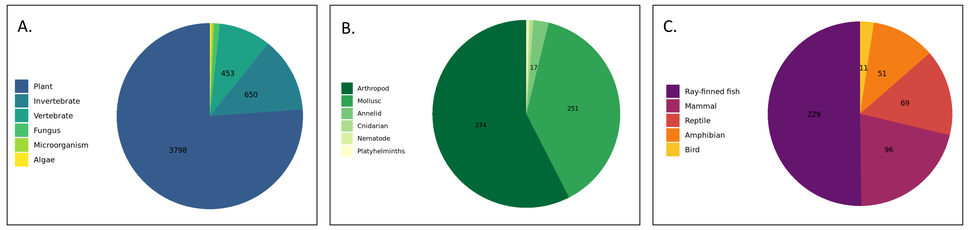


Figure 1. Proportions of taxa by all species (A), invertebrate species (B), and vertebrate species (C). In total, most of the invasive species reported were plants (n = 3798), followed by invertebrates (n = 650) and vertebrates (453). Among the invertebrate species, the vast majority were arthropods (n = 374) and molluscs (n = 251). Among the vertebrate species, approximately half were ray-finned fish (n = 279), while there were smaller proportions of mammals (n = 96), reptiles (n = 69), amphibians (n = 51), and birds (n = 11).

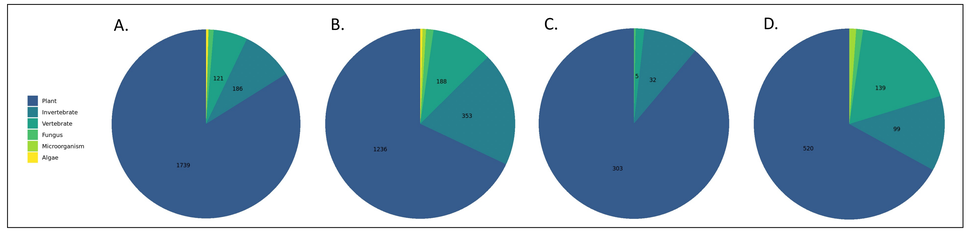


Figure 2. Proportions of taxa by the four different RISCC regions: Northeast (A), Northwest (B), North Central (C), and Southeast (D). Across all of the regions, most of the invasive species reported were plants; the next largest proportion was invertebrates in the Northeast, Northwest, and North Central, and vertebrates in the Southeast.

Frequently Reported Species

Table 1. Most frequently reported species in the Northeast region currently (left) and 10-20 years in the future (right).

Scientific Name	Common Name	Habitat Type	Species Type	Count
Microstegium vimineum	Japanese stiltgrass	Terrestrial	Plant	38
Polygonum cuspidatum	Japanese knotweed	Terrestrial	Plant	38
Phragmites australis	Common reed	Terrestrial	Plant	33
Agrilus planipennis	Emerald ash borer	Terrestrial	Invertebrate	27
Celastrus orbiculatus	Oriental bittersweet	Terrestrial	Plant	27
Rosa multiflora	Multiflora rose	Terrestrial	Plant	26
Alliaria petiolata	Garlic mustard	Terrestrial	Plant	24
Elaeagnus umbellata	Autumn olive	Terrestrial	Plant	22
Imperata cylindrica	Cogon grass	Terrestrial	Plant	22
Schinus terebinthifolius	Brazilian peppertree	Terrestrial	Plant	20

Scientific Name	Common Name	Habitat Type	Species Type	Count
Microstegium vimineum	Japanese stiltgrass	Terrestrial	Plant	35
Polygonum cuspidatum	Japanese knotweed	Terrestrial	Plant	27
Imperata cylindrica	Cogon grass	Terrestrial	Plant	26
Phragmites australis	Common reed	Terrestrial	Plant	26
Celastrus orbiculatus	Oriental bittersweet	Terrestrial	Plant	25
Pueraria montana	Kudzu	Terrestrial	Plant	19
Agrilus planipennis	Emerald ash borer	Terrestrial	Invertebrate	18
Hydrilla verticillata	Water thyme	Aquatic	Plant	18
Lycorma delicatula	Spotted lanternfly	Terrestrial	Invertebrate	18
Alliaria petiolata	Garlic mustard	Terrestrial	Plant	16

Table 2. Most frequently reported species in the Northwest region currently (left) and 10-20 years in the future (right).

