REGIONAL SPECIES OF GREATEST CONSERVATION NEED IN THE MIDWESTERN UNITED STATES

August 2021

Prepared for

Midwest Landscape Initiative
Midwest Association of Fish and Wildlife Agencies

Revised October 10, 2021

Prepared by Terwilliger Consulting Inc.

ACKNOWLEDGEMENTS

Thank you, Midwest Landscape Initiative partners – the U.S. Fish and Wildlife Service (USFWS) Region 3 Science Applications and 13 Midwest State Fish and Wildlife Agencies (MAFWA) – for your sponsorship through a USFWS Science Application Grant for this effort. Your guidance throughout the project and process allowed us to customize the RSGCN selection criteria and method. Your leadership and knowledge of the region enables the results to be used by a wide range of partners for conservation implementation in the Midwest. Heartfelt thanks to the MAFWA Wildlife Diversity Committee and their 125+ taxonomic experts for contributing their extensive expertise and time through collaborative discussion and review to identify regional priorities for their taxa. We thank Kelley Myers, Claire Beck, Kate Parsons, Katy Reeder, Eileen Dowd Stukel, John Kanter, and many others for their foresight and support to launch and coordinate this effort in the Midwest. This effort would not have been possible without the combined talents of the TCI/Terwilliger Team. Many thanks to: Tracy Monegan Rice, Elizabeth Crisfield, Donovan Drummey, David Munoz, and Karen Terwilliger.

EXECUTIVE SUMMARY

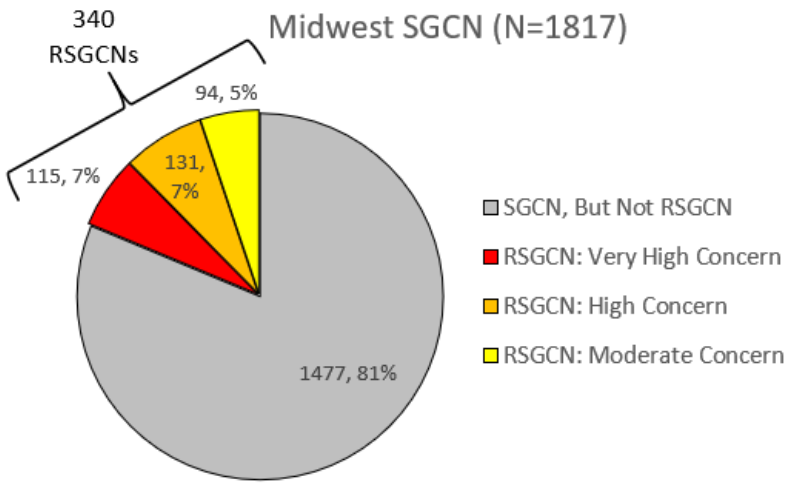
BACKGROUND

The Midwest Landscape Initiative (MLI) initiated the development of a Regional Species of Greatest Conservation Need (RSGCN) List to provide an effective, collaborative focus and approach for regional wildlife diversity conservation in the Midwest. The Midwest RSGCN effort applied a process initiated in the Northeast, advanced in the Southeast, and refined by the MLI At-Risk Species Working Group, to identify RSGCN for the Midwest.

REGIONAL SPECIES OF GREATEST CONSERVATION NEED

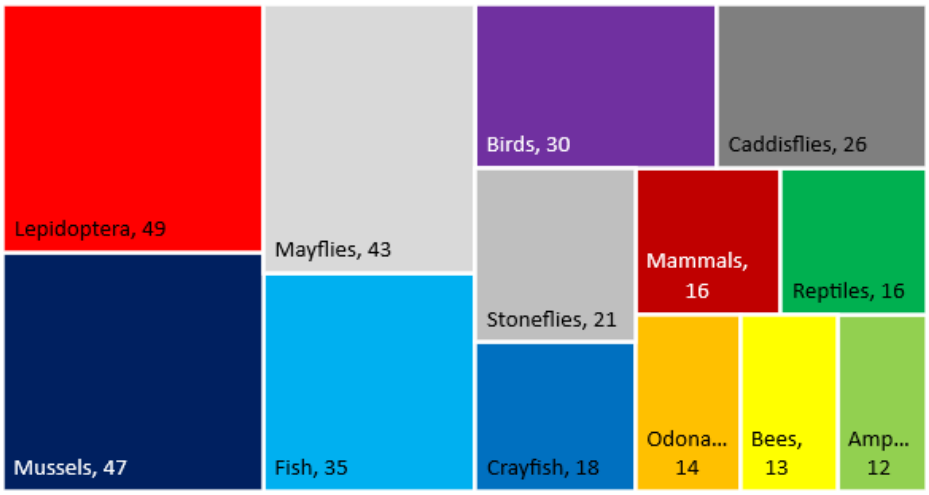
Of the 2740 Species of Greatest Conservation Need (SGCN) listed in Midwest Association of Fish and Wildlife Agencies' (MAFWA) 13 State Wildlife Action Plans (SWAP), team of taxa experts evaluated 1817 species in 13 taxonomic groups – mammals, birds, reptiles, amphibians, fish, crayfish, mussels, Odonates (dragonflies and damselflies), bumble and solitary bees, Lepidoptera (butterflies, skippers and moths), mayflies, stoneflies, and caddisflies. **Of these 1817 species, 340 SGCN met the criteria for RSGCN** (Figure ES-1), a designation signifying that these 19% of evaluated SGCN species should be assessed and managed at a regional scale with collaborative, multi-state efforts.

Figure ES-1. Number and percent of Midwest SGCN in evaluated taxa that are RSGCN, by Concern Levels.



Of the 13 taxonomic groups reviewed, Lepidoptera (Butterflies, Skippers, and Moths) and Freshwater Mussels contained the largest numbers of RSGCN, followed closely by Mayflies and Fish (Figure ES-2). **Aquatic species comprised nearly two-thirds of RSGCN species.**

Figure ES-2. Number of RSGCN by taxa.



RSGCN CATEGORY

More than 125 Midwest fish and wildlife experts applied the selection criteria developed by the MLI At-Risk/RSGCN Working Group and identified these 340 RSGCN species and an additional 364 Midwest fish and wildlife species that warranted conservation assessment (Figure ES-3 and Table ES-1).

Figure ES-3. Number of RSGCN in each RSGCN category by taxa.

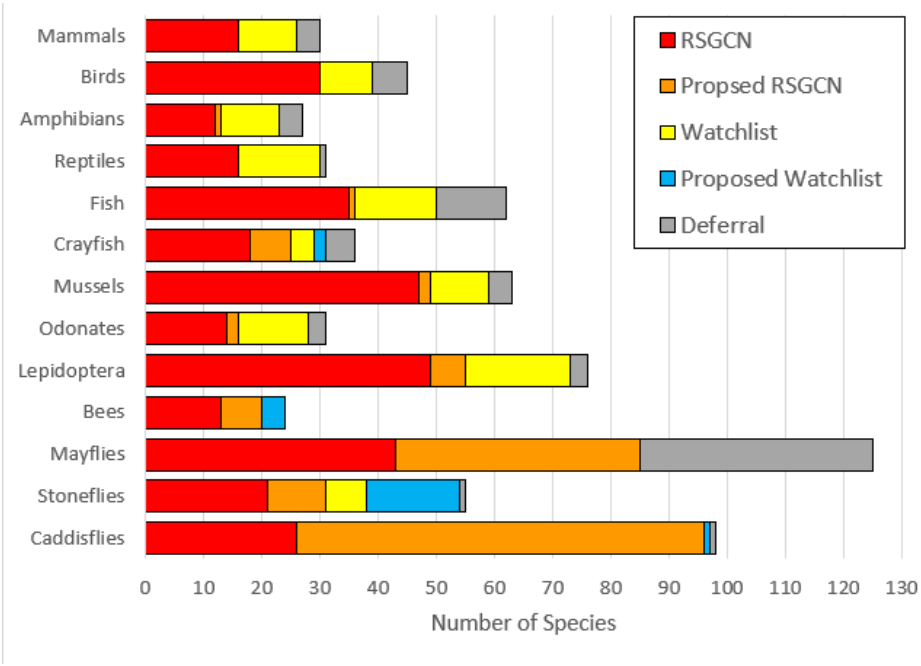


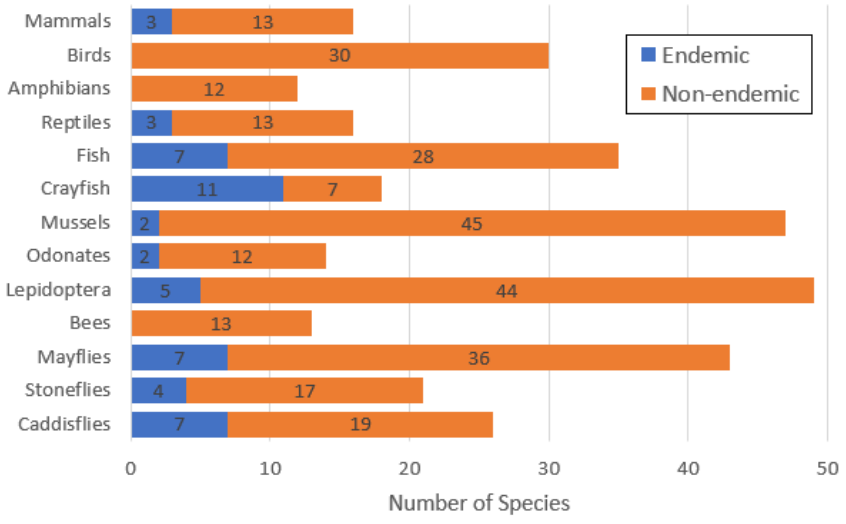
Table ES-1. Number of species that are RSGCN, Proposed RSGCN, RSGCN Watchlist, Proposed RSGCN Watchlist, and Watchlist Deferrals to adjacent regions, by taxa.

Taxa	RSGCN	Proposed RSGCN	Watchlist	Proposed Watchlist	Deferrals
Mammals	16	0	10	0	4
Birds	30	0	9	0	7
Amphibians	12	1	10	0	4
Reptiles	16	0	14	0	1
Fish	35	1	14	0	12
Crayfish	18	7	4	2	5
Mussels	47	1	10	1	4
Odonates	14	2	12	0	3
Bees	13	7	0	4	0
Lepidoptera	49	6	18	0	3
Mayflies	43	42	0	0	40
Stoneflies	21	10	7	16	1
Caddisflies	26	70	0	1	1
Totals	**340**	**147**	**108**	**24**	**85**

REGIONAL RESPONSIBILITY AND ENDEMIC SPECIES

In addition to supporting many wide-ranging species, the Midwest also supports a unique diversity of endemic species. **Across these taxonomic groups, 51 RSGCN (15%) and 25 Proposed RSGCN (17%) are MAFWA endemics** (Figure ES-4). More than 60% of the Crayfish RSGCN are endemic to the MAFWA region, the largest proportion of endemic RSGCN of any taxa.

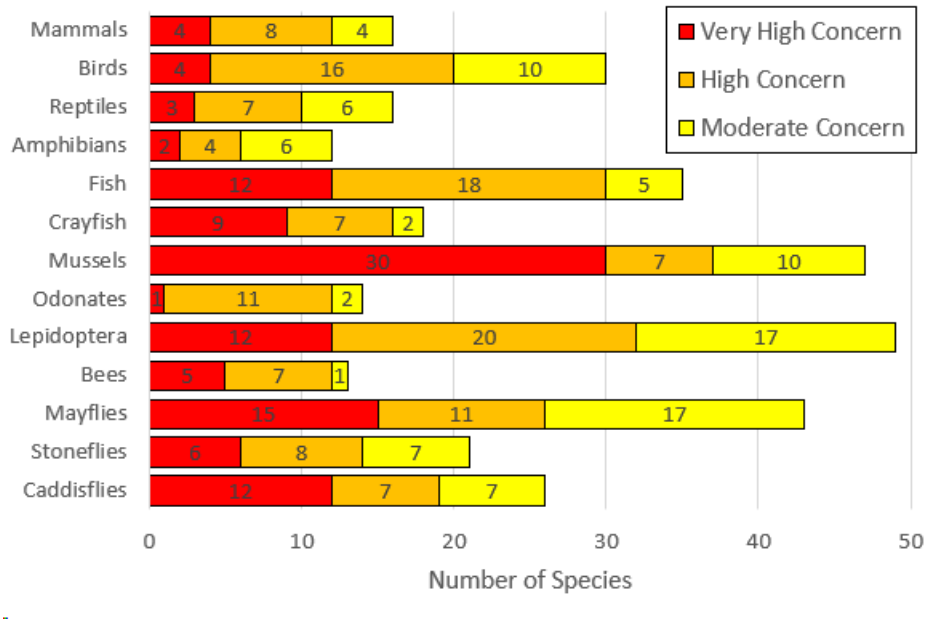
Figure ES-4. Number of endemic and non-endemic RSGCN by taxa.



CONSERVATION CONCERN LEVEL

More than one-third of the RSGCN, and nearly one-third of the Proposed RSGCN, were considered Very High Concern by the taxa teams (Figure ES-5). **Aquatic taxa have a greater proportion of Very High Concern species, highlighting the need for regional coordination on aquatic species conservation.** Seventy-four percent of the Very High Concern RSGCN are aquatic species: fish, crayfish, mussels, Odonates, mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera), excluding aquatic herpetofauna.

Figure ES-5. Number of RSGCN by Conservation Concern Level in each taxa.



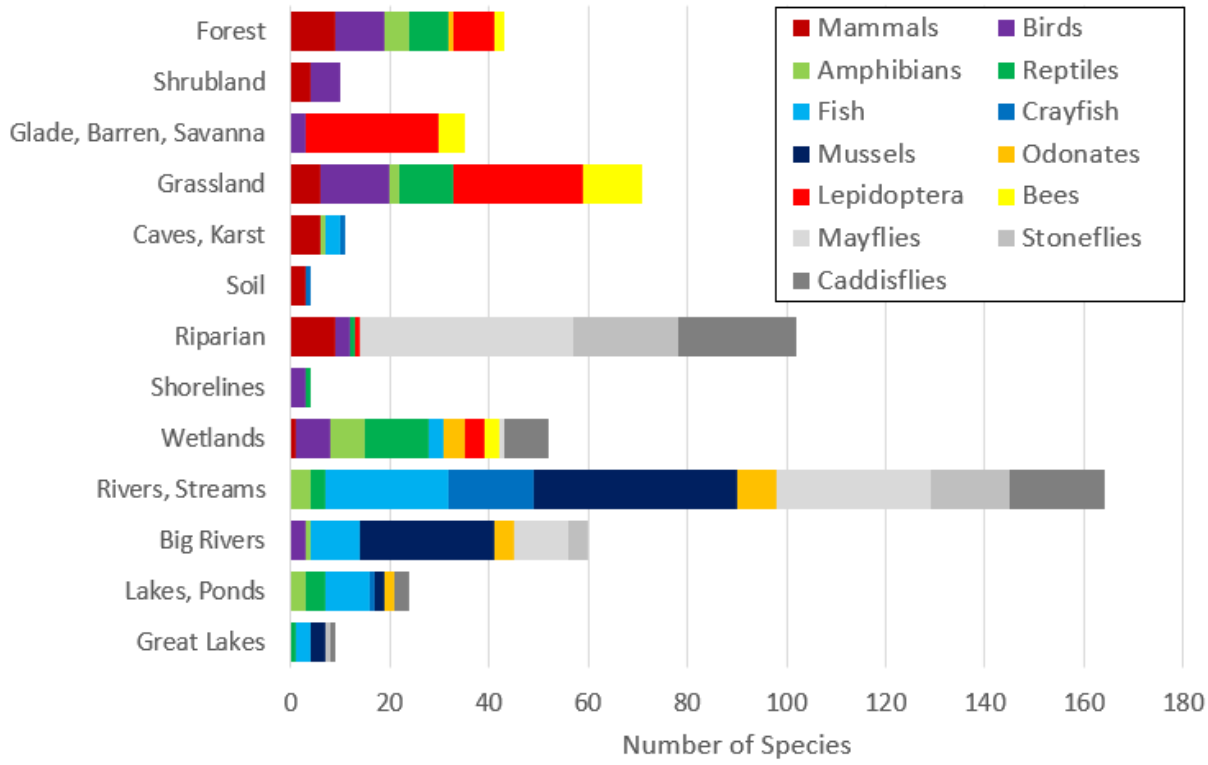
RSGCN HABITATS

One of the desired outcomes of the Midwest RSGCN listing effort was to associate each RSGCN species with their habitat needs and key limiting factors. Working with the MLI At-Risk /RSGCN Work Group and Habitat Sub-group, a classification system was developed to best describe the habitats of the Midwest, resulting in 20 coarse-level habitats grouped in four categories: Terrestrial, Transitional, Aquatic, and Anthropogenic.

Of the **terrestrial habitat** types, grasslands and forests support the greatest number of RSGCN taxa, while soil and shrublands support the fewest (Figure ES-6). Just over half of the species identified by the taxa teams as using grassland habitats are insect pollinators. Mammals are the most common RSGCN taxa in the two subterranean habitats (soil and caves / karst).

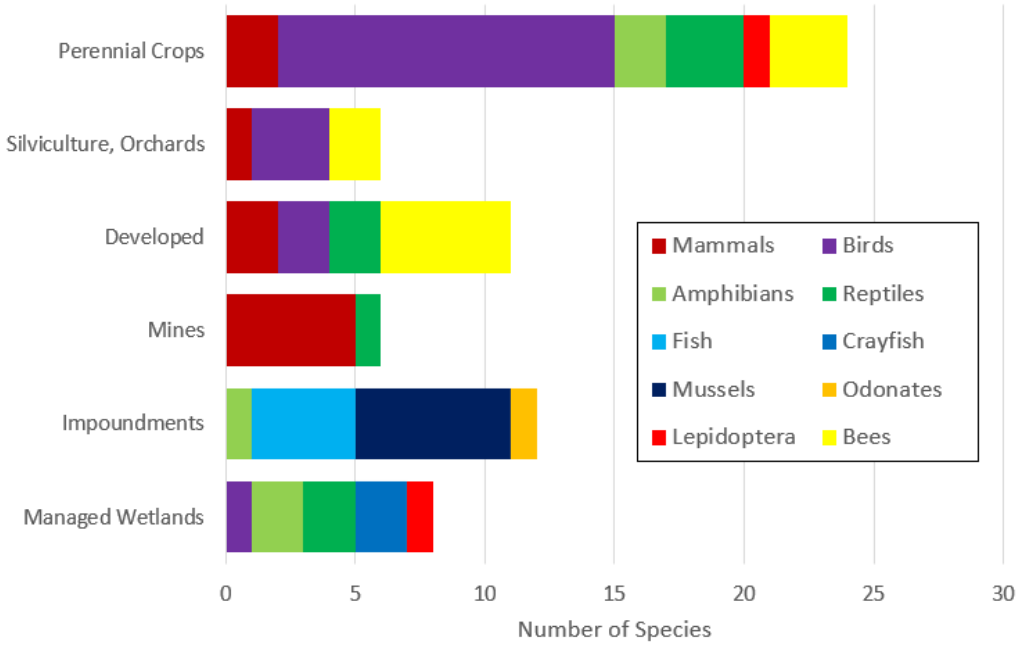
All of the **aquatic habitat** types are diverse, with rivers and streams supporting the most RSGCN diversity (Figure ES-6). Thirty-three of these RSGCN are considered habitat specialists, with nearly one third of the RSGCN species occurring only in river and stream habitats. The taxa teams identified 102 RSGCN that utilize riparian habitats, many of which are benthic macroinvertebrates.

Figure ES-6. Number of RSGCN (by taxa) associated with each natural habitat type.



Anthropogenic habitats are generally less preferred than natural habitats, with fewer RSGCN occurring in them (Figure ES-7). Human activity and impacts likely deter many species, but these habitats may offer valuable wildlife viewing and outreach opportunities due to their proximity to human populations.

Figure ES-7. Number of RSGCN (by taxa) associated with each anthropogenic habitat type.



By associating RSGCN with an agreed-upon suite of habitats, this project set the stage for further in-depth analyses and improved regional, collaborative conservation of habitat types essential to the conservation of RSGCN.

LIMITING FACTORS

The project attempted to identify limiting factors for RSGCN. However, this additional effort was limited by available time, data, and expertise. The summary table below indicates that habitat availability, condition, connectivity, and management were considered relatively more important factors limiting RSGCN (Table ES-2). Lack of information on key threats precluded more robust analyses and varied greatly by taxonomic group, likely resulting in underestimates of the numbers and percentages of species affected by each limiting factor as identified by the regional taxa teams.

Table ES-2. Common threats and limiting factors identified by the taxa teams for each of the taxonomic groups. Percentages indicate the *minimum* percent of RSGCN of species that are impacted or probably impacted by each limiting factor. Due to incomplete information, all values are likely to be underestimates. Note that the Climate Change and Invasive Species factors listed here relate to the impacts to habitat, not individual species; species-level impacts may also occur.

	RSGCN Species	Habitat Availability	Habitat Condition	Habitat Connectivity	Habitat Management	Climate Change	Invasive Species	Disease	Genetics	Pollution	Predation	Harvest/Take	Competition
Mammals	**16**	88%	38%	.	6%	13%	.	63%	6%	50%	.	50%	.
Birds	**30**	93%	70%	27%	83%	47%	10%	3%	13%	27%	27%	43%	10%
Amphibians	**12**	83%	92%	50%	42%	67%	25%	58%	17%	58%	58%	50%	17%
Reptiles	**16**	81%	69%	31%	63%	38%	6%	44%	19%	19%	19%	44%	.
Fishes	**35**	57%	89%	54%	6%	29%	3%	6%	40%	71%	37%	17%	29%
Crayfishes	**18**	39%	50%	17%	.	17%	.	.	11%	39%	.	.	61%
Mussels	**47**	40%	85%	66%	17%	4%	36%	.	30%	72%	9%	19%	4%
Dragonflies	**14**	36%	93%	21%	.	43%	.	.	7%	79%	14%	7%	.
Butterflies	**49**	92%	80%	90%	76%	12%	88%	4%	16%	33%	.	.	.
Bees	**13**	77%	62%	54%	46%	46%	38%	31%	46%	46%	8%	.	.

XX%	80-100% of RSGCNs affected
XX%	60-79% of RSGCNs affected
XX%	40-59% of RSGCNs affected
XX%	20-39% of RSGCNs affected
XX%	<20% of RSGCNs affected, or insufficient data (.)

CONCLUSIONS AND RECOMMENDATIONS

By working closely with the MLI, MAFWA WD Committee, and Taxa Team members for the past year, we have identified several key recommendations to help ensure the longevity and success of this regional initiative. These priority Midwest RSGCN species and their habitats can focus regional conservation efforts by applying a landscape and watershed lens to facilitate consistent objectives and approaches across the region. This enhances efficiency and conservation effectiveness, promoting coordinated conservation and recovery efforts to avert further declines and improve population trajectories. RSGCN can be grouped by taxa, habitat, or limiting factors identified by this process and addressed through shared expertise, consistent data collection, protocol development, and coordinated actions. This RSGCN list and data products can guide MLI and MAFWA collaboration with conservation partners in the region and leverage support from diverse funding sources by presenting key information on the many species of greatest conservation need across the Midwest.

TABLE OF CONTENTS

ACRONYMS

AFS – American Fisheries Society

AFWA – Association of Fish and Wildlife Agencies

BMP – Best Management Practice

CMP – Conservation Measures Partnership

DNR – Department of Natural Resources

EPT – Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies)

FHP – Fish Habitat Partnership

GIS – Geographic Information System

ITIS – Integrated Taxonomic Information System

IUCN – International Union for the Conservation of Nature

JV – Joint Venture

LCC – Landscape Conservation Cooperative

MAFWA – Midwest Association of Fish and Wildlife Agencies

MLI – Midwest Landscape Initiative

MWPARC – Midwest Partners for Amphibian and Reptile Conservation

MSCI – Midcontinent Shorebird Conservation Initiative

NEAFWA – Northeast Association of Fish and Wildlife Agencies

NEFWDTC – Northeast Fish and Wildlife Diversity Technical Committee

NLCD – National Land Cover Dataset

NOAA – National Oceanographic and Atmospheric Administration

NWF – National Wildlife Federation

NWI – National Wetlands Inventory

PIF – Partners in Flight

RAWA – Restoring America's Wildlife Act

RCN – Regional Conservation Needs

RSGCN – Regional Species of Greatest Conservation Need

SEAFWA – Southeast Association of Fish and Wildlife Agencies

SECAS – Southeast Conservation Adaptation Strategy

SGCN – Species of Greatest Conservation Need

SWAP – State Wildlife Action Plan

TCI – Terwilliger Consulting, Inc.

TNC – The Nature Conservancy

USFWS – U.S. Fish and Wildlife Service

USGS – U.S. Geological Survey

WDC or Committee – Wildlife Diversity Committee

WDPM – Wildlife Diversity Program Managers

WNS – White-nose Syndrome

INTRODUCTION

In August of 2020, the Midwest Landscape Initiative (MLI) – a partnership between the U. S. Fish and Wildlife Service (USFWS) Region 3 Science Applications (SA) and the 13 Midwest State Fish and Wildlife Agencies of the Midwest Association of Fish and Wildlife Agencies' (MAFWA) Wildlife Diversity Committee (WDC) – launched an effort to develop a list of Regional Species of Greatest Conservation Need (RSGCN). The goal was to enhance their ability to work collaboratively and proactively to sustain populations of endemic and shared Species of Greatest Conservation Need (SGCN) supported primarily by Midwest waters and landscapes.

The RSGCN effort, first initiated and updated in the Northeast by the Northeast Association of Fish and Wildlife Agencies (NEAFWA) in 2013 and 2018, was then applied and advanced in the Southeast by the Southeast Association of Fish and Wildlife Agencies (SEAFWA), USFWS SA, Southeast Conservation Adaptation Strategy (SECAS), and National Wildlife Federation (NWF) in 2019. The method improved with each application of the process and enabled each region to not only benefit from each iteration and its advancements, but also to customize it to capture and highlight the unique features of their region.

The RSGCN method application in the Midwest was a timely fit for the MLI partnership as it crafted its mission and planning. MAFWA, in cooperation with its USFWS Regions, established the Midwest Landscape Initiative Steering Committee in 2018 to identify shared priorities and define how to best address them. MLI's Charter further highlighted its objective to "identify shared conservation and management priorities requiring development of scalable collaborative solutions to achieve healthy, functioning ecosystems in the Midwest." This RSGCN effort directly addresses these objectives through the identification of priorities for conservation in the form of 340 RSGCN and their associated habitats and limiting factors.

The foundation for the RSGCN effort is State Wildlife Action Plans (SWAPs), and the 2740 SGCN designated within the 13 Midwest SWAPs. This process therefore begins with state priorities and refines the compilation of SGCN through an additional, transparent, repeatable step based on best available science, to further prioritize these and other species nominated by taxa teams by their level of conservation concern and regional responsibility. This results in a list of conservation priorities that can inform and help focus federal and state fish and wildlife agencies across the Midwest to fulfill their unique responsibilities to conserve the natural landscape and its incredible biodiversity based on best available science.

Once these priority RSGCN species, their habitats, and their limiting factors are identified, they can focus regional work by using a landscape and watershed lens to apply consistent conservation approaches across the region. This enhances efficiency and conservation

effectiveness by promoting coordinated conservation and recovery efforts, which can avert further declines or even the need for listing.

RSGCN limiting factors and data gaps identified by this process can be addressed through shared taxa team expertise, consistent and coordinated data collection, protocol development, and conservation actions including Best Management Practices (BMP). The RSGCN list and accompanying products can guide MLI and MAFWA collaboration with conservation partners in the region and leverage support from diverse funding sources by presenting key information on the many species of greatest conservation need across the Midwest.

METHOD

The RSGCN selection process began with the review of approximately 2740 SGCN in the Midwest and proceeded in four phases as outlined below. The selection of RSGCN was based on the conservation concern of the species and the MAFWA regional responsibility for stewardship of the species. Method documentation is detailed in Appendix A.

PHASE 1: PLANNING AND RSGCN SELECTION METHODOLOGY

The first phase of the project focused on coordination with Midwest Landscape Initiative (MLI) At-Risk Species Working Group to request state taxa expert contacts and data from the 13 states in the Midwest Association of Fish and Wildlife Agencies (MAFWA) to begin method development. Terwilliger Consulting, Inc. (TCI) was contracted by the U.S. Fish and Wildlife Service, Science Applications (USFWS, SA) to coordinate this collaboration.

State representatives and experts were engaged at key times and in strategic ways to accommodate state timing and resource needs. The process and list were designed to represent the most up-to-date ground-truthed assessment of SGCN while minimizing the work time of staff experts and state Wildlife Diversity Program Managers (WDPM). Consistent, regular coordination engaged 125 experts and state representatives in the most time-efficient way possible. TCI managed outreach and communication with the 13 states across the region through webinars and conference calls, participation in regularly scheduled meetings, and e-mail correspondences as each taxa team reviewed lists and provided input in a series of iterative webinars, calls, and surveys.

The Northeast Association of Fish and Wildlife Agencies (NEAFWA) and Southeast Association of Fish and Wildlife Agencies (SEAFWA) criteria for RSGCN selection were presented to the MLI for their consideration and refinement allowing the revised methodology to remain substantially

consistent with the Northeast and Southeast lists while meeting the MLI's unique objectives. Selection criteria and method guidelines were developed and approved by the MLI At-Risk Species Working Group to ensure that the final RSGCN list comprised species that represented the shared focus of the MAFWA states (see Appendix A for details).

As in the Northeast and Southeast regional methods, TCI and the MLI considered two major categories for criteria development:

- regional stewardship responsibility (including endemism), and
- conservation concern and status.

To facilitate the review of these fundamental selection criteria, along with guidelines and additional factors, TCI led the MLI At-Risk Species Working Group through several steps:

- requested methodology inputs, refinements, and other experts to include;
- conducted an online questionnaire of the states to identify SWAP revisions, uses of the RSGCN list, which taxa to include, RSGCN selection criteria, habitat classifications, limiting factors and threats, concerns, and potential issues;
- reviewed questionnaire results with the Working Group and facilitated discussion to:
    - review the NEAFWA and SEAFWA RSGCN selection methods and assess how all or portion of those could meet MAFWA needs, and
    - discuss factors not incorporated in the NEAFWA or SEAFWA methods and pros/cons of adapting the method;
- defined provisional RSGCN categories and criteria;
- identified taxa to be included;
- drafted MAFWA method based on Working Group feedback;
- revised the method documentation through iterative review with the Working Group;
- prepared the instructions for the taxonomic teams based on the method documentation; and
- presented method documentation (Appendix A) to the full Working Group for final approval.

PHASE 2: DATA COMPILATION, REVIEW, AND PRESCREENING

Phase 2 of the RSGCN selection process focused on compilation and review of SGCN data from the 13 MAFWA states and systematic pre-screening to categorize candidate RSGCN. From September to November 2020, TCI reviewed the MLI's comprehensive SGCN lists and associated data from each state.

Existing conservation assessment data was requested from NatureServe for all Midwest SGCN, then compiled and organized for each taxonomic group to facilitate taxonomic expert review

and the application of RSGCN-selection criteria. This project was able to update SGCN lists and use a national database of taxonomically reconciled SGCNs from the U.S. Geological Survey (USGS 2018), as well as several other key data sources including NatureServe and taxa-specific citations (Appendix A).

All SGCNs were merged into a database created by TCI with ongoing quality-control checks to identify duplicate records, correct misspellings, and update taxonomy. In total, the database contained approximately 2740 SGCN vertebrates, invertebrates, and plants. The structure of the database is described in Appendix A. Additional data fields were determined to assist experts in their Taxa Team Review (Phase 3) and added by TCI from various external sources: Partners in Flight (PIF 2016), American Fisheries Society (Taylor et al. 2007, as updated; and Jelks et al. 2008), Fish Habitat Partnerships (USFWS 2020), and NatureServe (NatureServe 2020).

Based on agreed-upon criteria (Appendix A), TCI conducted pre-screening of the available data and prepared draft taxa lists for taxonomic team review. Once QA/QC was complete, TCI applied the selection criteria to produce a list of species in five categories: Predicted RSGCN, Probable RSGCN, Possible RSGCN, Not Predicted RSGCN, and Unknown RSGCN (Appendix A). This prescreening effort helped to organize and prepare the data for more efficient review by taxa experts.

SGCN records were extracted from the database and separated into Microsoft Excel spreadsheets for 13 taxonomic groups – mammals, birds, reptiles, amphibians, fish, crayfish, mussels, Odonates (dragonflies and damselflies), bumble and solitary bees, Lepidoptera (butterflies, skippers and moths), mayflies, stoneflies, and caddisflies – totaling approximately 1817 of the 2740 SGCN.

The MLI At-Risk Species Working Group decided to move forward with analyses of all vertebrate SGCN animals and eight groups of invertebrates, with the goal of addressing additional invertebrate and plant groups in the future as data and support become available.

PHASE 3: TAXA TEAM REVIEW

The WDC provided TCI with taxonomic experts' contact information for 11 of these groups from each of the MAFWA states. Mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera, collectively referred to as EPT) were addressed by coordinating with regional EPT experts, as invertebrate data were lacking from many states. TCI invited each of the recommended taxonomic experts from all taxonomic groups to participate in the RSGCN selection process using the compiled and analyzed data.

From December 2020 through April 2021, TCI facilitated the taxa teams' reviews for RSGCN selection and identification of limiting factors using the methodology developed by the At-Risk Species Working Group (Appendix A). For all taxonomic groups except those for EPT, a representative from every state was selected by their WDPM to serve on the review team. Every effort was made to include biologists with field experience covering the entire region, especially for invertebrate groups where data were lacking. TCI reached out to individual states for additional information as needed or requested.

TCI facilitated two rounds of review for the selection of RSGCN by each taxa team. A series of introductory webinars was hosted and facilitated by TCI for all taxa teams in December 2020. A total of 125 taxonomic experts (Appendix B) participated in the taxa team-review process. TCI provided data, spreadsheets, and underlying research needed for taxa team review and consideration. Due to a lack of standard conservation assessment data, the bee team and Lepidoptera team were asked to pre-screen the SGCN species before beginning a focused review. The taxa teams spent the following month reviewing the pre-screened lists of potential RSGCN and completed an online survey to submit their votes, data corrections, and comments. In January and February 2021, each of the taxa teams had at least one taxa-specific webinar for each of the 13 state membership representatives to meet, review, and discuss the selection of RSGCN.

For many species, the decision to select them as RSGCN was clear based on application of criteria to the available distribution and conservation assessment data. However, in some instances (e.g., species with new information, emerging threats, or less certain population estimates), it was necessary for taxonomic experts to discuss the available information including any unpublished survey data. The taxa teams recommended use of a RSGCN Watchlist for species for which there was concern but insufficient information or differing trends across the region. Three categories of RSGCN Watchlist were created: Assessment Priority, Interdependent Species, and Defer to adjacent region (Appendix G).

The Bird Taxa Team was challenged by the migratory nature of birds, which have large geographic ranges and limited regional responsibilities based on geographic ranges alone. The taxa team therefore identified additional regional responsibilities for migratory birds during the breeding, migration, and wintering seasons, using data from PIF (2016) and its associated ACAD (https://pif.birdconservancy.org/), range maps from Birds of the World (https://birdsoftheworld.org/bow/home), and extrapolations from taxonomic experts. As a result, the migratory birds have four regional responsibility metrics – geographic, breeding, migration, and wintering regional responsibilities (Appendix J).

Due to the incomplete coverage of EPTs in the SWAPs and limited expertise available, the EPTs were not reviewed in the same manner as the other taxonomic groups. Rather than assessing only the 169 EPT species designated as SGCN in the Midwest SWAPs, the EPT Taxa Teams comprehensively reviewed these taxonomic groups. The EPT Taxa Teams compiled lists of all the mayflies (332), stoneflies (234), and caddisflies (595) known to occur in the MAFWA region and then reviewed all those species for RSGCN selection criteria (Appendices K, L, and M).

During the webinars, it became clear that there are many non-SGCN species that are of high concern in the Midwest. This was particularly true for invertebrate taxa that were not considered in all Midwest SWAPs. As these species are not currently SGCN, they cannot be listed as a RSGCN. The taxa teams wanted there to be a way to recognize high-concern species, regardless of their current status. This could be of particular value as states revise their SWAPs, providing a list of new potential SGCN. An additional 170 species that were not SGCN were recommended by taxa teams during this process, so each state was contacted to confirm species' status. Based on taxa team input and expertise, additional non-SGCN species were added to a Proposed RSGCN or Proposed RSGCN Watchlist for future consideration.

Upon completion of a draft set of RSGCN lists, TCI created a Microsoft Access database of limiting factors and vulnerabilities of RSGCN and Proposed RSGCN (see Appendix A). TCI pre-populated most of the database with publicly available information. Each taxa team reviewed the compiled information and completed a second online survey to confirm or revise the data and to fill data gaps. Taxa teams also were asked to confirm state-level data in the database for each species, including data fields on S-Ranks, state listing status, whether the species is SGCN in their state, and whether the species occurs in their state (regardless of SGCN status).

TCI delivered updates on monthly MLI At-Risk Species Working Group calls documenting the results and consensus after each round of review for MLI approval on progress and completion.

PHASE 4: RSGCN Finalization, Analysis, and Report Development

The final phase of the project occurred April - July 2021. TCI finalized the lists of RSGCNs, their habitats, and their limiting factors following the second round of taxa team review, coordinating with the taxa teams and the MLI biweekly and for final approval. Analysis of the RSGCN and the various metrics allowed TCI to prepare this report with summary results and discussions for each taxonomic group, plus implementation recommendations from the taxa teams for MAFWA and the MLI to facilitate RSGCN conservation in the Midwest. TCI also evaluated options for products and platforms to maximize utility and accessibility of the RSGCN list and its associated data, presenting them for consideration by the MLI in May and June 2021.

RESULTS

Of the approximately 2740 SGCNs found in MAFWA's 13 SWAPs, 1817 SGCN from 13 taxonomic groups – mammals, birds, reptiles, amphibians, fishes, crayfishes, freshwater mussels, dragonflies and damselflies, bumble bees and solitary bees, butterflies and moths, mayflies, stoneflies, and caddisflies – were evaluated and prescreened using the MLI-approved RSGCN selection criteria. The SGCN were prescreened into the following categories for taxa team review: Predicted RSGCN, Probable RSGCN, Possible RSGCN, Not Predicted RSGCN, and Unknown RSGCN (Appendix A). The taxa teams reviewed the prescreened lists and identified both SGCN and Non-SGCN species as RSGCN (Proposed RSGCN for Non-SGCN) or Watchlist (Proposed Watchlist for Non-SGCN) (Appendix C); results are organized in this order.

Approximately 693 invertebrates from other taxonomic groups and 230 plants were beyond the scope of this assessment due to insufficient data available for those species.

THE BIG PICTURE – 340 RSGCN AND 147 PROPOSED RSGCN

RSGCN

340 SGCN met the criteria for RSGCN (Table 1, Figure 1; Appendix D). Lepidoptera (Butterflies, Skippers and Moths) and Freshwater Mussels are the largest taxonomic groups of RSGCN, followed closely by Mayflies (Ephemeroptera) and Fish (Figure 2). More than 60% of the Crayfish RSGCN are endemic to the MAFWA region, the largest proportion of endemic RSGCN of any taxa (Figure 3).

Table 1. Number and proportion of RSGCN endemic to MAFWA region by taxonomic group.

Taxonomic Group	RSGCN Number	% of RSGCN Species	% MAFWA Endemic
Mammals	16	5%	19%
Birds	30	9%	0%
Amphibians	12	4%	0%
Reptiles	16	5%	19%
Fish	35	10%	20%
Crayfish	18	5%	61%
Freshwater Mussels	47	14%	4%

Taxonomic Group	RSGCN Number	% of RSGCN Species	% MAFWA Endemic
Dragonflies and Damselflies (Odonata)	14	4%	14%
Butterflies and Moths (Lepidoptera)	49	14%	10%
Bees	13	4%	0%
Mayflies (Ephemeroptera)	43	13%	16%
Stoneflies (Plecoptera)	21	6%	19%
Caddisflies (Trichoptera)	26	8%	27%
Total RSGCN	**340**	**100%**	**15%**

Figure 1. Number of RSGCN in each RSGCN category.

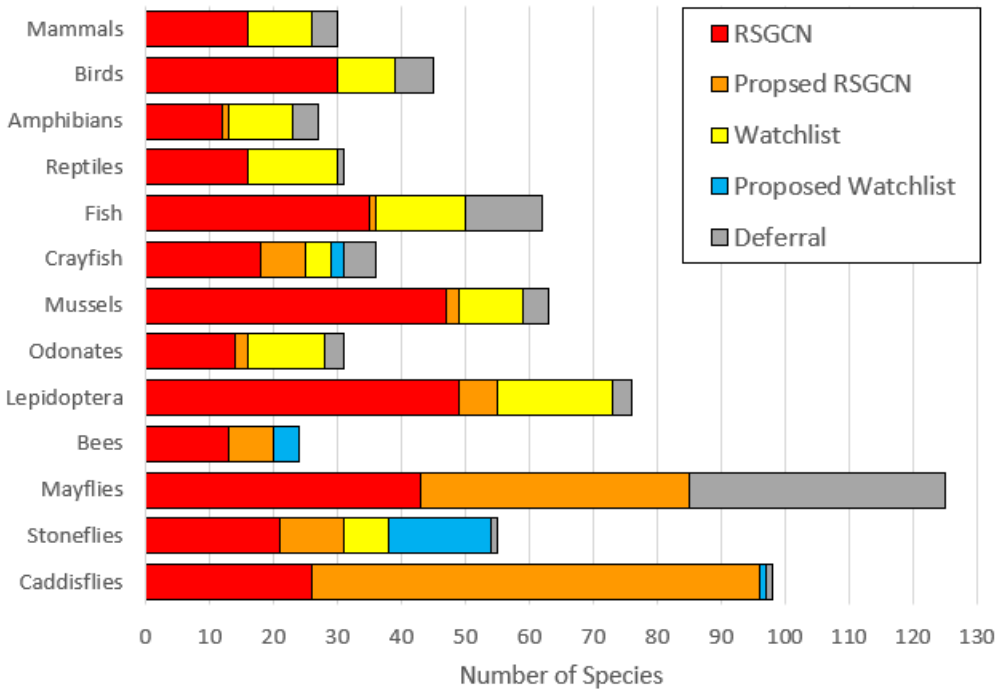


Figure 2. Number of Midwest RSGCN by taxonomic group.

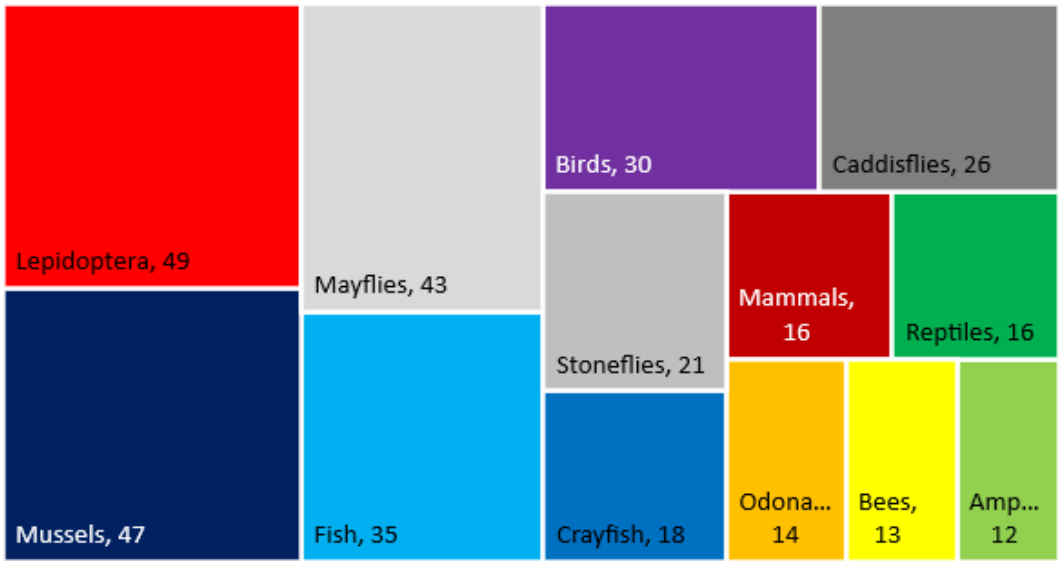
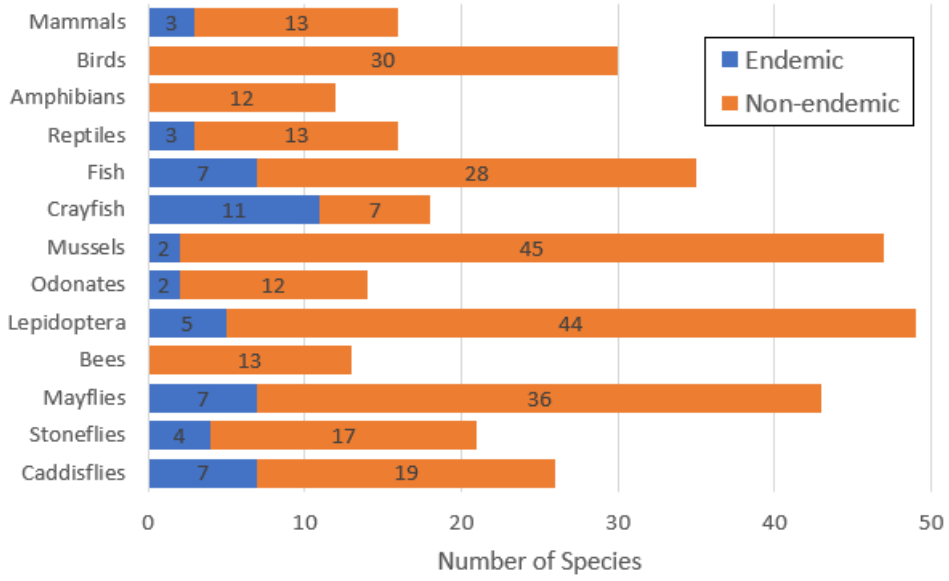


Figure 3. Number of RSGCN endemic to MAFWA region by taxonomic group.



PROPOSED RSGCN

An additional 147 species were identified as Proposed RSGCN (Table 2). These species met the selection criteria as RSGCN but are not currently identified as SGCN in any MAFWA state. Most (82%) of the Proposed RSGCN are EPT – Ephemeroptera (Mayflies), Plecoptera (Stoneflies), or Trichoptera (Caddisflies). Although 9 of the 13 MAFWA states included EPT in their SWAPs, 88% of the EPT SGCN were identified within only four states (Illinois, Indiana, Minnesota, and Wisconsin). The EPT Taxa Team generated new datasets on the occurrence and distribution of EPT throughout the Midwest, significantly increasing the knowledge base for these invertebrate taxa and identifying 122 Non-SGCN species as meeting RSGCN selection criteria (Appendices K, L, and M). The majority of Proposed RSGCN Stoneflies (60%) and Crayfish (57%) are endemic to the MAFWA region.

Table 2. Number and proportion of Proposed RSGCN in each taxonomic group, and proportion of Proposed RSGCN in each taxonomic group that are endemic to MAFWA region.

Taxonomic Group	Proposed RSGCN Number	% of Proposed RSGCN Species	% Proposed RSGCN MAFWA Endemic
Mammals	0	0	0
Birds	0	0	0
Amphibians	1	1%	0
Reptiles	0	0	0
Fish	1	1%	0
Crayfish	7	5%	57%
Freshwater Mussels	1	1%	0
Dragonflies and Damselflies (Odonata)	2	1%	0
Butterflies and Moths (Lepidoptera)	6	4%	17%
Bees	7	5%	0
Mayflies (Ephemeroptera)	42	29%	0
Stoneflies (Plecoptera)	10	7%	60%
Caddisflies (Trichoptera)	70	48%	20%
Total RSGCN	**147**	**100%**	**17%**

RSGCN WATCHLIST

108 SGCN were identified as RSGCN Watchlist [Assessment Priority], species for which there is concern but insufficient information (Table 3, Appendix G). In many cases regional differences were identified by the taxa teams in the status and trends of these SGCN. These species should be a priority for additional survey efforts to document threats and declines across the region. Nearly half (44%) of the RSGCN Watchlist [Assessment Priority] species are Lepidoptera (17%), fish (13%), and reptiles (13%). Three-quarters (75%) of the crayfish species identified as Watchlist [Assessment Priority] are endemic to the MAFWA region, as are nearly one-third (29%) of the reptiles.

Table 3. Number of Midwest RSGCN Watchlist [Assessment Priority] by taxonomic group.

Taxonomic Group	Watchlist Number	% of Watchlist Species	% MAFWA Endemic
Mammals	10	9%	10%
Birds	9	8%	0%
Amphibians	10	9%	0%
Reptiles	14	13%	29%
Fish	14	13%	14%
Crayfish	4	4%	75%
Freshwater Mussels	10	9%	0%
Dragonflies and Damselflies (Odonata)	12	11%	0%
Butterflies and Moths (Lepidoptera)	18	17%	0%
Bees	0	0%	0%
Mayflies (Ephemeroptera)	0	0%	0%
Stoneflies (Plecoptera)	7	6%	0%
Caddisflies (Trichoptera)	0	0%	0%
Total RSGCN	**108**	**100%**	**9%**

RSGCN PROPOSED WATCHLIST

An additional 24 Non-SGCN species are identified as Proposed RSGCN Watchlist [Assessment Priority] species, with 67% of these species being Stoneflies (Table 4, Appendix G). These species were identified by the taxa teams as in need of priority assessment but are not currently designated as SGCN within the MAFWA region; thus, they are Proposed RSGCN Watchlist [Assessment Priority] species. The other RSGCN Proposed Watchlist species are bees (4), crayfish (2), mussels (1), and caddisflies (1). Many of the stoneflies are rare and/or have narrow habitat requirements; some are Disjunct Populations or Core Populations in the Midwest (Appendix I). The four bees are solitary bees, and all have at least 50% regional responsibility. The Neosho Midget Crayfish (*Faxonius macrus*) is highly susceptible to invasive crayfish as they are small and easily displaced. Recent research indicates the Blue Crawfish (*Cambarus monongalensis*) in Ohio is isolated from populations in Pennsylvania and West Virginia.

Table 4. Number of Midwest RSGCN Proposed Watchlist [Assessment Priority] RSGCN by taxonomic group. None of the Proposed Watchlist species are endemic to the Midwest region.

Taxonomic Group	Proposed Watchlist Number	% of Proposed Watchlist Species
Mammals	0	0%
Birds	0	0%
Amphibians	0	0%
Reptiles	0	0%
Fish	0	0%
Crayfish	2	8%
Freshwater Mussels	1	4%
Dragonflies and Damselflies (Odonata)	0	0%
Butterflies and Moths (Lepidoptera)	0	0%
Bees	4	17%
Mayflies (Ephemeroptera)	0	0%
Stoneflies (Plecoptera)	16	67%
Caddisflies (Trichoptera)	1	4%
Total RSGCN	**24**	**100%**

RSGCN WATCHLIST DEFERRALS TO ADJACENT REGIONS

A number of species were identified by the taxa teams as of particular concern but for which the MAFWA region has low regional responsibility. These **85 species are categorized as RSGCN Watchlist [Deferral] to adjacent Association of Fish and Wildlife Agencies (AFWA) regions** (Table 5, Appendix G). The Midwest teams recommend that the adjacent regions consider these species for RSGCN, or if already RSGCN, to potentially modify the Concern Level considering the concerns of the Midwest states. Thirty (30) species are deferred to the Northeast Association of Fish and Wildlife Agencies (NEAFWA), 32 to the Southeast Association of Fish and Wildlife Agencies (SEAFWA), and eight to NEAFWA and SEAFWA jointly. Another 15 species are recommended as potential RSGCN to the Western Association of Fish and Wildlife Agencies (WAFWA), should that region identify RSGCN in the future. Nearly half (48%) of the RSGCN Watchlist [Deferral] species are Mayflies.

Table 5. Number of Midwest RSGCN Watchlist [Deferrals] by taxonomic group.

Taxonomic Group	Deferral to Northeast	Deferral to Southeast	Deferral to Northeast & Southeast	Deferral to West
Mammals	0	3	1	0
Birds	0	4	2	1
Amphibians	0	4	0	0
Reptiles	0	1	0	0
Fish	2	7	0	3
Crayfish	0	4	0	1
Freshwater Mussels	1	3	0	0
Dragonflies and Damselflies (Odonata)	2	1	0	0
Butterflies and Moths (Lepidoptera)	2	1	0	0
Bees	0	0	0	0
Mayflies (Ephemeroptera)	21	4	5	10
Stoneflies (Plecoptera)	1	0	0	0
Caddisflies (Trichoptera)	1	0	0	0
Total Watchlist [Deferrals]	**30**	**32**	**8**	**15**

REGIONAL RESPONSIBILITY RESULTS

Across all taxonomic groups, 51 RSGCN (15%) and 25 Proposed RSGCN (17%) are MAFWA endemics (Table 6, Figure 4, Appendix H). Eleven species reviewed by the taxa teams are endemic to the MAFWA region *and* federally listed as endangered, threatened, proposed, or under review. Eight were identified as RSGCN and three were deferred to the Southeast region. The three deferred species (all fish) are endemic to Missouri, which participates in both MAFWA and SEAFWA; the Fish Taxa Team recommended deferring these species to the Southeast because they are more ecologically aligned with Southeast ecoregions than with Midwest ecoregions.

Although the list is intended to highlight species with more than half their geographic range in the Midwest, 94 RSGCN and 9 Proposed RSGCN with lower than 50% regional responsibility are also recognized as priorities in the region because taxon experts agreed regional conservation is critical for sustaining populations (Table 7). Of the 94 RSGCN with lower regional responsibility levels, the largest group are birds (26) due to their migratory nature and large ranges; at least 3 species in every taxa were identified with regional Responsibility Overriding Factors. Fifty-nine (59) of the 94 RSGCN with less than 50% regional responsibility are Highly Imperiled throughout their ranges, 27 are Migratory Species with large ranges, and 11 are vulnerable to climate change or are experiencing or expected to experience range shifts due to climate change (Appendix I). Seven of the ten Mammal RSGCN with less than 50% regional responsibility are bats, three of which are migratory and threatened by collisions wind power facilities, and the others are imperiled by WNS. Nine of the 12 Lepidoptera RSGCN with less than 50% regional responsibility are found in barrens or savanna habitat. All three Mayfly RSGCN with less than 50% regional responsibility have Core Populations in the Midwest (Appendix I). Most of the RSGCN with less than 50% regional responsibility have more than one overriding factor identified by the taxa teams to justify their inclusion as RSGCN.

Eleven (11) of the Watchlist [Assessment Priority] species are endemic to the MAFWA region (Table 8). Endemic Watchlist [Assessment Priority] species include four reptiles, three crayfish, two fish, one mammal, and one Lepidoptera. Similar to the RSGCN and Proposed RSGCN, the 59 Watchlist [Assessment Priority] and 9 Proposed Watchlist [Assessment Priority] species that have less than 50% Midwest regional responsibility are facing Emerging Threats (15), are Core Populations (12), or are Highly Imperiled throughout their ranges (11) (Appendix I). Eight (8) are vulnerable to climate change or range shifts due to climate change, including five of the nine Odonates with less than 50% regional responsibility in the Midwest. One Freshwater Mussel was recently recognized as a species in need of further assessment to identify its distribution and status in the Midwest.

Table 6. Number and proportion of RSGCN and Proposed RSGCN in each Regional Responsibility category.

Regional Responsibility	RSGCN Number	RSGCN %	Proposed RSGCN	Proposed RSGCN %
100% MAFWA Endemic	51	15%	25	17%
75 - 99%	83	24%	29	20%
50 - 74%	112	33%	85	57%
< 50%	94	27%	9	6%
Total RSGCN	**340**	**100%**	**148**	**100%**

Figure 4. Percent of RSGCN in each Regional Responsibility category.

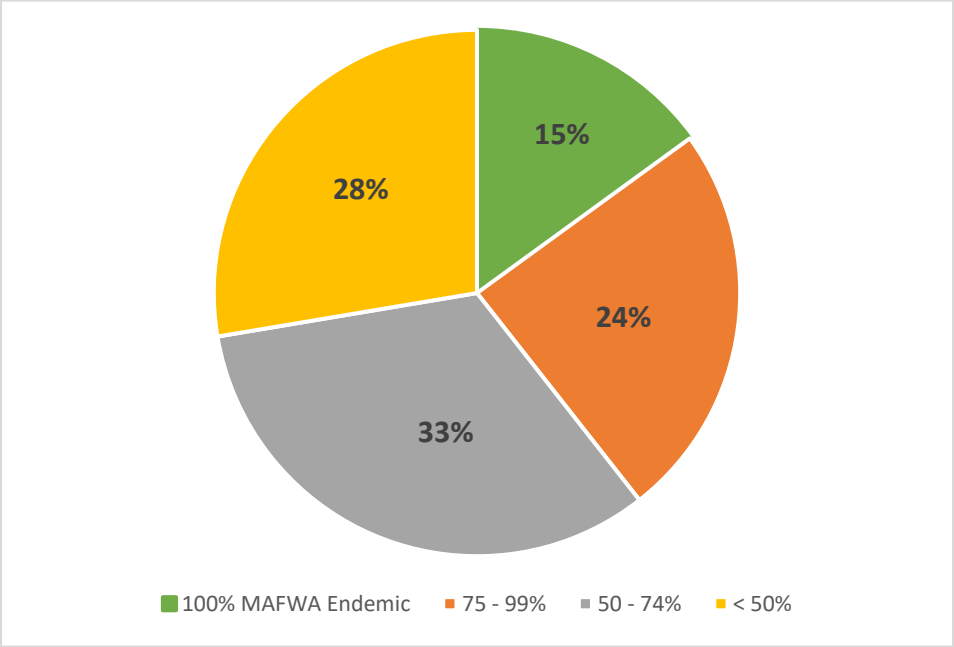


Table 7. Number and percent of RSGCN with less than 50% Regional Responsibility by taxonomic group.

Taxonomic Group	RSGCN Number	Percent
Mammals	10	11%
Birds	26	28%
Amphibians	4	4%
Reptiles	6	6%
Fish	7	7%
Crayfish	3	3%
Freshwater Mussels	9	10%
Dragonflies and Damselflies (Odonata)	4	4%
Butterflies and Moths (Lepidoptera)	12	13%
Bees	3	3%
Mayflies (Ephemeroptera)	3	3%
Stoneflies (Plecoptera)	4	4%
Caddisflies (Trichoptera)	3	3%
Total	**94**	**100%**

Table 8. Number and proportion of Watchlist and Proposed Watchlist in each Regional Responsibility category.

Regional Responsibility	Watchlist Number	Watchlist %	Proposed Watchlist	Proposed Watchlist %
100% MAFWA Endemic	11	10%	0	0%
75 - 99%	15	14%	3	13%
50 - 74%	24	22%	11	48%
< 50%	59	54%	9	39%
Total RSGCN	**109**	**100%**	**23**	**100%**

CONCERN LEVEL RESULTS

More than **one-third of the RSGCN and nearly one-third of the Proposed RSGCN were considered Very High Concern** (Table 9, Figure 5). **Seventy-four percent of the Very High Concern RSGCN are aquatic species** (fish, crayfish, mussels, Odonates, and EPT), not including aquatic herpetofauna (Table 10, Figure 6). **Of the 115 RSGCN that are Very High Concern, 28 (24%) are MAFWA endemics and another 32 (28%) have Midwest regional responsibilities over 75%**. Of the 28 RSGCN that are Very High Concern but less than 50% regional responsibility, all but two are Highly Imperiled throughout their ranges; one of those two has a Core Population in the Midwest and the other is experiencing or expected to experience a Range Shift due to Climate Change (Appendix I).

Table 9. Number and proportion of RSGCN and Proposed RSGCN in each Concern Level category.

Concern Level	RSGCN Number	RSGCN %	Proposed RSGCN	Proposed RSGCN %
Very High Concern	115	34%	45	30%
High Concern	131	39%	40	27%
Moderate Concern	94	28%	63	43%
Total RSGCN	**340**	**100%**	**148**	**100%**

Figure 5. Percent of RSGCN in each Concern Level category.

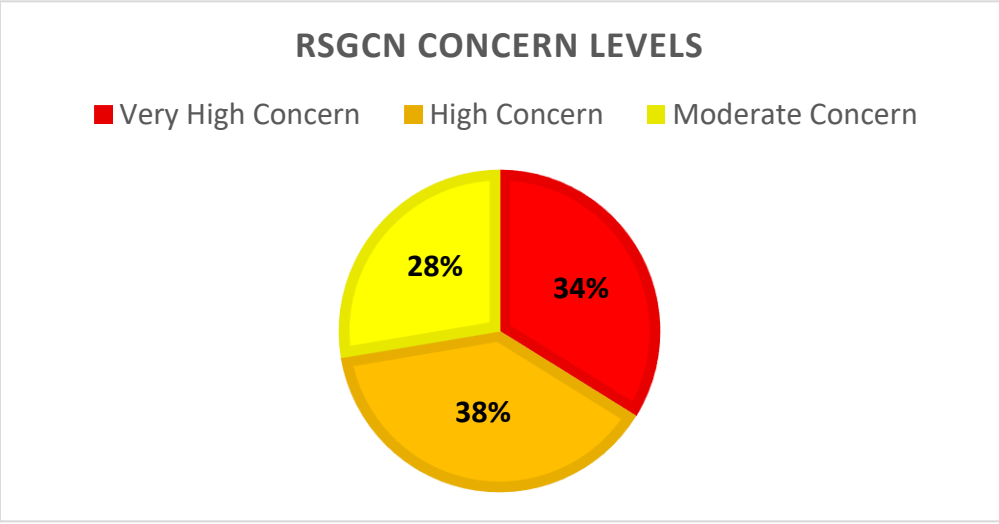
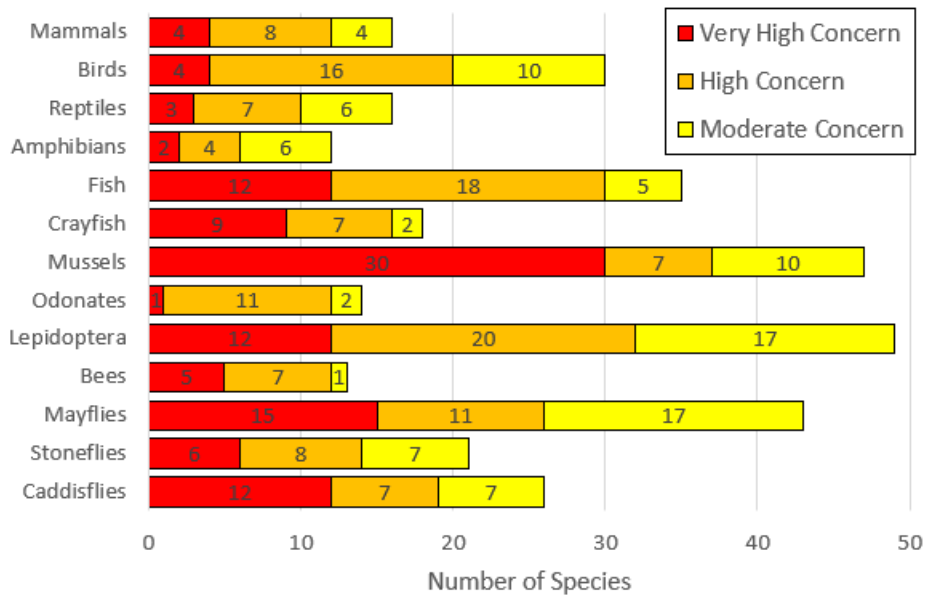


Table 10. Number and percent of RSGCN in each Concern Level category by taxonomic group.

	RSGCN Number and %						
Taxonomic Group	**Very High Concern**		**High Concern**		**Moderate Concern**		**Total RSGCN**
Mammals	4	25%	8	50%	4	25%	**16**
Birds	4	13%	16	53%	10	33%	**30**
Reptiles	3	19%	7	44%	6	38%	**16**
Amphibians	2	17%	4	33%	6	50%	**12**
Fish	12	34%	18	51%	5	14%	**35**
Crayfish	9	50%	7	39%	2	11%	**18**
Mussels	30	64%	7	15%	10	21%	**47**
Odonates	1	7%	11	79%	2	14%	**14**
Lepidoptera	12	24%	20	41%	17	35%	**49**
Bees	5	38%	7	54%	1	8%	**13**
Mayflies	15	35%	11	26%	17	40%	**43**
Stoneflies	6	29%	8	38%	7	33%	**21**
Caddisflies	12	46%	7	27%	7	27%	**26**
Total	**115**	**34%**	**131**	**39%**	**94**	**28%**	**340**

Figure 6. Number of RSGCN in each Concern Level category by taxonomic group.



Nearly two-thirds (64%) of the Freshwater Mussel RSGCN are of Very High Concern, as are half of the Crayfish RSGCN and nearly half (46%) of the Caddisfly RSGCN (Table 10, Appendix E). Ninety-two percent (92%) of the Bee RSGCN, 89% of the Crayfish RSGCN, 86% of the Odonate RSGCN and 86% of the Fish RSGCN and are of High or Very High Concern.

The Proposed RSGCN of Very High Concern are also dominated by aquatic species, with only one of the 45 species not aquatic (Table 11, Appendix F). Only two of the 45 species are vertebrates – one amphibian and one fish – and the rest are invertebrates. Almost half of the Proposed RSGCN of Very High Concern are Caddisflies. Eighty percent (80%) of the Stonefly Proposed RSGCN are of Very High Concern.

Table 11. Number and percent of Proposed RSGCN in each Concern Level category by taxonomic group.

	Proposed RSGCN Number and %						
Taxonomic Group	**Very High Concern**		**High Concern**		**Moderate Concern**		**Total Proposed RSGCN**
Mammals	0	0%	0	0%	0	0%	**0**
Birds	0	0%	0	0%	0	0%	**0**
Reptiles	0	0%	0	0%	0	0%	**0**
Amphibians	0	0%	0	0%	1	100%	**1**
Fish	0	0%	1	100%	0	0%	**1**
Crayfish	1	14%	2	29%	4	57%	**7**
Mussels	1	50%	0	0%	0	0%	**1**
Odonates	0	0%	1	50%	1	50%	**2**
Lepidoptera	1	17%	4	67%	1	100%	**6**
Bees	0	0%	3	43%	4	57%	**7**
Mayflies	12	29%	7	17%	23	55%	**42**
Stoneflies	8	80%	2	20%	0	0%	**10**
Caddisflies	22	31%	20	29%	28	40%	**70**
Total	**45**	**30%**	**40**	**27%**	**63**	**43%**	**148**

MAFWA ENDEMIC RSGCN OF VERY HIGH CONCERN

Of the 76 RSGCN and Proposed RSGCN that are endemic to the MAFWA region, 46 (61%) were identified as Very High Concern by the taxa teams (Table 12; Appendix H). Nearly half of these species are caddisflies (21). The remaining taxa include four fish, five crayfish, four Lepidoptera, four mayflies, four stoneflies, two mussels, one snake, and one Odonate. Five of the MAFWA RSGCN that are endemic and Very High Concern are federally listed, and two are proposed. The Poweshiek Skipperling (*Oarisma poweshiek*) and Hine's Emerald (*Somatochlora hineana*) are federally endangered. The Poweshiek Skipperling historically was found in eight MAFWA states (IA, IL, IN, MI, MN, ND, and SD) but is now extant only to Michigan and Manitoba. The Hine's Emerald occurs in six Midwest states (IL, IN, MI, MO, OH, and WI). Two mussels are also federally endangered – the White Catspaw (*Epioblasma perobliqua*) and Higgins Eye (*Lampsilis higginsii*). Four Midwest states share the White Catspaw: IN, KY, MI, and OH. The Higgins Eye is found in six MAFWA states (IA, IL, MN, MO, SD, and WI). The Dakota Skipper (*Hesperia dacotae*) is federally threatened and occurs in five Midwest states (IA, IL, MN, ND, and SD). The Big Creek Crayfish (*Faxonius peruncus*) and St. Francis River Crayfish (*Faxonius quadruncus*) are Proposed Threatened; these two crayfish also are listed as RSGCN in the Southeast, with both species endemic to Missouri, which is a member of both MAFWA and SEAFWA.

Table 12. RSGCN and Proposed RSGCN that are endemic to the MAFWA region and of Very High Concern.

RSGCN	Proposed RSGCN
Hoosier Cavefish (*Amblyopsis hoosieri*)	Kentucky Stone (*Acroneuria hitchcocki*)
Ives Lake Cisco (*Coregonus hubbsi*)	*Leuctra schusteri* (a needlefly)
Shortjaw Cisco (*Coregonus zenithicus*)	Ohio Stone (*Neoperla gaufini*)
Siskiwit Lake Cisco (*Coregonus zenithicus bartletti*)	Karst Forestfly (*Soyedina calcarean*)
Bagisara gulnare (a noctuid moth)	*Ceraclea erulla* (a longhorned caddisfly)
Michigan Dune Dart Moth (*Copablepharon michiganensis*)	*Ceraclea maccalmonti* (a longhorned caddisfly)
Dakota Skipper (*Hesperia dacotae*)	*Cernotina ohio* (a caddisfly)
Poweshiek Skipperling (*Oarisma poweshiek*)***	*Holocentropus chellus* (a polycentropodid caddisfly)
Crittenden Crayfish (*Faxonius bisectus*)	*Hydroptila danieli* (a purse casemaker caddisfly)
Louisville Crayfish (*Faxonius jeffersoni*)	*Hydroptila howelli* (a purse casemaker caddisfly)
Big Creek Crayfish (*Faxonius peruncus*)**	*Hydroptila kuehnei* (a purse casemaker caddisfly)

RSGCN	Proposed RSGCN
St. Francis River Crayfish (*Faxonius quadruncus*)**	*Hydroptila paraxella* (a purse casemaker caddisfly)
Caney Mountain Cave Crayfish (*Faxonius stygocaneyi*)	*Neotrichia paraokopa* (a microcaddisfly)
Hine's Emerald (*Somatochlora hineana*)***	*Neotrichia staufferi* (a microcaddisfly)
Wisconsin Small Square-gilled Mayfly (*Cercobrachys lilliei*)	*Plectrocnemia sabulosa* (a polycentropodid caddisfly)
Konza Prairie Mayfly (*Leptophlebia konza*)	*Polycentropus neiswanderi* (a polycentropodid caddisfly)
Paraleptophlebia sticta (a prongill mayfly)	*Setodes truncates* (a leptocerid caddisfly)
Robust Pentagenian Burrowing Mayfly (*Pentagenia robusta*)	Athens Triaenodes Caddisfly (*Triaenodes phalacris*)
Artesian Agapetus Caddisfly (*Agapetus artesus*)	
Headwater Chilostigman Caddisfly (*Chilostigma itascae*)	
Missouri Glyphopsyche Caddisfly (*Glyphopsyche missouri*)	
Holocentropus milaca (a polycentropodid caddisfly)	
Platte River Caddisfly (*Ironoquia plattensis*)	
Unhorned Microcaddisfly (*Oxyethira ecornuta*)	
Oxyethira itascae (an oxyethiran microcaddisfly)	
White Catspaw (*Epioblasma perobliqua*)***	
Higgins Eye (*Lampsilis higginsii*)***	
Plain-bellied Watersnake (Copperbelly pop.) (*Nerodia erythrogaster neglecta*)**	

** Under Review; ** Federally threatened or Proposed threatened; *** Federally endangered*

STATE AND REGIONAL OPPORTUNITY

Each of the species classifications – regional geographic responsibility, degree of conservation concern, number of states sharing a RSGCN – can be used to set priorities for collaboration in the Midwest region. For example, states and their partners, particularly the USFWS, may consider focusing on the species that are shared by multiple states (Figure 7). Priorities can be further refined to focus on the 60 species with Very High Concern and greater than 75%

Regional Responsibility. **RSGCN shared by ten or more states account for only 3% of the 1817 SGCN reviewed**.

States can identify opportunities to collaborate with neighboring states on shared RSGCN. Indiana and Illinois have the highest number of RSGCN (Figure 8, Table 13) occurring in their states, with 179 RSGCN occurring in both states and presenting an opportunity for collaboration between the neighboring states. Those two states have the highest number of Lepidoptera RSGCN and EPT RSGCN, which could prioritize taxa for collaboration (Table 13). The states that share the Ohio River all have high numbers of Freshwater Mussel RSGCN and could provide a regional collaboration opportunity. The classifications included in this RSGCN list allow for sorting and prioritization of the species in multiple ways, for customized use by MLI, MAFWA, and their partners.

Figure 7. Number of RSGCN by the number of MAFWA states sharing the species.

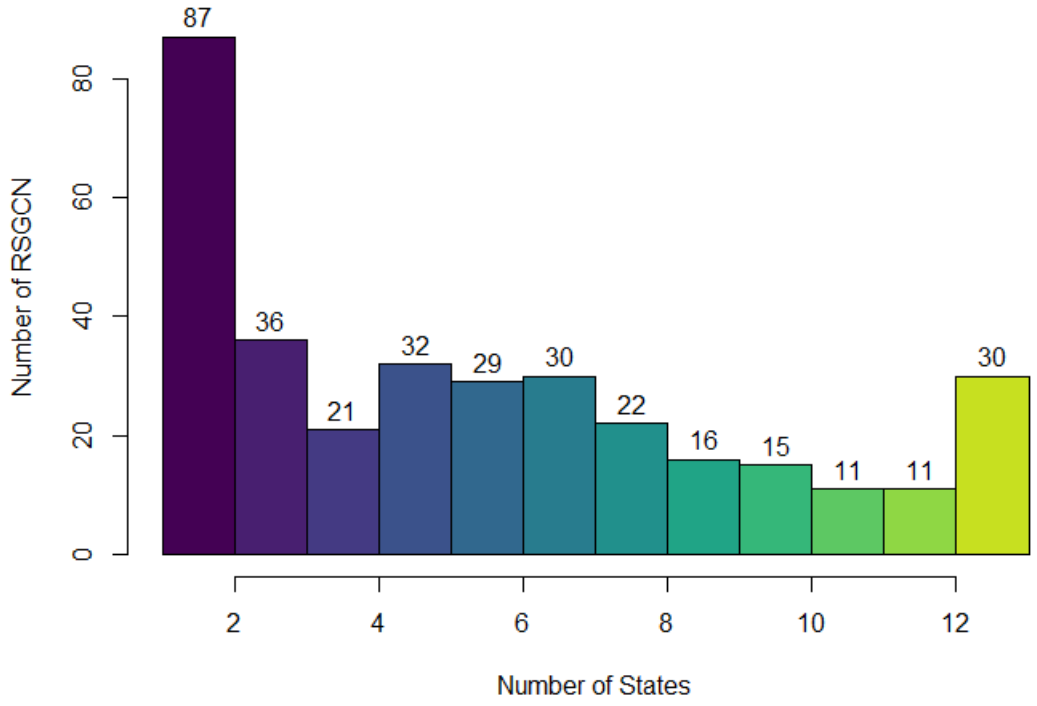


Figure 8. Number of RSGCN occurring in each MAFWA state.

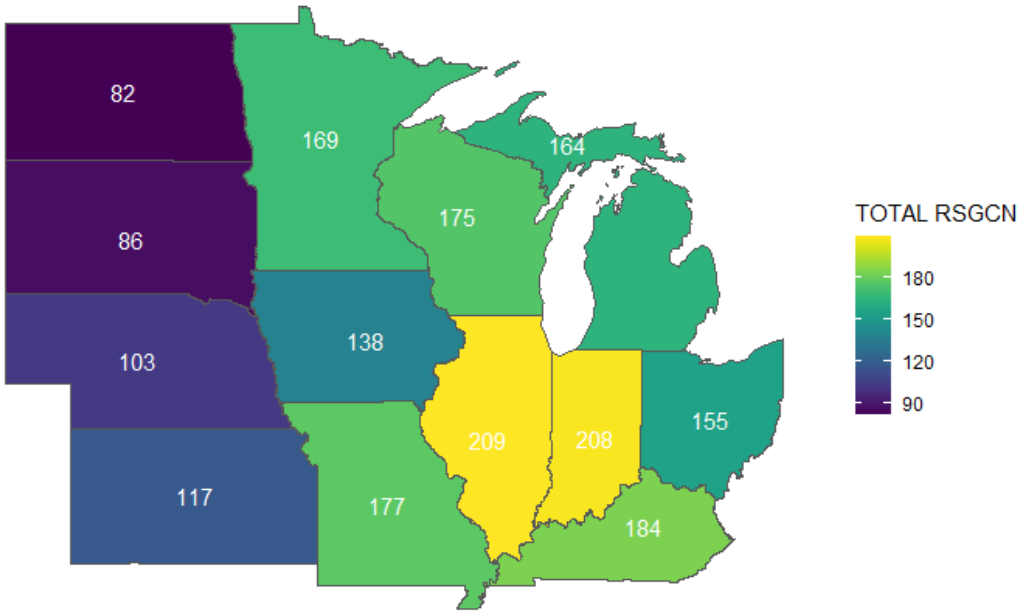


Table 13. RSGCN occurring in each MAFWA state in each taxa.

Taxa	IA	IL	IN	KS	KY	MI	MN	MO	ND	NE	OH	SD	WI
Mammals	10	9	9	10	10	7	10	10	8	13	7	10	8
Birds	28	29	26	28	26	25	28	24	25	28	27	28	27
Reptiles	7	10	8	6	2	9	6	9	2	6	9	4	6
Amphibians	4	8	8	4	6	6	5	9	1	1	7	2	5
Fish	12	14	14	12	19	12	13	15	10	10	8	11	7
Crayfish	1	4	2	0	7	1	1	8	0	0	1	0	1
Mussels	14	30	36	14	42	15	18	24	3	8	28	8	16
Odonates	6	7	9	3	8	9	11	7	1	3	9	3	11
Bees	5	7	9	3	4	4	6	9	8	3	5	4	7
Lepidoptera	20	36	34	15	23	33	26	27	12	11	18	11	37
Caddisflies	3	11	11	2	11	17	15	9	2	1	9	0	13
Mayflies	19	28	29	15	19	17	19	17	8	14	20	4	28
Stoneflies	9	16	13	5	7	9	11	9	2	5	7	1	9
Total RSGCN	**138**	**209**	**208**	**117**	**184**	**164**	**169**	**177**	**82**	**103**	**155**	**86**	**175**

TAXA-SPECIFIC DETERMINATIONS

The regional view of RSGCNs just presented is very useful for identifying conservation needs and prioritizing management efforts. However, on-the-ground conservation efforts do not usually occur for such broad taxonomic groups; management actions needed to protect the Indiana Myotis (*Myotis sodalis*) will differ from steps needed to protect pocket gophers, for example. Therefore, in the following sections we provide an in-depth discussion of at-risk species in each taxonomic group, including an analysis of current and potential threats to species in each taxon.

Within each taxonomic focus area – mammals, birds, reptiles, amphibians, fish, crayfish, freshwater mussels, dragonflies and damselflies, bumble bees and solitary bees, butterflies and moths, mayflies, stoneflies and caddisflies – some generally interesting findings are presented below, as well as subsets of those findings for Very High Concern, MAFWA endemics, Proposed RSGCN, and RSGCN limiting factors. A discussion for each taxon follows those findings. RSGCN Watchlist species are discussed in the Additional Taxa and Species Considered section.

MAMMALS

The Mammal Taxa Team addressed terrestrial species in several taxonomic Orders. Aside from threats of White Nose Syndrome to bats, threats to mammals in the Midwest identified by the Mammal Taxa Team include impacts from wind energy, climate change, development, and habitat loss.

RESULTS

The Mammal RSGCN list includes 16 species, out of 105 Mammal SGCN in the MAFWA region (Table 1, Figure 9, Appendix D). Four Mammal RSGCN are Very High Concern, eight are High Concern, and four are Moderate Concern (Table 9, Appendix E). The list includes nine Bats (*Chiroptera*), four Rodents (*Rodentia*), two Carnivores (*Carnivora*), and one jackrabbit (*Lagomorpha*). Six RSGCN Mammals are federally listed as endangered (2), threatened (1), or under review for potential listing (3). All but one of these mammals are bats, with the Plains Spotted Skunk (*Spilogale putorius interrupta*) under review the exception.

Most of the Midwest RSGCN Mammals are also identified as RSGCN in adjacent regions (Table 14), with eight of the Midwest RSGCN identified as Northeast RSGCN and seven species identified as Southeast RSGCN. Six mammals are RSGCN in all three regions: Hoary Bat (*Lasiurus cinereus*), Little Brown Myotis (*Myotis lucifugus*), Indiana Myotis (*Myotis sodalis*), Northern Long-eared Bat (*Myotis septentrionalis*), Tricolored Bat (*Perimyotis subflavus*), and Eastern

Spotted Skunk (*Spilogale putorius*). In the Midwest, the Mammal Taxa Team decided to consider the subspecies *Myotis lucifugus lucifugus* under the nominal species, not listing the subspecies separately as RSGCN.

There are no Proposed RSGCN Mammals (Table 2, Appendix F). **Ten additional mammals are on the RSGCN Watchlist as Assessment Priority species** (Table 3, Appendix G).

Figure 9. Number and percent of Midwest Mammal SGCN that are RSGCN and at what Concern Levels.

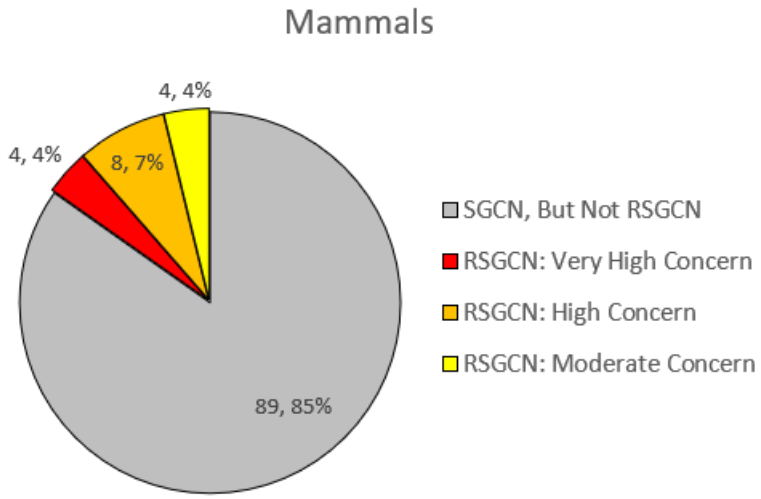


Table 14. Midwest RSGCN Mammals also listed as RSGCN in the Northeast and/or Southeast regions.

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Silver-haired Bat (*Lasionycteris noctivagans*)	Moderate	Moderate	n/a
Eastern Red Bat (*Lasiurus borealis*)	High	Moderate	n/a
Hoary Bat (*Lasiurus cinereus*)	High	Moderate	High
Gray Myotis (*Myotis grisescens*)***	High	n/a	Moderate
Little Brown Myotis (*Myotis lucifugus*)*	Very High	Very High	Very High
Northern Long-eared Bat (*Myotis septentrionalis*)**	Very High	Very High	Very High
Indiana Myotis (*Myotis sodalis*)*	Very High	Very High	Very High

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Tricolored Bat (*Perimyotis subflavus*)*	Very High	Very High	High
Eastern Spotted Skunk (*Spilogale putorius*)	High	Data Deficient	High

* Under Review; ** Federally threatened; *** Federally endangered

VERY HIGH CONCERN MAMMALS

The Mammal Taxa Team identified four Very High Concern Mammal RSGCN, all four of which are bats (Table 10; Appendix E, Table E-1). All four bats have a federally listed status or are under review for potential listing. The Indiana Myotis is federally endangered, the Northern Long-eared Bat is federally threatened, and the Tricolored Bat and Little Brown Bat are under review. The four bats also are listed as RSGCN in both the Northeast and Southeast regions, with all four considered Very High Concern in the Northeast and all but the Tricolored Bat (High Concern) considered Very High Concern in the Southeast (Table 14).

Little Brown Myotis and Northern Long-eared Bat occur in all 13 MAFWA states. The Indiana Myotis occurs in seven MAFWA states and the Tricolored Bat in 11. The Indiana Myotis has Midwest regional responsibility of 50-75%, while the other three bats have less than 50% regional responsibility with a Responsibility Overriding Factor (ROF) of Highly Imperiled throughout their ranges (Appendix I).

In addition to the Northern Long-eared Bat, the Mammal Taxa Team identified the Little Brown Myotis as one of the bat species most heavily impacted by White Nose Syndrome, with significant decreases (up to 90%) in population size observed in some states and stable or increasing overwintering and summer populations in other states. It is worth noting that the Tricolored Bat has a wide range, with populations occurring far to the south in Central America. These southern populations are fairly stable. However, the population in the Midwest is under a significant threat. The Tricolored Bat is one of the species most heavily impacted by White Nose Syndrome, with population decreases greater than 90% observed in numerous states.

MAFWA ENDEMIC MAMMALS

There are three RSGCN mammals that are endemic to the MAFWA region. All three of the MAFWA endemic RSGCN mammals are found in just one state. The Kentucky Red-backed Vole (*Myodes gapperi maurus*) is only found in mesic mid-slope and high elevation habitats (forest and wetland) in Kentucky and has always been rare. Kentucky is also at the southern extent of the (nominal) species range in the East. Because of this, climate change may result in decreased

population size or possible extirpation; the Mammal Taxa Team categorized this species with a COF of Climate Vulnerable. The Cheyenne Northern Pocket Gopher (*Thomomys talpoides cheyennensis*) and Pierre Northern Pocket Gopher (*Thomomys talpoides pierreicolus*) are endemic to Nebraska. The pocket gophers are found in grassland, riparian, and agricultural (perennial grasses / crops) habitats.

SHARED MAMMAL SPECIES

Of the 16 RSGCN mammals, 12 (75%) are shared by at least four MAFWA states. Ten states or more share responsibility for 44% of RSGCN mammals; none of these are endemic. MAFWA is more than 75% responsible for one of those, the Franklin's Ground Squirrel (*Poliocitellus franklinii*). The Franklin's Ground Squirrel was identified by the Mammal Taxa Team as a Stronghold Species facing Emerging Threats (Appendix I).

Five RSGCN mammals are found in all 13 MAFWA states; all five of these are bats: Little Brown Myotis, Northern Long-eared Bat, Hoary Bat (*Lasiurus cinereus*), Silver-haired Bat (*Lasionycteris noctivagans*), and Eastern Red Bat (*Lasiurus borealis*). The first two are Very High Concern, the Hoary and Eastern Red Bats are High Concern, and the Silver-haired Bat is Moderate Concern.

RSGCN MAMMAL HABITAT AND LIMITING FACTORS

From discussions with the Mammal Taxa Team, it appears bats may be the most imperiled group of mammals in the region. White-Nose Syndrome (WNS) may be the most significant and commonly recognized threat and has been detected in all six of the cave-hibernating bats. Some of these species, namely Northern Long-eared Bat, Little Brown Myotis, and Tricolored Bat, have experienced significant population declines near or in excess of 90%. While the other cave bats have not exhibited such extreme declines, WNS is a significant threat to all of them. Though not affected directly by the disease, several of the migrating bat species have been found positive for *Pseudogymnoascus destructans*, the fungus that causes WNS. This is concerning, as these species could be transporting the fungus along their migration routes, potentially spreading it to previously uninfected cave bat populations.

All nine of the bat RSGCN are affected by deforestation, regardless of whether they are a hibernating or migratory species. Forests are the primary habitat used by this group in summer for breeding, foraging, roosting, and most other activities. Further destruction of cave sites has additional impacts on the hibernating species; the Gray Myotis (*Myotis grisescens*) is particularly sensitive to human disturbance within caves.

An emerging threat identified by the taxa team for the three migratory bat species is wind power development. Significant mortalities of all three species have been observed around wind turbines, especially during migration. Increasing numbers of wind energy projects are

being proposed and planned throughout the region, suggesting that this threat may increase rapidly in the coming years. Mortality around turbines has been observed in some of the cave bat species, but is not thought to have as much of an impact on the overall populations.

Pesticide and insecticide use may have impacts on all of the species. As they are all insectivores, populations foraging in agricultural areas may be affected, particularly if the bats are ingesting large numbers of contaminated insects.

Disease and habitat loss are also significant threats to the White-tailed Jackrabbit (*Lepus townsendii*). The species is susceptible to rabbit hemorrhagic disease virus (RHDV2). Currently, this disease is not yet present in the Midwest region, but outbreaks in the Southwest may spread. Conversion of prairie habitat to agriculture has already contributed to declines in the White-tailed Jackrabbit. Climate change is another potential threat to this species; as the climate warms and dries, Black-tailed Jackrabbits (*Lepus californicus*) are expected to expand their range further into the Midwest and outcompete the White-tailed Jackrabbit.

The Eastern and Plains Spotted Skunks (*Spilogale putorius* and *S. p. interrupta*, respectively) are primarily impacted by urbanization and development reducing available habitat. These species are regulated by trapping in some states, which may affect populations there. They also appear to be susceptible to road mortality.

Franklin's Ground Squirrel is impacted by development, as land conversion both reduces the available habitat for this species, and fragments and isolates populations. This may affect the genetic diversity of populations in the future. Threats to other rodent RSGCN are less well defined, indicating a lack of available data for these species.

PROPOSED RSGCN MAMMALS

There are no Proposed RSGCN Mammals (Table 2).

MAMMALS DISCUSSION

The MAFWA states averaged more than nine RSGCN Mammals each, with Nebraska (13) supporting the largest number (Table 13). Iowa, Kansas, Kentucky, Minnesota, Missouri, and South Dakota supported higher than the average number of RSGCN Mammals as well. RSGCN Mammal species diversity appeared to be fairly consistent across the region, with 7 to 13 RSGCN per state.

The majority of RSGCN Mammals are bats, indicative of recent declines due to WNS and wind turbine mortality among other factors. All of the Very High Concern Mammal RSGCN are bats, with declines of up to 90% of some bat species in several Midwest states reported by the taxa team. Eight of the nine Midwest RSGCN bats have also been identified as RSGCN in adjacent

regions, reflective of rangewide concern, and in five cases, federal listing status or review. The USFWS currently is preparing a Species Status Assessments (SSAs) for three Midwest bat species – Little Brown Myotis (the nominal species, not the *Myotis lucifugus lucifugus* subspecies), Northern Long-eared Bat, and Tricolored Bat. Some members of the taxa team expressed concern that as more is discovered about the demography, migration, and impacts of wind energy on migratory bats, additional bats may require RSGCN listing in the future.

In recent years, more work has been done on bats due to emerging threats of WNS and wind energy. The Mammal Taxa Team found it is widely accepted that wind turbines are a major threat to migratory bats, but population-wide effects are not well known. For some of the cave bats that have very large ranges that extend into Central and South America, WNS is not a concern in the southern areas (warmer climate limits growth of the disease); in some areas the species is stable, but the Midwest population is not. Some taxa team representatives expressed concern that WNS has "exhausted" many agencies, facilitating other data deficiencies for several species of bats.

One exception to the imperiled bats in the Midwest is Gray Myotis (*Myotis grisescens*), which the Mammal Taxa Team noted is not affected by WNS and has been increasing in population throughout its range. The team discussed the ongoing 5-year review of this federally endangered bat by the USFWS, with the potential for a downgrade in its status to federally threatened. The taxa team chose to identify the Gray Myotis as Moderate Concern rather than High or Very High (as is typical for federally endangered species) for these reasons.

As opposed to the efforts to monitor bats, the Mammal Taxa Team identified a general lack of small mammal surveys, leading many states to have little knowledge of current status and trends. Minnesota may be the exception, as they have had funding for small mammal surveys over the past two or three decades. The lack of current status and trend data contributed to the Mammal Taxa Team identifying ten species as Watchlist [Assessment Priority] species. Some small mammal species are particularly difficult to monitor. Generally, voles and mice are easier to trap than shrews, which require extensive pitfall trapping.

BIRDS

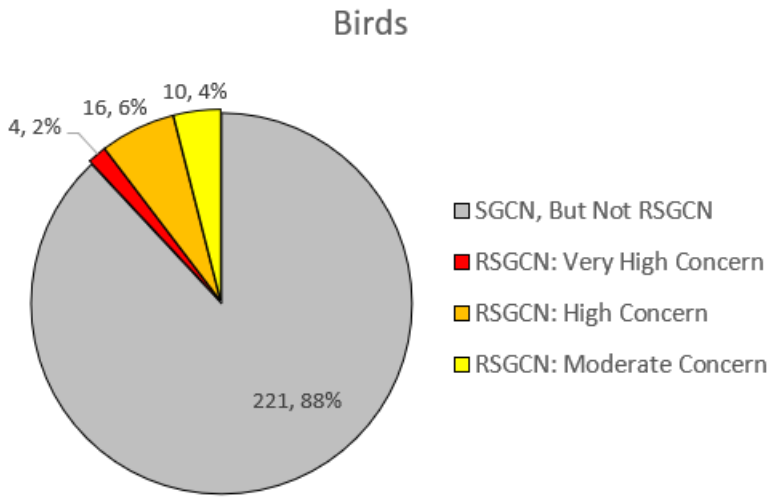
There was more comprehensive and robust taxonomic and conservation information available for bird species than for other taxonomic groups, including conservation status from PIF (2016) with its associated Avian Conservation Assessment Database (https://pif.birdconservancy.org/), Birds of the World (https://birdsoftheworld.org/bow/home), multiple Joint Ventures (Appalachian Mountains JV 2021, Central Hardwoods JV 2021, Eastern Habitat JV 2017, Northern Great Plains JV 2021, Prairie Habitat JV 2013, Prairie Pothole JV 2017, Rainwater Basin

JV 2013, Soulliere et al. 2020), the USFWS Birds of Conservation Concern (USFWS 2021), and the Midcontinent Shorebird Conservation Initiative (Manomet Center for Conservation Sciences 2021). This enabled the team to review bird species with more confidence and reach consensus on most species relatively quickly. The broad geographic ranges of birds and large number of migratory species presented a challenge in determining regional responsibility estimates for most Midwest species. The Bird Taxa Team expanded the regional responsibility metric beyond the North American geographic range to also identify the regional responsibilities for the breeding range, migratory stopover, and wintering range of RSGCN and Proposed RSGCN. These additional data address the challenge of identifying regional responsibility for highly migratory species and better capture the Midwest's responsibility for these species during specific portions of their life cycle.

RESULTS

The bird RSGCN list includes 30 species, out of 251 Bird SGCN in the MAFWA states (Table 1, Figure 10, Appendix D). Four Bird RSGCN are Very High Concern, 16 are High Concern, and 10 are Moderate Concern (Table 10, Appendix E). The RSGCN Birds list includes 14 passerines (*Passeriformes*); seven shorebirds (*Charadriiformes*); two coots, cranes, and rails (*Gruiformes*); two landfowl (*Galliformes*); and one species each from five other taxonomic orders.

Figure 10. Number and percent of Midwest Bird SGCN that are RSGCN and at what Concern Levels.



Four RSGCN Birds are federally listed or under review for potential listing and two have recently been delisted. The Great Lakes Population of Piping Plover (*Charadrius melodus*) and the Whooping Crane (*Grus americana*) are endangered. The Northern Great Plains Population of

Piping Plover is threatened. The Golden-winged Warbler (*Vermivora chrysoptera*) is under review. Kirtland's Warbler (*Setophaga kirtlandii*) was delisted in 2019, and the Interior Least Tern (*Sternula antillarum athalassos*) was delisted in 2021.

More than half of the Midwest RSGCN Birds are also identified as RSGCN in the Northeast and/or Southeast regions, a reflection of their migratory habits (Table 15). Two species are RSGCN Birds in all three regions: Cerulean Warbler (*Setophaga cerulea*) and Golden-winged Warbler. The 16 birds that are RSGCN in both the Midwest and Southeast are indicative of seasonal use of the regions, with many birds that breed in the Midwest overwintering in the Southeast.

There are no Proposed RSGCN Birds (Table 2). **Nine additional birds are on the RSGCN Watchlist as Assessment Priority species** (Table 3, Appendix G).

Table 15. Midwest RSGCN Birds also listed as RSGCN in the Northeast and/or Southeast regions.

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Grasshopper Sparrow (*Ammodramus savannarum*)	Moderate	n/a	High
LeConte's Sparrow (*Ammospiza leconteii*)	High	n/a	High
Nelson's Sparrow (*Ammospiza nelson*)	High	n/a	High
Sprague's Pipit (*Anthus spragueii*)	High	n/a	High
Eastern Whip-poor-will (*Antrostomus vociferus*)	High	n/a	High
Henslow's Sparrow (*Centronyx henslowii*)	High	n/a	High
Chimney Swift (*Chaetura pelagica*)	Moderate	n/a	Moderate
Piping Plover (*Charadrius melodus*)**†	Very High	High	High
Northern Bobwhite (*Colinus virginianus*)	Moderate	n/a	High
Yellow Rail (*Coturnicops noveboracensis*)	High	n/a	High
Rusty Blackbird (*Euphagus carolinus*)	High	n/a	High
Whooping Crane (*Grus americana*)***	Very High	n/a	High
Migrant Loggerhead Shrike (*Lanius ludovicianus migrans*)	High	Very High	n/a

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Cerulean Warbler (*Setophaga cerulea*)	High	Moderate	High
Kirtland's Warbler (*Setophaga kirtlandii*)	Very high	n/a	High
Eastern Meadowlark (*Sturnella magna*)	High	n/a	High
Golden-winged Warbler (*Vermivora chrysoptera*)*	High	Moderate	High

* Under Review; ** Federally threatened; *** Federally endangered

† Note that the Midwest has identified the federally endangered Great Lakes population and federally threatened Northern Great Plains populations of Piping Plover as separate RSGCN. The Northeast and Southeast regions have not split the species by breeding population; the Northeast supports the Great Lakes and federally threatened Atlantic Coast breeding and migrating populations, and the Southeast supports the Atlantic Coast breeding population and all three populations during the non-breeding seasons.

VERY HIGH CONCERN BIRDS

Taxa team representatives identified four Very High Concern RSGCN birds (Table 10; Appendix E, Table E-1). Three of these have a federal listing status, and the fourth has been delisted. The Whooping Crane is federally endangered. The Great Lakes population of the Piping Plover is also federally endangered, while the Northern Great Plains population of the Piping Plover is federally threatened. The Kirtland's Warbler was delisted in 2019. The Kirtland's Warbler and Whooping Crane are also RSGCN in the Southeast region (Table 15). The Piping Plover is RSGCN in both the Northeast and Southeast regions, although neither region lists the breeding populations as separate RSGCN; the Midwest region supports two distinct breeding populations of the Piping Plover.

None of the four Very High Concern RSGCN birds are MAFWA endemic, since all are migratory species (Appendix E, Table E-1). All four were identified by the Bird Taxa Team as Highly Imperiled and Core Populations as well as Migratory Species (Appendix I). The Midwest has 75-100% Regional Responsibility for the breeding range of both populations of Piping Plover. The entire breeding range of the Kirtland's Warbler is in Michigan, Wisconsin, and Ontario, all three of which are part of MAFWA. The Midwest has 75-100% regional responsibility for the migratory stopover habitat of the Whooping Crane.

MAFWA ENDEMIC BIRDS

None of the RSGCN birds are endemic to the MAFWA region (Table 1). One RSGCN bird, the Greater Prairie-Chicken (*Tympanuchus cupido*), has 75-100% of its geographic range in the MAFWA region. Eleven RSGCN Birds have at least 75% of their breeding range in the Midwest, including the Golden-winged Warbler with nearly its entire breeding population in the Great Lakes region (Table 16).