Scientific Name	Common Name	Habitat Type	Species Type	Count
Phalaris arundinacea	Reed canary grass	Terrestrial	Plant	49
Dreissena polymorpha	Zebra mussel	Aquatic	Invertebrate	42
Cytisus scoparius	Scotch broom	Terrestrial	Plant	39
Dreissena bugensis	Quagga mussel	Aquatic	Invertebrate	39
Bromus tectorum	Cheatgrass	Terrestrial	Plant	30
Rubus armeniacus	Himalayan blackberry	Terrestrial	Plant	30
Lythrum salicaria	Purple loosestrife	Terrestrial	Plant	24
Alliaria petiolata	Garlic mustard	Terrestrial	Plant	22
Hedera helix	Common ivy	Terrestrial	Plant	21
Esox lucius	Northern pike	Aquatic	Vertebrate	20

Scientific Name	Common Name	Habitat Type	Species Type	Count
Dreissena bugensis	Quagga mussel	Aquatic	Invertebrate	43
Dreissena polymorpha	Zebra mussel	Aquatic	Invertebrate	43
Phalaris arundinacea	Reed canary grass	Terrestrial	Plant	32
Cytisus scoparius	Scotch broom	Terrestrial	Plant	21
Esox lucius	Northern pike	Aquatic	Vertebrate	20
Alliaria petiolata	Garlic mustard	Terrestrial	Plant	19
Bromus tectorum	Cheatgrass	Terrestrial	Plant	18
Rubus armeniacus	Himalayan blackberry	Terrestrial	Plant	16
Agrilus planipennis	Emerald ash borer	Terrestrial	Invertebrate	15
Carcinus maenas	European green crab	Aquatic	Invertebrate	13

Table 3. Most frequently reported species in the North Central region currently (left) and 10-20 years in the future (right).

Scientific Name	Common Name	Habitat Type	Species Type	Count
Bromus tectorum	Cheatgrass	Terrestrial	Plant	18
Euphorbia esula	Leafy spurge	Terrestrial	Plant	12
Taeniatherum caput-medusae	Medusahead	Terrestrial	Plant	7
Centaurea stoebe	Spotted knapweed	Terrestrial	Plant	6
Ventenata dubia	North Africa grass	Terrestrial	Plant	6
Bromus inermis	Smooth brome	Terrestrial	Plant	5
Cirsium arvense	Creeping Thistle	Terrestrial	Plant	5
Lepidium draba	Whitetop	Terrestrial	Plant	5
Linaria vulgaris	Yellow toadflax	Terrestrial	Plant	5
Celastrus orbiculatus	Oriental bittersweet	Terrestrial	Plant	4

Scientific Name	Common Name	Habitat Type	Species Type	Count
Bromus tectorum	Cheatgrass	Terrestrial	Plant	9
Euphorbia esula	Leafy spurge	Terrestrial	Plant	7
Taeniatherum caput-medusae	Medusahead	Terrestrial	Plant	7
Ventenata dubia	North Africa grass	Terrestrial	Plant	6
Centaurea stoebe	Spotted knapweed	Terrestrial	Plant	4
Elaeagnus angustifolia	Russian Olive	Terrestrial	Plant	4
Lepidium draba	Whitetop	Terrestrial	Plant	4
Bothriochloa ischaemum	Yellow bluestem	Terrestrial	Plant	3
Bromus inermis	Smooth brome	Terrestrial	Plant	3
Linaria vulgaris	Yellow toadflax	Terrestrial	Plant	3

Table 4. Most frequently reported species in the Southeast region currently (left) and 10-20 years in the future (right).