The MAFWA region has primary responsibility (at least 75%) for the migration or migratory stopover habitat for six RSGCN birds: LeConte's Sparrow (*Ammospiza leconteii*), Upland Sandpiper (*Bartramia longicauda*), Henslow's Sparrow (*Centronyx henslowii*), Connecticut Warbler (*Oporornis agilis*), Golden-winged Warbler, and the Whooping Crane.

The Midwest supports at least 75% of the wintering range of the non-migratory Greater Prairie-Chicken and 25-50% of the Northern Bobwhite (*Colinus virginianus*), Short-eared Owl (*Asio flammeus*), and Rusty Blackbird (*Euphagus carolinus*). Most of the remaining RSGCN Birds do not winter in the MAFWA states or provinces.

Table 16. RSGCN Birds with at least 75% of their breeding range in the MAFWA region.

Species	Concern Level	Number of States
Nelson's Sparrow (*Ammospiza nelson*)	High	13
Bobolink (*Dolichonyx oryzivorus*)	Moderate	13
Piping Plover (Great Lakes pop.) (*Charadrius melodus*)***	Very High	7
Piping Plover (Northern Great Plains pop.) (*Charadrius melodus*)**	Very High	10
Upland Sandpiper (*Bartramia longicauda*)	Moderate	13
Henslow's Sparrow (*Centronyx henslowii*)	High	13
Connecticut Warbler (*Oporornis agilis*)	High	12
Golden-winged Warbler (*Vermivora chrysoptera*)*	High	13
Interior Least Tern (*Sternula antillarum athalassos*)	High	10
Greater Prairie-Chicken (*Tympanuchus cupido*)	High	9

Kirtland's Warbler (*Setophaga kirtlandii*)	Very High	4

** Under Review; ** Federally threatened; *** Federally endangered*

SHARED BIRD SPECIES

Of the 30 RSGCN birds, 100% are shared by at least four MAFWA states. RSGCN birds are more widely distributed within the MAFWA region than the RSGCN mammals are. RSGCN birds in 10 states or more account for 87% (26) of the RSGCN bird species.

Seventeen (17) RSGCN birds are shared by all 13 MAFWA states:

- High Concern – LeConte's Sparrow, Nelson's Sparrow, Eastern Whip-poor-will (*Antrostomus vociferus*), Henslow's Sparrow, Black Tern (*Chlidonias niger*), Rusty Blackbird, Migrant Loggerhead Shrike (*Lanius ludovicianus migrans*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), and Golden-winged Warbler (*Vermivora chrysoptera*)
- Moderate Concern – Grasshopper Sparrow (*Ammodramus savannarum*), Short-eared Owl, Upland Sandpiper, Buff-breasted Sandpiper, Chimney Swift (*Chaetura pelagica*), Black-billed Cuckoo (*Coccyzus erythropthalmus*), Bobolink, and Western Meadowlark (*Sturnella neglecta*).

RSGCN BIRD HABITAT AND LIMITING FACTORS

The threats to RSGCN Birds most consistently mentioned by taxa team members were for species dependent on grassland habitats. Conversion of native prairies and similar habitats to agriculture, especially row crops, impacts all grassland species as their natural habitat declines. Shifting agricultural areas from pasture and hayfields to row crops can also be detrimental. Agricultural intensification may contribute to fragmentation of suitable habitat, which may further impact area-sensitive species such as the Upland Sandpiper (*Bartramia longicauda*). The Upland Sandpiper has responded to the insufficient availability of habitat in some areas by shifting from native prairies to grassed waterways in soybean fields; while this shift indicates that the species may be able to adapt to certain agricultural practices, it is not clear if these changes affect fecundity or survival rates. Agricultural intensification also results in increased chemical pollutants present in adjoining suitable grassland habitats. Some pollutants have historically had major impacts on bird populations and accumulate in individuals that consume contaminated insects.

Habitat management has significant effects – both positive and negative – on **grassland birds**. Periodic fires are necessary to maintain healthy grasslands by preventing the invasion of woody

growth. Mowing and grazing can also be used to reduce woody growth, but these activities can have negative effects on grassland birds while they are nesting. The Bird Taxa Team indicated that at least nine RSGCN Bird species can be impacted by mowing activities. Timing mowing to occur after fledging has occurred is vital, or it can turn otherwise suitable habitat into an ecological sink.

Grasshopper Sparrow, Eastern Meadowlark (*Sturnella magna*), and Western Meadowlark are all impacted by **brood parasitism** by Brown-headed Cowbirds (*Molothrus ater*). Brood parasitism reduces reproductive success for the host species, but it is possible this is only a minor local effect and does not affect the overall population. For Kirtland's Warbler, however, cowbird parasitism can severely limit local population growth.

Habitat availability is also a threat to **forest birds**, but the precise threat can vary as the RSGCN Birds have different requirements. Species that prefer open forests or shrublands, such as the Eastern Whip-poor-will and Golden-Winged Warbler, are threatened by natural succession. Transitioning to older, more mature forests with closed canopies reduces the suitability for these birds. Selective timber harvests and prescribed fire can be used to help maintain suitable conditions. Woody invasives are thought to decrease Whip-poor-will habitat quality as well as lead to increased predation by mesopredators. Golden-winged Warbler also face hybridization with the Blue-winged Warbler.

Habitat fragmentation is a threat to other birds, especially those that require large contiguous forest tracts. Fragmentation may be a result of development or conversion to agriculture. Insecticides are potentially a problem to insectivore species in most habitats. For example, the Black-billed Cuckoo specializes in caterpillars and is affected by loss of food and ingestion of pesticides. Impacts of increased forest pest spraying (gypsy moth, emerald ash borer, etc.) are not well known, though birds in agricultural landscapes have been shown to have elevated levels of neonicotinoids in their bodies.

A few forest birds are highly dependent on **specific structures** being present within forest stands. Red-headed Woodpeckers and Chimney Swifts require snags and hollow trees for nesting and roosting. Retaining these structures during timber harvest activities can benefit these and other cavity-dwelling birds. Chimney Swifts can also utilize structures in urban areas, but the common practice of capping or lining chimneys limits the availability of useable structures. There is evidence that climate change may increase storm severity and frequency during fall migration and spring cold snaps may also reduce availability of insect prey. Climate change is predicted to increase flooding in Cerulean warbler riparian nesting sites.

Finally, some forest birds are **habitat specialists** with very specific requirements. Kirtland's Warblers are dependent on young, post-fire jack pine stands. These forests are very dense, but rapidly become unsuitable as the stand approaches 20 years in age. Active forest management

and prescribed fire is necessary to maintain suitable patches for this species, which breeds entirely within the Midwest and suffered potential bottleneck effects from low populations in the 1970s and 1980s.

For RSGCN Birds associated with **wetland habitats**, the greatest threats are wetland conversion for agriculture and increased variability due to climate change. Wetlands conversion is often permanent and irreversible without concerted restoration efforts (Moreno-Mateos et al. 2012). Draining the water from the wetland completely alters the hydrology of the system, resulting in changes to the plant community. Removing the canopy cover in forested wetlands can have similar impacts, reducing suitability for birds such as Yellow Rail (*Coturnicops noveboracensis*) and Rusty Blackbird. Climate change is also likely to have major impacts on the hydrology of wetlands by increasing the frequency and severity of both flooding and droughts. Black Tern is likely affected by purple loosestrife, hybrid cattail, and other invasives that alter wetland structure and composition. Aquatic system contaminants can be ingested with food. For example, the Rusty blackbird may be affected by acid deposition in the aquatic insect prey base. Also, when habitats are opened up (e.g., by timber harvest), Red-winged Blackbird and Common Grackle may invade and outcompete Rusty Blackbirds for nesting territories.

The final group of RSGCN Birds are those dependent on the **shorelines** of large rivers and lakes. This includes two species: Interior Least Tern and Piping Plover (both the Northern Great Plains and Great Lakes populations). These species depend on sandy beaches, shorelines, and sandbars for nesting habitat. In many places, these habitats are threatened by development and encroachment of woody plants. In some cases, management of the vegetation through mechanical or chemical control is necessary to maintain suitable nesting sites.

As these species nest so close to large water sources, fluctuations in **water levels** can also be detrimental. This includes surges caused by dam releases and natural flooding. Regulating how and when dams release water may help prevent flooding of local nesting sites. Natural flooding is more difficult to control, especially as it is exacerbated by climate change. As with the wetland birds, climate change has the potential to increase the frequency and severity of flooding. This may result in increased nest failures and scouring of suitable habitat.

Another major threat to this group is predation by a variety of **mesopredators**, especially raccoons (*Procyon lotor*), and predation by other bird species including Great-horned Owl (*Bubo virginianus*), Herring Gull (*Larus argentatus*), and Black-crowned Night Heron (*Nycticorax nycticorax*). As these species are ground-nesting, eggs and chicks are extremely vulnerable to predation. In many cases, fencing and predator enclosures may help protect the nests and chicks from the native predators. Where nests are established in proximity to humans, there is also the risk of predation by cats, disturbance by dogs, and the chance of disturbance or trampling by humans unaware of their presence. Fencing can provide protection from pets, and informational signage around nesting areas may help reduce human disturbance.

PROPOSED RSGCN BIRDS

There are no Proposed RSGCN Birds (Table 2).

BIRDS DISCUSSION

A number of RSGCN Birds are also focal or priority species for seven Joint Ventures (JV) that include portions of the MAFWA region and/or the Midcontinent Shorebird Conservation Initiative (Table 17, Appendix J). Nearly three-quarters of the RSGCN Birds (73%) also are identified as Birds of Conservation Concern by the USFWS (USFWS 2021; Appendix J). These jointly-identified species provide an opportunity for regional collaboration for avian conservation in the Midwest among multiple partners. The Upland Sandpiper, for example, is a Midwest RSGCN of Moderate Concern that is also a priority species by the Prairie Habitat JV, Northern Great Plains JV, Prairie Pothole JV, and Upper Mississippi-Great Lakes JV. The Grasshopper Sparrow and Short-eared Owl have been identified as priority species by six Joint Ventures, while the Red-headed Woodpecker has been identified by five; all three are also Birds of Conservation Concern.

Table 17. Midwest RSGCN Birds that are also priority or focal species for Joint Ventures or the Midcontinent Shorebird Conservation Initiative.

Joint Venture or Initiative	Priority / Focal Species that are RSGCN	MAFWA States or Provinces within JV
Prairie Habitat JV	14	Manitoba, Saskatchewan
Eastern Habitat JV	0	Ontario
Northern Great Plains JV	7	ND, SD
Prairie Pothole JV	8	IA, MN, ND, SD
Upper Mississippi – Great Lakes JV	13	IA, IL, IN, KS, NE, MI, MO, MN, OH, WI
Rainwater Basin JV	8	NE
Central Hardwoods JV	9	IN, IL, KY, MO
Appalachian Mountains JV	11	KY, OH
Midcontinent Shorebird Conservation Initiative	3	-
Birds of Conservation Concern	22	-

The MAFWA states average more than 26 RSGCN Birds each, with all of the Midwest states supporting between 24 and 29 species (Table 13). This consistency in RSGCN Birds species diversity across the region may be reflective of the migratory nature and large geographic ranges of the taxa.

The development of additional regional responsibility metrics for migratory birds by the Midwest Bird Taxa Team advanced the selection method for RSGCN and allows for increased understanding of the true responsibilities of the region for migratory species. Initially Responsibility Overriding Factors were included for breeding, migration, and wintering ranges, but the taxa team were not satisfied with depending on ROF to express the importance of the Midwest to birds. Identifying separate regional responsibilities for breeding, migration, and wintering of migratory species allowed the Bird Taxa Team and MLI to better understand and communicate which parts of the life cycle and/or seasons are of concern for each RSGCN, especially when compared to the regional responsibilities of non-migratory species. One point of discussion by the team was how to include the three Canadian provinces (Ontario, Manitoba, and Saskatchewan) that are part of MAFWA, particularly given the large geographic area that the three provinces add to breeding range calculations. Ultimately the Bird Taxa Team chose to include the Canadian provinces of MAFWA in their regional responsibility calculations to be consistent with and support Joint Ventures, Flyway Councils, and other international efforts for bird conservation.

REPTILES

The Herpetofauna Taxa Team was challenged by taxonomy issues in both reptiles and amphibians, and many species and/or subspecies had updated taxonomy since they were identified as SGCN. Some subspecies are no longer valid according to the Society for the Study of Amphibians and Reptiles (SSAR). The scientific and common names of several SGCN reptiles were updated with new taxonomy as well. One reptile retained its invalid subspecies taxonomy in order to remain consistent with the taxonomy of its federal listing.

RESULTS

The Reptile RSGCN list includes 16 species, out of 124 Reptile SGCN in the MAFWA region (Table 1, Figure 11, Appendix D). Three Reptile RSGCN are Very High Concern, seven are High Concern, and six are Moderate Concern (Table 10, Appendix E). The Reptiles RSGCN list includes 12 snakes (*Squamata*) and four turtles (*Testudines*). Two RSGCN reptiles are federally threatened: Eastern Massasauga (*Sistrurus catenatus*) and the Copperbelly Population of the Plain-bellied Watersnake (*Nerodia erythrogaster neglecta*), although the subspecies taxonomy of the latter is no longer valid. One RSGCN reptile has been delisted (Lake Erie Watersnake,

Nerodia sipedon insularum). Three RSGCN reptiles are under review for potential listing: Spotted Turtle (*Clemmys guttata*), Blanding's Turtle (*Emydoidea blandingii*), and Wood Turtle (*Glyptemys insculpta*).

There are six Midwest RSGCN Reptiles that have been identified as RSGCN in the Northeast and/or Southeast (Table 18). Two reptiles are RSGCN in all three regions: Timber Rattlesnake (*Crotalus horridus*) and Spotted Turtle (*Clemmys guttata*).

No additional reptiles are Proposed RSGCN (Table 2, Appendix F). **Fourteen additional reptiles are on the RSGCN Watchlist as Assessment Priority species** (Table 3, Appendix G).

Figure 11. Number and percent of Midwest Reptile SGCN that are RSGCN and at what Concern Levels.

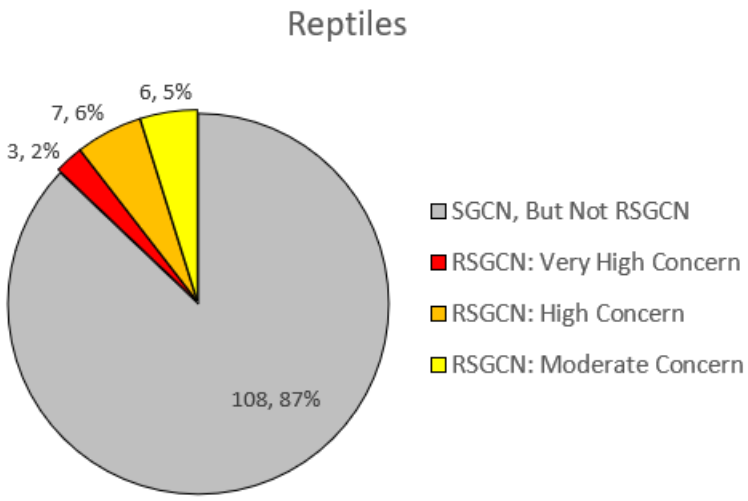


Table 18. Midwest RSGCN Reptiles also listed as RSGCN in the Northeast and/or Southeast regions.

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Wood Turtle (*Glyptemys insculpta*)*	High	High	n/a
Blanding's Turtle (*Emydoidea blandingii*)*	High	Very High	n/a
Timber Rattlesnake (*Crotalus horridus*)	Moderate	High	Moderate
Spotted Turtle (*Clemmys guttata*)*	High	High	High
Smooth Greensnake (*Opheodrys vernalis*)	High	Moderate	n/a

Dusty Hog-nosed Snake (*Heterodon gloydi*)	Very High	n/a	High

* Under Review; ** Federally threatened; *** Federally endangered

VERY HIGH CONCERN REPTILES

The Reptile Taxa Team identified three Very High Concern reptiles (Table 10; Appendix E, Table E-1). The Eastern Massasauga is federally threatened and the Midwest has 75-100% regional responsibility for this species. The Dusty Hog-Nosed Snake (*Heterodon gloydi*) has less than 50% regional responsibility but was identified by the Reptile Taxa Team as Highly Imperiled (Appendix I). The northern Distinct Population Segment (DPS) of the Copper-bellied Watersnake (= Plain-bellied Watersnake) is endemic to the Midwest, federally listed as threatened, and state-endangered in Indiana, Michigan, and Ohio. The subspecies taxonomy of the Copper-bellied Watersnake is no longer considered valid, but the Reptile Taxa Team chose to list the RSGCN with the invalid subspecies taxonomy to remain consistent with the taxonomy of its federal listing.

All three of these Very High Concern reptiles are shared by multiple states. The Dusty Hog-Nosed Snake and Plain-bellied Watersnake (Copperbelly DPS) are each shared by three Midwest states. The former occurs in IL, KS, and MO; the latter occurs in IN, MI, and OH. The Eastern Massasauga occurs in seven MAFWA states (IL, IN, MI, MN, MO, OH, and WI) and may occur in Iowa as well.

MAFWA ENDEMIC REPTILES

There are three RSGCN reptiles (19%) that are endemic to the MAFWA region (Table 1). One of the endemic RSGCN reptiles is of Very High Concern: the Copperbelly population of the Plain-bellied Watersnake, described above. The other two are of Moderate Concern. The Lake Erie Watersnake is a Disjunct Population found only in Ohio. The Great Lakes population of the Eastern Foxsnake (*Pantherophis gloydi*) was identified by the Reptile Taxa Team as a Disjunct Population with Genetic Distinctiveness; this species population occurs in Michigan and Illinois (Appendix I).

SHARED REPTILE SPECIES

Of the 16 RSGCN reptiles, 69% (11) are shared by at least four MAFWA states. Three RSGCN reptiles occur in ten or more MAFWA states. The Smooth Greensnake (*Opheodrys vernalis*) occurs in 12 of the 13 MAFWA states, only absent from Kentucky. The Reptile Taxa Team identified the Smooth Greensnake with a Core Population in the Midwest that is also a Stronghold Species and Keystone Species; the Midwest has a 50-75% regional responsibility for

this species. The Smooth Greensnake is a RSGCN of High Concern, with the Taxa Team identifying it as Highly Imperiled and facing Emerging Threats (Appendix I). This RSGCN snake is associated with Grassland and Riparian habitats.

The Timber Rattlesnake (*Crotalus horridus*) and Blanding's Turtle each occur in ten MAFWA states. The Timber Rattlesnake is of Moderate Concern with less than 50% regional responsibility. The Reptile Taxa Team identified the Timber Rattlesnake as Highly Imperiled with several Concern Overriding Factors: Emerging Threats, Keystone Species, Stronghold Species, and Genetic Distinctiveness (Appendix I). The Timber Rattlesnake occurs in all the MAFWA states except for Michigan, North Dakota, and South Dakota, and the snake is associated with Forest, Wetland, Agricultural, and Mine habitats. The Blanding's Turtle is a RSGCN of High Concern with a regional responsibility of 75-100%. Associated with Wetlands, Lakes and Ponds, Grassland, and Agricultural habitats, the Blanding's Turtle is absent from Kansas, Kentucky, and North Dakota but occurs in the remaining ten MAFWA states.

RSGCN REPTILE HABITAT AND LIMITING FACTORS

Regardless of the preferred habitat type, nearly all RSGCN Reptiles are threatened by **habitat loss**, primarily through development and conversion to agriculture. The Herpetofauna Taxa Team indicated that many species are habitat specialists, dependent on unique or rare communities. Eastern and Western Massasauga (*Sistrurus tergeminus*) utilize wet, bottomland prairie. The Copperbelly population of the Plain-bellied Watersnake requires forested wetlands and buttonbush swamps. Yellow-bellied Mud Turtles (*Kinosternon flavescens*) in Illinois, Missouri, and Iowa preferably occur in small, disjunct fragments of upland sand prairie. The unique requirements for all of these species makes them even more susceptible to habitat loss, as it results in suitable habitat patches becoming more isolated and fragmenting populations. Isolated populations may exhibit limited reproductive success, be prone to inbreeding, and are more vulnerable to extinction. This fragmentation can also limit species with large home ranges, such as the Wood Turtle, or species that require adjoining overwintering and breeding sites, such as Kirtland's Snake (*Clonophis kirtlandii*).

Many snakes in the region are further impacted by **Snake Fungal Disease** (SFD). Of the dozen RSGCN Snakes, SFD has been reported in at least half of them. Though the severity of the infection can vary with the species, the disease is often fatal. This has serious implications for all affected species but is especially true for the three species of viper in the region: Timber Rattlesnake, Eastern Massasauga, and Western Massasauga. These three species have a long history of human persecution. The combination of disease, persecution, and, in some cases, collection for the pet trade has severely impacted these species.

Collection is also the major concern for many turtle species in the Midwest. Spotted and Wood Turtles are heavily targeted for the pet trade; Blanding's Turtle is also often collected, but not

at the same level as the other two species. Loss of individuals to collection is especially concerning for turtles as they are long-lived species that are slow-growing and late to mature. Though populations seem stable in some areas, the taxa team noted little to no recruitment is occurring in other areas, which reduces the sustainability of the population. Recruitment is further affected by nest predation. A number of mesocarnivores, especially raccoons and skunks, have been implicated as a major factor in declines in some areas. Vehicle collisions is another source of significant mortality for turtles because reproductive females attempting to nest on roadsides are disproportionally affected and are the key demographic group driving population growth rates and viability. These three factors can combine to severely reduce reproduction rates in turtle populations.

PROPOSED RSGCN REPTILES

There are no Proposed RSGCN Reptiles (Table 2).

REPTILES DISCUSSION

The Herpetofauna Taxa Team discussions generated new information that there are **regional differences** both north to south and east to west in the population status and trends of several species. Most of these species were identified as RSGCN Watchlist [Assessment Priority] species to monitor whether these regional differences are expanding or indicative of emerging threats.

Four Reptile RSGCN were noted to have Responsibility Overriding Factors of **Disjunct Populations**: Lake Erie Watersnake, Eastern Foxsnake (Great Lakes pop.), Spotted Turtle, and the Illinois / Missouri population of Yellow Mud Turtle (*Kinosternon flavescens*) (Appendix I). The taxa team discussed that although there are no taxonomic distinctions between the Midwest and eastern and Southeast populations of Spotted Turtle, the Midwest population is only found in high-quality habitats, whereas the Southeast population is more generalist; the Great Lakes population and another disjunct population in Georgia and Florida are more highly imperiled than the Spotted Turtle populations of the Eastern seaboard. The isolated populations of Yellow Mud Turtle are associated with remnant sand prairie habitat and if the Midwest does not conserve these species and/or their habitat, the taxa team is concerned that they will become locally extirpated; historically the disjunct population was considered a separate subspecies and additional genetic work is needed. The taxonomic and distribution uncertainties of foxsnakes is discussed in the RSGCN Watchlist [Assessment Priority] section of this report.

The MAFWA states average over six RSGCN Reptiles each, with Illinois (10), Ohio (9), Michigan (9), and Missouri (9) supporting the largest numbers (Table 13). Indiana and Iowa support higher than the average number of RSGCN Reptiles as well.

The herpetofauna taxa team identified some **data gaps** limiting the conservation of reptiles and amphibians in the Midwest. Basic distribution and abundance information is lacking for a number of reptiles, as well as population trend data. Taxonomic splits of some "new" species from wider ranging species lack specific status data to gauge concern. The secretive and/or cryptic nature of some herpetofauna result in some of the data gaps, which then makes it challenging to understand population demographics and distributions.

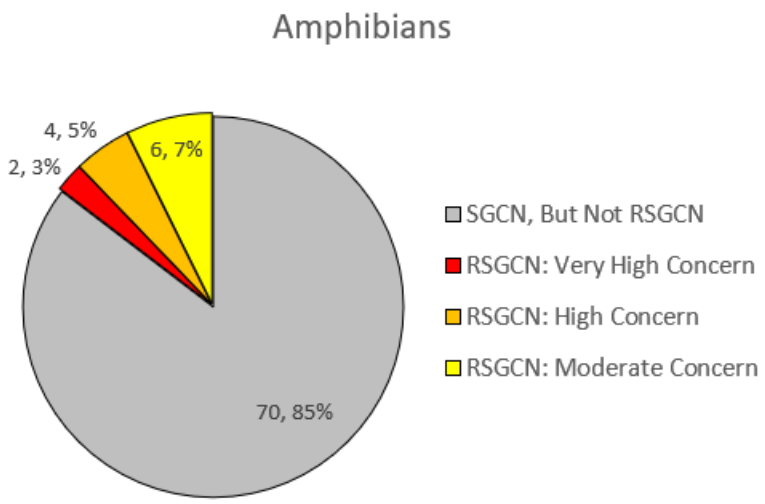
AMPHIBIANS

The Herpetofauna Taxa Team was challenged by taxonomy issues in both reptiles and amphibians, with several species and/or subspecies having updated taxonomy since they were listed as SGCN. A few subspecies are no longer valid according to the SSAR and were merged with their full species records. In one case the Amphibian Taxa Team created new scientific and common names for a complex of species / subspecies where the taxonomy of several hybrid species remains uncertain. The scientific and common names of several SGCN amphibians were updated with new taxonomy as well.

RESULTS

The amphibian RSGCN list includes 12 species, out of 82 amphibian SGCN in the MAFWA region (Table 1, Figure 12, Appendix D). Two Amphibian RSGCN are Very High Concern, four are High Concern, and six are Moderate Concern (Table 10, Appendix E). The list includes three frogs (*Anura*) and nine salamanders (*Caudata*). Three of the amphibian RSGCN are federally listed species or under review for potential listing. The Missouri Distinct Population Segment (DPS) of the Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*) is federally endangered and was identified as Highly Imperiled by the Amphibian Taxa Team as an ROF (Appendix I). The Ozark Hellbender (*Cryptobranchus alleganiensis bishopi*) is also federally endangered. The Amphibian Taxa Team retained separate RSGCN listings for the two hellbenders, consistent with the currently accepted taxonomy but anticipating a potential taxonomic revision to full species status for both. The Illinois Chorus Frog (*Pseudacris illinoensis*) is under review for potential listing at the federal level and is RSGCN of Very High Concern with 75-100% regional responsibility.

Figure 12. Number and percent of Midwest Amphibian SGCN that are RSGCN and at what Concern Levels.



There are five Midwest RSGCN Amphibians that are RSGCN in the Northeast and/or Southeast regions (Table 19). Green Salamander (*Aneides aeneus*) is RSGCN in all three regions.

One amphibian, the Western Tiger Salamander (*Ambystoma mavortium*), is a Proposed RSGCN amphibian, since it is not currently identified as SGCN within the MAFWA region (Table 2, Appendix F). More information is needed on the similarities and differences between Western and Eastern Tiger Salamanders (*Ambystoma tigrinum*), with the Midwest containing the edges of both species' ranges. The Amphibian Taxa Team identified the Western Tiger Salamander as of Moderate Concern with a Core Population in the Midwest (Appendix I).

Ten additional amphibians are on the RSGCN Watchlist as Assessment Priority species (Table 3, Appendix E). Six of these RSGCN Watchlist amphibians are frogs and toads, with the remaining four being salamanders and newts.

All but four of the 12 RSGCN amphibians have more than 50% MAFWA regional responsibility. The Eastern Hellbender has a 25-50% regional responsibility at the subspecies level, but the Missouri DPS is entirely within MAFWA and is High Concern. The Green Salamander and Four-toed Salamander (*Hemidactylium scutatum*) are also 25-50% regional responsibility and of Moderate Concern. The Amphibian Taxa Team identified a Core Population of the Green Salamander in the Midwest, with the species also a Stronghold Species facing Emerging Threats in the region. The Four-toed Salamander is expected to have a Climate Change Range Shift and was identified as Climate Vulnerable with Emerging Threats by the taxa team (Appendix I).

Table 19. Midwest RSGCN Amphibians also listed as RSGCN in the Northeast and/or Southeast regions.

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Green Salamander (*Aneides aeneus*)	Moderate	Moderate	High
Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*)***	High	Moderate	n/a
Ringed Salamander (*Ambystoma annulatum*)	Moderate	n/a	Moderate
Crawfish Frog (*Lithobates areolatus*)	High	n/a	High
Illinois Chorus Frog (*Pseudacris illinoensis*)*	Very High	n/a	High

* Under Review; ** Federally threatened; *** Federally endangered

VERY HIGH CONCERN AMPHIBIANS

Taxa team representatives identified two Very High Concern Amphibians (Table 10; Appendix E, Table E-1). The Illinois Chorus Frog is RSGCN of Very High Concern and 75-100% regional responsibility. The Illinois Chorus Frog is generally associated with very specific habitats and occurs in Illinois and Missouri (and Arkansas). The species may be susceptible to climate changes, as large population declines are common after any flooding events. The Ozark Hellbender is the other Very High Concern RSGCN Amphibian and also has 75-100% regional responsibility, occurring in Missouri (and Arkansas).

MAFWA ENDEMIC AMPHIBIANS

There are no RSGCN Amphibians endemic to the MAFWA region (Table 1). Three Amphibian RSGCN have Midwest regional responsibilities of 75-100%: Illinois Chorus Frog, Ozark Hellbender, and the Unisexual Ambystoma Complex (*Ambystoma* sp.). There are several *Ambystoma* salamander species whose taxonomy is uncertain or not fully defined, generally biotype populations of multiple Ambystoma species, including Jefferson Salamander (*A. jeffersonianum*) and Blue-spotted Salamander (*A. laterale*). At recent count, taxa team representatives were aware of 24 different genetic populations that have been identified with very little known about the distributions of each. The Amphibian Taxa Team chose to group these species as a complex with Genetic Distinctiveness for RSGCN status, pending further taxonomic research (Appendix I).

SHARED AMPHIBIAN SPECIES

Of the 12 RSGCN Amphibians, nine are shared by at least three MAFWA states. The Ozark Hellbender and the Ringed Salamander (*Ambystoma annulatum*) occur in one MAFWA state each. The Ozark Hellbender is endemic to Missouri and Arkansas. The Ringed Salamander is endemic to the Ozarks in Missouri and Oklahoma. The Illinois Chorus Frog and Green Salamander each are found in three MAFWA states, while the remaining seven Amphibian RSGCN occur in at least six states each.

Blanchard's Cricket Frog (*Acris blanchardi*) and Common Mudpuppy (*Necturus maculosus*) are both found in 12 MAFWA states, with the former absent from North Dakota and the latter absent from Nebraska. Blanchard's Cricket Frog (RSGCN High Concern) appears to have a stronghold population in Missouri. The species becomes less common toward the Great Lakes. Populations in Ohio and Minnesota appear to be increasing, but the species appears to be contracting eastward at the western fringes of its range in Kansas and Nebraska. Though widespread and common in many areas, unexplained population declines of the Common Mudpuppy (RSGCN Moderate Concern) have been observed in many parts of their range. Summer die-offs have been attributed to bacteria in the water, algal blooms, and other water-quality issues, and lampreycide application is toxic to mudpuppies. The species is the only known host for the Salamander Mussel (*Simpsonaias ambigua*), which is also RSGCN.

RSGCN AMPHIBIAN HABITAT AND LIMITING FACTORS

Habitat loss is a common threat to RSGCN Amphibians, but **fragmentation** and loss of connectivity may be of even greater concern. This is especially true when barriers, such as roads or dams, are built between suitable sites. Roads are of particular concern when they are placed between upland habitat and breeding areas, resulting in significant mortality during migration periods. Large roads and highways may completely separate populations from these breeding sites.

Protection of these **aquatic breeding sites** is crucial for amphibian conservation. With the exception of the Green Salamander, all the Midwest RSGCN Amphibians breed in aquatic sites. These species are sensitive to changes in water temperature, clarity, and oxygen content. Due to the semi-permeable nature of their skin, most are also susceptible to toxins and pollution. Agricultural activities can impact the hydrology of surrounding systems through draining and ditching of wetlands, conversion of forest and grassland habitats, soil erosion, and introduction of various chemicals and other pollutants. Invasive aquatic plants, such as *Phragmites*, can further degrade breeding wetlands. Predatory fish – both native and non-native – can decimate larval populations when introduced into otherwise naïve breeding ponds via stocking or accidental introduction due to flooding events.

Climate change impacts amphibians in several ways. Some examples include ephemeral water sources drying out before larvae complete metamorphosis, flooding, increased water temperatures coupled with decreased oxygen content, and shifting from mesic forests to drier, potentially fire-prone forest types less suitable for most amphibians.

Another common threat to RSGCN Amphibians is **disease**. Chytrid fungus (*Batrachochytrium dendrobatidis* and *B. salamandrivorans*) infects both frogs and salamanders. Chytrid fungus is estimated to have impacted 30% of amphibian species worldwide and has been the cause of numerous extinctions (Stuart et al. 2004). *B. dendrobatidis* is spreading further into the Midwest where it is already known to impact two of the three RSGCN frogs and one-third of the RSGCN salamanders. *B. salamandrivorans* (Bsal) is an emerging disease not currently known in North America, but it is causing massive mortality of salamanders in Europe (Waddle et al. 2020). If or when the pathogen arrives, it is expected to have devastating impacts on salamander populations and diversity (Waddle et al. 2020).

PROPOSED RSGCN AMPHIBIANS

There is one Proposed RSGCN Amphibian (Table 2). The Western Tiger Salamander is not currently designated as SGCN by any MAFWA state but the Amphibian Taxa Team identified the species as otherwise meeting RSGCN selection criteria. The Midwest has 25-50% regional responsibility for this species, which the Amphibian Taxa Team identified has a Core Population in the region (Appendix I). The Western Tiger Salamander is a Proposed RSGCN of Moderate Concern.

AMPHIBIANS DISCUSSION

The Amphibian Taxa Team discussed a number of **taxonomic uncertainties** with Midwest SGCN amphibians. The taxonomy of the Hellbenders is currently at the subspecies level, but the team anticipates revisions and new splits to species levels in the future. The Unisexual Ambystoma Complex is fraught with taxonomic uncertainties with little information on distributions of newly described biotypes. In general, the taxa team deferred to recognized taxonomy in SSAR as the definitive source for RSGCN taxonomy.

The taxa team identified the majority (58%) of the RSGCN Amphibians as facing **Emerging Threats** (Appendix I). Blanchard's Cricket Frog, Crawfish Frog, Ringed Salamander, Blue-spotted Salamander, Green Salamander, Four-toed Salamander, and Common Mudpuppy all have emerging threats, including mining, agriculture, forest management, algal blooms, bacteria, lampricide application, and other water quality issues.

The Midwest supports **stronghold populations** of five RSGCN Amphibians according to the Amphibian Taxa Team: Blanchard's Cricket Frog, Crawfish Frog, Ringed Salamander, Blue-spotted Salamander, and Green Salamander.

The MAFWA states averaged more than five RSGCN Amphibians each, with Michigan (10) and Missouri (9) supporting the largest numbers (Table 13). Indiana, Illinois, and Ohio supported higher than the average number of RSGCN Amphibians as well. RSGCN Amphibian species diversity appeared to decline in the western portion of the region, with the Dakotas, Nebraska, and Kansas supporting the fewest number of RSGCN Amphibians.

FISH

As with the herpetofauna, a few taxonomic changes have occurred for freshwater fish SGCN, including updates to genus or species names, or revisions to common names. One species (Scioto Madtom, *Noturus trautmani*) was identified by the Fish Taxa Team as currently being considered extinct and was not considered for RSGCN status. Extirpations of some species were noted in some MAFWA states, indicating a concern of population declines and/or range contractions. The Fish Taxa Team was provided with data on SGCN that were also identified as imperiled fishes from AFS (Jelks et al. 2008) and priority species identified by the Great Plains FHP (USFWS 2020).

RESULTS

The Fish RSGCN list includes 35 species, out of 251 fish SGCN in the MAFWA region; all of the species are freshwater fish (Table 1, Figure 13, Appendix D). Twelve Fish RSGCN are Very High Concern, 18 are High Concern, and 5 are Moderate Concern (Table 10, Appendix E). The list includes seven perches and darters (*Perciformes*); 14 minnows, carps, and suckers (*Cypriniformes*); four salmon and trout (*Salmoniformes*); three cavefish (*Percopsiformes*); and two sturgeon (*Acipenseriformes*), along with four other taxonomic orders of smaller numbers. One fish, the Tonguetied Minnow (*Exoglossum laurae*), is a Proposed RSGCN fish, since it is not currently identified as SGCN within the MAFWA region (Table 2, Appendix F).

Ten of the 35 RSGCN fish are federally listed species or under review for potential listing, three of which are endangered and a fourth is Proposed Endangered. The Relict Darter (*Etheostoma chienense*), Pallid Sturgeon (*Scaphirhynchus albus*), and Topeka Shiner (*Notropis topeka*) are federally endangered, and the Peppered Chub (*Macrhybopsis tetranema*) is proposed as federally endangered. The Blackside Dace (*Chrosomus cumberlandensis*) and Neosho Madtom (*Noturus placidus*) are federally threatened. Four RSGCN fish are under review

for potential listing: Lake Sturgeon (*Acipenser fulvescens*), Sturgeon Chub (*Macrhybopsis gelida*), Sicklefin Chub (*Macrhybopsis meeki*), and Popeye Shiner (*Notropis ariommus*).

There are 23 Midwest RSGCN Fish (63%) identified as RSGCN in the Northeast and/or Southeast regions as well (Table 20). Three Midwest RSGCN are Northeast RSGCN, and 22 Midwest RSGCN are shared RSGCN with the Southeast. The Spotted Darter (*Etheostoma maculatum*) and Longhead Darter (*Percina macrocephala*) are RSGCN in all three regions. An additional 15 fish are on the RSGCN Watchlist as Assessment Priority species (Table 3, Appendix G).

Figure 13. Number and percent of Midwest Fish SGCN that are RSGCN and at what Concern Levels.

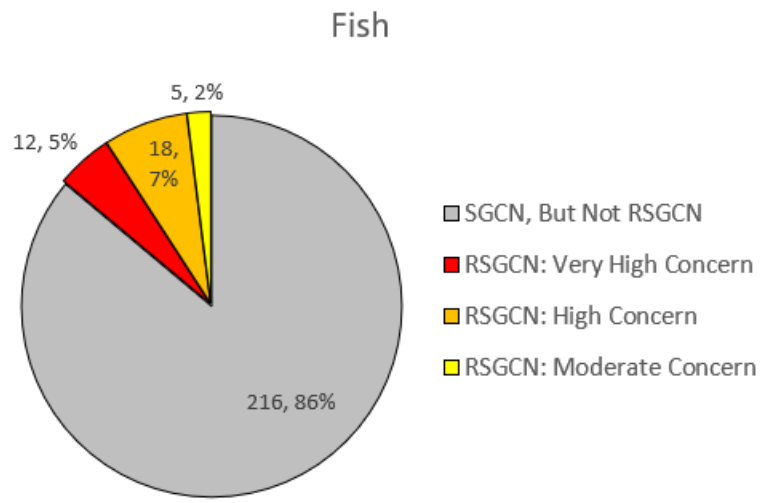


Table 20. Midwest RSGCN Fish also listed as RSGCN in the Northeast and/or Southeast regions.

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Lake Sturgeon (*Acipenser fulvescens*)*	High	n/a	High
Northern Cavefish (*Amblyopsis spelaea*)	High	n/a	Moderate
Western Sand Darter (*Ammocrypta clara*)	Moderate	n/a	High
Blackside Dace (*Chrosomus cumberlandensis*)**	High	n/a	High
Redside Dace (*Clinostomus elongatus*)	Moderate	Moderate	n/a

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Crystal Darter (*Crystallaria asprella*)	High	n/a	High
Relict Darter (*Etheostoma chienense*)***	Very High	n/a	High
Tuxedo Darter (*Etheostoma lemniscatum*)	Very High	n/a	Very High
Spotted Darter (*Etheostoma maculatum*)	High	Moderate	Moderate
Shawnee Darter (*Etheostoma tecumsehi*)	High	n/a	Moderate
Spring Cavefish (*Forbesichthys agassizii*)	High	n/a	High
Ohio Lamprey (*Ichthyomyzon bdellium*)	High	n/a	High
Sturgeon Chub (*Macrhybopsis gelida*)*	High	n/a	High
Sicklefin Chub (*Macrhybopsis meeki*)*	High	n/a	High
Peppered Chub (*Macrhybopsis tetranema)****	Very High	n/a	Very High
Popeye Shiner (*Notropis ariommus*)*	High	n/a	Moderate
Neosho Madtom (*Noturus placidus*)**	High	n/a	Moderate
Northern Madtom (*Noturus stigmosus*)	High	n/a	Moderate
Longhead Darter (*Percina macrocephala*)	Very High	High	Moderate
Eastern Slim Minnow (*Pimephales tenellus parviceps*)	High	n/a	Moderate
Flathead Chub (*Platygobio gracilis*)	High	n/a	Moderate
Pallid Sturgeon (*Scaphirhynchus albus*)***	Very High	n/a	Very High
Blackfin Sucker (*Thoburnia atripinnis*)	High	n/a	Moderate

* Under Review; ** Federally threatened; *** Federally endangered or Proposed endangered

VERY HIGH CONCERN FISH

Taxa team representatives identified 12 Very High Concern RSGCN fish (Table 10; Appendix E, Table E-1). Four of the Fish RSGCN of Very High Concern are federally listed as endangered or Proposed endangered: Relict Darter, Pallid Sturgeon, Topeka Shiner, and Peppered Chub. Half of the Very High Concern RSGCN fish are found in only one MAFWA state (Table 21). The Pallid Sturgeon is the most widespread of these RSGCN, occurring in eight Midwest states. The Pugnose Shiner (*Notropis anogenus*) and Cisco (*Coregonus artedi*) each are found in seven MAFWA states.

Four of the Very High Concern fish are endemic to the MAFWA region (Table 16). The Hoosier Cavefish (*Amblyopsis hoosieri*) is only found in caves in Indiana, the Ives Lake Cisco (*Coregonus hubbsi*) is in one lake in the Upper Peninsula of Michigan, and the Siskiwit Lake Cisco (*Coregonus zenithicus bartletti*) was in Michigan but is possibly extirpated. The Shortjaw Cisco (*Coregonus zenithicus*) occurs in Wisconsin, Michigan, and Minnesota.

Table 21. Midwest RSGCN Fish of Very High Concern, with the regional responsibility for each and the number of MAFWA states in which the species is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Hoosier Cavefish (*Amblyopsis hoosieri*)	100% (MAFWA Endemic)	1
Cisco (*Coregonus artedi*)	75-100%	7
Ives Lake Cisco (*Coregonus hubbsi*)	100% (MAFWA Endemic)	1
Shortjaw Cisco (*Coregonus zenithicus*)	100% (MAFWA Endemic)	3
Siskiwit Lake Cisco (*Coregonus zenithicus bartletti*)	100% (MAFWA Endemic)	1
Relict Darter (*Etheostoma chienense*)***	75-100%	1
Tuxedo Darter (*Etheostoma lemniscatum*)	25-50%	1
Peppered Chub (*Macrhybopsis tetranema*)***	25-50%	1
Pugnose Shiner (*Notropis anogenus*)	75-100%	7
Topeka Shiner (*Notropis topeka*)***	75-100%	6
Longhead Darter (*Percina macrocephala*)	25-50%	2
Pallid Sturgeon (*Scaphirhynchus albus*)***	50-75%	8

* Under Review; ** Federally threatened; *** Federally endangered or Proposed endangered

Another four Fish RSGCN of Very High Concern have more than 75% regional responsibility in the Midwest (Table 16). Only three Very High Concern RSGCN fish have less than 50% regional responsibility. The Tuxedo Darter (*Etheostoma lemniscatum*), Peppered Chub, and Longhead Darter (*Percina macrocephala*) all were identified by the Fish Taxa Team as Highly Imperiled (Appendix I). The Tuxedo Darter is G1 and a Southeast RSGCN of Very High Concern. As previously described, the Peppered Chub has recently been proposed as federally endangered and is currently restricted to only one river basin, a portion of which is in Kansas. The Longhead Darter has been identified as RSGCN in both the Northeast (High Concern) and Southeast (Moderate Concern).

MAFWA ENDEMIC FISH

There are seven RSGCN fish that are endemic to the MAFWA region. In addition to the four endemic Fish RSGCN that are Very High Concern described above, the Northern Cavefish (*Amblyopsis spelaea*), Shawnee Darter (*Etheostoma tecumsehi*), and Eastern Slim Minnow (*Pimephales tenellus parviceps*) are also endemic to the Midwest region. All three are High Concern. Northern Cavefish are endemic to Kentucky. The Shawnee Darter is identified as Endangered by IUCN. The fish has a limited range in Kentucky but is considered stable within that area. Both Kentucky fish have been identified as RSGCN (Moderate Concern) in the Southeast, since Kentucky participates in both MAFWA and SEAFWA. The Eastern Slim Minnow is endemic to Missouri and has also been identified as RSGCN (Moderate Concern) in the Southeast since Missouri participates in both MAFWA and SEAFWA.

SHARED FISH SPECIES

Of the 35 RSGCN freshwater and diadromous fishes, 63% (22) are shared by at least three MAFWA states. Over one-quarter (27%) of the shared freshwater and diadromous fish (6) occur in just three MAFWA states, reflecting the smaller distributions of most of the species.

Only one Fish RSGCN occurs in all 13 MAFWA states – the Lake Sturgeon, for which the Midwest has 75-100% regional responsibility. The Blacknose Shiner (*Notropis heterolepis*) is found in 11 Midwest states and is of High Concern; the Fish Taxa Team identified Climate Vulnerability and Emerging Threats as COF for this fish. Fourteen other RSGCN fish are found in six to nine Midwest states, representing collaboration opportunities for at least half of the states in the region.

The Flathead Chub (*Platygobio gracilis*) and Crystal Darter (*Crystallaria asprella*) are the only RSGCN fish shared by more than three states that have less than 50% regional responsibility. Both were identified as Highly Imperiled by the Fish Taxa Team, and the Flathead Chub is also considered a Core Population (Appendix I). The Ohio Lamprey (*Ichthyomyzon bdellium*) is RSGCN of High Concern, found in three Midwest states (IN, OH, and KY), and has less than 50%

regional responsibility. Like the Crystal Darter, the Fish Taxa Team identified Core Population and Highly Imperiled as ROF for the Ohio Lamprey.

RSGCN FISH HABITAT AND LIMITING FACTORS

In general, aquatic species are more constrained when directly or indirectly exposed to certain limiting factors and have a limited ability to escape from these threats. Aquatic species are often very sensitive to changes in their environment. While some species are more tolerant of variation, many have specific requirements related to water temperature, oxygen content, clarity, flow speeds, and substrate types. If conditions shift away of the suitable range for a species, that habitat is no longer suitable.

The Fish Taxa Team suggested that **habitat modification** may be the most significant cause of declines for this group. Dams and other structures were of particular concern, affecting at least 18 of the 35 RSGCN Fish species, but other sources of modification included channelization, dredging, agricultural expansion, and development.

Dams are particularly detrimental because they drastically change the function of riverine systems, both above and below the structure. Upstream of the dam, they inundate large areas, shifting the system from lentic to lotic, disturbing flow patterns and increasing water temperatures, which in turn affects oxygen content. The slower water speeds in these impoundments cause fine sediments to settle, creating soft bottom surfaces rather than the clean sand or gravel preferred by some species. Impoundments may be prone to eutrophication and algal blooms, which can rapidly deplete oxygen, leading to fish kills. Many impoundments are also stocked with various fish species that predate on RSGCN Fish, such as non-native trout, Largemouth Bass (*Micropterous salmoides*), and catfish (Whittier et al. 2002). Downstream, the dams can contribute to inconsistent flows, resulting in periodic drying of the riverbed when water is retained and flooding when water is released (Brandt 2000). The releases can be particularly detrimental, flooding the bed with a large amount of water that is significantly warmer or cooler than the rest of the stream or river. These pulses can also cause bank scour and erosion, resulting in deposition of sediments, or can displace individual fish far downstream. Dams and their associated impoundments are also a significant barrier in riverine systems, fragmenting and isolating populations (Watters 1996). If individuals cannot move upstream and downstream between populations, it can have significant impacts on genetic diversity and population stability. Even smaller structures, such as culverts, can become significant barriers to movement. This is especially true for species that seasonally migrate to breed; dams and other structures can prevent populations from reaching their spawning grounds entirely. Taxa experts indicate that the Pallid Sturgeon is estimated to have lost 36% of its historic range due to dams (USFWS 2018b).

Channelization is detrimental because it alters the structure and function of riverine systems. A natural stream or river contains bends, riffles, runs, pools, and an assortment of rocks, logs, and other structures. This variety of features provides variable flows, establishes low-flow areas for resting, and creates a number of microclimates that support a wide variety of plant and animal species. Many channelized areas also lack riparian vegetation, which provides bank stabilization, cover, and shade (Brooker 1985). The combination of faster flows, warmer temperatures, and low oxygen can make channelized areas inhospitable to many RSGCN Fish species.

Dredging, agricultural expansion, and development can all directly destroy fish habitat. However, the associated increases in **pollution** and sedimentation may be of greater concern. The Fish Taxa Team identified 30 RSGCN Fish species that are possibly impacted by pollution. This included sewage, mining waste, chemical spills, toxic compounds in disposed dredge material, and agricultural runoff. Agricultural runoff can include herbicides and other chemicals as well as fertilizers and other nutrient-dense materials, which can lead to eutrophication. A few species are sensitive to the application of lampreycides, which are applied in some areas to control sea lamprey (*Petromyzon marinus*) populations.

These sources of pollution are also potential sources of erosion and **sedimentation**. The Fish Taxa Team discussed the impacts of sedimentation on 23 species. Excess sediment can impact the clarity and turbidity of the water. As sediment settles out of the water column onto the bottom surface, it can cover preferred substrate types that may be crucial to reproduction. Even if the adults are tolerant of increased turbidity and sediment deposition, fish eggs can easily be suffocated by thin layers of sediment.

While most RSGCN Fish species are impacted by habitat modification, pollution, and sedimentation, some species are impacted by additional threats. Temperature-dependent species that require cold water, such as those that inhabit small, high-order streams or deep lakes, may be vulnerable to **climate change**. The four RSGCN ciscoes (*Coregonus sp.*) are of particular concern. Additional effects of climate change, such as increased frequency and severity of floods and droughts may influence a large proportion of the RSGCN Fish.

The impacts of non-native predaceous species have been mentioned previously, but other species can also be detrimental. **Introduced fish species**, both native and non-native, predate on or compete with at least 15 RSGCN Fish species. Zebra Mussels (*Dreissena polymorpha*) and Quagga Mussels (*Dreissena bugensis*) can eliminate spawning habitat for Lake Sturgeon, and Round Goby (*Neogobius melanostomus*) may prey on their eggs. Declines in Plains Topminnow (*Fundulus sciadicus*) have been linked to Western Mosquitofish (*Gambusia affinis*) incursions. Topeka Shiner is potentially outcompeted by Blackstripe Topminnow (*Fundulus notatus*), though the degree of impact is uncertain. For Neosho Madtom, Roundy Goby is potentially a

direct competitor. In the Cumberland River Basin, Blackside Dace are being outcompeted by Southern Redbelly Dace (*Chrosomus erythrogaster*), a recent emigrant.

Genetic diversity is a concern for at least 14 RSGCN Fish species. For some, the isolation and fragmentation of habitat and populations described above can lead to reduced gene flow and diversity, making the long-term viability of these populations uncertain. For other species, the concern is genetic contamination. The ciscoes are known to easily hybridize with one another, which may impact their recovery from historic declines. Pallid Sturgeon and Finescale Dace (*Chrosomus neogaeus*) are both known to hybridize with other species, but it is unclear whether this has impacts on the species as a whole. For Lake Sturgeon, the concern is genetic contamination caused by native individuals breeding with stocked or accidentally released individuals.

Overharvest has been a significant threat for several of the RSGCN Fish. Ciscoes and sturgeons were historically overharvested, which led to precipitous declines in many areas. Some of the sturgeons continue to be threatened by poaching, while the ciscoes are still sometimes imperiled as bycatch to other commercially harvested species. The Hoosier and Northern Cavefish (*Amblyopsis hoosieri* and *A. spelaea*, respectively) may be impacted by collection.

PROPOSED RSGCN FISH

There is one Proposed RSGCN Fish (Table 2). The Tonguetied Minnow is not currently designated as SGCN by any MAFWA state, but the Fish Taxa Team identified the species as otherwise meeting RSGCN selection criteria, indicating the species should be evaluated by states during the next round of SWAP updates for SGCN status. This fish is RSGCN in the Northeast with Moderate Concern. The Fish Taxa Team identified the Tonguetied Minnow as High Concern with 25-50% regional responsibility and a ROF of Highly Imperiled (Appendices F, I).

FISH DISCUSSION

The MAFWA states averaged more than 12 RSGCN Fish each, with Kentucky (19), Missouri (15), Indiana (14), and Illinois (14) supporting the largest numbers (Table 13). Minnesota supported higher than the average number of RSGCN Fish as well. The Fish Taxa Team had an in-depth discussion regarding the three SGCN fish endemic to Kentucky (Northern Cavefish, Shawnee Darter, and Tuxedo Darter) and four SGCN endemic to Missouri (Eastern Slim Minnow, Grotto Sculpin, Niangua Darter, and Bluestripe Darter), to determine if the species should be listed RSGCN in the Midwest or deferred to the Southeast region, as Kentucky and Missouri participate in both MAFWA and SEAFWA. Three of these endemic fish (Grotto Sculpin, Niangua Darter, and Bluestripe Darter) were deferred to the Southeast region by the Fish Taxa

Team on the recommendations of the representatives from Missouri and Kentucky, and the remaining four are identified as Midwest RSGCN.

The Fish Taxa Team noted that some RSGCN, particularly all the ciscoes, are temperature dependent and in many cases are still recovering from historic overharvesting. The ciscoes tend to do better in deeper lakes with a cool water layer that is not impacted by swings in temperature. This habitat characteristic makes these RSGCN fish vulnerable to **climate change**. Cisco historically was present in 50 lakes in northern Indiana but is now found in only seven, for example, and the fish is declining in all seven lakes. Redside Dace and Blacknose Shiner, in addition to the ciscoes, are identified as Climate Vulnerable by the Fish Taxa Team.

Six of the RSGCN Fish are considered Highly Imperiled by the taxa team: Crystal Darter, Tuxedo Darter, Longhead Darter, Peppered Chub, Longhead Chub, and Ohio Lamprey. Flathead Chub, Ohio Lamprey, plus Blackfin Sucker, have Core Populations in the Midwest (Appendix I).

The Fish Taxa Team noted a number of **extirpations of several species** in the Midwest, indicating a concern of population declines and/or contraction of ranges. Blacknose Shiner (*Notropis heterolepis*), for example, historically was widespread in the Midwest but is now only abundant in Michigan, having been extirpated from Iowa, Kansas, and Ohio, and now considered uncommon and in decline in South Dakota, Nebraska, Missouri, and Wisconsin. Western Silvery Minnow (*Hybognathus argyritis*) appears to be contracting toward the Northeast. Neosho Madtom (*Noturus placidus*) are extirpated from Oklahoma, restricting their range to the Midwest. Finescale Dace (*Chrosomus neogaeus*) appears to be stable in the core parts of its range in the Midwest but is in decline at the western edge in the Dakotas and Nebraska.

Another six RSGCN Fish have Emerging Threats identified by the Fish Taxa Team: Western Sand Darter, Finescale Dace, Redside Dace, Western Silvery Minnow, Plains Topminnow, and Blacknose Shiner. As mentioned above, Redside Dace and Blacknose Shiner are threatened by climate change.

CRAYFISH

The RSGCN crayfish are highly endemic to the region, with 11 out of 19 Crayfish RSGCN (58%) MAFWA endemic. Most crayfishes are endemic to a particular river basin or cave system. The Crayfish Taxa Team was provided with data on SGCN that are also identified as imperiled crayfish from AFS (Taylor et al. 2007, as updated).

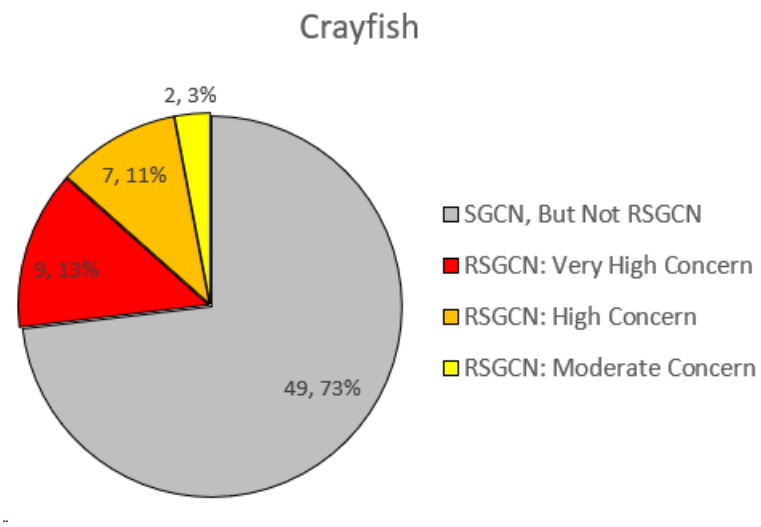
Crayfish as a taxonomic group have been identified as data deficient when compared to other taxa, with a continuous series of taxonomic revisions and uncertainties, not only in the Midwest but in the Southeast and Northeast as well. Several crayfish SGCN, for example, received

taxonomic updates since they were designated as SGCN, with the *Orconectes* genus now revised to include cave crayfish and surface crayfish revised to the *Faxonius* genus. Crandall and DeGrave (2017) provided an updated classification for freshwater crayfishes, which was utilized to update the taxonomy of the species in this assessment.

RESULTS

The Crayfish RSGCN list includes 18 species, out of 67 crayfish SGCN in the MAFWA region (Table 1, Figure 14, Appendix D). Nine Crayfish RSGCN are Very High Concern, seven are High Concern, and two are Moderate Concern (Table 10, Appendix E). Two of the Crayfish RSGCN are proposed for federal listing as threatened – the Big Creek Crayfish (*Faxonius peruncus*) and St. Francis River Crayfish (*Faxonius quadruncus*). The Mammoth Spring Crayfish (*Faxonius marchandi*) is under review for potential listing.

Figure 14. Number and percent of Midwest Crayfish SGCN that are RSGCN and at what Concern Levels.



There are 13 Midwest RSGCN Crayfish that are RSGCN in the Southeast (Table 22). No Midwest RSGCN Crayfish are RSGCN in the Northeast. Six of the Midwest and Southeast shared RSGCN Crayfish are found in Kentucky and seven are found in Missouri; both Kentucky and Missouri participate in both MAFWA and SEAFWA, allowing for RSGCN occurring in those states to be identified in both regions. Shared RSGCN found in Kentucky include Bottlebrush Crayfish (*Barbicambarus cornutus*), Big South Fork Crayfish (*Cambarus bouchardi*), Crittenden Crayfish (*Faxonius bisectus*), Blood River Crayfish (*Faxonius burri*), Louisville Crayfish (*Faxonius jeffersoni*), and Livingston Crayfish (*Faxonius margorectus*). The shared RSGCN Crayfish found in Missouri are the Coldwater Crayfish (*Faxonius eupunctus*), Mammoth Spring Crayfish (*Faxonius*

marchandi), Meek's Crayfish (*Faxonius meeki meeki*), Big Creek Crayfish (*Faxonius peruncus*), St. Francis River Crayfish (*Faxonius quadruncus*), Caney Mountain Cave Crayfish (*Faxonius stygocaneyi*), and Williams' Crayfish (*Faxonius williamsi*).

Seven additional crayfish are Proposed RSGCN, with none currently identified as SGCN within the MAFWA region (Table 2, Appendix F). **Four additional crayfish are on the RSGCN Watchlist as Assessment Priority species** (Table 3, Appendix G). Another **two crayfish are on the Proposed Watchlist as Assessment Priority** species, with neither currently identified as SGCN in the MAFWA region (Table 4, Appendix G).

Table 22. Midwest RSGCN Crayfish also listed as RSGCN in the Southeast regions. No Midwest RSGCN Crayfish are Northeast RSGCN.

Species	Midwest Concern Level	Southeast Concern Level
Bottlebrush Crayfish (*Barbicambarus cornutus*)	High	Moderate
Big South Fork Crayfish (*Cambarus bouchardi*)	Very High	High
Crittenden Crayfish (*Faxonius bisectus*)	Very High	Moderate
Blood River Crayfish (*Faxonius burri*)	High	High
Coldwater Crayfish (*Faxonius eupunctus*)	Very High	Very High
Louisville Crayfish (*Faxonius jeffersoni*)	Very High	Very High
Mammoth Spring Crayfish (*Faxonius marchandi*)*	Very High	High
Livingston Crayfish (*Faxonius margorectus*)	High	Very High
Meek's Crayfish (*Faxonius meeki meeki*)	Very High	High
Big Creek Crayfish (*Faxonius peruncus*)**	Very High	High
St. Francis River Crayfish (*Faxonius quadruncus*)**	Very High	High
Caney Mountain Cave Crayfish (*Faxonius stygocaneyi*)	Very High	Very High
Williams' Crayfish (*Faxonius williamsi*)	High	Moderate

* Under Review; ** Proposed Federally threatened; *** Federally endangered

VERY HIGH CONCERN CRAYFISH

Taxa team representatives identified nine species as Very High Concern, 50% of the RSGCN crayfish (Table 10; Appendix E, Table E-1). Five of these nine are endemic to the MAFWA region (Table 23). All nine are limited to only one state in Midwest. All but two of the Very High Concern RSGCN crayfish have greater than 50% regional responsibility. The Big South Fork Crayfish was identified by the Crayfish Taxa Team as a Core Population in the Kentucky and Highly Imperiled throughout its range (Appendix I). The Mammoth Spring Crayfish has an ROF of Climate Change Range Shift, occurring in Missouri. With Missouri and Kentucky also members of SEAFWA, both the Big South Fork Crayfish and the Mammoth Spring Crayfish are identified as a Southeast RSGCN of High Concern.

Table 23. Midwest RSGCN Crayfish of Very High Concern, with the regional responsibility for each and the number of MAFWA states in which the species is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Big South Fork Crayfish (*Cambarus bouchardi*)	25-50%	1
Crittenden Crayfish (*Faxonius bisectus*)	100% (MAFWA Endemic)	1
Coldwater Crayfish (*Faxonius eupunctus*)	75-100%	1
Louisville Crayfish (*Faxonius jeffersoni*)	100% (MAFWA Endemic)	1
Mammoth Spring Crayfish (*Faxonius marchandi*)	25-50%	1
Meek's Crayfish (*Faxonius meeki meeki*)	50-75%	1
Big Creek Crayfish (*Faxonius peruncus*)	100% (MAFWA Endemic)	1
St. Francis River Crayfish (*Faxonius quadruncus*)	100% (MAFWA Endemic)	1
Caney Mountain Cave Crayfish (*Faxonius stygocaneyi*)	100% (MAFWA Endemic)	1

MAFWA ENDEMIC CRAYFISH

More than half of the Crayfish RSGCN are endemic to the Midwest (Table 1). Five of the endemic RSGCN crayfish are of Very High Concern, five are High Concern, and one is Moderate Concern. All eleven are found in only one or two Midwest states. The Indiana Crayfish (*Faxonius indianensis*) and Kentucky Crayfish (*Faxonius kentuckiensis*) are each found in two states, while

the other nine endemic crayfish are limited to one state each. The Indiana Crayfish occurs in Indiana and Illinois, while the Kentucky Crayfish is found in Kentucky and Illinois.

Four Crayfish RSGCN are endemic to Kentucky: Bottlebrush Crayfish, Livingston Crayfish, Crittenden Crayfish, and Louisville Crayfish. All four of these crayfish are identified as RSGCN in the Southeast since Kentucky participates in both regions. One Crayfish RSGCN is endemic to Illinois, the Little Wabash Crayfish (*Faxonius stannardi*).

Four Crayfish RSGCN are endemic to Missouri: Freckled Crayfish (*Cambarus maculatus*), Big Creek Crayfish, St. Francis River Crayfish, and Caney Mountain Cave Crayfish. The Freckled Crayfish is a habitat specialist requiring large slab rocks that are threatened by sedimentation and pollution, including heavy metals mining, resulting in a COF of Emerging Threats (Appendix I). The Caney Mountain Cave Crayfish is known from only a single cave and may be one of the rarest crayfishes in North America. SEAFWA has identified the Big Creek Crayfish, St. Francis River Crayfish, and Caney Mountain Cave Crayfish as Crayfish RSGCN, since Missouri is a member of both MAFWA and SEAFWA (Table 22).

SHARED CRAYFISH SPECIES

Only one Crayfish RSGCN occurs in more than one MAFWA state. The Northern Clearwater Crayfish (*Faxonius propinquus*) is the most widespread Crayfish RSGCN in the Midwest, found in seven states: Iowa, Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. MAFWA has 50-75% regional responsibility for the Northern Clearwater Crayfish. The Crayfish Taxa Team identified a COF of Emerging Threats for this crayfish due to its extreme vulnerability to the invasive Rusty Crayfish (*Orconectes rusticus*), which have invaded the majority of the Midwest range of the Northern Clearwater Crayfish. Nearly two-thirds of the range in Illinois has been lost to the Rusty Crayfish. However, it is worth noting that not all Midwest populations are responding to Rusty Crayfish in the same way. It is possible there is either genetic variation among populations, or the presence of certain habitat characteristics enable the species to co-exist with Rusty Crayfish. Frequently, it has been found that Rusty Crayfish dominates the stream mainstems, while Northern Clearwater Crayfish are more abundant in the upper stream reaches. The Crayfish Taxa Team noted that populations where this habitat specialization is occurring also frequently exhibit dwarfism.

RSGCN CRAYFISH HABITAT AND LIMITING FACTORS

Invasive crayfish were the top threat to the RSGCN species identified by the Crayfish Taxa Team. Three are considered a risk to multiple RSGCN Crayfish: Rusty Crayfish (*Faxonius rusticus*), Ringed Crayfish (*F. neglectus*), and Woodland Crayfish (*F. hylas*). Other invasive species that are of lower concern include: Virile Crayfish (*F. virilis*), Mena Crayfish (*F. menae*), Placid Crayfish (*Orconectes placidus*), Red Swamp Crayfish (*Procambarus clarkii*), Calico Crayfish

(*F. immunis*), and White River Crayfish (*P. acutus*). Interestingly, all these "invasives" are native rather than exotic, presenting additional challenges to conservation (Colautti and MacIsaac 2004). At least a part of their native ranges includes the Midwest, but they are expanding aggressively into new stream reaches where they are pushing out other, more sensitive RSGCN Crayfish species.

As an aquatic taxonomic group, crayfish are vulnerable to many of the same threats as described for fish above. Many have specific needs related to water temperature, oxygen content, clarity, flow speeds, and substrate. **Habitat availability and quality** is a concern for a number of crayfish species. For some, urban development and associated channelization is encroaching on suitable habitats, resulting in increased sedimentation and pollution. Nearby coal and heavy metal mining operations can contribute additional contaminants and runoff, as can agricultural operations. This is especially concerning for species like Bottlebrush Crayfish (*Barbicambarus cornutus*), which requires large slab rock in its habitat; this feature is one of the first filled in by sedimentation. Habitat loss and degradation may be particularly concerning for species with narrow ranges like the Crittenden Crayfish (*Faxonius bisectus*), which is limited to a single stream in Kentucky, or the Caney Mountain Cave Crayfish (*Faxonius stygocaneyi*), which is known from a single 135-meter-long cave.

As is the case for fish, many RSGCN Crayfish are negatively impacted by the construction of **dams and impoundments**. These structures affect conditions both upstream and downstream, including altering water temperature, changing flow patterns, and increasing sedimentation. Periodic releases from dams can result in scouring, stranding, and temperature shock. The dams also form significant barriers to movement, isolating populations from one another and preventing gene flow. Crayfish can be more dispersal-limited than fish, so even a small dam can become an insurmountable barrier.

Crayfish are also likely to be impacted by **climate change** through a number of different mechanisms. Changing temperatures may force crayfish to migrate upstream or downstream to locate more suitable conditions. These temperature changes may also make some stream reaches accessible to invasive competitors that will displace RSGCN Crayfish. Climate change can also increase the frequency and intensity of flooding events in some areas, which could result in displacement, sedimentation, or scouring. As some crayfish inhabit smaller, groundwater-fed streams or caves, drought conditions may lower the water table, drying these sources out.

PROPOSED RSGCN CRAYFISH

There are seven Proposed RSGCN Crayfish that are not currently Midwest SGCN, but the Crayfish Taxa Team identified these species as otherwise meeting RSGCN selection criteria (Table 2). The Big Sandy Crayfish (*Cambarus callainus*) is Very High Concern, federally

threatened, and RSGCN in both the Northeast (High Concern) and Southeast (Very High Concern). This species was recently divided from *Cambarus veteranus*, which is a Midwest SGCN; the revised taxonomy is not currently reflected in Midwest SGCN. While the Midwest can claim a larger amount of the revised species' range (50-75%), populations in Kentucky tend to be smaller than those in West Virginia.

Two Proposed RSGCN Crayfish are High Concern: Dusky Mudbug (*Cambarus adustus*) and Leopard Crayfish (*Faxonius pardalotus*). Both species are endemic to the Midwest. The Dusky Mudbug is locally abundant when it occurs, but it has a small range; the crayfish is threatened by development and human removal because homeowners often dislike the mud burrows created by the species. The Leopard Crayfish is highly restricted in both range and water depth. As it is a large river species, it is difficult to collect, and most known occurrences are historic. The species may have been incorrectly assigned as *Faxonius placidus* in some collections. Currently, the Leopard Crayfish is only known from the Ohio River, but it may be present in other rivers that have not yet been sufficiently surveyed.

Four Proposed RSGCN Crayfish are Moderate Concern. The Brawny Crayfish (*Cambarus hazardi*) and Cutshin Crayfish (*Cambarus taylori*) were recently split from *Cambarus robustus* and are Midwest endemic in Kentucky. The Gap Ringed Crayfish's (*Faxonius neglectus chaenodactylus*) taxonomy is anticipated to be elevated to full species; the Missouri Crayfish Species of Conservation Concern Working Group have recommended that the species should be Missouri SGCN in the state's next SWAP. The Allegheny Crayfish (*Faxonius obscurus*) has been declining in Ohio, where it is threatened by Rusty Crayfish, but it appears stable outside of the state. The Crayfish Taxa Team identified a ROF of Highly Imperiled and a COF of Emerging Threats for the Allegheny Crayfish (Appendix I).

CRAYFISH DISCUSSION

The impacts of **invasive crayfish**, both native and exotic, on Midwest watersheds was of utmost concern to the Crayfish Taxa Team. Some of the invasive species are native to the Midwest but are moving or are being introduced into new drainages, where they are impacting other native species. Another top concern of the Crayfish Taxa Team was habitat alteration due to **sedimentation**. Slab boulder habitat is one of the first types to be lost due to sedimentation or organic enrichment from changes in land use in the surrounding watershed. Species that depend on this habitat should be considered habitat specialists and should be carefully monitored according to the taxa team.

The Crayfish Taxa Team had an in-depth discussion regarding the five SGCN crayfish **endemic** to Kentucky (Bottlebrush Crayfish, Crittenden Crayfish, Louisville Crayfish, Livingston Crayfish, and Kentucky Crayfish) and five SGCN endemic to Missouri (Belted Crayfish, Freckled Crayfish, Big Creek Crayfish, St. Francis River Crayfish, and Caney Mountain Cave Crayfish), to determine if

the species should be listed RSGCN in the Midwest or deferred to the Southeast region; Kentucky and Missouri participate in both MAFWA and SEAFWA. One of these endemic crayfish (Belted Crayfish) is identified as RSGCN Watchlist [Assessment Priority] by the Crayfish Taxa Team, and none are deferred to the Southeast, on the recommendations of the representatives from Missouri and Kentucky.

The MAFWA states averaged two RSGCN Crayfish each, with Missouri (8) and Kentucky (7) supporting the largest numbers (Table 13). Illinois supports higher than the average number of RSGCN Crayfish as well. RSGCN Crayfish species diversity appears to decline in the western portion of the region, with the Dakotas, Nebraska, and Kansas supporting no RSGCN Crayfish.

The Crayfish Taxa Team identified a few general **data deficiencies** in the taxa. Cave crayfish are data deficient in general. Many Midwest crayfish species need additional genetic assessment to determine if they are valid species. **Taxonomic revisions** are generally more common in crayfish and herpetofauna and create uncertainties in the status, trends and distributions of some species. The Guyandotte River Crayfish (*Cambarus veteranus*), for example, was historically considered to occur in Kentucky, West Virginia, and Virginia and is SGCN in Kentucky. Recent research evaluated specimens from the Guyandotte River (WV) and Big Sandy River (border area between KY, WV, and VA). This resulted in the populations in the Big Sandy River being described as a distinct species (the federally threatened *C. callainus*) from those in the Guyandotte (*C. veteranus*). *Cambarus veteranus* now only occurs in Virginia, and the taxa team determined the species is thus not a species that should be on the Midwest RSGCN. *Cambarus callainus*, as a new species, is not currently a Midwest SGCN, but as the species now occurring in Kentucky is identified by the Crayfish Taxa Team as a Proposed RSGCN under the common name Big Sandy Crayfish, and the scientific name *C. callainus.* Similarly, new taxonomic research has split Big Water Crayfish (*C. robustus*), SGCN in Kentucky, into three species: Brawny Crayfish (*C. hazardi*) and Cutshin Crayfish (C*. taylori*) are endemic to Kentucky and the original *C. robustus* no longer occurs in Kentucky (Loughman et al. 2017). The Crayfish Taxa Team identified both of the newly described species *C. hazardi* and *C. taylori* as Proposed RSGCN.

FRESHWATER MUSSELS

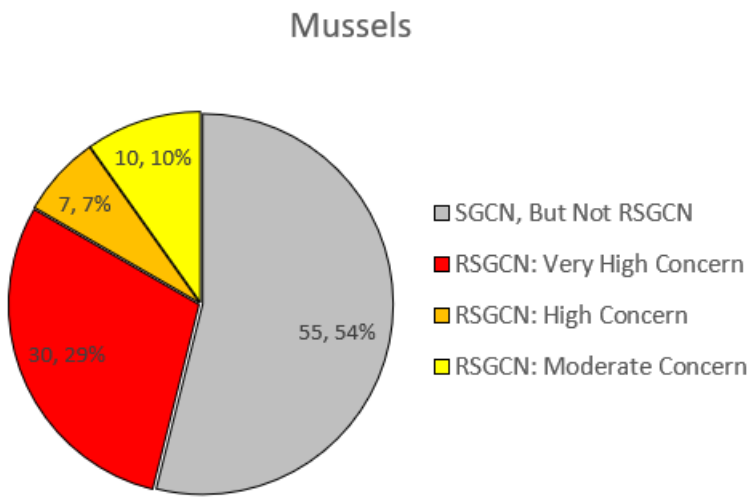
Freshwater mussel SGCN in the Midwest have had a small number of taxonomic revisions, similar to other taxa. Williams et al. (2017) provided an updated classification for freshwater mussels, which was utilized to update the taxonomy of these species. **Freshwater Mussel RSGCN are the second largest RSGCN taxa**, with Lepidoptera RSGCN the largest. The Freshwater Mussel Taxa Team was provided with data on SGCN that are also identified as priority species by the Great Plains FHP (USFWS 2020).

Several Midwest SGCN are believed to be extirpated from some MAFWA states, suggesting that some ranges may be contracting. At least one species is anticipated to soon have a taxonomic revision. A number of RSGCN are identified by the Mussel Taxa Team as Highly Imperiled or facing Emerging Threats (Appendix I).

RESULTS

The Freshwater Mussels RSGCN list includes 47 species, out of 102 mussel SGCN in the MAFWA region (Table 1, Figure 15, Appendix D). All RSGCN mussels are in the family *Unionoidae*. Thirty Freshwater Mussels RSGCN are Very High Concern, seven are High Concern, and ten are Moderate Concern (Table 10, Appendix E). More than half (55%) of the Freshwater Mussel RSGCN are federally listed or under review for potential listing. Twenty-four RSGCN mussels are federally endangered, all of which are Very High Concern (Table 24). The Western Fanshell (*Cyprogenia aberti*) and Salamander Mussel (*Simpsonaias ambigua*) are under review for potential listing.

Figure 15. Number and percent of Midwest Freshwater Mussel SGCN that are RSGCN and at what Concern Levels.



There are 28 Midwest RSGCN Mussels also identified as RSGCN in the Northeast and/or Southeast, 23 of which are federally listed or under review for listing (Table 25). Six mussels are shared RSGCN with the Northeast and 26 are shared with the Southeast. Pink Mucket (*Lampsilis abrupta*), Clubshell (*Pleurobema clava*), Fluted Kidneyshell (*Ptychobranchus subtentus*), and Rabbitsfoot (*Theliderma cylindrica*) are RSGCN in all three regions.

One additional mussel is Proposed RSGCN, not currently identified as SGCN within the MAFWA region (Table 2, Appendix F). An additional **ten mussels are on the RSGCN Watchlist as Assessment Priority species** (Table 3, Appendix G) and **one on the RSGCN Proposed Watchlist as an Assessment Priority** (Table 4).

Table 24. Midwest RSGCN Freshwater Mussels that are federally listed as Endangered, with the regional responsibility for each and the number of MAFWA states in which the species is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Cumberland Elktoe (*Alasmidonta atropurpurea*)	50-75%	1
Spectaclecase (*Cumberlandia monodonta*)	50-75%	8
Fanshell (*Cyprogenia stegaria*)	75-100%	4
Curtis Pearlymussel (*Epioblasma curtisii*)	75-100%	1
White Catspaw (*Epioblasma perobliqua*)	100% (MAFWA Endemic)	4
Northern Riffleshell (*Epioblasma rangiana*)	75-100%	5
Snuffbox (*Epioblasma triquetra*)	75-100%	9
Tan Riffleshell (*Epioblasma walkeri*)	50-75%	1
Cracking Pearlymussel (*Hemistena lata*)	25-50%	2
Pink Mucket (*Lampsilis abrupta*)	25-50%	4
Higgins Eye (*Lampsilis higginsii*)	100% (MAFWA Endemic)	6
Neosho Mucket (*Lampsilis rafinesqueana*)	75-100%	2
Scaleshell (*Leptodea leptodon*)	50-75%	8
Ring Pink (*Obovaria retusa*)	25-50%	2
Littlewing Pearlymussel (*Pegias fabula*)	25-50%	1
White Wartyback (*Plethobasus cicatricosus*)	50-75%	3
Orangefoot Pimpleback (*Plethobasus cooperianus*)	25-50%	3
Sheepnose (*Plethobasus cyphyus*)	75-100%	8
Clubshell (*Pleurobema clava*)	75-100%	6
Rough Pigtoe (*Pleurobema plenum*)	50-75%	3
Fat Pocketbook (*Potamilus capax*)	75-100%	5

Species	Regional Responsibility	Number of MAFWA States
Fluted Kidneyshell (*Ptychobranchus subtentus*)	25-50%	1
Winged Mapleleaf (*Quadrula fragosa*)	25-50%	7
Rayed Bean (*Villosa fabalis*)	75-100%	5

Table 25. Midwest RSGCN Mussels also listed as RSGCN in the Northeast and/or Southeast regions.

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Cumberland Elktoe (*Alasmidonta atropurpurea*)***	Very High	n/a	High
Cumberland Papershell (*Anodontoides denigrata*)	Very High	n/a	Very High
Spectaclecase (*Cumberlandia monodonta*)***	Very High	n/a	Very High
Western Fanshell (*Cyprogenia aberti*)*	High	n/a	Moderate
Fanshell (*Cyprogenia stegaria*)***	Very High	n/a	Very High
Curtis Pearlymussel (*Epioblasma curtisii*)***	Very High	n/a	Very High
Northern Riffleshell (*Epioblasma rangiana*)***	Very High	Very High	n/a
Snuffbox (*Epioblasma triquetra*)***	Very High	n/a	Very High
Tan Riffleshell (*Epioblasma walkeri*)***	Very High	n/a	Very High
Cracking Pearlymussel (*Hemistena lata*)***	Very High	n/a	Very High
Pink Mucket (*Lampsilis abrupta*)***	Very High	Data Deficient	High
Neosho Mucket (*Lampsilis rafinesqueana*)***	Very High	n/a	Very High
Scaleshell (*Leptodea leptodon*)***	Very High	n/a	Very High
Ring Pink (*Obovaria retusa*)***	Very High	n/a	High
Round Hickorynut (*Obovaria subrotunda*)	Very High	n/a	High

Species	Midwest Concern Level	Northeast Concern Level	Southeast Concern Level
Littlewing Pearlymussel (*Pegias fabula*)***	Very High	n/a	Very High
White Wartyback (*Plethobasus cicatricosus*)***	Very High	n/a	Very High
Orangefoot Pimpleback (*Plethobasus cooperianus*)***	Very High	n/a	Very High
Sheepnose (*Plethobasus cyphyus*)***	Very High	n/a	Very High
Clubshell (*Pleurobema clava*)***	Very High	Very High	High
Rough Pigtoe (*Pleurobema plenum*)***	Very High	n/a	Very High
Pyramid Pigtoe (*Pleurobema rubrum*)	Very High	n/a	High
Fat Pocketbook (*Potamilus capax*)***	Very High	n/a	Very High
Fluted Kidneyshell (*Ptychobranchus subtentus*)***	Very High	Moderate	Very High
Winged Mapleleaf (*Quadrula fragosa*)***	Very High	n/a	Very High
Rabbitsfoot (*Theliderma cylindrica*)	Very High	High	High
Rayed Bean (*Villosa fabalis*)***	Very High	Very High	n/a
Kentucky Creekshell (*Villosa ortmanni*)	Very High	n/a	High

* Under Review; ** Federally threatened; *** Federally endangered

VERY HIGH CONCERN FRESHWATER MUSSELS

Nearly two-thirds (64%) of the Freshwater Mussel RSGCN are of Very High Concern, the highest proportion of all RSGCN taxa. The Mussel Taxa Team identified 30 Very High Concern freshwater mussels (Table 10; Appendix E, Table E-1). Two of the Very High Concern RSGCN mussels are endemic to the MAFWA region: Higgins Eye (*Lampsilis higginsii*) and White Catspaw (*Epioblasma perobliqua*). The Higgins Eye is found in six states: Iowa, Illinois, Minnesota, Missouri, South Dakota, and Wisconsin. The Whites Catspaw occurs in four Midwest states: Indiana, Kentucky, Ohio, and Michigan. Both the Higgins Eye and White Catspaw are federally endangered (Table 25).

Thirteen Very High Concern Freshwater Mussel RSGCN have regional responsibilities of 75-100% and another six have 50-75% regional responsibility. Nine mussels have less than 50%

regional responsibility, with eight of the nine identified as Highly Imperiled by the Mussel Taxa Team (Appendix I). The remaining mussel, Pyramid Pigtoe (*Pleurobema rubrum*) has a Core Population in the Midwest. All but one of the Highly Imperiled Mussel RSGCN that has less than 50% regional responsibility is federally endangered (Table 25); the eighth is the Rabbitsfoot. The Rabbitsfoot also has been identified as RSGCN (High Concern) by both NEAFWA and SEAFWA.

MAFWA ENDEMIC FRESHWATER MUSSELS

Only two Freshwater Mussel RSGCN are endemic to the Midwest, the previously described Very High Concern Higgins Eye and White Catspaw. Slightly more than half (51%) of the RSGCN mussels have 75-100% regional responsibility. Of those 24 mussels, 13 are of Very High Concern, 4 of High Concern, and 7 of Moderate Concern. All seven of the Moderate Concern mussels with 75-100% regional responsibility were identified by the Mussel Taxa Team as facing Emerging Threats (Appendix I). Five of these Emerging Threats mussels are threatened by invasive Zebra Mussels and Quagga Mussels.

SHARED FRESHWATER MUSSEL SPECIES

The Freshwater Mussel RSGCN are more widely shared in the Midwest than the Crayfish RSGCN, with each RSGCN occurring in an average of five states. **Thirty-five of the 47 RSGCN mussels are shared by at least three Midwest states.** Eight Freshwater Mussel RSGCN occur in only one Midwest state, and another four only occur in two states.

Two RSGCN mussels occur in all 13 MAFWA states: Elktoe (*Alasmidonta marginata*) and Black Sandshell (*Ligumia recta*); both are threatened by invasive Zebra Mussels. The Purple Wartyback (*Cyclonaias tuberculata*), Yellow Sandhsell (*Lampsilis teres*), and Creek Heelsplitter (*Lasmigona compressa*) are found in 11 states each. Kentucky supports 42 out of the 47 RSGCN mussels, 89% of the species. Indiana (36 RSGCN), Illinois (30 RSGCN), and Ohio (28 RSGCN) also support high numbers of Freshwater Mussel RSGCN. Missouri has 24 RSGCN mussels, the most of any Midwest state west of the Mississippi River.

RSGCN FRESHWATER MUSSELS HABITAT AND LIMITING FACTORS

Even more so than the other aquatic taxa discussed previously, RSGCN Mussels are limited in their ability to respond to changing conditions by moving to more suitable habitats. Like the other aquatic taxa, mussels have **specific requirements** related to water temperature, oxygen content, clarity, flow speeds, and substrate. With these sensitivities to water conditions, mussels are likely susceptible to any changes caused by climate change, such as changed flow patterns, hydrology, temperatures, and increased frequency of droughts or floods.

While they can use their muscular foot to shift around on the bottom of a stream, river, lake, or pond, they are largely sedentary as adults. Generally, mussel dispersal occurs while they are in their larval (parasitic glochidia) stage; the glochidia attach to the gills of host fish species, which may carry them further up or downstream before the juvenile mussels drop off and settle in the substrate. This makes mussels more vulnerable to many of the threats that also affect fish and crayfish. This dependence on other species is especially concerning when the host is also a RSGCN, as is the case for Salamander Mussel (*Simpsonaias ambigua*), a mussel known to parasitize an amphibian, the Common Mudpuppy (*Necturus maculosus*).

As filter feeders, mussels are particularly **vulnerable to pollutants** and toxins. Discussions with the Mussel Taxa Team revealed that 45 of the 47 RSGCN Mussels are sensitive to pollution. The remaining two species are data deficient, so though it is not explicitly stated, they are likely impacted as well. Pollutants can come from a variety of sources. Agricultural runoff can contain harmful herbicides and chemicals, as well as fertilizers that can contribute to eutrophication. Mining slag can release a number of toxins and heavy metals into the water. Household sewage and urban wastewater can also contribute to eutrophication. Industrial chemical spills have been known to cause large mussel die offs in some locations.

Dams are another major threat to RSGCN Mussels in the Midwest. The Mussel Taxa Team suggested that at least 39 RSGCN Mussels are impacted by dams. These impacts can vary, but include destruction and inundation of suitable habitat, isolation of populations, increased sedimentation, altered flow regimes resulting in stranding or scouring, shock mortality caused by cold water releases, and prevention of host fish movement (Watters 1996, Brandt 2000). Dredging, channelization, urbanization, and removal of riparian vegetation have also decreased available habitat.

Invasive species also have an impact on RSGCN Mussels. The primary concern in the Midwest is Zebra Mussels (*Dreissena polymorpha*). This species competes for food resources and attaches to – and incapacitates – native mussels. At least 16 RSGCN Mussels are impacted by Zebra Mussels; three species are additionally impacted by Asian Clam (*Corbicula fluminea*), and one is impacted by Quagga Mussel.

PROPOSED RSGCN FRESHWATER MUSSELS

There is one Proposed RSGCN Freshwater Mussel (Table 2). The Proposed RSGCN Freshwater Mussel is not currently designated as SGCN by any MAFWA state but the Freshwater Mussel Taxa Team identified this species as otherwise meeting RSGCN selection criteria. The Catspaw (*Epioblasma obliquata*) is Proposed RSGCN of Very High Concern with 75-100% regional responsibility. The only extant population of Catspaw globally is in Ohio, except for where the mussel has been reintroduced.

FRESHWATER MUSSELS DISCUSSION

The MAFWA states averaged more than 19 RSGCN Mussels each, with Kentucky (42) and Indiana (36) supporting the largest numbers (Table 13). Illinois, Ohio, and Missouri supported higher than the average number of RSGCN Mussels as well. RSGCN Mussel species diversity appears to decline in the northwestern portion of the region, with the Dakotas and Nebraska supporting the fewest number of RSGCN Mussels.

Several Midwest SGCN are believed to be extirpated from some MAFWA states, suggesting that **some ranges may be contracting**. Pyramid Pigtoe is extirpated from several Midwest states. Snuffbox is extirpated from Iowa, and Sheepnose is largely extirpated from Iowa. Salamander Mussel has not been found in Iowa in decades, but Wisconsin is successfully propagating the species, which may allow restoration to historical areas. Round Hickorynut is extirpated from parts of the Midwest and has declined almost everywhere; the taxa team anticipates the mussel may become federally listed as threatened.

Western Fanshell (*Cyprogenia aberti*) is anticipated to soon have a taxonomic split into two species, with Missouri and Kansas supporting the core population of the true Western Fanshell and the other species occurring in one river basin in Arkansas. The regional responsibility for Western Fanshell as Midwest RSGCN is 75-100% and could increase with a taxonomic split.

A number of RSGCN are identified by the Mussel Taxa Team as Highly Imperiled (8 species) or facing Emerging Threats (10 species). **Population isolation** is the most common reason cited by the Mussel Taxa Team for Highly Imperiled RSGCN, such as Ring Pink (*Obovaria retusa*), Orangefoot Pimpleback (*Plethobasus cooperianus*), and Winged Mapleleaf. When population isolation occurs, there is an increased need for conservation of remaining populations, according to the taxa team. The Midwest region supports Core Populations of two mussels, Pyramid Pigtoe and Winged Mapleleaf (*Quadrula fragosa*). The most prevalent emerging threat cited by the Mussel Taxa Team is invasive Zebra Mussel. Dams and other ecosystem modifications that impede fish passage are also a concern of the taxa team for mussel conservation, due to the interdependency of mussels with host fish.

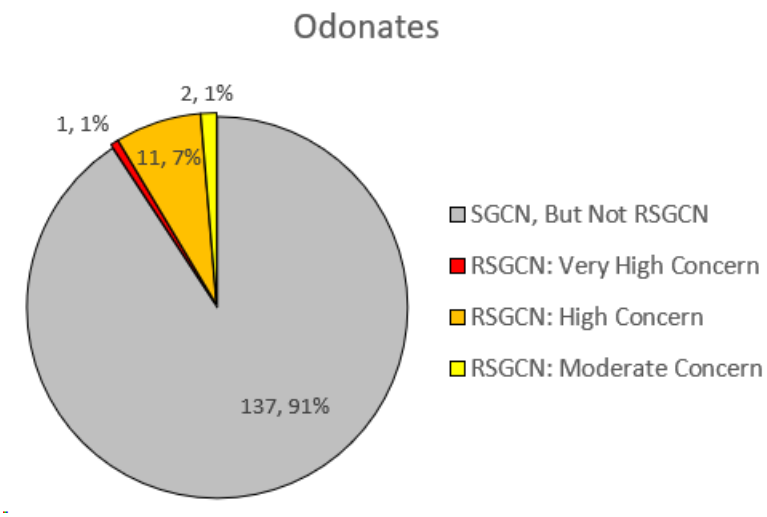
ODONATES (DRAGONFLIES AND DAMSELFLIES)

Dragonflies and damselflies are both aquatic and terrestrial species, depending on the life stage. Larvae (nymphs) are aquatic and adults are aerial predators. Both odonate larvae and adults are carnivorous, usually insectivores. Odonates, much like EPT, can be bioindicators of water quality in aquatic habitats. NEAFWA identified RSGCN Odonates but SEAFWA has not yet identified Odonate RSGCN as of 2021.

RESULTS

The Odonate RSGCN list includes 14 dragonflies, out of 151 dragonfly and damselfly SGCN in the MAFWA region (Table 1, Figure 16, Appendix D). One Odonate RSGCN is Very High Concern, 11 are High Concern, and two are Moderate Concern (Table 10, Appendix E). Seven species are club-tailed dragonflies (*Gomphidae*), four are emerald dragonflies (*Corduliidae*), and one each in three other families – a darner (*Aeshnidae*), a skimmer (*Libellulidae*), and a petaltail (*Petaluridae*). One RSGCN Odonate is federally endangered, the Hine's Emerald (*Domatoclora hineana*).

Figure 16. Number and percent of Midwest Odonate SGCN that are RSGCN and at what Concern Levels.



Four dragonfly RSGCN have also been identified as RSGCN in the Northeast. Elfin Skimmer (*Nannothemis bella*) and Spatterdock Darner (*Rhionaeschna mutata*) are Northeast RSGCN Odonates with Moderate Concern Levels. Pygmy Snaketail (*Ophiogomphus howei*) is a High Concern RSGCN in the Northeast region. Quebec Emerald (*Somatochlora brevicincta*) is identified by NEAFWA as a Data Deficient RSGCN.

Two additional Odonates are Proposed RSGCN, with neither currently identified as SGCN within the MAFWA region (Table 2, Appendix F). Twelve additional dragonflies and damselflies are on the RSGCN Watchlist as Assessment Priority species (Table 3, Appendix G).

VERY HIGH CONCERN ODONATES

Only one Odonate RSGCN is Very High Concern (Table 10; Appendix E, Table E-1). Hine's Emerald is endemic to the MAFWA region and occurs in the calcareous wetlands of six Midwest states: Illinois, Indiana, Michigan, Missouri, Ohio, and Wisconsin.

MAFWA ODONATE ENDEMICS

Two RSGCN Odonates are MAFWA endemics: Hine's Emerald and Sioux Snaketail (*Ophiogomphus smithi*) (Table 1). Hine's Emerald is RSGCN Very High Concern and Sioux Snaketail High Concern. The Sioux Snaketail has half the state distribution in the Midwest as the Hine's Emerald, known to occur in three states – Iowa, Minnesota, and Wisconsin.

SHARED ODONATE SPECIES

Of the 14 RSGCN Odonates, 11 are shared by at least three MAFWA states. **Nearly two-thirds (64%) of the shared RSGCN Odonates are found in at least six Midwest states**. The Riverine Clubtail (*Stylurus amnicola*) occurs in 12 of the 13 MAFWA states, all but North Dakota. The Elusive Clubtail (*Stylurus notatus*) is found in all MAFWA states except Kansas and North Dakota. Both clubtails are of High Concern and have 75-100% regional responsibility.

Two dragonfly RSGCN are shared by nine states, both of High Concern: Skillet Clubtail (*Gomphurus ventricosus*) and Spatterdock Darner. The Skillet Clubtail has a 75-100% regional responsibility and the Spatterdock Darner 50-75%. The Odonate Taxa Team identified the Midwest as supporting a Core Population of Spatterdock Darner and that the species is expected to have increasing regional responsibility with a Climate Change Range Shift (Appendix I). The Plains Emerald (*Somatochlora ensigera*) is found in eight Midwest states, with 75-100% regional responsibility; the dragonfly is of High Concern.

Three RSGCN Odonates are limited to one or two Midwest states. The St. Croix Snaketail (*Ophiogomphus susbehcha*) occurs in Minnesota and Wisconsin but has 50-75% regional responsibility. The Ozark Emerald (*Somatochlora ozarkensis*) and Quebec Emerald are two of four RSGCN Odonates with less than 50% regional responsibility. Ozark Emerald is found only in Kansas and Missouri in the Midwest region and the Quebec Emerald in Minnesota. The former RSGCN has a ROF of Climate Change Range Shift and a High Concern Level. The latter RSGCN was identified by the Odonate Taxa Team as Highly Imperiled, with Genetic Distinctiveness and a Climate Change Range Shift (Appendix I).

The other two RSGCN Odonates with less than 50% regional responsibility are the Elfin Skimmer and Gray Petaltail (*Tachopteryx thoreyi*); both are found in seven MAFWA states. The Odonate Taxa Team categorized the Elfin Skimmer as Highly Imperiled with a Climate Change Range Shift. The Gray Petaltail has a Core Population in the Midwest and is vulnerable to Emerging Threats (Appendix I). Both dragonflies are High Concern.

RSGCN ODONATE HABITAT AND LIMITING FACTORS

For the odonates designated as RSGCN in the Midwest, **habitat condition**, rather than availability, is the primary concern. Nine are associated with lotic systems, from forest streams to large rivers. One species is associated with lakes and impoundments, and the remaining four are associated with various wetlands.

Dams are a primary cause of habitat degradation for the riverine species. These species require flowing water which dams – and the associated impoundments behind them – prevent. The dams can also contribute to inconsistent water levels, temperature changes, decreased dissolved oxygen levels, and increased siltation and turbidity (Watters 1996, Brandt 2000). Even beyond the dams, alterations to riparian areas can impact these species through the removal of tree cover, loss of necessary habitat features, and increased erosion. Several of the RSGCN Odonates are specialists that require shallow streams bordered by forest; these species are especially sensitive to changes in the riparian zone.

The **wetland species** are all habitat specialists. The Gray Petaltail (*Tachopteryx thoreyi*) is obligate to seeps. The other three species are associated with bogs and similar wetlands. Seeps and bogs are both vulnerable to degradation as a result of changes to the water table. These changes could be the result of groundwater withdrawals or drying driven by climate change. These water sources are also vulnerable to contamination, pollution, and peat moss harvest.

The final species, Spatterdock Darner (*Rhionaeschna mutata*), is generally found in smaller ponds and impoundments. These habitats are also vulnerable to alteration of riparian areas, pollution, and changed hydrology. Nymphs of the species are also predated by various fish species; the species generally prefers fishless ponds.

PROPOSED RSGCN ODONATES

There are two Proposed RSGCN Odonates: Ozark Clubtail (*Gomphurus ozarkensis*) and Acuminate Snaketail (*Ophiogomphus acuminatus*); the former is High Concern and the latter Moderate Concern (Table 2). Neither is currently designated as SGCN by any MAFWA state but the Odonate Taxa Team identified these species as otherwise meeting RSGCN selection criteria. Acuminate Snaketail has 50-75% regional responsibility (found only in KY in the Midwest) but has Climate Vulnerability, an expected or occurring Climate Change Range Shift and Emerging

Threats (Appendix I). Ozark Clubtail has 25-50% regional responsibility (occurring in KS and MO), with the Odonate Taxa Team identifying the species as Highly Imperiled (Appendix I).

ODONATES DISCUSSION

The MAFWA states averaged more than six RSGCN Odonates each, with Minnesota (11), Wisconsin (11), Indiana (9), and Ohio (9) supporting the largest numbers (Table 13). RSGCN Odonate species diversity appears to decline in the western portion of the region, with the Dakotas, Nebraska, and Kansas supporting the fewest number of RSGCN Odonates.

The Odonate Taxa Team stated that **surveys for adult odonates can provide very different results than surveys for nymphs** at the same sites. This is something that should be kept in mind for future surveys of species where the adults are difficult to locate. It was also suggested that surveys of nymphs may better reflect species success in an area.

The genus *Somatochlora* was of particular concern to the Odonate Taxa Team. *Somatochlora* species are rare with **narrow thermal preferences**, resulting in vulnerable and declining habitat availability and condition. Of the 15 *Somatochlora* SGCN in the Midwest, four were identified as RSGCN and three as RSGCN Watchlist [Assessment Priority] species, with the taxa team citing range shifts due to climate change for five of those seven species.