Scientific Name	Common Name	Habitat Type	Species Type	Count
Imperata cylindrica	Cogon grass	Terrestrial	Plant	38
Schinus terebinthifolius	Brazilian peppertree	Terrestrial	Plant	19
Triadica sebifera	Chinese tallow	Terrestrial	Plant	15
Hydrilla verticillata	Water thyme	Aquatic	Plant	12
Sus scrofa	Wild boar	Terrestrial	Vertebrate	12
Ligustrum sinense	Chinese privet	Terrestrial	Plant	9
Agrilus planipennis	Emerald ash borer	Terrestrial	Invertebrate	8
Lygodium microphyllum	Old World climbing fern	Terrestrial	Plant	8
Python molurus bivittatus	Burmese python	Terrestrial	Vertebrate	8
Dreissena polymorpha	Zebra mussel	Aquatic	Invertebrate	7

Scientific Name	Common Name	Habitat Type	Species Type	Count
Imperata cylindrica	Cogon grass	Terrestrial	Plant	32
Schinus terebinthifolius	Brazilian peppertree	Terrestrial	Plant	17
Sus scrofa	Wild boar	Terrestrial	Vertebrate	10
Triadica sebifera	Chinese tallow	Terrestrial	Plant	10
Dreissena polymorpha	Zebra mussel	Aquatic	Invertebrate	9
Hydrilla verticillata	Water thyme	Aquatic	Plant	9
Lygodium microphyllum	Old World climbing fern	Terrestrial	Plant	7
Anoplophora glabripennis	Asian long-horned beetle	Terrestrial	Invertebrate	6
Dioscorea bulbifera	Air Potato	Terrestrial	Plant	6
Lygodium japonicum	Japanese climbing fern	Terrestrial	Plant	6

Conclusions

- The reported species included plants, invertebrates, vertebrates, fungi, algae, and other microorganisms. Within the reported invertebrates, classes included arthropods, molluscs, annelids, cnidarians, nematodes, and platyhelminths. Within the reported vertebrates, classes included ray-finned fish, mammals, reptiles, amphibians, and birds.
- Overall, most species reported were plants (76%), followed by invertebrates (13%), vertebrates (9%), fungi (1%), microorganisms (<1%), then algae (<1%). Within the reported invertebrates, most species reported were arthropods (58%), followed, by molluscs (39%), annelids (3%), cnidarians (<1%), then nematodes (<1%) and platyhelminths (<1%).
- Within the reported vertebrates, most species reported were ray-finned fish (50%), followed by mammals (21%), reptiles (15%), amphibians (11%), then birds (2%).
- Among the four different regions, plants made up the largest proportion of species reported; the next largest proportion of species reported was invertebrates in the Northeast, Northwest, and North Central, and invertebrates in the Southeast.
- Tables 1-4 display the most frequently reported species by region currently (a) and in the next 10-20 years (b). There is significant overlap between species listed as current and future threats, however,
- There were numerous species listed only as future threats in each region: 53 in the Northeast, 20 in the Northwest, 12 in the North Central, and 30 in the Southeast.

Implications

- The identification of specific classes with a higher representation among invasive species (e.g., arthropods, ray-finned fish) suggests the need for targeted research and monitoring efforts to understand their ecological impacts and patterns of spread.
- The regional differences in the composition of invasive species highlight the importance of considering local ecological contexts and factors in designing invasive species management plans.
- The numerous species listed only as future threats emphasize the importance of proactive management and early intervention strategies to address impending invasive species issues, particularly under climate change.
- Considering the potential changes in species distributions due to climate change, future invasive species management strategies should incorporate climate adaptation measures.

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RISCC MANAGEMENT NETWORK

Duke UNIVERSITY