The Odonate Taxa Team cited the Dunkle (2012) publication “Critical species of Odonata in North America” during their discussions for identifying Midwest RSGCN Odonates. Dunkle (2012) identified 25 Odonates of conservation concern across the U.S. and Canada, out of approximately 439 species known; three of these odonates are SGCN in the Midwest, and all three are identified as RSGCN (Acuminate Snaketail, Hine’s Emerald, and Ringed Boghunter). A fourth RSGCN odonate (Quebec Emerald) was identified by Dunkle (2012) of conservation interest, but it should be noted that at the time of the review of Dunkle (2012), the Minnesota population of *Somatochlora bevicincta* (Quebec Emerald) was not known.

BEES

The Midwest Bee Taxa Team identified both Bumble Bee and Solitary Bee RSGCN. Only one of the Solitary Bee RSGCN has a common name, therefore scientific names predominate this section. The Northeast region identified Bee RSGCN, mostly Bumble Bees. The Southeast region identified only Bumble Bee RSGCN.

Because states include bee species to varying degrees in SGCN lists and the list of SGCN bees in the Midwest may not be comprehensive or representative, the taxa team identified species they believe meet the criteria to be included as RSGCN even if they were not included as SGCN by the states in the region. Since bumble bees have relatively few species and are easier to identify, there is substantially more information about them than other bees. Nonetheless, the Bee Taxa Team tried to address all bees for this review. Sixteen (16) bumble bees (*Bombus sp.*) are included as SGCN in six of the 13 MAFWA states. A total of 34 solitary bees are listed as SGCN in the region. These were primarily listed in the Missouri SWAP (33 species), with two listed on the Wisconsin SWAP. *Epeolus ainsliei* (Ainslie's Cuckoo Nomad Bee) was listed on both. After reviewing these 50 SGCN species, the Bee Taxa Team suggested 60 additional species for consideration; 10 bees of the 60 non-SGCN bees were ultimately recommended as Proposed RSGCN or Proposed RSGCN Watchlist [Assessment Priority] species.

RESULTS

The bees RSGCN list includes 13 species, out of 50 bee SGCN in the MAFWA region (Table 1, Figure 17, Appendix D). There are six RSGCN bumble bees (out of 16 SGCN) and seven RSGCN solitary bees (out of 34 SGCN). Five Bee RSGCN are Very High Concern, seven are High Concern and one is Moderate Concern (Table 10, Appendix E). All of the Bumble Bee RSGCN are of the genus *Bombus*. The Solitary Bee RSGCN are from multiple families, with two *Apidae*, two *Megachilidae* (leafcutting, mason, and resin bees), one *Andrenidae* (ground-nesting bees), one *Halictidae* (sweat bees), and one *Melittidae*. One bumble bee is federally listed as endangered, the Rusty-patched Bumble Bee (*Bombus affinis*).

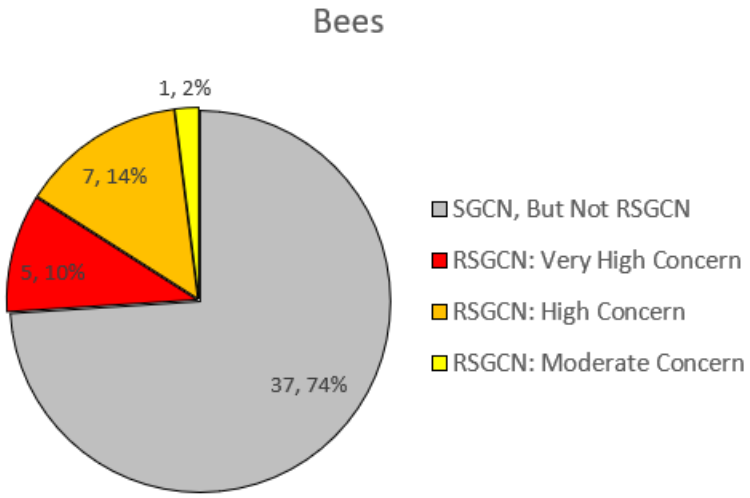
Seven Midwest RSGCN Bees have been identified as RSGCN Bees in the Northeast and/or Southeast regions as well. The Rusty-patched Bumble Bee is RSGCN in both the Northeast and Southeast, at Very High Concern in both regions, with the Southeast RSGCN status applying to the region's endemic population. The Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) and *Megachile ingenua* (a leafcutter bee) are Northeast RSGCN Bees of Moderate Concern. The Southern Plains Bumble Bee (*Bombus fraternus*) is Southeast RSGCN of Moderate Concern. The American Bumble Bee (*Bombus pensylvanicus*), Yellow-banded Bumble Bee (*Bombus terricola*), and Variable Cuckoo Bumble Bee (*Bombus variabilis*) are RSGCN Bees in both the Northeast and Southeast, with the Southeast RSGCN status applying to the region's endemic population. The

American Bumble Bee is Moderate Concern in both regions, the Yellow-banded Bumble Bee is High Concern in the Southeast and Moderate in the Northeast, and the Variable Cuckoo Bumble Bee is Very High Concern in both regions.

Seven additional bees are Proposed RSGCN, with none currently identified as SGCN within the MAFWA region (Table 2, Appendix F).

Seven additional bees are on the RSGCN Watchlist as Assessment Priority species (Table 3, Appendix E). **Four bees are on the Proposed Watchlist as Assessment Priority**, with none currently identified as SGCN in the Midwest (Table 4, Appendix G).

Figure 17. Number and percent of Midwest Bee SGCN that are RSGCN and at what Concern Levels.



VERY HIGH CONCERN BEES

Taxa team representatives identified **five Very High Concern RSGCN Bees** (Table 10; Appendix E, Table E-1). Four of these species are bumble bees and one is a solitary bee. The federally endangered Rusty-patched Bumble Bee has a Core Population in the Midwest and occurs in ten MAFWA states, with Kansas, Missouri and Nebraska the exceptions. The Southern Plains Bumble Bee, shared with the Southeast region, may rely on remnant prairies; MAFWA has a 50-75% regional responsibility for this species.

The Gypsy Cuckoo Bumble Bee is Highly Imperiled and increasingly rare in the Midwest, now considered historic in Michigan and Minnesota by the Bee Taxa Team. The Variable Cuckoo Bumble Bee has not been observed in the Midwest since 2000 according to the Bee Taxa Team, but historical observations were reliable and indicate 75-100% regional responsibility in 9-11 MAFWA states; the Bee Taxa Team believe the most likely remaining population(s) would be in

the southern Midwest where American Bumble Bee populations are strongest. Cuckoo bumble bees place their eggs in the provisioned nest of other bumble bees. The host species for the Gypsy Cuckoo Bumble Bee are the Yellow-banded Bumble Bee (RSGCN of High Concern) and Rusty-patched Bumble Bee (RSGCN of Very High Concern). The host species for the Variable Cuckoo Bumble Bee is the American Bumble Bee, which is also a RSGCN but of High Concern.

One solitary bee, *Osmia illinoiensis* (a mason bee), is RSGCN of Very High Concern with 50-75% regional responsibility. This bee is very rare and only males have been found in recent surveys; it is less habitat specific than other RSGCN bees. Indiana, Missouri, and North Dakota share this bee, which was historically also found in Illinois.

MAFWA ENDEMIC BEES

None of the RSGCN Bees are endemic to the MAFWA region. Five bees are 75-100% regional responsibility: two bumble bees and three solitary bees. The Rusty-patched Bumble Bee and Variable Cuckoo Bumble Bee are Very High Concern. *Megachile ingenua* (a leafcutter bee) and *Lasioglossum fedorense* (a sweat bee) are High Concern. *Andrena beameri* (an andrenid bee) is Moderate Concern. *Megachile ingenua* is very rare (categorized as Highly Imperiled by the Bee Taxa Team) and less habitat specific. *Lasioglossum fedorense* is an indicator of high-quality habitats, found on deep sands like sand dunes, sand savannas and remnant habitats. *Andrena beameri* is nearly Midwest endemic in Missouri and is confined to remnant habitats.

SHARED BEE SPECIES

Ten RSGCN Bees are shared by at least three MAFWA states: six bumble bees and four solitary bees. The American Bumble Bee is shared by all 13 MAFWA states, and the Southern Plains Bumble Bee is shared by all MAFWA states except Wisconsin. Rusty-patched Bumble Bee is found in ten Midwest states. The Yellow-banded Bumble Bee is found in six MAFWA states and was historically present in two more. The Bee Taxa Team identified a Core Population of Yellow-banded Bumble Bee in the Midwest, and the species as a Stewardship Priority (Appendix I). The Highly Imperiled Gypsy Cuckoo Bumble Bee occurs in five states and historically occurred in two more.

The four Solitary Bee RSGCN shared by more than three states each are Ainslie's Cuckoo Nomad Bee (*Epeolus ainsliei*), *Lasioglossum fedorense*, *Osmia illinoiensis,* and *Megachile ingenua. Osmia illinoiensis* is Very High Concern and the other three are High Concern. All four of these solitary bees have at least 50% regional responsibility in the Midwest region. Ainslie's Cuckoo Nomad Bee is found in Illinois, Minnesota, North Dakota, and Wisconsin, and historically in Michigan. *Lasioglossum fedorense* is shared by Illinois, Indiana, Missouri, and Wisconsin. *Osmia illinoiensis* occurs in Indiana, Missouri and North Dakota, plus historically Illinois. Indiana, Illinois, and Missouri also share *Megachile ingenua*.

RSGCN BEE HABITAT AND LIMITING FACTORS

All but one of the 13 RSGCN Bees are at least partially associated with **grassland habitats**. Seven are specifically dependent on remnant prairie patches. The isolated nature of these patches limits the dispersal potential for many of the species, which in turn may result in limited genetic diversity in these populations. These remnant prairie habitats are under particular threat from conversion to agricultural land. This is especially true as neonicotinoid pesticide use contributes to population declines, and the crops planted are often not suitable food sources for these species. In fact, many of the species are dependent on either specific host species or a collection of fire-adapted plants; prescribed fires may be necessary to prevent encroachment of woody plants and maintain suitable floral resources throughout the growing season. Unfortunately, fire can promote the proliferation of certain invasive species, especially members of the genus *Melilotus*. Pulling and mowing are two means to control these undesirable plants. However, it is important that mowing not remove flowering parts of desirable native plants.

The six RSGCN Bumble Bees are facing an additional potential threat. The **pathogen *Nosema bombi*** has been observed in half of the species, though the overall effect on the populations is currently not known. Two of the remaining species are cuckoo bumble bees, which parasitize at least one of the species that are affected by *N. bombi*, so they may also be indirectly impacted by the pathogen. No threats beyond those already described arose amongst the group of RSGCN Solitary Bees.

PROPOSED RSGCN BEES

There is one Proposed RSGCN Bumble Bee (Table 2, Appendix F). The Black-and-gold Bumble Bee (*Bombus auricomus*) is not currently designated as SGCN by any MAFWA state. Some states in the eastern portion of the region have concerns about declines, but evidence isn't strong and the species seems stable in other places. The Bee Taxa Team identified the Black-and-gold Bumble Bee as Moderate Concern with 50-75% regional responsibility.

There are six Proposed RSGCN Solitary Bees (Table 2, Appendix F). None are currently designated as SGCN by any MAFWA state but the Bee Taxa Team identified these species as otherwise meeting RSGCN selection criteria. Three are of High Concern and 50-75% regional responsibility: Macropis Cuckoo Bee (*Epeoloides pilosulus*), Yellow Loosestrife Bee (*Macropis ciliata*), and Nude Yellow Loosestrife Bee (*Macropis nuda*); all three are RSGCN in the Northeast. The Macropis Cuckoo Bee is parasitic on *Macropis* spp. Historically *Macropis* bees were more common but are now rare in the Midwest, for unknown reasons. These two *Macropis* spp. are associated with *Lysimachia* (Loosestrife) plants.

The other three are Moderate Concern: Interrupted Cuckoo Nomad Bee (*Epeolus interruptus*), Peckham's Miner Bee (*Andrena peckhami*), and Planed Miner Bee (*Andrena runcinatae*). The latter *Andrena* spp. are very rare and indicative of high-quality habitat condition; they are sand obligate species. The Midwest has 50-75% regional responsibility for the Peckham's Miner Bee and Planed Miner Bee, but 25-50% for the Interrupted Cuckoo Nomad Bee. The Bee Taxa Team identified the Interrupted Cuckoo Nomad Bee as Highly Imperiled (Appendix I). This Proposed RSGCN is associated with Andrew's Plasterer Bee (*Colletes andrewsi*) and is rare, occurring on remnant sand habitats.

BEES DISCUSSION

T**he MAFWA states averaged more than five RSGCN Bees each**, with Indiana (9), Missouri (9), and North Dakota (8) supporting the largest numbers (Table 13). Illinois and Wisconsin supported higher than the average number of RSGCN Bees as well.

Several states reported **ongoing efforts to survey and identify SGCN bees** for upcoming SWAP revisions. Missouri anticipates identifying new SGCN bees, and Illinois has several disparate but very good surveys ongoing that need to be networked and pulled into the next SWAP. Missouri also has been working to host a Midwestern Bee Conference prior to the upcoming SWAP updates, which will facilitate regional communication and understanding. Some states, like Indiana, lack statutory authority for insects and do not anticipate including bees as SGCN.

The Bee Taxa Team cited overall concerns about **sand obligate and wetland species** as particularly vulnerable. Numerous RSGCN and Proposed RSGCN are habitat specialists limited to remnant natural habitats in sandy soils. The team found the entire *Macropis* genus to be rare in the Midwest, as habitat plant specialists in wetlands.

Insufficient survey efforts were cited as a limiting factor in determining population trends in many states, creating challenges for the taxa team to identify current species ranges, regional responsibilities, and RSGCN Concern Levels in the Midwest. Some state fish and wildlife agencies lack expertise and authority over insects. A general need for additional distribution and abundance information, as well as identification of host plants, was noted.

Some solitary bees are cleptoparasitic, creating **interdependency between species**. Two solitary bees were identified by the Bee Taxa Team as Interdependent Species – Aberrant Cellophane Bee (*Colletes aberrans*) and Susanna's Cellophane Bee (*Colletes susannae*), both of which serve as hosts for the RSGCN Ainslee's Cuckoo Bee. As interdependent hosts, the taxa team identified an assessment priority for both species and identified both as Proposed RSGCN Watchlist [Assessment Priority] since neither currently are SGCN in the Midwest.

LEPIDOPTERA (BUTTERFLIES, SKIPPERS, AND MOTHS)

Lepidoptera, or Butterflies, Skippers, and Moths, is the **largest taxa in numbers of Midwest SGCN and RSGCN**. The Midwest region has 464 SGCN butterflies, skippers, and moths. Experts on the Lepidoptera Taxa Team estimated that the Midwest states support approximately 2000 lepidoptera species each, highlighting the biodiversity in the region. The Northeast region identified RSGCN Lepidoptera, but the Southeast region has not yet identified Lepidoptera RSGCN.

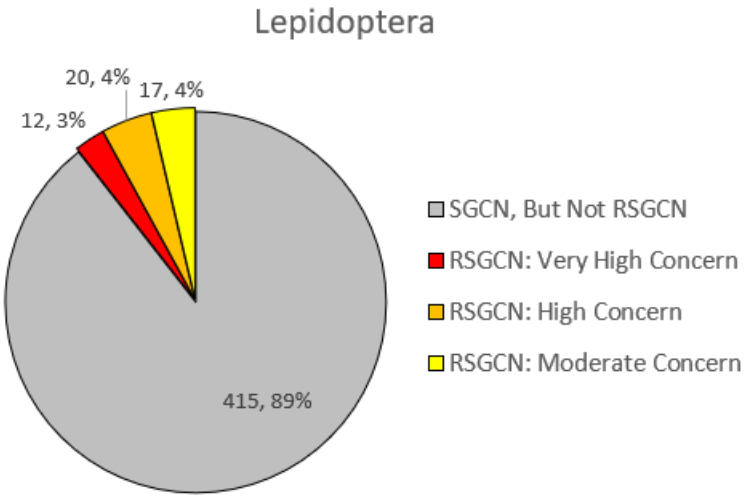
Like some of the other taxa teams, the Lepidoptera Taxa Team dealt with taxonomic issues, including whether subspecies should be merged with nominal species or identified as separate RSGCN. When Concern Levels for a subspecies are higher than for a nominal species, taxa teams typically will identify subspecies as separate RSGCN and may or may not identify the nominal species as RSGCN. At least seven lepidoptera subspecies-nominal species SGCN pairs were discussed by the Lepidoptera Taxa Team, with at least three listed at the nominal level only and one listed at both the nominal and subspecies levels.

Another challenge faced by the taxa team was a lack of regional responsibility data. The taxa team identified the regional responsibilities for all of the SGCN reviewed by the team using published and unpublished data sources. Given the large number of SGCN (464), this task was challenging and the resulting data represent a significant advancement in the understanding of Midwest Lepidoptera (especially moths) and identification of remaining data gaps.

RESULTS

The Lepidoptera RSGCN list includes 49 species, out of 464 Lepidoptera SGCN in the MAFWA region (Table 1, Figure 18, Appendix D). The Lepidoptera RSGCN include 21 butterflies and skippers and 28 moths. Twelve (12) Lepidoptera RSGCN are Very High Concern, 20 are High Concern and 17 are Moderate Concern (Table 10, Appendix E). The butterfly and skipper RSGCN represent five taxonomic families: *Hesperiidae* or skippers (12 RSGCN), *Lycaenidae* or gossamer-winged butterflies (3), *Nymphalidae* or brush-footed butterflies (4), *Papilionidae* or swallowtail butterflies (1), and *Riodinidae* or metalmark butterflies (1). The moth RSGCN include eight families: *Choreutidae* or metalmark moths (1 RSGCN), *Crambidae* or crambid snout moths (1), *Erebidae* or erebid moths (3), *Gelechiidae* or twirler moths (1), *Geometridae* or geometer moths (3), *Noctuidae* or owlet moths, cutworms or armyworms (15), *Pyralidae* or snout or grass moths (1), and *Tortricidae* or tortrix or leafroller moths (3).

Figure 18. Number and percent of Midwest Lepidoptera SGCN that are RSGCN and at what Concern Levels.



Four RSGCN Lepidopterans are federally listed as endangered, threatened, or candidate species and two are under review for potential listing. The Karner Blue (*Plebejus samuelis*) and Poweshiek Skipperling (*Oarisma poweshiek*) are endangered and the Dakota Skipper (*Hesperia dacotae*) is threatened. The Monarch (*Danaus plexippus*) was listed as a candidate species in December 2020 and is undergoing further review for listing as threatened or endangered. Linda's Roadside-Skipper (*Amblyscirtes linda*) and Regal Fritillary (*Argynnis idalia*) are under review for potential federal listing.

Thirteen Lepidoptera RSGCN are also identified as RSGCN in the Northeast region. Four are Very High Concern RSGCN in the Northeast: Frosted Elfin (*Callophrys irus*), Persius Duskywing (*Erynnis persius persius*), Milne's Looper Moth (*Euchlaena milnei*), and Karner Blue. Six are High Concern RSGCN in the Northeast: New Jersey Tea Inchworm (*Apodrepanulatrix liberaria*), Regal Fritillary, The Starry Campion Moth (*Hadena ectypa*), Barrens Metarranthis Moth (*Metarranthis apiciaria*), Appalachian Grizzled Skipper (*Pyrgus centaureae wyandot*), and Mottled Duskywing (*Erynnis martialis*). Golden Borer Moth (*Papaipema cerina*) and Monarch are Moderate Concern RSGCN in the Northeast and Doll's Dagger Moth (*Acronicta dolli*) is a Data Deficient Northeast RSGCN.

Six additional Lepidoptera are Proposed RSGCN, with none currently identified as SGCN within the MAFWA region (Table 2, Appendix F). An additional **18 butterflies, skippers, or moths are on the RSGCN Watchlist as Assessment Priority species** (Table 3, Appendix G).

VERY HIGH CONCERN LEPIDOPTERA

Of the 12 Very High Concern RSGCN Lepidoptera, the Lepidoptera Taxa Team identified **six Very High Concern butterflies and skippers and six Very High Concern moths** (Table 26; Appendix E, Table E-1). Four of the Very High Concern Lepidoptera RSGCN are endemic to the MAFWA region: Dakota Skipper, Poweshiek Skipperling, *Bagisara gulnare* (a noctuid moth), and Michigan Dune Dart Moth (*Copablepharon michiganensis*). The Dakota Skipper and Poweshiek Skipperling are prairie species, while the Michigan Dune Dart Moth prefers dune habitats. *Bagisara gulnare* is found in forests as well as glades, barrens or savanna habitats.

Another four have at least 75% regional responsibility: Regal Fritillary, Whitney's Underwing (*Catocala whitneyi*), Two-spotted Eucosma (*Eucosma bipunctella*), and Phlox Moth (*Schinia indiana*). All four RSGCN are found in prairie or grassland habitat; Whitney's Underwing and Phlox Moth also use glades, barrens, or savanna habitat.

The Frosted Elfin, Appalachian Grizzled Skipper, and Barrens Metarranthis Moth (*Metarranthis apiciaria*) each has less than 50% regional responsibility in the Midwest (Table 19). The Lepidoptera Taxa Team identified the Frosted Elfin as Highly Imperiled, occurring in over half of the Midwest states. The Appalachian Grizzled Skipper is categorized as Highly Imperiled with Genetic Distinctiveness, and the Midwest (Ohio and Michigan) as having a Stewardship Priority. Barrens Metarranthis Moth is Highly Imperiled and only occurs in Indiana in the Midwest (Appendix I). All three of these lepidoptera are found on barrens or savanna habitat.

Table 26. Midwest RSGCN Lepidoptera of Very High Concern, with the regional responsibility for each and the number of MAFWA states in which the species is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Regal Fritillary (*Argynnis idalia*)*	75-100%	13
Frosted Elfin (*Callophrys irus*)	25-50%	7
Dakota Skipper (*Hesperia dacotae*)**	100% (MAFWA Endemic)	5
Ottoe Skipper (*Hesperia ottoe*)	50-75%	11
Poweshiek Skipperling (*Oarisma poweshiek*)***	100% (MAFWA Endemic)	1
Appalachian Grizzled Skipper (*Pyrgus centaureae wyandot*)	25-50%	2
Bagisara gulnare (a noctuid moth)	100% (MAFWA Endemic)	4
Whitney's Underwing (*Catocala whitneyi*)	75-100%	11

Michigan Dune Dart Moth (*Copablepharon michiganensis*)	100% (MAFWA Endemic)	2
Two-spotted Eucosma (*Eucosma bipunctella*)	75-100%	5
Barrens Metarranthis Moth (*Metarranthis apiciaria*)	25-50%	1
Phlox Moth (*Schinia indiana*)	75-100%	5

* Under Review; ** Federally threatened; *** Federally endangered

MAFWA ENDEMIC LEPIDOPTERA

There are five RSGCN Lepidoptera that are endemic to the MAFWA region: two butterflies / skippers and three moths. Four are Very High Concern – Dakota Skipper, Poweshiek Skipperling, *Bagisara gulnare*, and Michigan Dune Dart Moth. The other endemic RSGCN is a High Concern moth, the Culvers Root Borer (*Papaipema sciata*). Poweshiek Skipperling historically occurred in eight states (IA, IL, IN, MI, MN, ND, SD, and WI) but is not extant to isolated populations in Michigan and Manitoba. Culvers Root Borer is found in seven MAFWA states (IA, IL, IN, MI, MN, MO, and WI). Dakota Skipper is found in five MAFWA states: Iowa, Illinois, Minnesota, North Dakota, and South Dakota. Four states share *Bagisara gulnare* – Illinois, Indiana, Kentucky, and Wisconsin. The Michigan Dune Darth Moth is more restricted in its Midwest range, occurring in Michigan and Wisconsin.

SHARED LEPIDOPTERAN SPECIES

Fourteen Lepidoptera RSGCN are found in only one or two MAFWA states, while the remaining 35 are shared by at least three states each. **There are nine RSGCN that occur in ten or more Midwest states.** Regal Fritillary, Dusted Skipper (*Atrytonopsis hianna*), Monarch, and Leopard's Skipper (*Hesperia leonardus*) occur in all 13 MAFWA states. The first is Very High Concern and the other three are all Moderate Concern. The Regal Fritillary and Monarch are Stronghold Species in the Midwest; the Monarch also is a Migratory Species (Appendix I).

Mottled Duskywing (*Erynnis martialis*) is High Concern RSGCN and found in all but one of the Midwest states, absent from North Dakota. The Lepidoptera Taxa Team identified the Mottled Duskywing as a Stronghold Species in the Midwest that is Highly Imperiled and a Stewardship Priority for the region (Appendix I). Whitney's Underwing and Ottoe Skipper are found in 11 Midwest states, with Whitney's Underwing not found in Ohio and Michigan and the Ottoe Skipper not found in Ohio and Kentucky. Two RSGCN are shared by ten states: Two-spotted Skipper (*Euphyes bimacula*) and Blazing Star Stem Borer (*Papaipema beeriana*). Two-spotted Skipper is Moderate Concern and not known to occur in Kentucky or North Dakota and may

occur in South Dakota. Blazing Star Stem Borer High Concern with Emerging Threats; this RSGCN is not known to occur in Kansas, Nebraska, and South Dakota (Appendix I).

RSGCN LEPIDOPTERAN HABITAT AND LIMITING FACTORS

Like many of the bees, most RSGCN Lepidopterans depend on a variety of plant species for nectar. However, many of their **larval stages are specialists**, requiring the presence of specific host plants to feed on. This close relationship between host and pollinator means that lepidopterans are susceptible twice over to habitat alteration: changes could make conditions directly unsuitable to them, or unsuitable for the host plant.

The majority of the RSGCN butterflies and moths (37 of 49) are divided between **grassland habitats and glades, barrens, and savannas**. Both of these habitat types are susceptible to changes caused by woody plant encroachment and agricultural expansion. Agricultural runoff and pesticide residues may also be detrimental to this group when they are present on host flowers. As described above with bees, some of the habitat types preferred by RSGCN Lepidopterans– such as native prairie, oak savannah, and pine barrens – exist only in isolated patches from one another. The disconnected nature of these habitats can make it difficult for individuals to migrate to new patches if their current patch is destroyed and may have implications for genetic diversity. Historically, these habitat types required fairly frequent disturbance – usually fire – in order to be maintained. Prescribed burns benefit these grassland and barrens-dependent species, but can also temporarily decrease local abundance. Another potential threat in these habitats is deer browsing on the required host plants. Controlling the deer populations or fencing off patches of sensitive plants can benefit the lepidopteran species that utilize them.

Another eight RSGCN species depend primarily on **forested habitats**. The primary threat to these species is the spread of invasive plants, such as garlic mustard (*Alliaria petiolata*), replacing native understory species, including required plant hosts. Timber harvesting may also impact the species, as the process may destroy suitable habitat and make the area more susceptible to additional invasions.

Three RSGCN Lepidopterans are associated with **wetland habitats**. Wetlands are similar to grasslands in that they are generally isolated and often require disturbance to maintain the community. Wetlands that are left undisturbed often become overgrown, transition to woody rather than herbaceous species, and have more invasive species, such as *Phragmites* and purple loosestrife (*Lythrum salicaria*), in them. Wetland habitats are also susceptible to the effects of climate change; changing temperatures and rainfall can affect the hydrology and could lead to either drying or flooding of wetland habitats.

The remaining species, the Monarch, is a habitat generalist but **host-specific**, and can be found most anywhere so long as it is open enough and its plant host, milkweed (*Asclepias* spp.), is

present. Because of this flexibility in its breeding and migratory ranges, it is less susceptible than specialist species to some of the threats described above as it can easily move away from the unsuitable site to a more suitable one. However, monarchs face their own set of potential threats. As a long-distance **migratory species**, they need suitable habitat both in the Midwest and at their overwintering sites in Mexico. Logging in these winter sites may remove suitable roosts, and climate change may change the microclimates in these sites enough to make them unsuitable. Monarchs are also impacted by the parasite *Ophryocystis elektroscirrha*, though migratory populations have lower infection rates than non-migratory ones (Bartel et al. 2011). Individuals infected by this parasite have lower survival rates, and many do not survive the migration south to the wintering grounds.

One glade and barren-dwelling species, the Tawny Crescent (*Phyciodes batesii*), is declining in many parts of its range to the east. However, the forces driving this decline are currently unknown. More research is needed to determine the factors impacting this species.

PROPOSED RSGCN LEPIDOPTERA

There are six Proposed RSGCN Lepidoptera: five moths and one butterfly (Table 2, Appendix F). None of the six are currently designated as SGCN by any MAFWA state but the Lepidoptera Taxa Team identified these species as otherwise meeting RSGCN selection criteria. Mitchell's Satyr (*Neonympha mitchellii*) has 50-75% regional responsibility in the Midwest and is of Very High Concern. Of the five Proposed RSGCN moths, *Agonopterix pergandeella* (a grass miner moth) is endemic to the MAFWA region and is High Concern. Three Proposed RSGCN moths have 75-100% regional responsibility: Marbleseed Leafminer (*Acrocercops pnosmodiella*), Franclemont's Lithophane (*Lithophane franclemonti*), and *Pyrausta pythialis* (a crambid snout moth). The Marbleseed Leafminer and *Pyrausta pythialis* are High Concern and the Franclemont's Lithophane is Moderate Concern. The remaining Proposed RSGCN Lepidopteran is the Dark-banded Flower Gem Moth (Melaporphyria immortua), which has 50-75% regional responsibility and is of High Concern.

The *Agonopterix pergandeella* and Marbleseed Leafminer inhabit prairie habitat. The Dark-banded Flower Gem Moth and *Pyrausta pythialis* are found in prairie, barrens and dune habitats. Mitchell's Satyr is associated with non-boreal fen habitat. Franclemont's Lithopane is associated with deciduous forest and woodland habitat.

LEPIDOPTERA DISCUSSION

The MAFWA states averaged nearly 24 RSGCN Lepidopterans each, with Wisconsin (38), Illinois (37), and Indiana (35) supporting the largest numbers (Table 13). Michigan also supported higher than the average number of RSGCN Lepidoptera. RSGCN Lepidoptera species

diversity appears to decline in the western portion of the region, with the Dakotas, Nebraska, and Kansas supporting the fewest number of RSGCN Lepidopterans.

Proper identification of some lepidoptera was noted by the taxa team as contributing to data deficiencies in understanding status, trends, and distributions. Similar to the bees, a number of butterflies, skippers, and moths of concern to the Lepidoptera Taxa Team are habitat specialists in remnant prairie or grassland habitats. Many of the prairie-dependent species are in decline in their Midwest ranges, but the taxa team also considered species associated with and representative of other habitats to avoid bias toward the prairie/grassland species in the RSGCN Lepidoptera list. Thus, the high proportion of RSGCN Lepidoptera associated with prairies and grasslands in the Midwest are a more accurate reflection of conservation concern and degree of imperilment and not a selection bias.

EPHEMEROPTERA (MAYFLIES)

The team of national and regional EPT researchers reviewed all the Midwest SGCN Mayfly (Ephemeroptera) species and conducted a regional mayfly species inventory to identify additional species that meet RSGCN or Watchlist selection criteria. A summary of the Ephemeroptera Taxa Team inventory and review is provided in Appendix K. Like Odonates, Ephemeroptera, or mayflies, are aquatic as larvae or nymphs but aerial as adults. Most mayflies are associated with rivers and streams of various sizes, but some are associated with lakes, ponds, the Great Lakes, or wetlands like seeps and springs. As aerial adults, mayflies inhabit adjacent terrestrial habitats like riparian areas. Neither the Northeast or Southeast regions have yet identified Mayfly RSGCN.

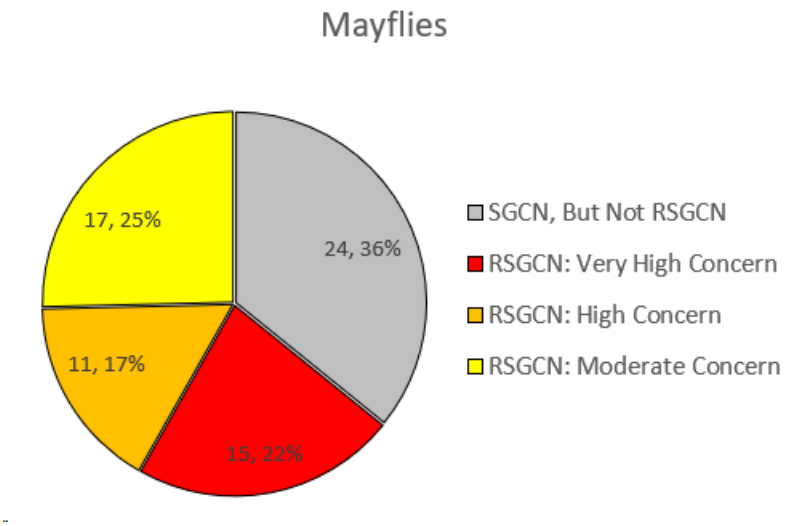
RESULTS

The Mayfly RSGCN list includes 43 species, out of 67 mayfly SGCN in the MAFWA region (Table 1, Figure 19, Appendix D). Fifteen (15) Mayfly RSGCN are Very High Concern, 11 are High Concern, and 17 are Moderate Concern (Table 10, Appendix E). The Mayfly RSGCN belong to 16 taxonomic families. Nine RSGCN are flat-headed or cookie-headed mayflies (*Heptageniidae*), seven are small minnow mayflies (*Baetidae*), five are small squaregill mayflies (*Caenidae*), four are spiny crawler mayflies (*Ephemerellidae*), four are prong-gilled mayflies (*Leptophlebiidae*), three are cleftfooted minnow mayflies (*Metretopodidae*), and smaller numbers for ten other families.

None of the RSGCN Mayflies are federally listed as endangered, threatened, candidate, or under review. Forty-two (42) additional mayflies are Proposed RSGCN, with none currently

identified as SGCN within the MAFWA region (Table 2, Appendix F). No additional mayflies are on the RSGCN Watchlist as Assessment Priority species (Table 3, Appendix G).

Figure 19. Number and percent of Midwest Mayfly SGCN that are RSGCN and at what Concern Levels.



VERY HIGH CONCERN MAYFLIES

Taxa team representatives identified 15 Very High Concern RSGCN Mayflies (Table 27; Appendix E, Table E-1). Four of the 15 Very High Concern species are endemic to the MAFWA region, each found in only a handful of states. The Wisconsin Small Square-gilled Mayfly (*Cercobrachys lilliei*) occurs in Wisconsin, Minnesota, and Nebraska. The Konza Prairie Mayfly (*Leptophlebia konza*) is found only in Kansas. *Paraleptophlebia sticta* is (a prongill mayfly) occurs in Indiana and Illinois and is in decline. The Robust Pentagenian Burrowing Mayfly (*Pentagenia robusta*) is found in Ohio and Kentucky but is potentially extinct.

Three RSGCN Mayflies that are Very High Concern have 75-100% regional responsibility: Winnebago Small Square-gilled Mayfly (*Cercobrachys Winnebago*), Canadian Large Square-gilled Mayfly (*Neoephemera bicolor*), and *Sparbarus nasutus* (a small square-gilled mayfly). Iowa, Wisconsin, Kansas, and Nebraska share the Winnebago Small Square-gilled Mayfly. The Canadian Large Square-gilled Mayfly occurs in Michigan, Minnesota, and Wisconsin. *Sparbarus nasutus* is the most widespread of the trio, found in seven MAFWA states (IN, IL, IA, MN, NE, SD, and WI).

The remaining eight RSGCN Mayflies of Very High Concern are 50-75% regional responsibility (Table 27). Half of this group of mayflies are shared by at least five Midwest states, and half are more narrowly distributed in the region. Lacustrine Small Square-gilled Mayfly (*Sparbarus*

lacustris) is found in 11 of the 13 MAFWA states, absent in Kentucky and South Dakota. Nine states share the *Macdunnoa persimplex* (a mayfly) – IA, IN, IL, KY, MN, MO, NE, OH, and WI. Dirty Spiny Crawler Mayfly (*Eurylophella lutulenta*) occurs in seven states (IL, IN, MI, MN, MO, OH, and WI), and the southern Illinois population may be a new species that needs more investigation. Frison's Serratellan Mayfly (*Serratella frisoni*) is shared by five Midwest states: IL, IN, KY, MO, and OH; the Midwest supports a Core Population and the species is Highly Imperiled, with its type location decimated (Appendix I).

The American Sand-burrowing Mayfly (*Dolania americana*) has a Disjunct Population in the northern Midwest, separated from the Southeast population; the Mayfly Taxa Team identified the Midwest population as likely genetically distinct from the possibly imperiled Southeast population. The Boreal Cleft-footed Minnow Mayfly (*Metretopus borealis*) is identified by the taxa team as Highly Imperiled with declining populations, occurring in sand habitat that is also imperiled (Appendix I).

Table 27. Midwest RSGCN Ephemeroptera (Mayflies) of Very High Concern, with the regional responsibility for each and the number of MAFWA states in which the species is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Pecatonica River Mayfly (*Acanthametropus pecatonica*)	50-75%	2
Wisconsin Small Square-gilled Mayfly (*Cercobrachys lilliei*)	100% (MAFWA endemic)	3
Winnebago Small Square-gilled Mayfly (*Cercobrachys winnebago*)	75-100%	4
American Sand-burrowing Mayfly (*Dolania americana*)	50-75%	2
Blushing Flat-headed Mayfly (*Epeorus suffusus*)	50-75%	1
Dirty Spiny Crawler Mayfly (*Eurylophella lutulenta*)	50-75%	7
Konza Prairie Mayfly (*Leptophlebia konza*)	100% (MAFWA endemic)	1
Macdunnoa persimplex (a mayfly)	50-75%	9
Boreal Cleft-footed Minnow Mayfly (*Metretopus borealis*)	50-75%	2

Species	Regional Responsibility	Number of MAFWA States
Canadian Large Square-gilled Mayfly (*Neoephemera bicolor*)	75-100%	3
Paraleptophlebia sticta (a prongill mayfly)	100% (MAFWA endemic)	2
Robust Pentagenian Burrowing Mayfly (*Pentagenia robusta*)	100% (MAFWA endemic)	2
Frison's Serratellan Mayfly (*Serratella frisoni*)	50-75%	5
Lacustrine Small Square-gilled Mayfly (*Sparbarus lacustris*)	50-75%	11
Sparbarus nasutus (a small square-gilled mayfly)	75-100%	7

MAFWA ENDEMIC MAYFLIES

There are seven RSGCN Mayflies that are endemic to the MAFWA region, four of which are Very High Concern (discussed above) and three are High Concern. *Apobaetis lakota* (a mayfly) is found in three Midwest states: Kansas, Nebraska, and North Dakota. Fox Small Square-gilled Mayfly (*Cercobrachys fox*) is shared by eight states (IA, IN, KS, MO, ND, NE, SD, and WI). Five states share *Homoeoneuria ammophila* (a sand-filtering mayfly): Iowa, Illinois, Indiana, Kansas, and Wisconsin.

SHARED MAYFLY SPECIES

The 43 Mayfly RSGCN occur in five or six Midwest states each, on average. Thirty-three (77%) are shared by at least three states each. The other ten Mayfly RSGCN occur in only one or two states each. There are eight mayflies that are shared by at least nine MAFWA states. The White Small Minnow Mayfly (*Centroptilum album*), White Sand-river Mayfly (*Pseudiron centralis*), and Lacustrine Small Square-gilled Mayfly all are found in 11 states each. White Small Minnow Mayfly is Moderate Concern and is not known to occur in Missouri or North Dakota. White Sand-river Mayfly is not known to occur in Kentucky and Minnesota and is Moderate Concern. The Very High Concern Lacustrine Small Square-gilled Mayfly is not known to occur in Kentucky and South Dakota.

Two Mayfly RSGCN are shared by ten Midwest states: Band-bellied Small Minnow Mayfly (*Plauditus cestus;* Moderate Concern) and Minnetonka Flat-headed Mayfly (*Stenacron Minnetonka;* High Concern). The former is not known to occur in Minnesota, Nebraska, or

South Dakota, and the latter is not known to occur in Kansas, Missouri, or South Dakota. The Manitoba White Burrowing Mayfly (*Tortopsis primus*; High Concern), *Macdunnoa persimplex* (Very High Concern), and Late Hex Burrowing Mayfly (*Hexagenia atrocaudata*; Moderate Concern) are all shared by nine Midwest states each.

RSGCN MAYFLY HABITAT AND LIMITING FACTORS

The taxa team did not identify limiting factors for each RSGCN Mayfly individually. However, as an aquatic species, they are threatened by many of the **same factors as other aquatic groups**, such as Freshwater Mussels and Crayfishes. Members of this order are commonly considered an indicator of good water quality. The effects vary species to species, but in general, mayfly nymphs are susceptible to a number of **pollutants** including agricultural runoff (i.e., pesticides, fertilizers, and herbicides), industrial effluents, and urban sewage.

Climate change also has the potential to impact mayflies. Many mayfly species have narrow tolerances, requiring specific water temperatures, oxygen levels, substrate types, and flow speeds. Mayflies are highly sensitive to the increased temperatures and increased flooding associated with climate change. While some species will be able to adjust by shifting their range to more suitable habitat, a number of RSGCN Mayflies have extremely restricted distributions, sometimes of just a few stream reaches. These species may not be able to respond sufficiently, putting their populations at risk of extirpation.

The Brown Spiny Crawler Mayfly (*Eurylophella funeralis*) is a habitat specialist dependent on seeps and springs. These habitats are especially vulnerable to changing climactic conditions. Increased rainfall may scour ravine streams destroying perched seeps where the species occurs. Drought or groundwater pumping may reduce flow in these small seeps and springs, causing local extirpation.

PROPOSED RSGCN MAYFLIES

The EPT Taxa Teams each compiled full inventories of the known mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) species diversity in the Midwest (Appendices J, K, and L, respectively). Using extensive published and unpublished resources, the teams identified 332 mayflies in the MAFWA region. The teams developed distributions of each of these species and then applied the RSGCN selection criteria to all of the species. Many non-SGCN species were then identified by the taxa teams as Proposed RSGCN or Proposed Watchlist [Assessment Priority].

There are 42 Proposed RSGCN Mayflies (Table 2, Appendix F). None of the Proposed RSGCN are currently designated as SGCN by any MAFWA state but the Mayfly Taxa Team identified these species as otherwise meeting RSGCN selection criteria. Twelve Proposed RSGCN Mayflies

are Very High Concern, seven are High Concern, and 23 are Moderate Concern. All 42 Proposed RSGCN Mayflies have at least 50% regional responsibility, but none are endemic to the region. All but one of the Very High Concern Proposed RSGCN have at least 75% regional responsibility.

The Mayfly Taxa Team identified three Proposed RSGCN Mayflies as having Core Populations in the Midwest: Victoria's Small Minnow Mayfly (*Centroptilum victoriae*), Painted Small Minnow Mayfly (*Procloeon rubropictum*), and Hobbs's Small Minnow Mayfly (*Procloeon rufostrigatum*) (Appendix I). All three are of Moderate Concern. Several species of *Procloeon* are rarely collected and seem sensitive to changes; the Mayfly Taxa Team identified a need for more study of this genus.

Two Proposed RSGCN Mayflies are Highly Imperiled: *Cercobrachys etowah* (a small square-gilled mayfly; High Concern) and Straight Hex Burrowing Mayfly (*Hexagenia rigida*; Moderate Concern). *Cercobrachys etowah* is a psammophilous mayfly that requires meandering sand streams, a habitat that is imperiled by channel modification, flooding, and irrigation for agricultural crops. Straight Hex Burrowing Mayfly is another burrowing mayfly of medium to large rivers that seems to be declining from historical distributions.

MAYFLIES DISCUSSION

Mayflies are an important part of healthy aquatic ecosystems as indicators of water quality and as prey for many species. The larvae serve as prey for numerous fishes, amphibians, crayfish, and carnivorous caddisfly, stonefly, and dragonfly larvae; adults are preyed on by birds, bats, small mammals, and additional predaceous insects. **As a foundation of the food web in aquatic and terrestrial systems, loss of mayflies may have cascading effects at higher trophic levels.**

The MAFWA states averaged more than 18 RSGCN Mayflies each, with Indiana (29), Illinois (28), and Wisconsin (28) supporting the largest numbers (Table 13). Ohio, Kentucky, Iowa, and Minnesota supported higher than the average number of RSGCN Mayflies as well. RSGCN Mayfly species diversity appears to decline in the northwestern portion of the region, with the Dakotas supporting the fewest number of RSGCN Mayflies.

The Mayfly Taxa Team identified 11 RSGCN with Core Populations in the Midwest. Nine of these species are RSGCN of Moderate Concern. Frison’s Serratellan Mayfly is of Very High Concern and Minnetonka Flat-headed Mayfly is of High Concern.

Proper identification of some mayflies was of concern by the Mayfly Taxa Team. Two Mayfly RSGCN were reported by the taxa team as historically misidentified – Flapped Cleft-footed Minnow Mayfly (*Siphloplecton basale*) and Flapless Cleft-footed Minnow Mayfly (*Siphloplecton interlineatum*) – and in need of survey work with updated keys. White Small Minnow Mayfly (*Centroptilum album*) and Forky Small Minnow Mayfly (*Centroptilum bifurcatum*) are also difficult to identify and need survey work. The larva of Blushing Flat-headed Mayfly (*Epeorus*

suffusus) are unknown, with the taxa team noting that the rarity of the species may be an artifact with indication that additional survey work with rearing / barcode association is needed.

PLECOPTERA (STONEFLIES)

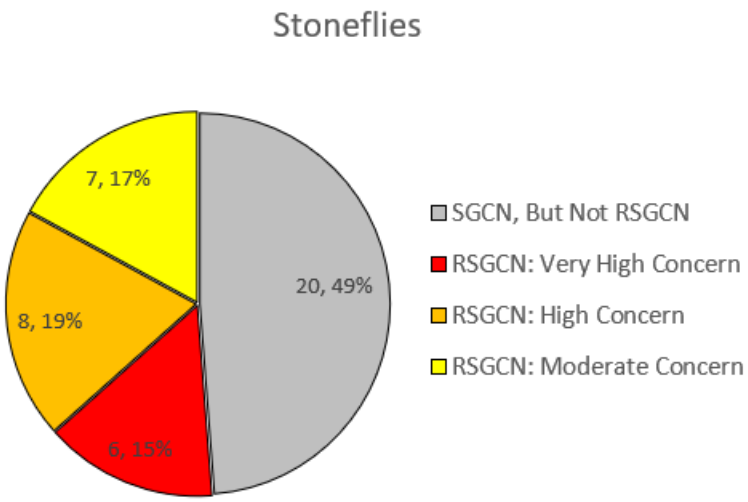
The team of national and regional EPT researchers reviewed all the Midwest SGCN Stonefly (Plecoptera) species and conducted a regional stonefly species inventory to identify additional species that meet RSGCN or Watchlist selection criteria. A summary of the Plecoptera Taxa Team inventory and review is provided in Appendix L. Like mayflies, Plecoptera, or stoneflies, are aquatic as larvae or nymphs but aerial as adults. Most stoneflies are associated with rivers and streams of various sizes, but some are associated with lakes, ponds, the Great Lakes, or wetlands like seeps and springs. As aerial adults, stoneflies inhabit adjacent terrestrial habitats like riparian or shoreline areas. The Northeast region has identified RSGCN Stoneflies but the Southeast region has not yet identified stonefly RSGCN.

RESULTS

The Stonefly RSGCN list includes 21 species, out of 41 stonefly SGCN in the MAFWA region (Table 1, Figure 20, Appendix D). Six Stonefly RSGCN are Very High Concern, eight are High Concern, and seven are Moderate Concern (Table 10, Appendix E). The RSGCN Stoneflies represent four taxonomic families: nine common stoneflies (*Perlidae*), eight perlodid stoneflies, stripetails or springflies (*Perlodidae*), two small winter stoneflies (*Capniidae*), and two rolled-wing stoneflies and needleflies (*Leuctridae*). None of the RSGCN Stoneflies are federally listed. One Midwest RSGCN Stonefly, the Illinois Snowfly (*Allocapnia illinoensis*), is identified as RSGCN in the Northeast region as well; in the Midwest the Illinois Snowfly is High Concern and in the Northeast it is Moderate Concern.

Ten additional stoneflies are Proposed RSGCN, with none currently identified as SGCN within the MAFWA region (Table 2, Appendix F). **An additional seven stoneflies are on the RSGCN Watchlist as Assessment Priority species** (Table 3, Appendix G). Sixteen stoneflies are on the Proposed Watchlist as Assessment Priority species, since none are currently listed as SGCN in the Midwest (Table 4, Appendix G).

Figure 20. Number and percent of Midwest Stonefly SGCN that are RSGCN and at what Concern Levels.



VERY HIGH CONCERN STONEFLIES

The Stonefly Taxa Team identified six Very High Concern stoneflies (Table 10; Appendix E, Table E-1). The Three-lobed Snowfly (*Allocapnia smithi*) has 75-100% regional responsibility and is shared by Illinois, Indiana, Kentucky, and Ohio. This RSGCN Stonefly has approximately 80% of its range within unglaciated areas of Ohio, Indiana, and Illinois yet at very few locations; it is an intermittent stream specialist.

The Indiana Springfly (*Isogenoides doratus*) and Hudsonian Springfly (*Isogenoides frontalis*) both have 50-75% regional responsibility, with the Indiana Springfly found in Iowa, Michigan, and Minnesota and the Hudsonian Springfly found in Michigan, Minnesota, and Wisconsin. The Indiana Springfly is the most uncommon *Isogenoides* species in the region with a patchy distribution in the glaciated Midwest, found in low abundance; it is presumed extirpated from its historical locality in southeast Michigan but still occurs in Iowa and Minnesota. Conversely, the Hudsonian Springfly is the most common *Isogenoides* species in the Midwest, found in unglaciated northern areas, often in small direct tributaries of Lake Superior (MI, MN, and WI), and it is also a resident of Lake Superior.

The other three RSGCN Stoneflies of Very High Concern have less than 50% regional responsibility in the Midwest and are each Highly Imperiled (Appendix I). Illinois Stone (*Acroneuria filicis*) is found in scattered populations across unglaciated portions of the Midwest in five states (IL, IN, KY, MO, and OH). Holarctic Springfly (*Arcynopteryx dichroa*) has a Disjunct Population in the Midwest and Climate Vulnerability; populations of this species are incredibly disjunct, known only from the Michigan mainland and Isle Royale of Lake Superior; the species

should occur along the Lake Superior shorelines of Minnesota, Wisconsin, and Ontario but needs inventory work. Rock Island Springfly (*Isogenoides varians*) is uncommon and in low abundance in the Midwest, where it occurs in Iowa, Illinois, Indiana, Kansas, and Minnesota.

MAFWA ENDEMIC STONEFLIES

There are four RSGCN Stoneflies that are endemic to the MAFWA region, all of the genus *Perlesta*. The Pawnee Stone (*Perlesta xube*) is High Concern and found in both glaciated and unglaciated parts of the Midwest. This RSGCN Stonefly is known to occur in six states (IA, IL, IN, ND, NE, and OH) but is not yet known from Michigan, Minnesota, and Wisconsin.

The other three endemic RSGCN Stoneflies are of Moderate Concern. The Dakota Stone (*Perlesta dakota*) is endemic to the region (ND and SD) but little is known about the species biology, needing further investigation. The Two-lined Stone (*Perlesta golconda*) is a large-river specialist, found in the lower Ohio and Missouri Rivers and some sections of the Mississippi River; large-river stoneflies are poorly sampled, according to the taxa team. Eight states are known to share the Two-lined Stone: Iowa, Illinois, Indiana, Michigan, Minnesota, Missouri, Nebraska, and Wisconsin. The Wabash Stone (*Perlesta ouabache*) is uncommon for the genus and is a river species that the Stonefly Taxa Team identified as in need of much more inventory work; it is currently known from six Midwest states – Iowa, Illinois, Indiana, Kentucky, Minnesota, and Wisconsin.

SHARED STONEFLY SPECIES

RSGCN Stoneflies occurred in an average of five Midwest states each. Eighteen of the 21 stoneflies (86%) are found in at least three Midwest states each; three occur in only one or two states. The Giant Stone (*Attaneuria ruralis*) and Midwestern Stripetail (*Isoperla marlynia*) occurred in ten states each, the most widely distributed Stonefly RSGCN in the region. Giant Stone (Moderate Concern) is not known to occur in Kentucky, North Dakota, or South Dakota. Midwestern Stripetail (High Concern) is not known to occur in Ohio, North Dakota, or South Dakota. Both stoneflies have 50-75% regional responsibility.

Cloudy Stonefly (*Perlesta ephelida*) is known to occur in nine Midwest states and the endemic Two-lined Stone in eight. The Midwest distribution of the latter is described in the previous section. The former is 50-75% regional responsibility and is known to occur in all the MAFWA states except Kansas, Nebraska, North Dakota, and South Dakota on the western edge of the region. Both of these stoneflies have Moderate Concern.

RSGCN STONEFLY HABITAT AND LIMITING FACTORS

The taxa team did not identify limiting factors for each RSGCN Stonefly individually. However, as an aquatic species, they are threatened by many of the **same factors as other aquatic groups**, such as Freshwater Mussels and Crayfishes. Members of this order are commonly considered an indicator of good water quality. The effects vary species to species, but in general, stonefly nymphs are susceptible to a number of **pollutants** including agricultural runoff (i.e., pesticides, fertilizers, and herbicides), industrial effluents, and urban sewage.

Climate change also has the potential to impact stoneflies. Many stonefly species have narrow tolerances, requiring specific water temperatures, oxygen levels, substrate types, and flow speeds. Stoneflies are highly sensitive to the increased temperatures and increased flooding associated with climate change. While some species will be able to adjust by shifting their range to more suitable habitat, a number of RSGCN Stoneflies have extremely restricted distributions, sometimes of just a few stream reaches. These species may not be able to respond sufficiently, putting their populations at risk of extirpation.

PROPOSED RSGCN STONEFLIES

The EPT Taxa Teams each compiled full inventories of the known mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) species diversity in the Midwest (Appendices J, K, and L, respectively). Using extensive published and unpublished resources, the teams identified 234 stoneflies in the MAFWA region. The teams developed distributions of each of these species and then applied the RSGCN selection criteria to all of the species. Many non-SGCN species were then identified by the taxa teams as Proposed RSGCN or Proposed Watchlist [Assessment Priority].

There are ten Proposed RSGCN Stoneflies (Table 28). None of the Proposed RSGCN are currently designated as SGCN by any MAFWA state but the Stonefly Taxa Team identified these species as otherwise meeting RSGCN selection criteria. Eight of the ten Proposed RSGCN Stoneflies are Very High Concern and the other two are High Concern. Shawnee Stone (*Acroneuria covelli*) is a large river specialist with several new locations found in Indiana; this stonefly is also known to occur in Kentucky and Ohio. The Great Lakes Springfly (*Cultus decisus decisus*) requires cold waters of high quality; the taxa team suspects that the species is probably declining in boreal areas. In the Midwest, Great Lakes Springfly is known to occur in Ohio and Michigan. *Leuctra schusteri* (a needlefly) and Karst Forestfly (*Soyedina calcarea*) require karst habitat and are restricted to annual-flowing spring seeps and spring runs.

Maine Stone (*Neoperla mainensis*) historically was found in Ohio and Illinois in warmwater streams and western Lake Erie islands and Pelee Point in Ontario, but now may be extinct; the Northeast region has identified the Maine Stone as RSGCN of Very High Concern. The species

Crescent Stripetail *(Isoperla emarginata*) is known for a single female collected at Grand Marais in Minnesota in 1939; a recent taxonomic revision of Isoperla expressed some uncertainty about the identity of the holotype. More recent efforts to collect Crescent Stripetails have been unsuccessful. Minnesota Stripetail (*Isoperla maxana*), High Concern Proposed RSGCN, is known from a single distinctive male specimen collected in Hubbard County, Minnesota; three separate efforts to collect additional specimens have been unsuccessful. The Stonefly Taxa Team recommends one last concerted effort to inventory for each of these three species to determine their status.

Six of the ten Proposed RSGCN Stoneflies are endemic to the MAFWA region (Table 21). Kentucky Stone (*Acroneuria hitchcocki*) is found only in Kentucky and Indiana. Crescent Stripetail and Minnesota Stripetail are endemic to Minnesota. *Leuctra schusteri* and Karst Forestfly are endemic to Kentucky. Ohio Stone (*Neoperla gaufini*) occurs in Ohio, Kentucky, and Indiana.

Plains Stripetail (*Isoperla longiseta*) is the most widely distributed Proposed RSGCN Stonefly, known to occur in seven Midwest states (IA, IL, KS, MN, MO, ND, and SD). This prairie stonefly is the only Proposed RSGCN with less than 50% regional responsibility, with its range split with the West region; the Stonefly Taxa Team identified the species as Highly Imperiled due to extirpations from at least three Midwest states, possibly four (Appendix I).

Table 28. Proposed Midwest RSGCN Plecoptera (Stoneflies), with the concern level and regional responsibility for each and the number of MAFWA states in which the species is known to occur.

Species	Concern Level	Regional Responsibility	Number of MAFWA States
Shawnee Stone (*Acroneuria covelli*)	Very High	75-100%	3
Kentucky Stone (*Acroneuria hitchcocki*)	Very High	100% (MAFWA Endemic)	2
Great Lakes Springfly (*Cultus decisus decisus*)	Very high	50-75%	2
Crescent Stripetail *(Isoperla emarginata*)	High	100% (MAFWA Endemic)	1
Plains Stripetail (*Isoperla longiseta*)	Very high	25-50%	7
Minnesota Stripetail (*Isoperla maxana*)	High	100% (MAFWA Endemic)	1
Leuctra schusteri (a needlefly)	Very High	100% (MAFWA Endemic)	1

Ohio Stone (*Neoperla gaufini*)	Very High	100% (MAFWA Endemic)	3
Maine Stone (*Neoperla mainensis*)	Very high	50-75%	2
Karst Forestfly (*Soyedina calcarea*)	Very High	100% (MAFWA Endemic)	1

STONEFLIES DISCUSSION

Stoneflies are an important part of healthy aquatic ecosystems as indicators of water quality and as prey for many species. The larvae serve as prey for numerous fishes, amphibians, crayfish, and carnivorous caddisfly, mayfly, and dragonfly larvae; adults are preyed on by birds, bats, small mammals, and additional predaceous insects. **As a foundation of the food web in aquatic and terrestrial systems, loss of stoneflies may have cascading effects at higher trophic levels.**

The Midwest region is large with a variety of biomes represented, and at least 234 stonefly species occur in the region (Appendix L). There are not likely to be many more species recorded from this region, but tallies are incomplete for some individual states and provinces, especially those in the west of the region. Eastern states and provinces were richest in stonefly biodiversity, with Ohio and Kentucky having over 100 species. Northern states and provinces (Michigan, Minnesota, Ontario, and Wisconsin) associated with hardwood and mixed coniferous forest have similar species richness. Missouri has similar numbers of species and shares many species with the east and north, most of which are now separated by glacial till plains of Iowa, Illinois, and Indiana. States and provinces with predominantly prairie landscapes support many fewer stonefly species.

The MAFWA states averaged nearly eight RSGCN Stoneflies each, with Illinois (16) and Indiana (13) supporting the largest numbers (Table 13). Minnesota, Michigan, Missouri, Wisconsin, and Iowa supported higher than the average number of RSGCN Stoneflies as well. RSGCN Stonefly species diversity appears to decline in the northwestern portion of the region, with the Dakotas supporting the fewest number of RSGCN Stoneflies.

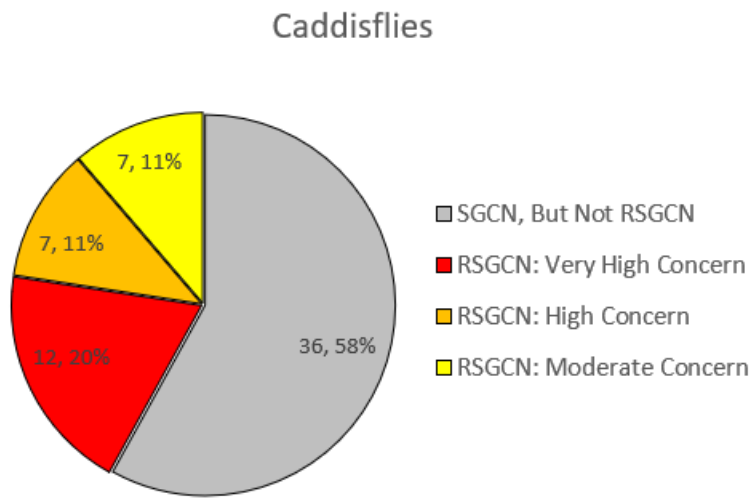
TRICHOPTERA (CADDISFLIES)

The team of national and regional EPT researchers reviewed all the Midwest SGCN Caddisfly (Trichoptera) species and conducted a regional caddisfly species inventory to identify additional species that meet RSGCN or Watchlist selection criteria. A summary of the Trichoptera Taxa Team inventory and review is provided in Appendix M. Like mayflies and stoneflies, Trichoptera, or caddisflies, are aquatic as larvae or nymphs but aerial as adults. Most caddisflies are associated with rivers and streams of various sizes, but some are associated with lakes, ponds, the Great Lakes, or wetlands like seeps and springs. As aerial adults, caddisflies inhabit adjacent terrestrial habitats like riparian areas. EPT larvae are predaceous and may eat EPT eggs. Neither the Northeast nor Southeast regions have identified Caddisfly RSGCN yet.

RESULTS

The caddisfly RSGCN list includes 26 species, out of 62 caddisfly SGCN in the MAFWA region (Table 1, Figure 21, Appendix D). Twelve (12) RSGCN are Very High Concern, seven are High Concern, and seven are Moderate Concern (Table 10, Appendix E). Caddisfly RSGCN represent nine taxonomic families. Eight RSGCN are tube-case caddisflies (*Limnephilidae*), five are microcaddisflies or purse-case caddisflies (*Hydroptilidae*), four are net-spinning caddisflies (*Hydropsychidae*), three caddisflies are tortoise or saddle-case makers (*Glossosomatidae*), two are trumpet-net and tube-making caddisflies (*Polycentropodidae*), and one caddisfly each are in the families *Brachycentridae*, *Goeridae*, *Leptoceridae*, and *Phryganeidae*.

Figure 21. Number and percent of Midwest Caddisfly SGCN that are RSGCN and at what Concern Levels.



None of the Caddisfly RSGCN are federally listed. **Seventy (70) additional caddisflies are Proposed RSGCN**, with none currently identified as SGCN within the MAFWA region (Table 2, Appendix F). No additional caddisflies are on the RSGCN Watchlist as Assessment Priority species, but **one caddisfly is on the Proposed RSGCN Watchlist** because it is not currently identified as SGCN in the Midwest (Tables 3 and 4, Appendix G).

VERY HIGH CONCERN CADDISFLIES

The Caddisfly Taxa Team identified 12 Very High Concern caddisflies (Table 10; Appendix E, Table E-1). Seven of these caddisflies are endemic to the Midwest region, and all 12 have 50% or more regional responsibility (Table 29). The Very High Concern RSGCN Caddisflies are narrowly distributed in the Midwest, average approximately two MAFWA states each. The Caddisfly Taxa Team found that some of these caddisflies may be more abundant than commonly thought due to fall or winter emergences, but additional survey work is needed.

Each of the endemic Very High Concern RSGCN Caddisflies are known to occur in only one or two states. Artesian Agapetus Caddisfly (*Agapetus artesus*) and Missouri Glyphopsyche Caddisfly (*Glyphopsyche missouri*) are found only in Missouri. Headwater Chilostigman Caddisfly (*Chilostigma itascae*) occurs in Minnesota. Platte River Caddisfly (*Ironoquia plattensis*) is found only in Nebraska. *Holocentropus milaca* (a polycentropodid caddisfly), Unhorned Microcaddisfly (*Oxyethira ecornuta*), and *Oxyethira itascae* (an oxyethiran microcaddisfly) are known from Michigan and Minnesota.

The non-endemic RSGCN Caddisflies of Very High Concern are distributed in more Midwest states than the endemic species, with the exception of the Pale Northern Caddisfly (*Limnephilus samoedus*) that is found only in Michigan in the MAFWA region. Ozburn's Northern Caddisfly (*Anabolia ozburni*) and *Pycnopsyche rossi* (a northern casemaker caddisfly) are each known to occur in five Midwest states. The former is known to occur in Ohio, Michigan, Minnesota, Wisconsin, and North Dakota. The latter has a more southern distribution, occurring in Missouri, Illinois, Indiana, Ohio, and Kentucky.

Table 29. Midwest RSGCN Trichoptera (Caddisflies) of Very High Concern, with the regional responsibility for each and the number of MAFWA states in which the species is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Artesian Agapetus Caddisfly (*Agapetus artesus*)	100% (MAFWA Endemic)	1
Ozburn's Northern Caddisfly (*Anabolia ozburni*)	50-75%	5
Ross's Northern Caddisfly (*Asynarchus rossi*)	75-100%	3

Species	Regional Responsibility	Number of MAFWA States
Complex Giant Caddisfly (*Beothukus complicatus*)	50-75%	3
Headwater Chilostigman Caddisfly (*Chilostigma itascae*)	100% (MAFWA Endemic)	1
Missouri Glyphopsyche Caddisfly (*Glyphopsyche missouri*)	100% (MAFWA Endemic)	1
Holocentropus milaca (a polycentropodid caddisfly)	100% (MAFWA Endemic)	2
Platte River Caddisfly (*Ironoquia plattensis*)	100% (MAFWA Endemic)	1
Pale Northern Caddisfly (*Limnephilus samoedus*)	50-75%	1
Unhorned Microcaddisfly (*Oxyethira ecornuta*)	100% (MAFWA Endemic)	2
Oxyethira itascae (an oxyethiran microcaddisfly)	100% (MAFWA Endemic)	2
Pycnopsyche rossi (a northern casemaker caddisfly)	50-75%	5

MAFWA ENDEMIC CADDISFLIES

There are seven RSGCN Caddisflies that are endemic to the MAFWA region. All seven of these caddisflies are Very High Concern, described above.

SHARED CADDISFLY SPECIES

Seventeen RSGCN Caddisflies (65%) are shared by three states or more in the MAFWA region. Beautiful Net-spinning Caddisfly (*Cheumatopsyche speciosa*) is the most widely distributed species, known to occur in ten of the MAFWA states; this Moderate Concern caddisfly is not known to occur in Kansas, Nebraska, or South Dakota. Four Caddisfly RSGCN are known to occur in seven Midwest states each. Sideways Humpless Caddisfly (*Brachycentrus lateralis*) and Prickled Microcaddisfly (*Ochrotrichia spinosa*) are High Concern RSGCN. Reisen's Hydropsyche Caddisfly (*Hydropsyche arinale*) and Harping Northern Caddisfly (*Ironoquia lyrate*) are Moderate Concern. Harping Northern Caddisfly inhabits small streams and emerges in the fall, and additional survey work is needed for this species.

RSGCN CADDISFLY HABITAT AND LIMITING FACTORS

The taxa team did not identify limiting factors for each RSGCN Caddisfly individually. However, as an aquatic species, they are threatened by many of the **same factors as other aquatic groups**, such as RSGCN Freshwater Mussels and Crayfishes. Members of this order are commonly considered an indicator of good water quality. The effects vary species to species, but in general, caddisfly nymphs are susceptible to a number of **pollutants** including agricultural runoff (i.e., pesticides, fertilizers, and herbicides), industrial effluents, and urban sewage.

Climate change also has the potential to impact caddisflies. Many caddisfly species have narrow tolerances, requiring specific water temperatures, oxygen levels, substrate types, and flow speeds. Caddisflies are highly sensitive to the increased temperatures and increased flooding associated with climate change. While some species will be able to adjust by shifting their range to more suitable habitat, a number of RSGCN Caddisflies have extremely restricted distributions, sometimes of just a few stream reaches. These species may not be able to respond sufficiently, putting their populations at risk of extirpation.

Six RSGCN Caddisflies are habitat specialists that are dependent on **seeps and springs**. These habitats are especially vulnerable to changing climactic conditions. Increased rainfall may scour ravine streams destroying perched seeps where the species occurs. Drought or groundwater pumping may reduce flow in these small seeps and springs, causing local extirpation.

PROPOSED RSGCN CADDISFLIES

The EPT Taxa Teams each compiled full inventories of the known mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) species diversity in the Midwest (Appendices J, K, and L, respectively). Using extensive published and unpublished resources, the teams identified 595 caddisflies in the MAFWA region. The teams developed distributions of each of these species and then applied the RSGCN selection criteria to all of the species. Many non-SGCN species were then identified by the taxa teams as Proposed RSGCN or Proposed Watchlist [Assessment Priority].

There are 70 Proposed RSGCN Caddisflies (Table 2, Appendix F). None of the Proposed RSGCN are currently designated as SGCN by any MAFWA state but the Caddisfly Taxa Team identified these species as otherwise meeting RSGCN selection criteria. Twenty-two (22) of the Proposed RSGCN Caddisflies are Very High Concern, 20 are High Concern, and 28 are Moderate Concern.

Fourteen of the 70 Proposed RSGCN Caddisflies (20%) are endemic to the MAFWA region, and the Caddisfly Taxa Team identified all of them as Very High Concern (Table 30). Nearly half (6 of 14) of these endemic Very High Concern Proposed RSGCN are found in Ohio. Four are found in Kentucky, two are found in Missouri, two in Michigan, one is found in North Dakota, and one is in Illinois.

Table 30. Midwest Proposed RSGCN Trichoptera (Caddisflies) that are Very High Concern and endemic to the region, with the number and names of MAFWA states in which the species is known to occur.

Species	Number of MAFWA States	Known States where Occurs
Ceraclea erulla (a longhorned caddisfly)	1	OH
Ceraclea maccalmonti (a longhorned caddisfly)	1	MO
Cernotina ohio (a caddisfly)	1	OH
Holocentropus chellus (a polycentropodid caddisfly)	1	ND
Hydroptila danieli (a purse casemaker caddisfly)	1	OH
Hydroptila howelli (a purse casemaker caddisfly)	1	KY
Hydroptila kuehnei (a purse casemaker caddisfly)	1	KY
Hydroptila paraxella (a purse casemaker caddisfly)	2	KY, OH
Neotrichia paraokopa (a microcaddisfly)	1	MO
Neotrichia staufferi (a microcaddisfly)	1	IL
Plectrocnemia sabulosa (a polycentropodid caddisfly)	1	MI
Polycentropus neiswanderi (a polycentropodid caddisfly)	2	KY, OH
Setodes truncates (a leptocerid caddisfly)	1	MI
Athens Triaenodes Caddisfly (*Triaenodes phalacris*)	1	OH

In addition to the 14 Proposed RSGCN Caddisflies that are endemic and Very High Concern, there are eight other caddisflies of Very High Concern. Three of these have 75-100% regional responsibility: Sooty Humpless Caddisfly (*Brachycentrus fuliginosus*), Slender Northern Caddisfly (*Leptophylax gracilis*), and *Ochrotrichia riesi* (a purse casemaker caddisfly). White-spotted Long-horned Caddisfly (*Ceraclea albosticta*), *Cheumatopsyche rossi* (a hydropsychid caddisfly), Spineless Net-spinning Caddisfly (*Hydropsyche piatrix*), and Nearctic Paduniellan Caddisfly (*Paduniella nearctica*) have 50-75% regional responsibility. White-spotted Long-horned Caddisfly is a rarely collected Great Lakes species. *Cheumatopsyche rossi* is Climate Vulnerable. Additional survey work is needed on the Nearctic Paduniellan Caddisfly.

Ladoga Net-spinning Caddisfly (*Arctopsyche ladogensis*) has less than 50% regional responsibility but a Disjunct Population in the Midwest near Lake Superior in Michigan and

Manitoba (Appendix I). The Caddisfly Taxa Team suspects that the Michigan population is likely genetically distinct from disjunct populations in the western mountains and in New Hampshire.

CADDISFLIES DISCUSSION

Caddisflies are an important part of healthy aquatic ecosystems as indicators of water quality and as prey for many species. The larvae serve as prey for numerous fishes, amphibians, crayfish, and carnivorous mayfly, stonefly, and dragonfly larvae; adults are preyed on by birds, bats, small mammals, and additional predaceous insects. **As a foundation of the food web in aquatic and terrestrial systems, loss of caddisflies may have cascading effects at higher trophic levels.**

The MAFWA target area is extremely large, perhaps outsized for the intended purpose according to the taxa team. This **large region consists of several biomes**: Eastern Deciduous Forest, Taiga, Tallgrass Prairie, and Subarctic Tundra. Because of this intersection of biomes and the historical connectivity to southern and western glacial refugia and the Bering Land Bridge the region is hyperdiverse, perhaps supporting as many as one-fourth of all species known from North America. Holarctic species (those known from both the Palearctic and Nearctic Biogeographic Regions), western mountains species, plains originated species, Interior Highlands species, and Appalachian origin species are found in the Midwest region.

Caddisfly larvae are used globally as indicators of water quality and are in the top three orders of insects with the highest sensitivity to organic enrichment and habitat disturbance in running water systems (Barbour et al. 1999).

The Caddisfly Taxa Team documented that nearly 600 caddisfly species reside in the MAFWA region (Appendix M). The number of species within the region is not likely to grow substantially from this tally since only 14 species have been described since the year 2000 with distributions in the region. The taxa team search for regional records uncovered 21 of the 26 families of caddisflies known to occur in North America.

Species richness of caddisflies within states and provinces is highest in eastern and northern forested political units (OH, ON, WI, MN, KY, MI) (Appendix M). As forests are gradually replaced by prairie, species numbers dramatically decline. Western prairie states and provinces have much diminished richness, some of which is certainly real, some attributable to lack of survey effort. In the future, there should be substantial increase in richness in these western states and provinces due to inventory work.

The MAFWA states averaged eight RSGCN Caddisflies each, with Michigan (17) and Minnesota (15) supporting the largest numbers (Table 13). Wisconsin, Illinois, Indiana, and Kentucky supported higher than the average number of RSGCN Caddisflies as well. RSGCN Caddisflies

species diversity appears to decline in the northwestern portion of the region, with the Dakotas supporting the fewest number of RSGCN Caddisflies.

ADDITIONAL SPECIES CONSIDERED – RSGCN WATCHLISTS

The Midwest taxa teams identified a need to include and categorize species in multiple ways. A RSGCN Watchlist was developed, with three subcategories. The largest subcategory is the RSGCN Watchlist [Assessment Priority] (see Appendix C for category definitions). The Watchlist [Assessment Priority] are species for which there is concern but insufficient information; species should be a priority for additional survey efforts to document threats and declines across the region before they become severe. The Watchlist [Interdependent Species] are species on which a RSGCN is dependent, such as parasitic bees, host fish for mussels, or host plants. Finally, the taxa teams sought to recognize species with high levels of concern but for which the region has low regional responsibility; deferral to adjacent regions recommends those regions consider the species for RSGCN or, if already RSGCN, to modify the Concern Level. These species are the Watchlist [Deferral] to an adjacent region.

In addition to the 1800+ SGCN reviewed by the taxa teams, more than 170 additional species were recommended by taxa team participants for consideration as RSGCN. These species were recommended as RSGCN but lacked SGCN status and have been placed on a Proposed RSGCN list (147) or Proposed Watchlist (23) (Appendices F, G). These non-SGCN species include those that have been recently been described; have recently received taxonomic updates; or have new data regarding emerging threats. At least two of these species have already been proposed as SGCN in at least one state, and the Proposed RSGCN and Proposed Watchlist species can provide states with lists of species recognized by the regional taxa teams as being of concern for potential consideration as future SGCN. The Proposed RSGCN were discussed in the taxa summaries of the previous section. The RSGCN Watchlists are summarized below.

RSGCN WATCHLIST [ASSESSMENT PRIORITY]

The Midwest taxa teams identified 108 SGCN species as RSGCN Watchlist [Assessment Priority] species (Table 3, Appendix G). Lepidoptera (18), Reptiles (14), Fish (14), and Odonates (12) have the highest numbers of assessment priority species. No Bee, Mayfly, or Caddisfly SGCN are identified as RSGCN Watchlist [Assessment Priority]. There are no Concern Levels for RSGCN Watchlist [Assessment Priority] species, primarily because additional information is needed on their status and trends. The taxa teams did, however, identify regional responsibility for each of these species. Many RSGCN Watchlist [Assessment Priority] species have differing

status and trends across the Midwest, with some states reporting declines or emerging threats, while others reported stable populations. The taxa teams consistently chose to place these species with no clear regional trend on the RSGCN Watchlist [Assessment Priority] to monitor them for more information and to detect emerging threats and more widespread declines early.

MAMMALS

The Mammal Taxa Team identified ten Mammal SGCN as RSGCN Watchlist [Assessment Priority] – four rodents, three shrews, one bat, and one carnivore (Table 31). One mammal, a subspecies of Plains Pocket Mouse (*Perognathus flavescens perniger*), is endemic to the Midwest region. Populations of Plains Pocket Mouse are threatened by urbanization, habitat loss, and grassland conversion. All ten of these mammals are found in at least four Midwest states, with Gray Fox (*Urocyon cinereoargenteus*) and Prairie Vole (*Microtus ochrogaster*) found in all 13 states.

Three of the RSGCN Watchlist [Assessment Priority] Mammals are RSGCN in adjacent regions. The North American Least Shrew (*Cryptotis parva*) is Northeast RSGCN and identified as Data Deficient. Though assumed to be stable is several states, the North American Least Shrew is declining in others. More targeted surveys are needed to assess to species fully. The Mammal Taxa Team identified a Core Population of the North American Least Shrew in the Midwest. An undescribed subspecies of Woodland Vole (*Microtus pinetorum*) is Southeast RSGCN and of Moderate Concern. The Woodland Vole is generally poorly understood. Populations appear to be more stable in the eastern parts of the Midwest, and are uncommon further west, which may indicate that the Midwest encompasses their western range edge. In Michigan, invasive earthworms are problematic for the species, as they destroy the duff layer that the species tunnels in. The Eastern Small-footed Myotis (*Myotis leibii*) is both Northeast and Southeast RSGCN, with High Concern Levels in both regions. The Eastern Small-footed Myotis is less impacted by WNS than other bat species. It has always been fairly rare in the Midwest, as it approaches the western edge of its range, and generally occurs in small numbers.

Elliot's Short-tailed Shrew (*Blarina hylophaga*) is very poorly understood. The Mammal Taxa Team identified the Midwest population as genetically distinct. The team also identified the Midwest population of American Pygmy Shrew as genetically distinct.

Three mammals were identified by the taxa team as Highly Imperiled: Eastern Small-footed Myotis, American Pygmy Shrew, and Gray Fox. The American Pygmy Shrew is a poorly understood species, in part due to the difficulty of capturing shrews. Populations are stable in Minnesota, but the species is rare in Kentucky and Indiana, and possibly extirpated in Iowa.

Though actively managed as a furbearer in parts of the Midwest, the taxa team reported that the Gray Fox has also exhibited massive unexplained population declines in Illinois and Indiana.

The Plains Pocket Gopher (*Geomys bursarius*) is identified as a Keystone Species by the taxa team. The Mammal Taxa Team identified several of the RSGCN Watchlist [Assessment Priority] Mammals as facing Emerging Threats: North American Least Shrew, Plains Pocket Gopher, Prairie Vole, both the nominal and subspecies of Plains Pocket Mouse, and Gray Fox.

Table 31. RSGCN Watchlist [Assessment Priority] Mammals, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Elliot's Short-tailed Shrew (*Blarina hylophaga*)	50-75%	4
North American Least Shrew (*Cryptotis parva*)	25-50%	12
Plains Pocket Gopher (*Geomys bursarius*)	75-100%	10
Prairie Vole (*Microtus ochrogaster*)	50-75%	13
Woodland Vole (*Microtus pinetorum*)	25-50%	11
Eastern Small-footed Myotis (*Myotis leibii*)	25-50%	6
Plains Pocket Mouse (*Perognathus flavescens*)	25-50%	7
Plains Pocket Mouse (*Perognathus flavescens perniger*)	100% (MAFWA Endemic)	5
American Pygmy Shrew (*Sorex hoyi*)	25-50%	10
Gray Fox (*Urocyon cinereoargenteus*)	<25%	13

BIRDS

The Bird Taxa Team identified nine Bird SGCN as RSGCN Watchlist [Assessment Priority] – five passerines, two shorebirds, one rail, and one grouse (Table 32). None of the species are federally listed or under review for potential listing. All of the RSGCN Watchlist [Assessment Priority] Birds have less than 50% regional responsibility because all of them are migratory with large geographic ranges. Five of the nine birds occur in all 13 MAFWA states: Semipalmated Sandpiper (*Calidris pusilla*), Wood Thrush (*Hylocichla mustelina*), Bank Swallow (*Riparia riparia*), Field Sparrow (*Spizella pusilla*), and Willet (*Tringa semipalmata*).

The Midwest Bird Taxa Team identified two RSGCN Watchlist [Assessment Priority] Birds as having Core Populations in the Midwest - Chestnut-collared Longspur (*Calcarius ornatus*) and King Rail (*Rallus elegans*). The team also categorized both as Highly Imperiled and the Chestnut-collared Longspur as a Stronghold Species in the region facing Emerging Threats and a Climate Change Range Shift. The Midwest taxa team identified the Wood Thrush as a Stronghold Species in the region as well.

Table 32. RSGCN Watchlist [Assessment Priority] Birds, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Chestnut-collared Longspur (*Calcarius ornatus*)	25-50%	7
Semipalmated Sandpiper (*Calidris pusilla*)	25-50%	13
Baird's Sparrow (*Centronyx bairdii*)	<25%	5
Wood Thrush (*Hylocichla mustelina*)	25-50%	13
King Rail (*Rallus elegans*)	25-50%	12
Bank Swallow (*Riparia riparia*)	<25%	13
Field Sparrow (*Spizella pusilla*)	25-50%	13
Willet (*Tringa semipalmata*)	<25%	13
Sharp-tailed Grouse (*Tympanuchus phasianellus*)	25-50%	7

AMPHIBIANS

The Amphibian Taxa Team identified ten Amphibian SGCN as RSGCN Watchlist [Assessment Priority] – four salamanders, four frogs, and two toads (Table 33). One of the species is under review for potential listing, the Streamside Salamander (*Ambystoma barbouri*). Streamside Salamander has 75-100% regional responsibility in the Midwest, where it is found in Kentucky, Ohio, and Indiana; the taxa team identified the majority of the species range.

The Amphibian Taxa Team identified four of RSGCN Watchlist [Assessment Priority] Amphibians with Core Populations in the Midwest: Streamside Salamander, Fowler's Toad (*Anaxyrus fowleri*), Kentucky Spring Salamander (*Gyrinophilus porphyriticus duryi*), and Eastern Newt (*Notophthalmus viridescens*). Fowler's Toad is a habitat specialist and has seen significant

declines in Michigan, where it is threatened by habitat conversion for development or blueberry farms and changes to the water table due to drainage or agricultural use. The species is now functionally absent from the southern parts of Michigan, but other states to the south report the toad as fairly widespread and common. Kentucky Spring Salamander may be genetically distinct from the nominal species in the Midwest.

Four amphibians are recognized by the taxa team as Climate Vulnerable and/or facing a Climate Change Range Shift: Spotted Salamander (*Ambystoma maculatum*), Pickerel Frog (*Lithobates palustris*), Mink Frog (*Lithobates septentrionalis*), and Wood Frog (*Lithobates sylvaticus*). Spotted Salamander is a forest ecosystem and vernal pool dependent species. Increased habitat loss across its range and collection for the pet trade and fishing have reduced populations. Habitat fragmentation has also reduced population viability and size. Pickerel Frog is ecologically sensitive and a habitat specialist with recent declines, associated with springs and seeps. The Amphibian Taxa Team identified Mink Frog as ecologically unique with the majority of its range in the Midwest; the species is in decline in the Upper Peninsula of Michigan, where it has disappeared from some areas while remaining locally common in others. Some team members expressed concern that the species cannot shift its range much farther north due to climate change, due to the Great Lakes being a barrier.

The Wood Frog and American Toad (*Anaxyrus americanus*) are identified as Keystone Species by the Amphibian Taxa Team. The team identified Wood Frog as a habitat specialist (forest or woodland with ephemeral pools) that is an important indicator species for high quality forest landscape health. Species declines are primarily because of loss of ephemeral pools to forest management practices and development, and in areas where reforestation is occurring, new species records are following in some states. A few states reported recent declines in American Toad populations, with North Dakota not finding any of these toads at all in the past three years of surveys, which cover all of the state wildlife management areas; they appear to be being replaced with Canadian Toad (*Anaxyrus hemiophrys*) in the state. Michigan has seen significant declines from historic densities and recruitment reduction over the past decade. Most of the other Midwest states reported that American Toads are still common but expressed concerns about the recent declines in North Dakota and Michigan, as well as potential hybridization with other toads. For these reasons, the team placed American Toad on the RSGCN Watchlist [Assessment Priority] to monitor its status.

Kentucky Spring Salamander and Eastern Newt are Stronghold Species in the Midwest. Emerging Threats threaten Streamside Salamander, Spotted Salamander, Fowler's Toad, and Eastern Newt. The Eastern Newt is predicted to be the amphibian most impacted by *Batrachochytrium salamandrivorans (Bsal)* in the Midwest, if the deadly fungal pathogen arrives in the Midwest, according to the taxa team.

Two RSGCN Watchlist [Assessment Priority] Amphibians are RSGCN in adjacent regions. Streamside Salamander is a Southeast RSGCN of High Concern. Kentucky Spring Salamander is a Northeast RSGCN of Moderate Concern.

Table 33. RSGCN Watchlist [Assessment Priority] Amphibians, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Streamside Salamander (*Ambystoma barbouri*)	75-100%	3
Spotted Salamander (*Ambystoma maculatum*)	25-50%	8
American Toad (*Anaxyrus americanus*)	25-50%	13
Fowler's Toad (*Anaxyrus fowleri*)	25-50%	7
Kentucky Spring Salamander (*Gyrinophilus porphyriticus duryi*)	50-75%	2
Pickerel Frog (*Lithobates palustris*)	25-50%	10
Northern Leopard Frog (*Lithobates pipiens*)	25-50%	12
Mink Frog (*Lithobates septentrionalis*)	50-75%	3
Wood Frog (*Lithobates sylvaticus*)	25-50%	10
Eastern Newt (*Notophthalmus viridescens*)	25-50%	10

REPTILES

The Reptile Taxa Team identified 14 Reptile SGCN as RSGCN Watchlist [Assessment Priority] – eight snakes, four turtles, and two lizards (Table 34). None of the species are federally listed or under review for potential listing. Four RSGCN Watchlist [Assessment Priority] Reptiles are RSGCN in adjacent regions. Blue Racer (*Coluber constrictor foxii*) is Southeast RSGCN of Moderate Concern. Slender Glass Lizard (*Ophisaurus attenuatus*) and Ornate Box Turtle (*Terrapene ornata*) are Southeast RSGCN of High Concern. Eastern Box Turtle (*Terrapene carolina*) is RSGCN of Moderate Concern in both the Northeast and Southeast regions.

Four of the 14 reptiles on the RSGCN Watchlist [Assessment Priority] are endemic to the Midwest region: Blue Racer, Western Foxsnake (*Pantherophis ramspotti*), Eastern Foxsnake (*Pantherophis vulpinus*), and Northern Prairie Skink (*Plestiodon septentrionalis septentrionalis*).

Blue Racer has almost completely disappeared from Ohio, where it is associated with grassland habitat and is an insectivore. In Wisconsin the Blue Racer is pretty rare and limited to big tracts of grassland. Where they still occur in Michigan and Illinois, they are fairly common. The Northern Prairie Skink also is associated with larger blocks of remnant prairie habitat.

Eastern Box Turtle is Highly Imperiled according to the Reptile Taxa Team. Michigan has proposed elevating the species from Special Concern to Threatened but the species is common in Illinois, Indiana, and Missouri. The Eastern Box Turtle is threatened by disease, pet trade collection, and road mortality.

Eastern Hog-nosed Snake (*Heterodon platirhinos*) was noted to be associated with Cultural Values. The Reptile Taxa Team discussed the difficulties in surveying for this snake in states where they are not common. The species does get snake fungal disease, but it is not known if it is affected more than other snakes. Populations appear to be declining in Illinois as compared to historical numbers despite abundance of their primary food source (toads). The snakes can be somewhat common locally in Michigan, but not abundant; uncertainty exists whether this is due to increasing populations or increased movements in response to ecological stressors or changes in hunting patterns.

The Reptile Taxa Team discussed the taxonomy of the Eastern and Western Foxsnakes at length, which historically were recognized as two subspecies of *Pantherophis vulpinus* (*P. v. vulpinus* and *P. v. gloydi*, respectively). *Pantherophis vulpinus gloydi* was elevated to species status by Collins (1991) and retained the common name Eastern Foxsnake. More recently Eastern Foxsnake (*P.v. vulpinus*) was elevated to species status as *Pantherophis vulpinus* (Crother et al. 2011) and the Western Foxsnake as *Pantherophis ramspotti* (Crother et al. 2017). The distribution of the two species in the Midwest is not clear, but Crother et al. (2011) determined the Mississippi River as the dividing line. Illinois has both species, indicating that the Mississippi River is not a solid border between the two. Eastern Foxsnake is a habitat specialist, found in Great Lakes coastal wetlands. In Ohio, there is evidence that the Eastern Foxsnake is expanding its range south and west from the marshes around Lake Erie, possibly along ditches. The Western Foxsnake is considered common, especially along large river corridors, in the western portion of the region.

Members of the taxa team stated the Eastern Foxsnake population in the Lake Erie watershed is either a genetically distinct subspecies or an ecological unit of *Panterophis gloydi*. The Lake Erie watershed population of Eastern Foxsnake is state threatened in Michigan (as a genetically distinct subspecies or ecological unit of *P. gloydi*), provincially endangered in Ontario, and nationally endangered in Canada; it is also Special Concern in Ohio. The provincial and national listings in Canada use the taxonomy of *P. vulpinus* (Pop. 1 – Great Lakes-St. Lawrence population). Given the unsettled taxonomy and regional distributions of the foxsnakes, the

Reptile Taxa Team identified both as RSGCN Watchlist [Assessment Priority] and identified The Eastern Foxsnake (Great Lakes population) of *P. gloydi* as a separate RSGCN, recognizing its taxonomy and state-listing status in Michigan as such.

Midland Smooth Softshell (*Apalone mutica mutica*) is a Keystone Species. In several Midwest states the Midland Smooth Softshell is a game species but it is not regularly monitored, a concern of the Reptile Taxa Team, particularly given that larger females are harvested since there are no size limits. The turtle is found in bigger rivers, requiring sandy shores for nesting. Threats include flooding of nesting sites and aridification and dewatering of western rivers. In Illinois, the subspecies was recently downgraded from state-endangered to state-threatened due to an increased number of sightings. The western extent of the range in Kansas is unknown, as is the response of the species to boom and bust cycles in water flows along major rivers.

Eastern Hog-nosed Snake and Western Foxsnake have Emerging Threats. The Eastern Hog-nosed snake is threatened by snake fungal disease. In Nebraska the Western Foxsnake has an Emerging Threat of take, with people mistaking the snake with rattlesnakes and killing them on sight.

Ornate Box Turtle is a prairie relict species that is likely to disappear from Indiana in the next 30-40 years if prairie habitat is not preserved. Wisconsin may only have one viable population remaining, with some unexplained mortality at one site. This turtle is fairly common in Kansas but poaching is a major concern as are emerging diseases. Illinois also reports declining populations with threats from ranavirus and the pet trade. Missouri, in comparison, appears to have stable populations.

The Reptile Taxa Team found general data deficiencies on the status and trends of the Ouachita Map Turtle (*Graptemys ouachitensis)*. The turtle appears to be widespread, particularly in big rivers, but is little understood. Plains Gartersnake (*Thamnophis radix*) also has information gaps. In the western states of the region with more of the preferred grassland / prairie habitat, the Plains Gartersnake is common. Ohio populations are at the edge of the range and now disjunct and relict. Indiana has found the snake in only two out of eight known counties since 2000. Capture rates are very low in Missouri compared to other gartersnakes. The taxa team discussed the difficulties in capturing and identifying Plains Gartersnake, with the potential for misidentification.

Gray Ratsnake (*Pantherophis spiloides*) is another reptile that appears to have different status and trends across the region, from north to south. In northern parts of the region like Michigan, Wisconsin, northern Indiana, and Ohio, the Gray Ratsnake is not common and in decline. In more southern areas, including southern Indiana, Illinois, and Kentucky, the snake is common. Wisconsin anticipates potential listing of the Gray Ratsnake as SGCN in the next update.

Two more snakes on the RSGCN Watchlist [Assessment Priority] have inconsistent status and trends across the Midwest. Bullsnake (*Pituophis catenifer sayi*) generally is common in the western portion of the region in grassland habitat but has dramatic declines in Iowa in recent years and is fairly rare in Wisconsin. The Reptile Taxa Team identified collection for the pet trade as a serious threat for Bullsnake. Queen Snake (*Regina septemvittata*) is in decline in Michigan and Wisconsin, having disappeared from numerous historical sites. The snake is state-endangered in Wisconsin, which may only have six known extant sites. In northern Illinois, the species is still found but whether there are declines is unknown. Queen Snakes remain fairly common in Indiana.

Table 34. RSGCN Watchlist [Assessment Priority] Reptiles, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Midland Smooth Softshell (*Apalone mutica mutica*)	50-75%	8
Blue Racer (*Coluber constrictor foxii*)	100% (MAFWA Endemic)	3
Ouachita Map Turtle (*Graptemys ouachitensis)*	25-50%	9
Eastern Hog-nosed Snake (*Heterodon platirhinos*)	25-50%	12
Slender Glass Lizard (*Ophisaurus attenuatus*)	25-50%	8
Western Foxsnake (*Pantherophis ramspotti*)	100% (MAFWA Endemic)	6
Gray Ratsnake (*Pantherophis spiloides*)	50-75%	6
Eastern Foxsnake (*Pantherophis vulpinus*)	100% (MAFWA Endemic)	5
Bullsnake (*Pituophis catenifer sayi*)	25-50%	4
Northern Prairie Skink (*Plestiodon septentrionalis septentrionalis*)	100% (MAFWA Endemic)	6
Queen Snake (*Regina septemvittata*)	25-50%	6
Eastern Box Turtle (*Terrapene carolina*)	25-50%	7
Ornate Box Turtle (*Terrapene ornata*)	25-50%	8
Plains Gartersnake (*Thamnophis radix*)	50-75%	11

The Fish Taxa Team identified 14 Fish SGCN as RSGCN Watchlist [Assessment Priority] – representing six taxonomic families (Table 35). One species, Nipigon Cisco (*Coregonus nipigon*), is endemic to the Midwest, occurring only in Minnesota. Seven of the Midwest RSGCN Watchlist [Assessment Priority] Fish are listed as RSGCN in the Southeast region. American Eel (*Anguilla rostrata*) is Southeast RSGCN of Very High Concern. Least Darter (*Etheostoma microperca*), Plains Minnow (*Hybognathus placitus*), and Mountain Madtom (*Noturus eleutherus*) are Southeast RSGCN of High Concern. Cumberland Arrow Darter (*Etheostoma sagitta*), Starhead Topminnow (*Fundulus dispar*), and Channel Darter (*Percina copelandi*) are RSGCN of Moderate Concern in the Southeast.

Four of the RSGCN Watchlist [Assessment Priority] Fish have 75-100% regional responsibility in the Midwest (Table 35). The Gravel Chub (*Erimystax x-punctatus*) is not particularly well understood. Though populations are robust in Illinois and Missouri, they are rare in Wisconsin and Indiana. There are indications that populations are declining, even in areas where populations are large. The Least Darter is rare in much of the Midwest, except for the core part of the range in Indiana. Indiana is a stronghold for the species, and the darter can be found just about everywhere, including ditches. It is possible that the species is overlooked or misidentified in surveys, which may result in the species appearing to be much less common than it actually is, making it an assessment priority. The Cumberland Arrow Darter is found only in Kentucky and Tennessee, splitting the regional responsibility between the Midwest and Southeast regions; habitat for the species is vulnerable to pollution from coal mining. Northern Longear Sunfish (*Lepomis peltastes*) is intolerant of degradation, as it requires very clean water for breeding. In more turbid waters, hybridization becomes a problem, as adults have difficulty locating conspecifics visually. Though common in Michigan, Northern Longear Sunfish populations elsewhere in the Midwest are less common, and population trends are unclear.

The Fish Taxa Team identified three RSGCN Watchlist [Assessment Priority] Fish as Keystone Species: Gravel Chub, Starhead Topminnow, and Channel Darter. The Gravel Chub, Starhead Topminnow, and five other fish (Least Darter, Cumberland Arrow Darter, Plains Minnow, Northern Pearl Dace (*Margariscus nachtriebi*), and Mountain Madtom) as facing Emerging Threats. The Northern Pearl Dace, for example, occurs in a number of disjunct sub-populations. They are associated with highly imperiled habitat. The Starhead Topminnow is common in the core part of its range in Indiana but is rare at the edges of the range in Wisconsin, Kentucky, and Michigan. They are commonly associated with weedy habitat with high water quality. Channel Darters are a difficult species to survey for, making it difficult for the taxa team to determine if populations are declining or not in the Midwest. Canada has split the Channel

Darter into separate units, listing the Lake Erie population as endangered. The taxa team identified the Midwest as supporting a Core Population of Channel Darter.

Plains Minnow is not as threatened as the Western Silvery Minnow (*Hybognathus argyritis*), a Midwest RSGCN Fish, but is still of concern to the Fish Taxa Team, which designated it an assessment priority. Populations of Mountain Madtom are patchily distributed at the edge of their range in Kentucky but are largely abundant in the core part of their range in Indiana.

The Fish Taxa Team identified two fish as Highly Imperiled – American Eel and Channel Darter. The American Eel is distributed sporadically in the Midwest, and data are often lacking. They are difficult to find, even with intense survey effort, though it is worth noting that the species reaches its range edges in the Midwest. There are indications that channelization may have a major impact on the species, which may contribute to the limited information available in the Midwest.

The Northern Redbelly Dace is distributed across much of the Midwest in seven states, but trends are not consistent across the area. In north and eastern states, such as Michigan and Wisconsin, populations are stable and can often be found in large numbers. In the North Dakota, South Dakota, and Nebraska, populations are smaller and declining, and ranges seem to be contracting.

Stable populations of Gilt Darter are found in a number of states and river drainages in the Midwest: Illinois, Indiana, Kentucky, Minnesota, Missouri, Ohio, and Wisconsin. Indiana has listed the Gilt Darter as state-endangered; however, where the fish is restricted to one river; the populations there appear to be stable. In Kentucky the fish has healthy populations in two river systems but is sporadically present outside of those systems.

The Southern Cavefish are threatened by a number of risks to cave systems. The taxonomy of the species may be revised in the next few years, which may result in a Midwest endemic species being described.

Table 35. RSGCN Watchlist [Assessment Priority] Fish, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
American Eel (*Anguilla rostrata*)	25-50%	12
Northern Redbelly Dace (*Chrosomus eos*)	50-75%	7
Nipigon Cisco (*Coregonus nipigon*)	100% (MAFWA Endemic)	1
Gravel Chub (*Erimystax x-punctatus*)	75-100%	8
Least Darter (*Etheostoma microperca*)	75-100%	9
Cumberland Arrow Darter (*Etheostoma sagitta*)	75-100%	1
Starhead Topminnow (*Fundulus dispar*)	50-75%	6
Plains Minnow (*Hybognathus placitus*)	25-50%	8
Northern Longear Sunfish (*Lepomis peltastes*)	75-100%	6
Northern Pearl Dace (*Margariscus nachtriebi*)	50-75%	7
Mountain Madtom (*Noturus eleutherus*)	50-75%	5
Channel Darter (*Percina copelandi*)	25-50%	6
Gilt Darter (*Percina evides*)	50-75%	7
Southern Cavefish (*Typhlichthys subterraneus*)	25-50%	1

CRAYFISH

The Crayfish Taxa Team identified four Crayfish SGCN as RSGCN Watchlist [Assessment Priority], three of which are endemic to the Midwest (Table 36). The Belted Crayfish (*Faxonius harrisonii*) is restricted to a single river drainage in Missouri, nearly half of which is affected by mining of heavy metals. Norwood River Crayfish (*Faxonius raymondi*) has a small distribution in Ohio, but the status is relatively unknown. It is a habitat specialist, requiring small streams with limestone bedrock. The range may be contracting, but further surveys are needed to confirm.

Golden Crayfish (*Faxonius luteus*) is endemic to Kansas, Missouri, Iowa, and Minnesota. Populations appear widespread and stable, but the Crayfish Taxa Team recommended identifying the species as RSGCN Watchlist [Assessment Priority] because it is endemic to the region and there are multiple threats to crayfish in general.

The fourth RSGCN Watchlist [Assessment Priority] Crayfish is Ringed Crayfish (*Faxonius neglectus*), which occurs in Missouri and Kansas in the Midwest region. This species is considered invasive in Missouri and Arkansas, and therefore is an assessment priority. One of two subspecies that occur in Missouri, *F. neglectus chaenodactylus* is rarer than the nominal species, and Missouri is accumulating data on the distribution of both subspecies.

Table 36. RSGCN Watchlist [Assessment Priority] Crayfish, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Belted Crayfish (*Faxonius harrisonii*)	100% (MAFWA Endemic)	1
Golden Crayfish (*Faxonius luteus*)	100% (MAFWA Endemic)	4
Ringed Crayfish (*Faxonius neglectus*)	25-50%	2
Norwood River Crayfish (*Faxonius raymondi*)	100% (MAFWA Endemic)	1

FRESHWATER MUSSELS

The Mussels Taxa Team identified ten Mussel SGCN as RSGCN Watchlist [Assessment Priority], none of which are endemic to the Midwest (Table 37). None of the species are federally listed or under review for potential listing. The Slippershell Mussel (*Alasmidonta viridis*) is RSGCN in the Southeast with High Concern.

Six RSGCN Watchlist [Assessment Priority] Mussels have 75-100% regional responsibility in the Midwest: Slippershell Mussel, Spike (*Eurynia dilatata*), Wavy-rayed Lampmussel (*Lampsilis fasciola*), Round Pigtoe (*Pleurobema sintoxia*), Monkeyface (*Theliderma metanevra*), and Flat Floater (*Utterbackiana suborbiculata*).

Slippershell Mussel is challenging to survey due to its small size and headwater habitat that is under surveyed. New populations have been discovered with increased survey effort in Iowa

and Michigan. The mussel is susceptible to water-quality degradation, particularly pesticides when it occurs in agriculture areas.

Spike cannot tolerate disturbance and can be reduced in number quickly; this mussel has been extirpated from entire systems in the Midwest. The species seems to be doing better in larger river systems and doing worse in interior systems. Round Pigtoe also is threatened with disturbance; the species is stable in its core area in the Midwest but declining outside of that core area.

Wavy-rayed Lampmussel is depleted in Michigan. The species was recently downgraded from federally endangered in Canada but is identified as SGCN in four out of the five Midwest states in which it is known to occur. With its high regional responsibility and SGCN status, the Mussels Taxa Team considered the Wavy-rayed Lampmussel an assessment priority.

Flat Floater is very common in oxbows or ponds when it is found, but the Mussel Taxa Team identified emerging threats and its widespread distribution with high regional responsibility in the region that make the species an assessment priority.

Rock Pocketbook (*Arcidens confragosus*), Fawnsfoot (*Truncilla donaciformis*), and Rainbow Mussel (*Villosa iris*) all have 50-75% regional responsibility. Habitat for the Rock Pocketbook includes large rivers and slack water, so the species is more commonly found in or near big rivers and slack water and not in smaller tributaries; the mussel is often found with Bleufer (*Potamilus purpuratus*). A stronghold for the species may exist in Ohio, Indiana, Illinois, Kentucky, and Missouri in the eastern portion of region, but the mussel not doing as well outside of that core area. Rock Pocketbook was not found in recent a statewide survey of South Dakota and is very rare in Wisconsin.

Fawnsfoot was previously found in good numbers in Wisconsin and Minnesota, but a recent population crash makes it very difficult to find. The mussel has had a precipitous decline in the last decade in Missouri outside of the mainstem Mississippi River. The Mussel Taxa Team found that the core of security appears to be Kentucky, Illinois, and Missouri.

The Mussel Taxa Team identified the Rainbow Mussel as a complex of many species. Taxonomic work on the Rainbow Mussel complex is on-going and genetics may alter the taxonomy with new species and/or Midwest endemics. Therefore, the Mussel Taxa Team considered this species an assessment priority.

Gulf Mapleleaf (*Quadrula nobilis*) has less than 25% regional responsibility in the Midwest but the species was only recently recognized; it is difficult to identify from other mapleleafs by morphology. The Mussel Taxa Team identified a known current Midwest distribution in Minnesota, Illinois, Missouri, and Kentucky. Historical records show the species range

previously extended northward to Minnesota and South Dakota; the exact species distribution is uncertain and therefore an assessment priority.

Table 37. RSGCN Watchlist [Assessment Priority] Freshwater Mussels, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Slippershell Mussel (*Alasmidonta viridis*)	75-100%	9
Rock Pocketbook (*Arcidens confragosus*)	50-75%	9
Spike (*Eurynia dilatata*)	75-100%	12
Wavy-rayed Lampmussel (*Lampsilis fasciola*)	75-100%	5
Round Pigtoe (*Pleurobema sintoxia*)	75-100%	12
Gulf Mapleleaf (*Quadrula nobilis*)	<25%	4
Monkeyface (*Theliderma metanevra*)	75-100%	10
Fawnsfoot (*Truncilla donaciformis*)	50-75%	12
Flat Floater (*Utterbackiana suborbiculata*)	75-100%	11
Rainbow Mussel (*Villosa iris*)	50-75%	7

ODONATES: DRAGONFLIES AND DAMSELFLIES

The Odonate Taxa Team identified 12 Odonate SGCN as RSGCN Watchlist [Assessment Priority] – 11 dragonflies and one damselfly (Table 38). None of the species are federally listed or under review for potential listing. Three Midwest RSGCN Watchlist [Assessment Priority] Odonates are identified as RSGCN in the Northeast. Ringed Boghaunter (*Williamsonia lintneri*) is Northeast RSGCN of Very High Concern. Extra-striped Snaketail (*Ophiogomphus anomalus*) is Northeast RSGCN of High Concern. Ski-tipped Emerald (*Somatochlora elongata*) is Moderate Concern RSGCN in the Northeast.

None of RSGCN Watchlist [Assessment Priority] Odonates are endemic to the Midwest. Two dragonflies have 75-100% regional responsibility – the Horned Clubtail (*Arigomphus cornutus*) and Westfall's Snaketail (*Ophiogomphus westfalli*). Horned Clubtail is state-listed in Indiana and also is found in eight other Midwest states. The Odonate Taxa Team identified the Westfall's

Snaketail as a Stronghold Species in the Midwest, which supports most of the population although the range is evenly split between the Midwest and Southeast.

The Odonate Taxa Team identified four RSGCN Watchlist [Assessment Priority] Odonates as having Core Populations in the Midwest: Zigzag Darner (*Aeshna sitchensis*), Subarctic Darner (*Aeshna subarctica*), Extra-striped Snaketail, and Ringed Boghaunter. Zigzag Darner has become difficult to find in Michigan, where it is suspected climate change may already be shifting their range north; this darner is a habitat specialist needing peatland bogs with buckbean plants. Subarctic Darner requires the same habitat as Zigzag Darner and may already be extirpated from Michigan as their range may be shifting north. Extra-striped Snaketail is state-listed in Michigan, Minnesota and Wisconsin; this genus is difficult to survey for as adults. Ringed Boghaunter is also Highly Imperiled, facing Emerging Threats (it is obligate to acidic bogs), and has Genetic Distinctiveness; the species is considered one of the 25 critical Odonates of North America (Dunkle 2012). The taxa team noted that the species has not been sufficiently surveyed in some states, resulting in information gaps. The Midwest population of Splendid Clubtail (*Gomphurus lineatifrons*) also has Genetic Distinctiveness.

Five RSGCN Watchlist [Assessment Priority] Odonates are Climate Vulnerable and/or subject to a Climate Change Range Shift. Extra-striped Snaketail has narrow thermal preferences, needing cold, pristine rivers that have been experiencing habitat degradation. Ski-tipped Emerald is a habitat specialist with narrow thermal tolerances in peatlands, making it vulnerable to changing climatic conditions. Forcipate Emerald (*Somatochlora forcipata*) is more widespread than Ski-tipped Emerald, but the *Somatochlora* genus was of particular concern to the Odonate Taxa Team. Brush-tipped Emerald (*Somatochlora walshii*) is fairly widespread in the Northeast and is not as specialized as other *Somatochlora* species. In Minnesota, however, they have very narrow habitat requirements; where they are present, they tend to be somewhat abundant. Russet-tipped Clubtail (*Stylurus plagiatus*) may have a disjunct population in the western Great Lakes area, where in Michigan they are associated with big rivers in upland habitat, requiring big trees for resting and nearby open fields for hunting and mating; whether the population is genetically distinct is uncertain but a possibility. Michigan has proposed the species as state-endangered. In Kentucky the species is the most common and widely distributed *Stylurus* species, found in a variety of habitats. The species' thermal preferences render it climate vulnerable.

Springwater Dancer (*Argia plana*), the sole damselfly RSGCN Watchlist [Assessment Priority] Odonate, is more of a southern species, but the Odonate Taxa Team noted that there could be some field identification issues that create uncertainty in understanding their distribution in the Midwest. As primarily a spring breeder, the species may be at risk under changing climate conditions as groundwater recedes. In some places Springwater Dancer is found in drainage

ditches in urban areas, so the species may not be as much of a habitat specialist as previously thought. These uncertainties led the taxa team to identify Springwater Dancer as an assessment priority.

Table 38. RSGCN Watchlist [Assessment Priority] Odonates, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Zigzag Darner (*Aeshna sitchensis*)	25-50%	3
Subarctic Darner (*Aeshna subarctica*)	25-50%	3
Springwater Dancer (*Argia plana*)	25-50%	7
Horned Clubtail (*Arigomphus cornutus*)	75-100%	9
Splendid Clubtail (*Gomphurus lineatifrons*)	50-75%	7
Extra-striped Snaketail (*Ophiogomphus anomalus*)	25-50%	3
Westfall's Snaketail (*Ophiogomphus westfalli*)	75-100%	3
Ski-tipped Emerald (*Somatochlora elongata*)	25-50%	3
Forcipate Emerald (*Somatochlora forcipata*)	25-50%	3
Brush-tipped Emerald (*Somatochlora walshii*)	25-50%	4
Russet-tipped Clubtail (*Stylurus plagiatus*)	25-50%	12
Ringed Boghaunter (*Williamsonia lintneri*)	25-50%	2

LEPIDOPTERA: BUTTERFLIES, SKIPPERS AND MOTHS

The Lepidoptera Taxa Team identified 18 SGCN as RSGCN Watchlist [Assessment Priority] – nine butterflies and skippers and nine moths (Table 39). None of the species are federally listed or under review for potential listing. Four Lepidoptera are identified as RSGCN in the Northeast, all of Moderate Concern: Columbine Duskywing (*Erynnis lucilius*), Aralia Shoot Borer Moth (*Papaipema araliae*), West Virginia White (*Pieris virginiensis*), and Edwards' Hairstreak (*Satyrium edwardsii*). Edwards' Hairstreak occurs in all 13 MAFWA states.

The Northern Cloudywing (*Cecropterus pylades*) also is found in all 13 MAFWA states but the Midwest has less than 25% regional responsibility for this species due to its very large range in North America; threats to the species are unknown, however. Aphrodite Fritillary (*Argynnis aphrodite*) is shared by 12 states in the Midwest, not known to occur in Missouri. Southern Cloudywing (*Cecropterus bathyllus*) occurs in 11 Midwest states, absent from the Dakotas, but is in serious decline in Ohio and general decline in central Illinois. In other parts of the region, including Kentucky, southern Illinois, and Iowa, populations appear stable.

One skipper, the subspecies Byssus Skipper (*Problema byssus kumskaka*) is endemic to the Midwest, found only in Nebraska. The Byssus Skipper (*Problema byssus*) nominal species is also a RSGCN Watchlist [Assessment Priority] species and is more widespread, known to occur in seven Midwest states (IA, IN, IL, KS, MO, NE, and WI). One moth has 75-100% regional responsibility, an aethes moth (*Aethes patricia*). *Aethes patricia* is challenging to identify without dissection but available evidence strongly suggests the core of the range from Ohio / Michigan to Iowa / Missouri; further work would clarify identification of records and species status and trends.

The Lepidoptera Taxa Team identified three RSGCN Watchlist [Assessment Priority] Lepidoptera with Genetic Distinctiveness: an aethes moth (*Aethes patricia*), Imperial Moth (*Eacles imperialis pini*), and Clouded Veneer Moth (*Prionapteryx nebulifera*). The core range of Imperial Moth extends from southern Ontario into northern Lower Michigan and the Northeast region. Most giant silk moths have declined but it is not known how this species has fared in comparison to others in the region, making it an assessment priority. The Great Lakes populations of Clouded Veneer Moth are disjunct from the Atlantic coastal populations.

The Midwest supports Stronghold Species populations of two RSGCN Watchlist [Assessment Priority] Lepidoptera – Aralia Shoot Borer Moth and Turtle Head Borer Moth (*Papaipema nepheleptena*). The Turtle Head Borer Moth could be a wetland flagship species according to the Lepidoptera Taxa Team.

The Lepidoptera RSGCN Watchlist [Assessment Priority] species represent a variety of habitats in the Midwest. One-third (6) of the 18 RSGCN Watchlist [Assessment Priority] Lepidoptera are found in grassland or prairie habitat: *Aethes patricia,* Sand Dune Panic Grass Moth (*Coenochroa bipunctella*), a prairie sedge moth (*Neodactria murellus*), Clouded Veneer Moth (*Prionapteryx nebulifera*), Byssus Skipper, and Leadplant Flower Moth (*Schinia lucens*). One-third of the Lepidoptera are associated with glades, barrens or savanna habitat - *Aethes patricia,* Southern Cloudywing, Sand Dune Panic Grass Moth, Columbine Duskywing (*Erynnis lucilius)*, *Neodactria murellus*, and Clouded Veneer Moth. Imperial Moth (*Eacles imperialis pini*), Aralia Shoot Borer Moth (*Papaipema araliae*), and West Virginia White are forest species. A grass miner moth (*Agonopterix lythrella*) and Turtle Head Borer are associated with wetlands.

Table 39. RSGCN Watchlist [Assessment Priority] Lepidoptera, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
an aethes moth (*Aethes patricia*)	75-100%	6
a grass miner moth (*Agonopterix lythrella*)	50-75%	3
Aphrodite Fritillary (*Argynnis aphrodite*)	25-50%	12
Southern Cloudywing (*Cecropterus bathyllus*)	25-50%	11
Northern Cloudywing (*Cecropterus pylades*)	<25%	13
Sand Dune Panic Grass Moth (*Coenochroa bipunctella*)	25-50%	3
Imperial Moth (*Eacles imperialis pini*)	50-75%	2
Taiga Alpine (*Erebia mancinus*)	<25%	1
Columbine Duskywing (*Erynnis lucilius*)	50-75%	9
a prairie sedge moth (*Neodactria murellus*)	50-75%	7
Aralia Shoot Borer Moth (*Papaipema araliae*)	25-50%	3
Turtle Head Borer Moth (*Papaipema nepheleptena*)	50-75%	7
West Virginia White (*Pieris virginiensis*)	25-50%	6
Clouded Veneer Moth (*Prionapteryx nebulifera*)	50-75%	3
Byssus Skipper (*Problema byssus*)	25-50%	7
Byssus Skipper (*Problema byssus kumskaka*)	100% (MAFWA Endemic)	1
Edwards' Hairstreak (*Satyrium edwardsii*)	50-75%	13
Leadplant Flower Moth (*Schinia lucens*)	50-75%	8

PLECOPTERA: STONEFLIES

The Stonefly Taxa Team identified seven SGCN as RSGCN Watchlist [Assessment Priority] – representing three taxonomic families (Table 40). All of the RSGCN Watchlist [Assessment Priority] Stoneflies have less than 50% regional responsibility but three have Disjunct Populations in the Midwest and one is a Stewardship Priority. Both Brook Needlefly (*Leuctra sibleyi*) and Narrow-lobed Needlefly (*Leuctra tenuis*) have Disjunct Populations in the Driftless region of Wisconsin and the unglaciated south. Ashcave Needlefly (*Zealeuctra fraxina*) is typically uncommon for the genus in the unglaciated south.

The Midwest has a Stewardship Priority for Teays Stone (*Perlesta teaysia*) according to the Stonefly Taxa Team. Teays Stone is a common species in streams in the unglaciated areas of the Midwest, especially Indiana and Kentucky.

Constricted Stone (*Acroneuria evoluta*) survives in some large rivers of Iowa, Illinois, Missouri, and Nebraska. Banded Stripetail (*Isoperla burksi*) is found mainly in permanent streams and small rivers in unglaciated Midwest states. Slippery Stone (*Neoperla catharae*) has been lost from larger warmwater rivers in the southern Midwest region. The stonefly is still found in unglaciated areas in parts of the region and the St. Joseph River in southern Michigan.

Table 40. RSGCN Watchlist [Assessment Priority] Stoneflies, with the regional responsibility and the number of MAFWA states in which each is known to occur.

Species	Regional Responsibility	Number of MAFWA States
Constricted Stone (*Acroneuria evoluta*)	25-50%	6
Banded Stripetail (*Isoperla burksi*)	25-50%	5
Brook Needlefly (*Leuctra sibleyi*)	25-50%	5
Narrow-lobed Needlefly (*Leuctra tenuis*)	25-50%	9
Slippery Stone (*Neoperla catharae*)	25-50%	6
Teays Stone (*Perlesta teaysia*)	25-50%	4
Ashcave Needlefly (*Zealeuctra fraxina*)	25-50%	4

RSGCN PROPOSED WATCHLIST [ASSESSMENT PRIORITY]

The taxa teams recommended 24 species in five taxa that are not currently SGCN in the MAFWA region as assessment priorities (Table 4). These species constitute the RSGCN Proposed Watchlist [Assessment Priority] (Table 41). Two of the 24 RSGCN Proposed Watchlist [Assessment Priority] species are identified as RSGCN in adjacent regions. Splendid Stone (*Hansonoperla hokolesqua*) is identified as a Data Deficient RSGCN in the Northeast. Neosho Midget Crayfish (*Faxonius macrus*) is identified as RSGCN in the Southeast with Moderate Concern.

The four RSGCN Watchlist [Assessment Priority] Bees are all solitary bees. Aberrant Cellophane Bee (*Colletes aberrans*), Susanna's Cellophane Bee (*Colletes susannae*), and Bald-spot Sweat Bee (*Lasioglossum paraforbesii*) are threatened by habitat loss and alteration due to agriculture, development, and other ecosystem modifications. Both Aberrant Cellophane Bee and Susanna's Cellophane Bee are interdependent species, serving as host species for other bees. Both *Colletes* spp. are host to Ainslie's Cuckoo Nomad Bee (*Epeolus ainsliei*), which is a RSGCN Bee and is associated with the Purple Prairie Clover (*Dalea purpurea*). Susanna's Cellophane Bee can be common in Nebraska, where it is often associated with sandy soils. In Illinois and Wisconsin, the bee is dependent on remnant, gravelly/sandy, older glacier habitats. Bald-spot Sweat Bee is very difficult to identify, capable of losing identifying hairs during processing for identification; this bee is common in Minnesota but also occurs in seven other Midwest states where its status is less understood. *Melissodes intortus* (a callirhoe bee) is found more in the western portion of the MAFWA region, where it seems to be doing well in Kansas and Nebraska where there are more plants of the *Callirhoe* (poppy mallow) genus; it is much rarer in the eastern states of the Midwest.

Of the two crayfish, Blue Crawfish (*Cambarus monongalensis*) has a Disjunct Population in Ohio, isolated from the Pennsylvania and West Virginia population. Neosho Midget Crayfish (*Faxonius macrus*) is of concern to the Crayfish Taxa Team because although there are no major immediate threats in Missouri and Oklahoma, where it occurs, but the species may be highly susceptible to invasive species as they are small and easily displaced. The taxa team noted that crayfish populations of several species have or can become locally extirpated in a decade's time due to displacement and competition with invasive species, whether they are native or exotic species.

The Canary Kingshell (*Lampsilis sietmani*) is the only mussel identified as RSGCN Proposed Watchlist [Assessment Priority], with 50-75% regional responsibility. The Canary Kingshell was recently split from *Lampsilis teres* and its status is not well known.

The EPT Taxa Teams each compiled full inventories of the known mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) species diversity in the Midwest (Appendices J, K, and L, respectively). Using extensive published and unpublished resources, the teams identified 332 mayflies, 234 stoneflies, and 595 caddisflies in the MAFWA region. The teams developed distributions of each of these species and then applied the RSGCN selection criteria to all of the species. Many non-SGCN species were then identified by the taxa teams as Proposed RSGCN or Proposed Watchlist [Assessment Priority]. One caddisfly and 16 stoneflies are recommended as assessment priorities.

Intermediate Saddle-case Caddisfly (*Glossosoma intermedium*) is known to occur in nine MAFWA states but has a regional responsibility of less than 50% since its range extends across Canada and into the Northeast and Southeast regions of the U.S. The Caddisfly Taxa Team identified the non-SGCN species as an assessment priority.

The largest group of species on the RSGCN Proposed Watchlist [Assessment Priority] are 16 stoneflies (Table 41). Three of these stoneflies have Disjunct Populations in the Midwest that warrant assessment priority: Atlantic Sallfly (*Alloperla atlantica*), Vernal Snowfly (*Capnia vernalis*), Truncate Snowfly (*Alloperla leonarda*), and Northeastern Snowfly (*Paracapnia opis*). Atlantic Sallfly is associated with Lake Superior shoreline habitat and is considered regionally imperiled by the taxa team. Vernal Snowfly is tied tightly to cold tributaries of Lake Superior and the depths of the lake itself; warming of streams and lakes through a number of stressors could reduce the range or remove them altogether. Truncate Snowfly has disjunct distributions in the boreal forests of Michigan, Minnesota and northeast Canada, and the unglaciated Ozarks of Missouri; there are no recent records from Nebraska. Compared to other snowflies in the genus, Truncate Snowfly is uncommon and needs inventory work. Northeastern Snowfly also is closely tied to the Lake Superior shoreline and considered regionally imperiled by the taxa team.

Many of the non-SGCN species identified by the Stonefly Taxa Team as assessment priorities have been lost from many Midwest states. The Lobed Stone (*Acroneuria internata*) has been lost from many southeastern Midwest states and is spotty in northern Midwest states; its status in the western Midwest is unknown, and its stronghold appears to be in the Missouri Ozarks. Enigmatic Stone (*Acroneuria perplexa*) is disappearing from the Ohio River valley, in Illinois, Indiana, Kentucky and Ohio; it may be common in Missouri but surveys are needed to verify. Sterling Stripetail (*Isoperla richardsoni*) has historical records in the southern Midwest, and is now extirpated from Indiana and Illinois, retreating to Wisconsin; the Missouri Ozarks population is now disjunct. The Missouri Ozarks population of Slender Stone (*Neoperla robisoni*) is also disjunct, with known extirpation from Illinois and possible extirpation from Indiana.

Hooked Willowfly (*Taeniopteryx parvula*) is being phased out of the southern half of the region (i.e., the Ozarks and east of the Mississippi River) due to changing water temperatures.

Other stoneflies have narrow habitat requirements and high regional responsibility. Indiana Snowfly (*Allocapnia indianae*) and Ohio Snowfly (Allocapnia ohioensis) are associated with unglaciated habitat and intermittent streams in southern Indiana and Ohio and are considered rare. Barbed Sallfly (*Alloperla hamata*) also is tied to unglaciated lands in the region, including the Missouri Ozarks, and is rare. Manitoba Snowfly (*Capnura manitoba*) is very rare and is associated with coldwater streams. The Splendid Stone (*Hansonoperla hokolesqua*) is almost endemic to Kentucky, associated with the Outer Bluegrass region around Cave Run Lake; there is only one locality record in western West Virginia of the species. Canadian Willowfly (*Oemopteryx glacialis*) appears to be tied to a minimum latitude; increasing stream temperatures may threaten this species.

Table 41. RSGCN Proposed Watchlist [Assessment Priority] species, with the taxa, regional responsibility, and number of MAFWA states in which each is known to occur.

Taxa	Species	Regional Responsibility	Number of MAFWA States
Bees	Aberrant Cellophane Bee (*Colletes aberrans*)	50-75%	6
Bees	Susanna's Cellophane Bee (*Colletes susannae*)	75-100%	6
Bees	Bald-spot Sweat Bee (*Lasioglossum paraforbesii*)	50-75%	8
Bees	a callirhoe bee (*Melissodes intortus*)	75-100%	3
Caddisfly	Intermediate Saddle-case Caddisfly (*Glossosoma intermedium*)	25-50%	9
Crayfish	Blue Crawfish (*Cambarus monongalensis*)	<25%	1
Crayfish	Neosho Midget Crayfish (*Faxonius macrus*)	25-50%	2
Freshwater Mussels	Canary Kingshell (*Lampsilis sietmani*)	50-75%	8
Stonefly	Lobed Stone (*Acroneuria internata*)	50-75%	8
Stonefly	Enigmatic Stone (*Acroneuria perplexa*)	25-50%	5
Stonefly	Indiana Snowfly (*Allocapnia indianae*)	50-75%	3
Stonefly	Ohio Snowfly (*Allocapnia ohioensis*)	50-75%	3

Taxa	Species	Regional Responsibility	Number of MAFWA States
Stonefly	Atlantic Sallfly (*Alloperla atlantica*)	<25%	3
Stonefly	Barbed Sallfly (*Alloperla hamata*)	50-75%	4
Stonefly	Truncate Sallfly (*Alloperla leonarda*)	25-50%	3
Stonefly	Vernal Snowfly (*Capnia vernalis*)	<25%	3
Stonefly	Manitoba Snowfly (*Capnura manitoba*)	50-75%	2
Stonefly	Splendid Stone (*Hansonoperla hokolesqua*)	50-75%	1
Stonefly	Quadrate Sallfly (*Haploperla orpha*)	50-75%	4
Stonefly	Sterling Stripetail (*Isoperla richardsoni*)	75-100%	9
Stonefly	Slender Stone (*Neoperla robisoni*)	50-75%	6
Stonefly	Canadian Willowfly (*Oemopteryx glacialis*)	50-75%	3
Stonefly	Northeastern Snowfly (*Paracapnia opis*)	25-50%	3
Stonefly	Hooked Willowfly (*Taeniopteryx parvula*)	25-50%	8

RSGCN WATCHLIST [DEFER TO ADJACENT REGION]

The Midwest taxa teams opted to defer 85 species to adjacent regions for RSGCN evaluation (Table 5; Appendix G). These are species for which the taxa teams had significant concern but for which the region has low regional responsibility. Thirty-four (30) species are deferred to the Northeast, 32 to the Southeast, eight to both the Northeast and Southeast, and 15 to the West. The Northeast and Southeast have identified RSGCN, with the Northeast planning to update its list in the winter of 2021-22. WAFWA has not yet identified RSGCN.

Of the 85 species identified by the Midwest taxa teams as recommendations to adjacent teams for RSGCN evaluation, 31 are already RSGCN in the Northeast and/or Southeast. Twenty-one (21) are Southeast RSGCN, five are Northeast RSGCN, and five are RSGCN in both the Northeast and Southeast. When these regions update and revise their RSGCN lists, they will now have the concerns of the Midwest region to consider when deciding which species remain on their RSGCN lists and at what Concern Levels. The Midwest Reptile taxa team, for example, recommends that the Southeast Reptile Taxa Team elevate their RSGCN Concern Level for the

Cumberland Plateau Salamander (*Plethodon kentucki*), which is currently Moderate. The other 57 species on the Midwest deferral RSGCN Watchlist are recommendations from the Midwest taxa teams for the Northeast, Southeast, and West taxa teams to consider as RSGCN; some of these species are newly described or taxonomically split species.

Ten species on the Midwest deferral Watchlist are federally endangered (4), threatened (4), or under review for potential listing (2). All of these species are existing RSGCN in the Northeast and/or Southeast, where more than 50% of the regional responsibility has been identified by those regions for all but one species; the lone exception is Red Knot (*Calidris canutus rufa*) with less than 50% regional responsibility in the Northeast and Southeast, because the bird is a migratory shorebird with one of the largest geographic ranges of any animal stretching from the Arctic to the southern tip of South America. Seven of the ten listed or under review species are considered endemic to the Southeast, with their Midwest range occurring in the two states (KY and MO) shared by the two regions. The Midwest taxa teams determined that those species are more ecologically aligned with the Southeast than the Midwest and chose to defer RSGCN status to SEAFWA.

Mayflies are the largest taxa in terms of numbers of deferrals (40), with 21 RSGCN Watchlist [Defer to Northeast] species, ten RSGCN Watchlist [Defer to West] species, four RSGCN Watchlist [Defer to Southeast] species, and five RSGCN Watchlist [Defer to Northeast & Southeast] species. Fish are the second largest group, with 12 deferral species (seven to the Southeast, three to the West, and two to the Northeast).

While the vast majority (84%) of the Midwest deferral Watchlist species have less than 50% regional responsibility in the MAFWA region, with 21 of them less than 25%, there are 13 species with greater than 50% regional responsibility in the Midwest. Three of these species – Grotto Sculpin (*Cottus specus*), Niangua Darter (*Etheostoma nianguae*), and Bluestripe Darter (*Percina cymatotaenia*) – are endemic to Missouri, which participates in both MAFWA and SEAFWA. The Fish Taxa Team, particularly Missouri's representative, chose to defer responsibility to SEAFWA as all three species are more closely associated with Southeast ecosystems / watersheds than Midwest ones.

Five Midwest deferral Watchlist species have 75-100% regional responsibility, due to the fact that each species occurs in Kentucky or Missouri, which participates in both MAFWA and SEAFWA. Thus, both regions share high regional responsibility. The Midwest taxa teams deferred Black Mountain Salamander (*Desmognathus welteri*), Cumberland Plateau Salamander (*Plethodon kentucki*), Kentucky Arrow Darter (*Etheostoma spilotum*), Appalachian Cave Crayfish (*Orconectes packardi*), and Long-tailed or Rock Shrew (*Sorex dispar blitchi*) to the Southeast due to their occurrence in Kentucky.

Four other deferral species have 50-75% regional responsibility in the Midwest but are deferred by the taxa teams to adjacent regions. Cumberland Darter (*Etheostoma susanae*) occurs in Kentucky and is deferred to SEAFWA, of which Kentucky is also a member. Ozark Shiner (*Notropis ozarcanus*) and Ozark Cavefish (*Troglichthys rosae*) occur in Missouri and are likewise deferred to SEAFWA, of which Missouri is also a member. The Ottawa Little Caddisfly (*Neophylax ottawa*) is deferred to NEAFWA because it is only known to occur in Ontario (part of MAFWA) and New York (part of NEAFWA).

RSGCN HABITATS AND LIMITING FACTORS

One of the desired outcomes of the Midwest RSGCN list was to be able to associate each RSGCN with its habitat needs. A recent review of Midwest SWAPs (Paskus et al. 2016) indicated that no standardized classification system exists for the Upper Midwest and Great Lakes region, as it does in the Northeast where a common Northeast Lexicon (Crisfield and NEFWDTC, 2013) and Northeast Habitat Classification systems (Gawler et al. 2008) were developed by NEAFWA's Northeast Fish and Wildlife Diversity Technical Committee (NEFWDTC). Thus, there was no consensus or standard way to classify habitats across the Midwest. In order to approach species and habitat conservation from a regional perspective, it was necessary to first define a classification system that meaningfully captured the variability of habitats present across the Midwest in the context of both terrestrial and aquatic fish and wildlife habitat.

Since the MLI Habitat Working Group was planning to develop a robust, regional habitat classification, we consulted and coordinated with this team to create a system that could serve as a foundation for their continuing effort as well. This project's scope and timeline only allowed identification of coarse-level habitat types. Several well-recognized, national habitat classification systems already exist, including the USGS' National Land Cover Database (NLCD; USGS 2016) and NatureServe's Ecological Systems Classification (ESC) system (Comer et al. 2003). Each state utilized their own classification system in their State Wildlife Action Plan (SWAP), which was often at a finer scale. The structure of these classification systems formed a foundation from which a system was developed for use with the Midwest RSGCN project.

TCI met with the MLI Habitat Working Group to develop a list of functional habitat categories. Initially, TCI provided the Sub-group with a list of proposed habitats; this preliminary list included 16 habitats broken into six larger groups. These habitats were a mix of categories from both NLCD and ESC. The Sub-group also considered example habitat classifications from the State Wildlife Action Plans within the Midwest region. In particular, they looked at Wisconsin's SWAP, which contains 104 natural communities divided amongst eight major community types, and Missouri's SWAP, which contains 28 natural communities divided among six major community types (Wisconsin DNR 2015, Missouri Department of Conservation 2015). After considering these different systems, the MLI Habitat Working Group discussed changes that should be made to better capture the habitats of the Midwest. This process grouped some natural communities together, split others apart, and identified areas where a new category was needed to capture habitat types that were previously not acknowledged, particularly anthropogenic habitats. Ultimately, this resulted in 20 habitats that were then grouped into four categories:

- Terrestrial Habitats
    - Forests
    - Shrublands
    - Glades, Barrens, and Savannas
    - Grasslands
    - Caves and Karst
    - Soil
- Aquatic Habitats
    - Rivers and Streams
    - Big Rivers
    - Lakes and Ponds
    - Great Lakes
- Transitional Habitats
    - Riparian
    - Shoreline
    - Wetlands
- Anthropogenic Habitats
    - Annual Cropland
    - Perennial Cropland and Pasture
    - Silviculture and Orchards
    - Developed
    - Mines
    - Impoundments
    - Managed Wetlands

The definitions for each habitat type in the summaries below reflect the collaborative development process with the MLI Habitat Working Group and seemed to best meet our mutual needs. These definitions combine aspects of the original NLCD and ESC classifications with language from the SWAPs and clarifying points from the discussions with the Habitat Working Group.

Multiple data fields were chosen to describe and characterize habitats and threats, or limiting factors (as listed in the method documentation Appendix A). These characteristics were matched with NatureServe data fields to prepopulate the habitat worksheets. These data fields were then sent to the MLI Habitat Working Group to refine and approve, and then the taxa experts to review, confirm, and assign RSGCN to their key habitats and habitat condition characteristics.

While threats to RSGCN can be found in the Wildlife Action Plans, linkages to explain why the threats are responsible for the decline of species or degradation of habitats can be difficult to summarize at a regional scale. One reason is that the intention of the current threat-classification system is to identify *direct* threats to species and habitats. But this approach can downplay or fail to capture *indirect, interrelated,* or *amplifying* threats (e.g., climate change,

shifts in food availability, predator-prey relationships). Additionally, detailed habitat requirements are not systematically captured, making it difficult to sort species sharing specific niches or conditions.

These limiting factors help explain how (and in what ways) threats are causing declining populations or degrading habitats. Limiting factors data were collected for all RSGCN and Proposed RSGCN. They are organized in four groups 1) habitat use and condition requirements; 2) seasonal and life cycle requirements; 3) innate biological characteristics including breeding, reproduction, and survivorship; and 4) food needs. The limiting factors help document why species are in decline, making it possible to produce more confident regional statements of conservation action goals that address concerns across many taxonomic groups. The number of RSGCN and Proposed RSGCN that the taxa teams identified as impacted or possibly impacted by each limiting factor are summarized in Table 42. Due to incomplete information, all values in Table 42 are likely to be underestimates. Note that the Climate Change and Invasive Species factors listed in the table relate to the impacts to habitat, not individual species; species-level impacts may also occur.

Table 42. Common threats and limiting factors identified by the taxa teams for each of the taxonomic groups. Percentages indicate the *minimum* percent of RSGCN of species that are impacted or probably impacted by each limiting factor. Due to incomplete information, all values are likely to be underestimates. Note that the Climate Change and Invasive Species factors listed here relate to the impacts to habitat, not individual species; species-level impacts may also occur.

	RSGCN Species	Habitat Availability	Habitat Condition	Habitat Connectivity	Habitat Management	Climate Change	Invasive Species	Disease	Genetics	Pollution	Predation	Harvest/Take	Competition
Mammals	**16**	88%	38%	.	6%	13%	.	63%	6%	50%	.	50%	.
Birds	**30**	93%	70%	27%	83%	47%	10%	3%	13%	27%	27%	43%	10%
Amphibians	**12**	83%	92%	50%	42%	67%	25%	58%	17%	58%	58%	50%	17%
Reptiles	**16**	81%	69%	31%	63%	38%	6%	44%	19%	19%	19%	44%	.
Fishes	**35**	57%	89%	54%	6%	29%	3%	6%	40%	71%	37%	17%	29%
Crayfishes	**18**	39%	50%	17%	.	17%	.	.	11%	39%	.	.	61%
Mussels	**47**	40%	85%	66%	17%	4%	36%	.	30%	72%	9%	19%	4%
Dragonflies	**14**	36%	93%	21%	.	43%	.	.	7%	79%	14%	7%	.
Butterflies	**49**	92%	80%	90%	76%	12%	88%	4%	16%	33%	.	.	.
Bees	**13**	77%	62%	54%	46%	46%	38%	31%	46%	46%	8%	.	.

XX%	80-100% of RSGCNs affected
XX%	60-79% of RSGCNs affected
XX%	40-59% of RSGCNs affected
XX%	20-39% of RSGCNs affected
XX%	<20% of RSGCNs affected, or insufficient data (.)

TERRESTRIAL HABITATS

The defining characteristics of most terrestrial habitats are related to the type and quantity of different plants present. Plants, whether they are woody or herbaceous, provide much of the structure in terrestrial systems. This structure creates a variety of niches and microclimates that many different species can then exploit. Many terrestrial RSGCN have close relationships with various plant species, driven by the food resources or the cover and protection they can provide.

In contrast to aquatic habitats, terrestrial habitats are not submerged in water. Water can act as a stabilizer or insulator, so terrestrial habitats are highly variable; humidity and temperature can change, sometimes rapidly, over the course of a day, and fluctuate seasonally. While water is a key feature in most terrestrial habitats, it is generally as rainfall or contained within the borders of a lake, pond, river, or stream. Terrestrial RSGCN may interact with water, but their daily activities are carried out in the open air.

Taxonomic groups that are absent from terrestrial habitats include the freshwater mussels, caddisflies, mayflies, and stoneflies (Table 43, Figure 22). Of the terrestrial habitat types, grasslands and forests appear to support the greatest number of taxa, while soil and shrublands support the fewest. Mammals are the most common RSGCN taxa in the two subterranean habitats, soil and caves and karst, though they also make up a significant proportion of the RSGCN that occur in shrublands. Pollinator RSGCN – bees, butterflies, and moths – dominate the grasslands and glades, barrens, and savannas. More than half of the shrubland RSGCN are birds.

Figure 22. Number of RSGCN occurring in each terrestrial habitat type.

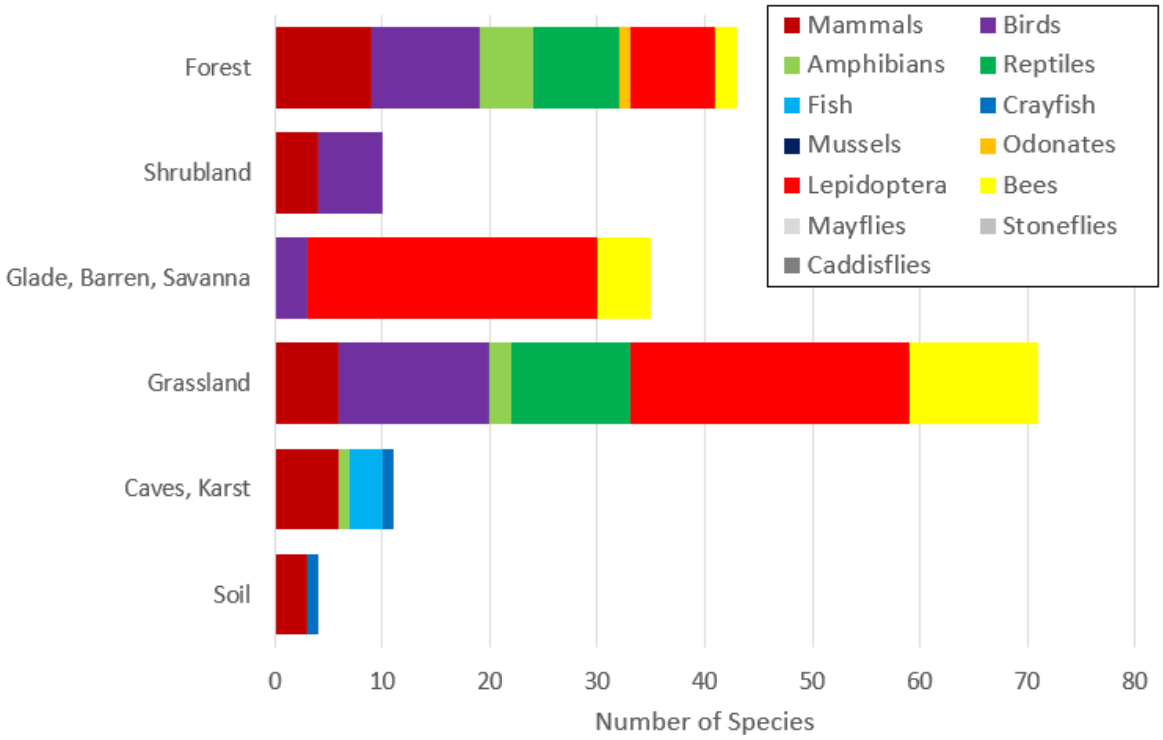


Table 43. Number of RSGCN from each taxonomic group occurring in each terrestrial habitat type.

	Caves and Karst	Forest	Glades, Barrens, or Savanna	Grassland	Shrubland	Soil
Mammals	6	9	0	6	4	3
Birds	0	10	3	14	6	0
Amphibians	1	5	0	2	0	0
Reptiles	0	8	0	11	0	0
Fishes	3	3	0	6	0	0
Crayfishes	1	0	0	0	0	0
Odonates	0	1	0	0	0	0
Lepidoptera	0	8	27	26	0	0
Bees	0	2	5	12	0	0
Total	**11**	**46**	**35**	**77**	**10**	**3**

FORESTS

DESCRIPTION

Forests are areas dominated by woody vegetation greater than five meters in height, generally with distinct canopy and understory layers. Generally, the canopy must be at least 25% closed in order to be considered a forest; areas below this threshold may be designated as a glade, savanna, forested wetland, or other category dependent on other associated characteristics. The complete or partial closure of the canopy in forested areas can exert an influence on the climate and hydrological regimes of the system. In the Midwest, forests can be coarsely grouped into three types: deciduous, coniferous, and mixed.

SPECIES OVERVIEW

A total of 43 RSGCN species utilize forest habitats (Appendix N, Table N-1). Birds are the predominant forest species (10 RSGCN), followed closely by mammals (9), reptiles (8), and lepidopterans (8); a handful of amphibians (5), fishes (3), bees (2), and a single odonate are also present (Figure 23). Nine forest RSGCN were identified by the Taxa Teams as habitat specialists, and six were identified as restricted to forested habitats (Table 44).

Taxonomic experts identified a single Proposed RSGCN moth that also uses forested habitat, Franclemont's Lithopane (Appendix N, Table N-1). This species is not considered a habitat specialist, but it is restricted to forests (Table 44).

Figure 23. Distribution of the different RSGCN taxa that utilize forest habitats.

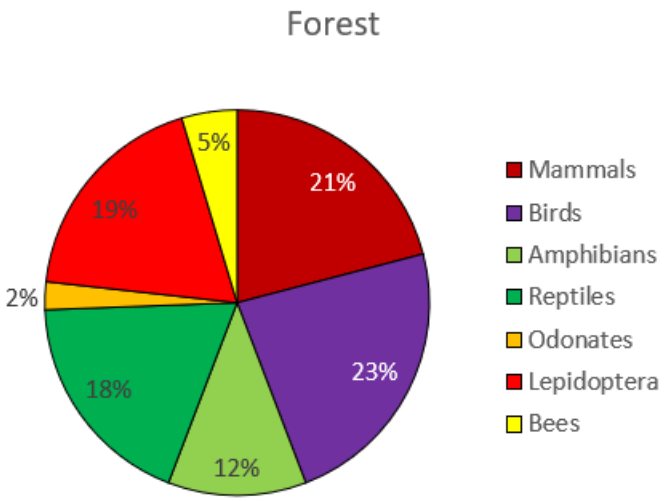


Table 44. Forest RSGCN and Proposed RSGCN that are habitat specialists or utilize only forested areas.

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Forests?
Amphibians	*Ambystoma laterale*	Blue-spotted Salamander	RSGCN	Yes	
Amphibians	*Ambystoma sp.*	Unisexual Ambystoma Complex	RSGCN	Yes	
Amphibians	*Aneides aeneus*	Green Salamander	RSGCN	Yes	Yes
Amphibians	*Hemidactylium scutatum*	Four-toed Salamander	RSGCN	Yes	
Birds	*Setophaga kirtlandii*	Kirtland's Warbler	RSGCN	Yes	Yes
Lepidoptera	*Amblyscirtes linda*	Linda's Roadside-Skipper	RSGCN	Yes	
Lepidoptera	*Catocala dulciola*	Quiet or Sweet Underwing	RSGCN		Yes
Lepidoptera	*Euchlaena milnei*	Milne's Looper Moth	RSGCN		Yes
Lepidoptera	*Hadena ectypa*	The Starry Campion Moth	RSGCN		Yes
Lepidoptera	*Lithophane franclemonti*	Franclemont's Lithophane	Proposed RSGCN		Yes
Lepidoptera	*Papilio joanae*	Ozark Swallowtail	RSGCN		Yes
Odonates	*Tachopteryx thoreyi*	Gray Petaltail	RSGCN	Yes	
Reptiles	*Sistrurus catenatus*	Eastern Massasauga	RSGCN	Yes	

HABITAT SYNTHESIS

For forests, the primary threats are timber harvest and development. Generally, development is more permanent; areas cleared for this purpose are not able to turn back to forest. Similar to grasslands, development can result in fragmentation, isolating patches from one another and reducing individual movement between sites. Some species, such as interior birds, need larger patches to buffer themselves from edge effects; other species may only occur in large, contiguous patches.

The taxa experts indicated that timber harvest is both a major threat and a valuable management tool for forested habitat. Forests can recover from timber harvest operations, provided the area is allowed to return to forest. Harvest is actually beneficial is some cases, allowing early successional forest patches to grow, a necessary habitat type for some RSGCN, such as Kirtland's Warbler. However, some operations can cause major ecological damage to the system, such as alteration of the local hydrology, loss of appropriate seed tree species, and

erosion. In these cases, the forest may not be able to return to its previous state, resulting in a very different forest community arising in its place.

Development and timber harvest can also open forest patches up to invasion by non-native species, another common threat identified by the taxa teams. This included woody plants, herbaceous plants, and insects. Many invasive plants outcompete native species, resulting in reduced regeneration and simplification of the native plant community. Insect pests target certain species, again reducing forest diversity.

Additional threats identified by the taxa teams included fire suppression and climate change. The effects of these two threats are the inverse of one another. Fire exclusion from certain forest types, such as jack pine and dry oak forests, can result in stands transitioning from fire-adapted species to more mesic species. Climate change may result in hotter and drier summers, which may result in some mesic forest stands transitioning to drier, fire-dependent species. Unfortunately, the two are unlikely to be happening in close to proximity to one another, so RSGCN species will be unable to respond to the changes by shifting to nearby sites.

SHRUBLANDS

DESCRIPTION

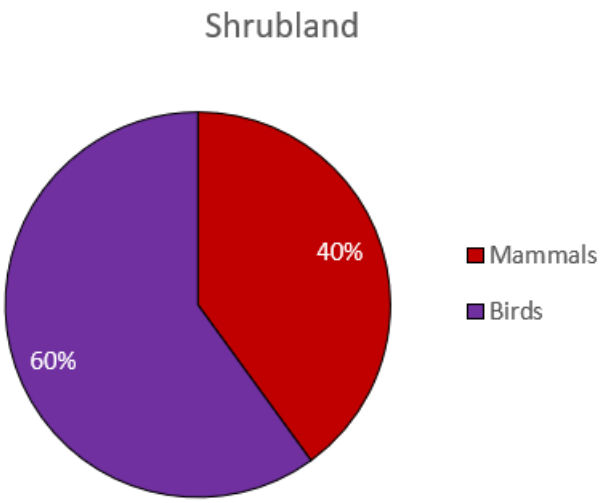
Shrublands are defined as areas where typically greater that 20% of the total vegetation is comprised of shrubs or shrub-like growth, woody plant species that are typically less than five meters in height. This can include true shrubs, early successional stages of certain tree species, or trees stunted by environmental conditions. Many shrublands have an herbaceous component comprised of grasses, sedges, forbs, and other species.

SPECIES OVERVIEW

Ten RSGCN species utilize shrubland habitats (Appendix N, Table N-2). This included six birds and four mammals (Figure 24). With the exception of the Golden-winged Warbler, none of these species are considered habitat specialists, nor are any of these species restricted to only shrubland habitats. This may indicate that shrublands act more as a transitional habitat type for the remaining nine species.

One Proposed RSGCN bee can also be found in shrublands, the Macropis Cuckoo Bee (Appendix N, Table N-2). This species is not a habitat specialist and can also be found in wetland and riparian areas.

Figure 24. Distribution of the different RSGCN taxa that utilize shrubland habitats.



HABITAT SYNTHESIS

Shrublands are often a temporary habitat, existing for a relatively short period of time. They will transition to forest over time, as tree species grow and form a canopy over the shorter shrubs. The closing of the overstory prevents sun from reaching the shrubby plants that require it, shifting the community entirely. Many shrubland habitats form in response to disturbance; suppressing forms of disturbance, such as fire, can prevent new patches from forming. Increasing fire frequency can also suppress shrubland formation; woody species tend to be excluded from fire-prone areas in preference of more fire-tolerant grasses and forbs.

Taxonomic experts indicated that human development also poses a significant threat to shrubland habitat. These changes are often permanent, forever removing the area's potential to become shrubland. The exception to this is agricultural lands; fields and pasture often transition back to shrubland, sometimes rapidly. Development can also result in fragmentation of this habitat. The juxtaposition of developed areas with shrublands carries additional risks; RSGCN species may be more vulnerable to predation in these areas (University of New Hampshire Cooperative Extension 2018).

GLADES, BARRENS, AND SAVANNAS

DESCRIPTION

Habitats in this category are characterized by having lower vegetation densities compared other habitats. They are often a mosaic of trees, shrubs, and herbaceous vegetation, with the herbaceous species dominant over the trees and shrubs.

Glades are open and rocky, often forming in areas with shallow soils and bedrock outcrops. Glades are dominated by drought-adapted wildflowers, warm-season grasses, mosses, and lichens. Few, if any, trees or shrubs occur in these landscapes. Periodic fire is needed to prevent incursion of woody species.

Savannas are grasslands interspersed with groups of trees and shrubs. The woody species represent less than 30% of the cover. Savannas are often the intermediate zone between grasslands and forests. These habitats also require periodic fires to prevent incursion of woody species. Numerous herbaceous species reach their maximum relative abundance in savannas, as opposed to prairies or forests, and are considered savanna indicators. Natural communities along the savanna gradient (e.g., oak opening to oak woodland) can have between 5 to 80% canopy cover.

Barrens are unique in that they are defined by having limited vegetation. Generally, barrens occur in areas with thin, low-nutrient soil. Vegetation is widely spaced and scrubby, and generally accounts for less than 15% of the total land cover but can have a wide range of tree cover. Barrens have unique plant species compositions that can be determined by the soil type and underlying geology, such as shale barrens, oak barrens, or calcareous barrens. Barrens plant communities may contain specific host plants for numerous insects.

SPECIES OVERVIEW

The Taxa Teams identified 36 species that utilize glade, barren, and savanna habitats (Appendix N, Table N-3). This group was dominated by the lepidopterans. The remaining glade, barren, and savanna species included bees and birds (Figure 25). A majority of these species (74%) are considered habitat specialists (Table 45), a high proportion is driven by the plant communities in these habitats. Many bees, butterflies, and moths are host-specific, requiring certain plant species be present. The lack of these plant hosts can exclude a species from a site, even if all other habitat conditions are suitable. Eight butterfly and four moth RSGCN species occur only in glade, barren, and savanna habitats (Table 45).

Six Proposed RSGCN are found in glades, barrens, and savannas, all insects (Appendix N, Table N-3). The taxa teams indicated that all of these species are habitat specialists, though they can

all also be found in grassland habitats (Table 44). Peckham's Miner Bee, Planed Miner Bee, and Dark-banded Flower Gem Moth require sandy substrates; the other three species are prairie obligates.

Figure 25. Distribution of the different RSGCN taxa that utilize glade, barren, or savanna habitats.

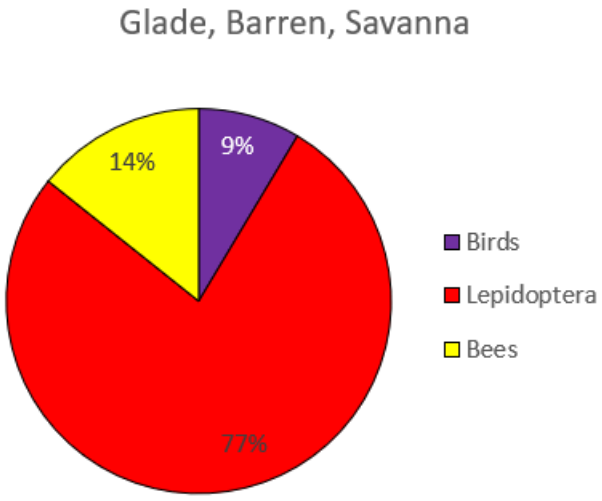


Table 45. Glade, barren, and savannah RSGCN and Proposed RSGCN that are habitat specialists or utilize only these areas.

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Glades etc.?
Bees	*Andrena beameri*	an andrenid bee	RSGCN	Yes	
Bees	*Andrena peckhami*	Peckham's Miner Bee	Proposed RSGCN	Yes	
Bees	*Andrena runcinatae*	Planed Miner Bee	Proposed RSGCN	Yes	
Bees	*Bombus pensylvanicus*	American Bumble Bee	RSGCN	Yes	
Bees	*Epeolus ainsliei*	Ainslie's Cuckoo Nomad Bee	RSGCN	Yes	
Bees	*Megachile ingenua*	a leafcutter bee	RSGCN	Yes	
Lepidoptera	*Acrocercops pnosmodiella*	Marbleseed Leafminer	Proposed RSGCN	Yes	

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Glades etc.?
Lepidoptera	*Acronicta dolli*	Doll's Dagger Moth	RSGCN	Yes	Yes
Lepidoptera	*Agonopterix pergandeella*	a grass miner moth	Proposed RSGCN	Yes	
Lepidoptera	*Ancylis semiovana*	a tortricid moth	RSGCN	Yes	Yes
Lepidoptera	*Apodrepanulatrix liberaria*	New Jersey Tea Inchworm	RSGCN	Yes	Yes
Lepidoptera	*Atrytonopsis hianna*	Dusted Skipper	RSGCN	Yes	
Lepidoptera	*Callophrys irus*	Frosted Elfin	RSGCN	Yes	Yes
Lepidoptera	*Catocala abbreviatella*	Abbreviated Underwing	RSGCN	Yes	
Lepidoptera	*Catocala whitneyi*	Whitney's Underwing	RSGCN	Yes	
Lepidoptera	*Erynnis martialis*	Mottled Duskywing	RSGCN	Yes	Yes
Lepidoptera	*Erynnis persius persius*	Persius Duskywing	RSGCN	Yes	Yes
Lepidoptera	*Hesperia leonardus*	Leonard's Skipper	RSGCN	Yes	
Lepidoptera	*Hesperia metea*	Cobweb Skipper	RSGCN	Yes	
Lepidoptera	*Hesperia ottoe*	Ottoe Skipper	RSGCN	Yes	
Lepidoptera	*Melaporphyria immortua*	Dark-banded Flower Gem Moth	Proposed RSGCN	Yes	
Lepidoptera	*Metarranthis apiciaria*	Barrens Metarranthis Moth	RSGCN	Yes	Yes
Lepidoptera	*Oeneis chryxus*	Chryxus Arctic	RSGCN	Yes	Yes
Lepidoptera	*Papaipema beeriana*	Blazing Star Stem Borer	RSGCN	Yes	
Lepidoptera	*Papaipema eryngii*	Rattlesnake-master Borer Moth	RSGCN	Yes	
Lepidoptera	*Papaipema sciata*	Culvers Root Borer	RSGCN	Yes	Yes
Lepidoptera	*Plebejus idas nabokovi*	Nabokov's Blue	RSGCN	Yes	Yes
Lepidoptera	*Plebejus samuelis*	Karner Blue	RSGCN	Yes	Yes
Lepidoptera	*Pyrausta pythialis*	a crambid snout moth	Proposed RSGCN	Yes	

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Glades etc.?
Lepidoptera	*Pyrgus centaureae Wyandot*	Appalachian Grizzled Skipper	RSGCN	Yes	Yes
Lepidoptera	*Schinia bina*	Bina Flower Moth	RSGCN	Yes	
Lepidoptera	*Schinia indiana*	Phlox Moth	RSGCN	Yes	

HABITAT SYNTHESIS

Fire suppression is the greatest threat to glade, barren, and savanna habitats. These communities contain unique plant communities adapted to frequent fires. Without fire or other forms of disturbance, they transition to other habitat types that are unsuitable for the RSGCN that utilize glades, barrens, and savannas. Taxa experts indicated that the primary reasons for the transition are the incursion of woody species and the introduction of invasive species that are otherwise excluded by fire.

Habitat loss is another threat to this species, due to development and conversion to agriculture. Natural occurrences of glades, barrens, and savannas have already disappeared from many areas; these habitats are very sensitive, making them particularly vulnerable to change. These habitats are becoming increasingly fragmented as well, which has implications to RSGCN movement and genetics.

GRASSLANDS

DESCRIPTION

Grasslands are areas dominated by grasses, sedges, and other herbaceous vegetation, usually in excess of 80% of the total land cover. In the Midwest, native prairies are included in this category. These ecosystems are fire-dependent. Fire prevention can result in woody species encroaching into the grassland habitats. Some grasslands may be used for grazing and related agricultural activities, but intensive management practices such as tilling are absent.

SPECIES OVERVIEW

Grasslands represent the most commonly utilized terrestrial habitat type with a total of 71 RSGCN species (Appendix N, Table N-4). Just over half of the species identified by the taxa teams as using grassland habitats are insect pollinators, including 26 butterflies and moths and

12 bees (Figure 26). The other RSGCN that use grasslands include 14 birds, 11 reptiles, six mammals, six fish, and two amphibians (Figure 26). More than half of these RSGCN species (55%) are considered habitat specialists (Table 46). This high level of specificity may indicate that grassland systems contain significant variation, providing many microhabitats that species can exploit. Seventeen RSGCN species occur only in grassland habitats (Table 46).

Nine Proposed RSGCN species are found in grassland habitats (Appendix N, Table N-4). Eight of them were identified as habitat specialists by the taxa teams (Table 46). The *Andrena* bees and Dark-banded Flower Gem Moth require sandy substrates. The Nude Yellow Loosestrife Bee is restricted by the range of its host, plants of the genus *Lysimachia*. The remaining four species are prairie specialists. Two species, the Black-and-gold Bumble Bee and Interrupted Cuckoo Nomad Bee, are restricted to grassland habitats. The Nude Yellow Loostrife Bee is also found in wetland habitats, while the remaining species are found in glades, barrens, and savannas.

Figure 26. Distribution of the different RSGCN taxa that utilize grassland habitats.

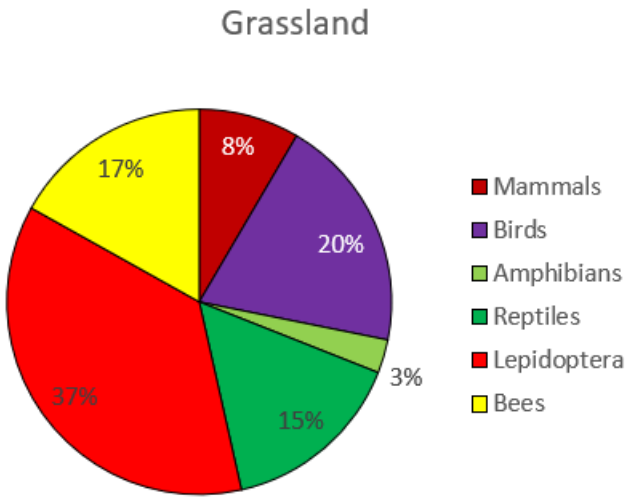


Table 46. Grassland RSGCN and Proposed RSGCN that are habitat specialists or utilize only grassland areas.

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist ?	Restricted to Grasslands ?
Amphibians	*Lithobates areolatus*	Crawfish Frog	RSGCN	Yes	
Amphibians	*Pseudacris illinoensis*	Illinois Chorus Frog	RSGCN	Yes	
Bees	*Andrena beameri*	an andrenid bee	RSGCN	Yes	
Bees	*Andrena peckhami*	Peckham's Miner Bee	Proposed RSGCN	Yes	
Bees	*Andrena runcinatae*	Planed Miner Bee	Proposed RSGCN	Yes	
Bees	*Bombus auricomus*	Black-and-gold Bumble Bee	Proposed RSGCN		Yes
Bees	*Bombus fraternus*	Southern Plains Bumble Bee	RSGCN	Yes	
Bees	*Bombus pensylvanicus*	American Bumble Bee	RSGCN	Yes	
Bees	*Epeolus ainsliei*	Ainslie's Cuckoo Nomad Bee	RSGCN	Yes	
Bees	*Epeolus interruptus*	Interrupted Cuckoo Nomad Bee	Proposed RSGCN	Yes	Yes
Bees	*Lasioglossum fedorense*	a sweat bee	RSGCN	Yes	Yes
Bees	*Macropis nuda*	Nude Yellow Loosestrife Bee	Proposed RSGCN	Yes	
Bees	*Macropis steironematis*	an oil-collecting bee	RSGCN	Yes	Yes
Bees	*Megachile ingenua*	a leafcutter bee	RSGCN	Yes	
Bees	*Osmia illinoensis*	a mason bee	RSGCN		Yes
Birds	*Tympanuchus cupido*	Greater Prairie-Chicken	RSGCN	Yes	
Lepidoptera	*Acrocercops pnosmodiella*	Marbleseed Leafminer	Proposed RSGCN	Yes	

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist ?	Restricted to Grasslands ?
Lepidoptera	*Agonopterix pergandeella*	a grass miner moth	Proposed RSGCN	Yes	
Lepidoptera	*Anacampsis wikeri*	Early Leadplant Leaf-twirler Moth	RSGCN	Yes	Yes
Lepidoptera	*Argynnis idalia*	Regal Fritillary	RSGCN	Yes	Yes
Lepidoptera	*Atrytone arogos*	Arogos Skipper	RSGCN	Yes	Yes
Lepidoptera	*Atrytonopsis hianna*	Dusted Skipper	RSGCN	Yes	
Lepidoptera	*Catocala abbreviatella*	Abbreviated Underwing	RSGCN	Yes	
Lepidoptera	*Catocala whitneyi*	Whitney's Underwing	RSGCN	Yes	
Lepidoptera	*Copablepharon michiganensis*	Michigan Dune Dart Moth	RSGCN	Yes	Yes
Lepidoptera	*Dichagyris reliqua*	a dart moth	RSGCN	Yes	Yes
Lepidoptera	*Eucosma bipunctella*	Two-spotted Eucosma	RSGCN	Yes	Yes
Lepidoptera	*Euxoa aurulenta*	Dune Cutworm Moth	RSGCN	Yes	Yes
Lepidoptera	*Hesperia dacotae*	Dakota Skipper	RSGCN	Yes	Yes
Lepidoptera	*Hesperia leonardus*	Leonard's Skipper	RSGCN	Yes	
Lepidoptera	*Hesperia metea*	Cobweb Skipper	RSGCN	Yes	
Lepidoptera	*Hesperia ottoe*	Ottoe Skipper	RSGCN	Yes	
Lepidoptera	*Melaporphyria immortua*	Dark-banded Flower Gem Moth	Proposed RSGCN	Yes	
Lepidoptera	*Oarisma poweshiek*	Poweshiek Skipperling	RSGCN	Yes	Yes
Lepidoptera	*Papaipema beeriana*	Blazing Star Stem Borer	RSGCN	Yes	
Lepidoptera	*Papaipema eryngii*	Rattlesnake-master Borer Moth	RSGCN	Yes	

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist ?	Restricted to Grasslands ?
Lepidoptera	*Papaipema sciata*	Culvers Root Borer	RSGCN	Yes	
Lepidoptera	*Papaipema silphii*	Silphium Borer Moth	RSGCN	Yes	Yes
Lepidoptera	*Pyla arenaeola*	a pyralid moth	RSGCN	Yes	Yes
Lepidoptera	*Pyrausta pythialis*	a crambid snout moth	Proposed RSGCN	Yes	
Lepidoptera	*Schinia bina*	Bina Flower Moth	RSGCN	Yes	
Lepidoptera	*Schinia indiana*	Phlox Moth	RSGCN	Yes	
Lepidoptera	*Sitochroa dasconalis*	Pearly Indigo Borer	RSGCN	Yes	Yes
Lepidoptera	*Tebenna silphiella*	Rosinweed Moth	RSGCN	Yes	Yes
Lepidoptera	*Tricholita notata*	Marked Noctuid	RSGCN	Yes	Yes
Reptiles	*Clonophis kirtlandii*	Kirtland's Snake	RSGCN	Yes	
Reptiles	*Emydoidea blandingii*	Blanding's Turtle	RSGCN	Yes	
Reptiles	*Kinosternon flavescens*	Yellow Mud Turtle (Illinois/Missouri/Iowa pop.)	RSGCN	Yes	
Reptiles	*Sistrurus catenatus*	Eastern Massasauga	RSGCN	Yes	

HABITAT SYNTHESIS

The primary threat identified by taxonomic experts to grassland habitat is exclusion of fire. Most grasslands need regular fire in order to prevent encroachment of woody plant species. Fire also removes buildup of dead tissue, adds nutrients back to the soil, and promotes new growth. Fire suppression contributes to another major threat: invasion of non-native species. The taxa teams identified *Meliotus sp.* as a particular concern, but many other plants, both woody and herbaceous, can proliferate in the absence of fire. Ultimately, lack of fire can result in simplification of grassland flora, resulting in habitat that is less biodiverse and less resilient to further changes.

Habitat loss is also a significant threat to grasslands. Much loss of grassland habitat was historic, occurring during the late 1800s and early 1900s, but loss continues today. Habitat loss is primarily due to conversion to agriculture, but development also has an impact in some areas. Regardless of which use the grassland is being converted for, the result is the destruction – often permanent – of that habitat patch.

Habitat conversion can also result in large, contiguous tracts of grassland being broken up into smaller, isolated patches. This fragmentation can sever important movement corridors, reduces or prevents genetic exchange, and can result in patches that are more sensitive to change and disturbance. Fragmentation can be especially detrimental that require interconnected or contiguous grassland habitat.

CAVES AND KARST

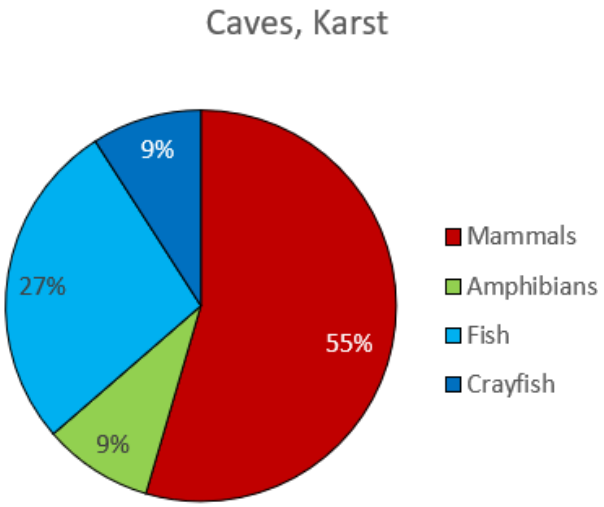
DESCRIPTION

Cave and karst habitats are both subterranean habitat types. Karst is a distinctive topography formed by a soluble bedrock, such as limestone, being slowly dissolved over time by the movement of water. This process can result in the formation of sinkholes, springs, and caves. Not all caves are associated with karst; a cave is any large, naturally-occurring cavity formed underground or in the face of a cliff or hillside.

SPECIES OVERVIEW

A total of 11 RSGCN species utilize cave habitats (Appendix N, Table N-5). Six of these species are bats, which use caves for roosting and hibernating. The remaining five RSGCN species include one amphibian, one crayfish, and three fish (Figure 27): Grotto Salamander, Caney Mountain Cave Crayfish, Hoosier Cavefish, Northern Cavefish, and Spring Cavefish (*Forbesichthys agassizii*). These five are all considered habitat specialists and are restricted to cave systems, though some may be flushed from caves by flooding and can thus sometimes be found in surface pools. No Proposed RSGCN utilize cave or karst habitats.

Figure 27. Distribution of the different RSGCN taxa that utilize cave and karst habitats.



HABITAT SYNTHESIS

Cave and karst systems are extremely delicate and sensitive. Taxa team members identified several threats to these habitats, primarily related to hydrology. Most caves and karsts are fed by groundwater. Draining nearby aquifers or other groundwater sources can reduce the amount of water entering the cave or karst system. Contamination in the water, such as pesticides, pipeline spills, or other sources of pollution can drastically alter the balance of these habitats. Influxes of nutrients, such as those coming from fertilizers or urban sources, can be detrimental as most caves are naturally nutrient poor. Tracing the source of contamination can be difficult, making remediation unlikely.

Cave and karst systems can also be inadvertently flooded by construction of dams and reservoirs nearby. This has obvious implications for terrestrial species, such as cave insects, millipedes, and bats, but aquatic species are also impacted; exclusion of the terrestrial species reduces the availability of important food resources.

Disturbance is the other major threat associated with cave and karst ecosystems. Humans can have a direct impact on the species that use caves, such as spreading WNS, collecting rare species, or trampling, but they also can cause alterations to the habitat itself; depending on how frequently the cave is visited, human visitors can cause the temperature and humidity to change (Isaia et al. 2011).Vandalism may be a problem in some caves, and the oils, microbes, and other materials humans carry with them can be harmful as well.

SOIL

DESCRIPTION

This habitat type is unique in that it can occur in conjunction with any other habitat type. Its primary identifying characteristic is that it encompasses any subterranean habitat formed entirely in mineral soil. This differentiates it from caves and karst, where the bedrock provides structure. Another key difference is scale; soil habitats are excavated by fossorial species, rather than geological processes. Thus, they tend to be rather small, and may not last very long before erosion and soil settling fill them back in.

Many species may utilize underground burrows for an assortment of purposes, including resting, rearing young, and caching food resources. These species may excavate the burrow themselves, exclude another species from its burrow, or utilize abandoned burrows. For our purposes, a species was only designated as using soil habitat if it spends a majority of its time in subterranean spaces that it excavates for itself.

SPECIES OVERVIEW

The taxa teams identified only three RSGCN species that burrow and utilize subterranean habitats (Appendix N, Table N-6). All three were mammals – Franklin's Ground Squirrel and the Northern and Cheyenne Pocket Gophers. These species are considered habitat generalists, tolerant of a range of conditions so long as conditions are suitable for burrowing. None of the RSGCN identified are restricted to subterranean soil habitats.

One Proposed RSGCN crayfish, Dusky Mudbug, is a habitat specialist that requires spring-fed groundwater seeps (Appendix N, Table N-6). It is not restricted to soil habitats.

HABITAT SYNTHESIS

The taxa teams described very few species as using this habitat. It may be worth reviewing certain key groups, such as ground-dwelling rodents, digger bees, and burrowing crayfish, to ensure no species were missed. These fossorial species are an important part of the ecosystem. Their activities disturb the soil layers, transport minerals to the surface, aerate the soil, and assist with decomposition, a process referred to as bioturbation.

Due to the variable nature of soil habitats, the taxa team did not identify any common threats that affect these areas. Development is likely to detrimentally impact soil habitat; transition to impervious surfaces, compaction, and substrate removal would all make the subsurface soil habitat inhospitable. Some agricultural practices may also have negative impacts. Tilling would disturb soil horizons and likely destroy any burrows or tunnels close to the surface. Irrigation

could change the qualities of the soil, making it less suitable for burrowing, or could flood tunnels.

TRANSITIONAL HABITATS

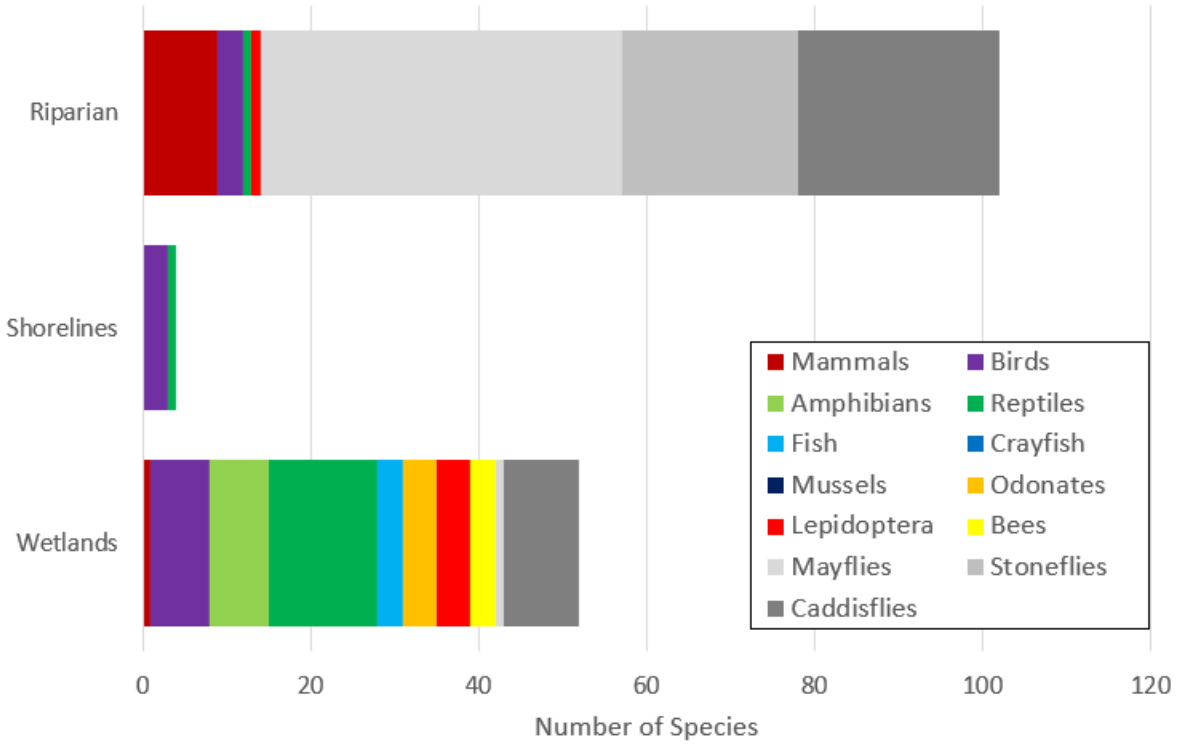
Transitional habitats exist at the interface between terrestrial and aquatic systems. They can vary based on vegetation, like terrestrial systems, and are heavily influenced by water, like aquatic systems. Transitional habitats are usually not inundated with water but are prone to frequent fluctuations and flooding. The defining characteristics for transitional habitat are related to how frequently the area is flooded and the amount of vegetation present in the system.

The taxonomic groups absent from transitional habitat are crayfishes and freshwater mussels (Table 47). Wetlands appear to be the most diverse with ten different taxonomic groups present, reflecting the high productivity of these systems (Figure 28; Cherry 2011). Reptiles are the most common taxon, representing 25% of the total RSGCN diversity, though caddisflies come close to that. Shoreline areas are fairly sparse in terms of diversity, representing only four RSGCN, the majority of which are birds. Riparian areas are dominated by mayflies, though caddisflies and stoneflies are also significant components of this habitat type.

Table 47. Number of RSGCN from each taxonomic group occurring in each transitional habitat type.

	Riparian	Shoreline	Wetlands
Mammals	9	0	1
Birds	3	3	7
Amphibians	0	0	7
Reptiles	1	1	13
Fishes	0	0	3
Odonates	0	0	4
Lepidoptera	1	0	4
Bees	0	0	3
Mayflies	43	0	1
Stoneflies	21	0	0
Caddisflies	24	0	9
Total	**102**	**4**	**52**

Figure 28. Number of RSGCN occurring in each transitional habitat type.



RIPARIAN

DESCRIPTION

Riparian areas describe a narrow zone of habitats directly associated with streams, rivers, ponds, lakes, and other aquatic habitats. They may be vegetated but are not required to be. Though generally set back from the water itself, these habitats are still frequently influenced by events such as flooding.

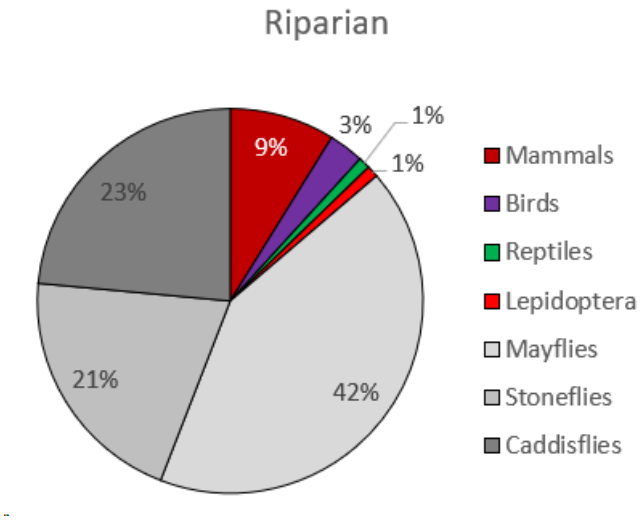
SPECIES OVERVIEW

The taxa teams identified 102 RSGCN species that utilize riparian habitats (Appendix N, Table N-7). This number is driven in particular by benthic macroinvertebrates; 43 mayflies, 24 caddisflies, and 21 stoneflies (Figure 29). Other taxa that utilize riparian habitats include mammals (9 RSGCN), birds (3), butterflies and moths (1), and reptiles (1). Despite the extensive length of this list, the taxa teams identified only one species, Linda's Roadside Skipper, as a

habitat specialist. However, EPTs did not have habitat specificity assigned and likely some should be considered specialists. No RSGCN species are restricted to riparian areas.

The taxa teams identified an additional 120 Proposed RSGCN that use riparian areas (Appendix N, Table N-7). This list is primarily caddisflies, mayflies, and stoneflies, with the addition of two bees. Only one species, the Yellow Loosestrife Bee, is considered a habitat specialist, restricted to sites where its host, plants of the genus *Lysimachia*, can be found. No Proposed RSGCN species are restricted to riparian areas.

Figure 29. Distribution of the different RSGCN taxa that utilize riparian habitats.



HABITAT SYNTHESIS

This habitat type was not fully evaluated for all taxonomic groups. In fact, riparian habitat is dominated by mayflies, stoneflies, and caddisflies because these species were batch-assigned to this habitat, rather than evaluated individually. As a result, some species, such as the seep specialists, may have been assigned to riparian habitat, but the terrestrial habitat they use may not match the definition of riparian used above. It may also be valuable to revisit the habitat associations for certain other key taxonomic groups, such as the odonatans, to ensure all riparian-associated species were appropriately labeled.

The greatest threat to riparian areas identified by the taxa team is climate-change driven changes to hydrological cycles. Though riparian areas are adapted to regular flooding, increases to the intensity or frequency of such events may be detrimental. These floods could cause scour, remove necessary bank material, or could lead to the exclusion of certain less tolerant

riparian flora. The inverse is also true; fewer floods leaves banks more stable, allowing less flood-tolerant species to encroach, potentially outcompeting riparian plants.

Installation of dams may also contribute to changes in the local hydrology. Areas immediately upstream of a dam would become inundated, completely submerging riparian habitat. Below the dam, flooding would become dependent on dam releases rather than natural events, which could result in changes to either frequency or intensity of flooding events. This would have similar results to climate change.

Invasive species are also a major concern in most riparian areas. Material from invasive plants is easily carried downstream, where it can settle and establish in areas recently impacted by floods. The disturbance-driven nature of riparian habitat makes it highly susceptible to these plant invaders (Poff et al. 2011).

SHORELINES

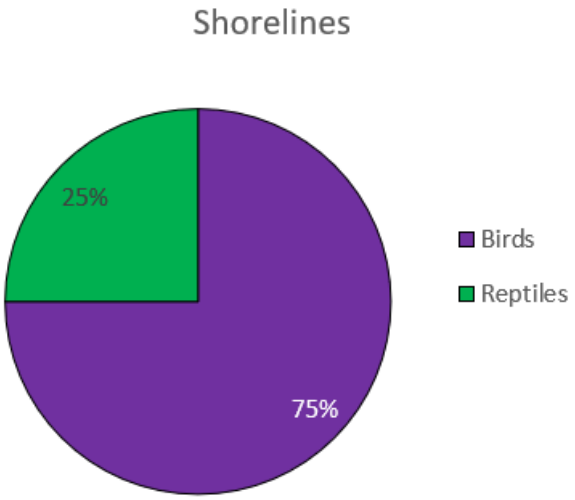
DESCRIPTION

Similar to riparian habitats, shorelines describe a narrow zone directly associated with aquatic habitats, both lacustrine and riverine. Shorelines are generally not vegetated, and are dominated by outwashes of sand, gravel, and stone. These habitats are directly adjacent to the water, and in some cases, such as sand and gravel bars, are completely surrounded by water. This leaves them susceptible to more frequent flooding and other fluctuations than riparian habitats.

SPECIES OVERVIEW

A total of four RSGCN species utilize shoreline habitats (Appendix N, Table N-8). This includes the Lake Erie Watersnake, Interior Least Tern, and the Northern Great Plains and Great Lakes populations of Piping Plover (Figure 30). The three bird RSGCN are considered habitat specialists, needing sparsely-vegetated sandy areas for nesting. None of these species are restricted to shoreline areas. The taxa teams did not identify any Proposed RSGCN that use shoreline habitat.

Figure 30. Distribution of the different RSGCN taxa that utilize shoreline habitats.



HABITAT SYNTHESIS

As was the case for riparian habitats, shoreline use was not fully evaluated for all taxonomic groups. It may be valuable to review the aquatic insects to ensure species associated with shoreline are properly assigned.

The threat to shoreline habitat most frequently mentioned by the taxa teams was development. The popularity of lakefront properties puts incredible pressure on shorelines; the taxonomic experts indicated this is especially true on the Great Lakes.

Increased development is also frequently accompanied by increased recreational activity in these areas. Increased numbers of boats in the water can create waves that erode the shoreline, while individuals walking on the sand could disturb sensitive plant communities. Again, this could be especially true in shoreline dunes on the Great Lakes.

Climate change is also likely to impact shoreline habitat. Changing water levels will affect the plants that grow in these sandy, water-stressed systems. Increased storm and flood severity will contribute to increased flooding and erosion.

WETLANDS

DESCRIPTION

Wetlands encompass a number of habitats and natural communities where the soils are saturated by surface or groundwater. Soil type, water chemistry, and water source can vary widely, resulting in a number of different wetland types. Examples include marshes, swamps, fens, bogs, seeps and springs, and ephemeral pools. Water levels can fluctuate seasonally, at times flooding the surface and at others just saturating the soil. As the soils are saturated, they contain very little oxygen, contributing to unique plant communities.

SPECIES OVERVIEW

A total of 52 RSGCN species utilize wetland habitats (Appendix N, Table N-9). This includes 13 reptiles, nine caddisflies, seven amphibians, seven birds, four lepidopterans, four odonatans, three bees, three fish, one mammal, and one mayfly (Figure 31). Twenty-three of these RSGCN species were identified as habitat specialists (Table 48). Eight wetland RSGCN species occur only in these habitats (Table 48).

Fifteen Proposed RSGCN make use of wetland habitats; 60% of them are caddisflies (Appendix N, Table N-9). Three species were identified as habitat specialists by the taxonomic experts (Table 48); Yellow Loosestrife Bee, Nude Yellow Loostrife Bee, and Mitchell's Satyr. The two *Macropis* bees are associated with their host plants, the genus *Lysimachia*. Mitchell's Satyr is obligate to prairie fens and sedge wetlands. Mitchell's Satyr is the only Proposed RSGCN restricted to wetland habitats.

Figure 31. Distribution of the different RSGCN taxa that utilize wetland habitats.

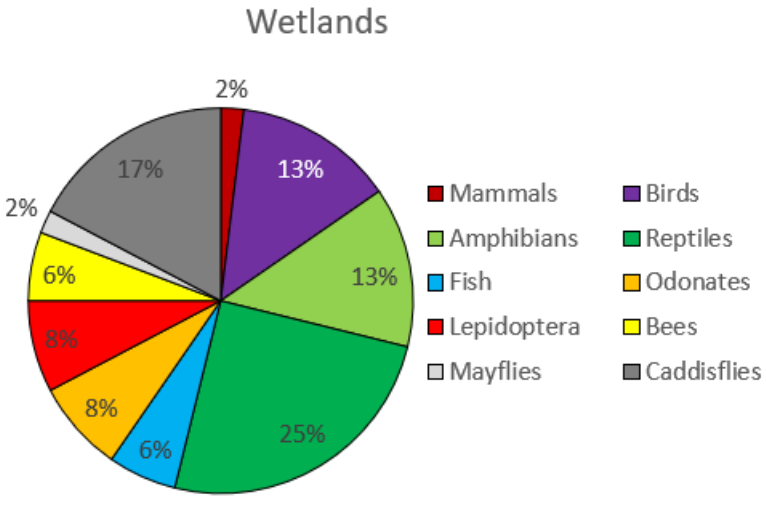


Table 48. Wetland RSGCN and Proposed RSGCN that are habitat specialists or utilize only wetland areas.

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Wetlands?
Amphibians	*Ambystoma laterale*	Blue-spotted Salamander	RSGCN	Yes	
Amphibians	*Ambystoma sp.*	Unisexual Ambystoma Complex	RSGCN	Yes	
Amphibians	*Hemidactylium scutatum*	Four-toed Salamander	RSGCN	Yes	
Amphibians	*Lithobates areolatus*	Crawfish Frog	RSGCN	Yes	
Amphibians	*Pseudacris illinoensis*	Illinois Chorus Frog	RSGCN	Yes	
Bees	*Andrena beameri*	an andrenid bee	RSGCN	Yes	
Bees	*Macropis ciliata*	Yellow Loosestrife Bee	Proposed RSGCN	Yes	
Bees	*Macropis nuda*	Nude Yellow Loosestrife Bee	Proposed RSGCN	Yes	
Birds	*Ammospiza nelsoni*	Nelson's Sparrow	RSGCN		Yes
Birds	*Coturnicops noveboracensis*	Yellow Rail	RSGCN		Yes
Lepidoptera	*Calephelis muticum*	Swamp Metalmark	RSGCN		Yes
Lepidoptera	*Euphyes bimacula*	Two-spotted Skipper	RSGCN		Yes
Lepidoptera	*Neonympha mitchellii*	Mitchell's Satyr	Proposed RSGCN		Yes
Lepidoptera	*Papaipema aweme*	Aweme Borer Moth	RSGCN		Yes
Crayfishes	*Cambarus adustus*	Dusky Mudbug	Proposed RSGCN	Yes	
Odonates	*Nannothemis bella*	Elfin Skimmer	RSGCN		Yes
Odonates	*Somatochlora brevicincta*	Quebec Emerald	RSGCN		Yes

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Wetlands?
Odonates	*Somatochlora hineana*	Hine's Emerald	RSGCN		Yes
Odonates	*Tachopteryx thoreyi*	Gray Petaltail	RSGCN	Yes	
Fishes	*Chrosomus neogaeus*	Finescale Dace	RSGCN	Yes	
Fishes	*Fundulus sciadicus*	Plains Topminnow	RSGCN	Yes	
Reptiles	*Clonophis kirtlandii*	Kirtland's Snake	RSGCN	Yes	
Reptiles	*Emydoidea blandingii*	Blanding's Turtle	RSGCN	Yes	
Reptiles	*Kinosternon flavescens*	Yellow Mud Turtle (IL/MO/IA pop.)	RSGCN	Yes	
Reptiles	*Nerodia erythrogaster neglecta*	Plain-bellied Watersnake (Copperbelly pop.)	RSGCN	Yes	
Reptiles	*Sistrurus catenatus*	Eastern Massasauga	RSGCN	Yes	

HABITAT SYNTHESIS

The taxa teams identified loss and degradation as a result of human activity as the greatest threats to wetland habitat in the Midwest. Loss is driven primarily by conversion to agricultural uses, such as row crops or pasture, and development. Degradation is often driven by alterations to the local hydrological cycles. Channelization, ditching, and reservoir construction can all change the frequency, intensity, and timing of wetland inundation, upsetting the balance in these ecosystems. Changes in inundation cycles can result in erosion and deposition of excess sediment, slowly wearing away and burying previously productive wetland habitat. Decreases to flood and other disturbance allows non-wetland species to encroach, slowly changing the wetland to a different habitat type. Climate change may further contribute to changes in the hydrological system, altering water availability and temperatures. Peatlands, in particular, will likely be sensitive to climate change according to the taxonomic experts.

Pollution is another source of degradation in wetland habitats. Agricultural runoff was most frequently cited by the experts, but mining waste, logging effluents, and urban sewage were

also mentioned. As many wetlands are groundwater-fed, contamination can easily spread from the source of pollution.

Invasive species are also a threat to many wetlands. *Phragmites*, purple loosestrife, hybrid cattail, and other invasives can significantly change the structure and composition of the floral community, which in turn changes the structure and composition of the entire wetland community.

AQUATIC HABITATS

Aquatic habitats are those where the presence of water is constant. While water levels may certainly rise and ebb in response to weather events such as rainfall, aquatic habitats are generally continuously inundated. Water has insulative properties, so aquatic systems tend to be more stable than terrestrial ones, exhibiting less-extreme shifts in temperature over time. Key characteristics for defining the four aquatic habitats are related to waterbody size and whether it is a lacustrine system with still water or a riverine system with moving water.

Aquatic RSGCN are immersed in and confined by their habitats in ways that terrestrial species are not. As these species are surrounded by water, they are generally very sensitive to changes in the environment around them. While some aquatic species are more tolerant of variation, many have specific requirements related to water temperature, oxygen content, clarity, flow speed, and substrate type. If conditions shift away from the suitable range for a species, that habitat is no longer suitable. Aquatic species are also more restricted in their ability to move than terrestrial species are. While a bird can theoretically fly from one forest patch to another regardless of the intervening landscape matrix, aquatic species are limited in that they can usually only travel between sites that are directly connected to one another.

The taxonomic groups absent from aquatic habitats are bees, butterflies and moths, and mammals. All of the aquatic habitat types are diverse, supporting several different taxonomic groups. The Great Lakes are least diverse, with only five taxonomic groups, while rivers and streams are the most diverse with nine (Table 49, Figure 32). Fishes and freshwater mussels are the most common taxa found in all four aquatic habitats. Most of the other taxa are absent from one of the aquatic habitat types, with a few exceptions. Mayflies are only found in riverine systems, crayfish are not found in the largest water bodies, and birds are only found in big rivers.

Figure 32. Number of RSGCN occurring in each aquatic habitat type.

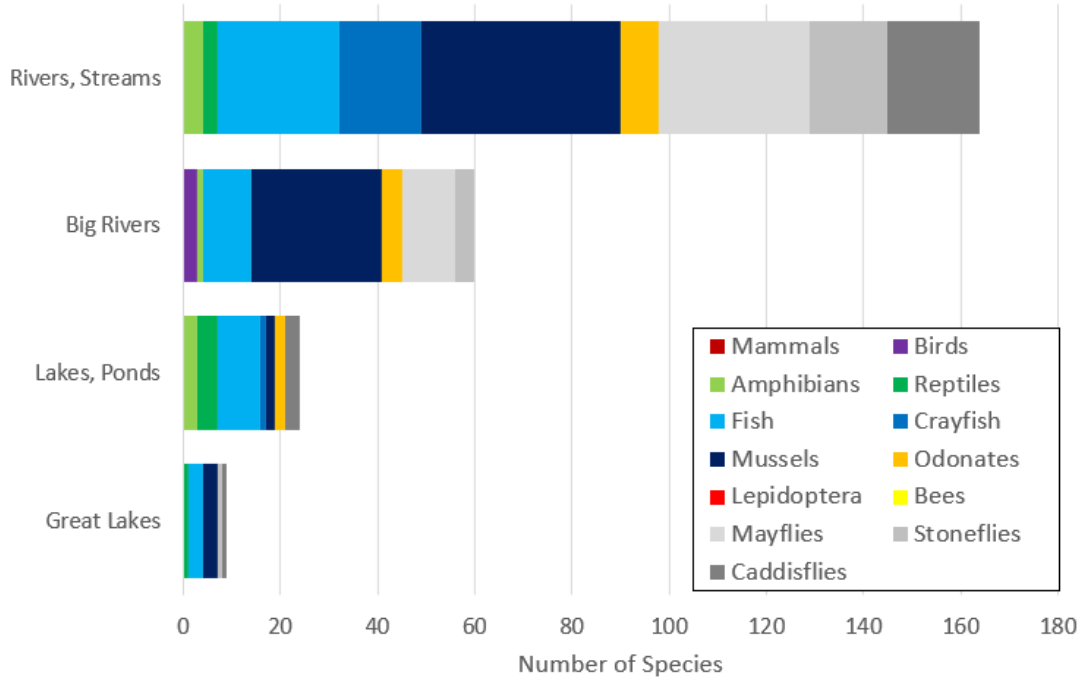


Table 49. Number of RSGCN from each taxonomic group occurring in each aquatic habitat type.

Taxa	Rivers and Streams	Big Rivers	Lakes and Ponds	Great Lakes
Birds	0	3	0	0
Amphibians	4	1	3	0
Reptiles	3	0	4	1
Fishes	25	10	9	3
Crayfishes	17	0	1	0
Freshwater Mussels	41	28	2	3
Odonates	8	4	2	0
Mayflies	31	11	0	0
Stoneflies	16	4	0	1
Caddisflies	19	0	4	1
Total	**164**	**61**	**25**	**9**

RIVERS AND STREAMS

DESCRIPTION

Rivers and streams encompass the majority of riverine habitats. They are characterized as channelized, linear bodies of moving water. These habitats often intersperse slower moving pools with faster riffles and runs. Rivers and streams vary greatly in size, sinuosity, gradient, flow speed, turbidity, nutrient content, substrate type, and many other factors. Flow often varies seasonally, with spring generally being the wettest season; some smaller streams may be ephemeral, drying up entirely during the summer months.

SPECIES OVERVIEW

A total of 164 RSGCN species use river and stream habitats (Appendix N, Table N-10). This is the most commonly utilized habitat in all four of the groups, likely reflecting the high amount of variability in river and stream morphology. Freshwater mussels are the most common taxa with 41 species, followed by 31 mayflies, 25 fishes, 19 caddisflies, 17 crayfishes, 16 stoneflies, eight odonates, four amphibians, and three reptiles (Figure 33). Thirty-three of these RSGCN are considered habitat specialists (Table 50). Nearly one-third of the RSGCN species (53 of 164) occur only in river and stream habitats (Table 50).

Taxa teams identified 114 Proposed RSGCN that also utilize these habitats; 93% of these were caddisflies, mayflies, and stoneflies (Appendix N, Table N-10). Four species were identified as habitat specialists; Cutshin Crayfish, Brawny Crayfish, Ozark Clubtail, and Acuminate Snaketail. The two crayfish species require boulder and slab-rock; these features are the first impacted by sedimentation and pollution. The dragonflies have precise requirements related to water clarity and substrate. Seven of the Proposed RSGCN species are restricted to river and stream habitats (Table 50).

Figure 33. Distribution of the different RSGCN taxa that utilize riverine habitats.

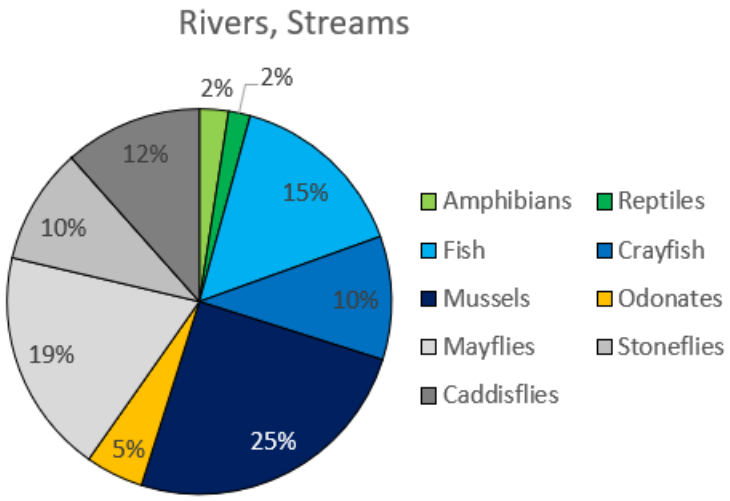


Table 50. River and stream RSGCN and Proposed RSGCN that are habitat specialists or utilize only riverine areas.

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Rivers and Streams?
Amphibians	*Cryptobranchus alleganiensis alleganiensis*	Eastern Hellbender	RSGCN	Yes	Yes
Amphibians	*Cryptobranchus alleganiensis bishopi*	Ozark Hellbender	RSGCN	Yes	Yes
Crayfishes	*Barbicambarus cornutus*	Bottlebrush Crayfish	RSGCN		Yes
Crayfishes	*Cambarus callainus*	Big Sandy Crayfish	Proposed RSGCN		Yes
Crayfishes	*Cambarus hazardi*	Brawny Crayfish	Proposed RSGCN	Yes	Yes
Crayfishes	*Cambarus maculatus*	Freckled Crayfish	RSGCN	Yes	Yes
Crayfishes	*Cambarus taylori*	Cutshin Crayfish	Proposed RSGCN	Yes	Yes
Crayfishes	*Faxonius bisectus*	Crittenden Crayfish	RSGCN		Yes
Crayfishes	*Faxonius burri*	Blood River Crayfish	RSGCN		Yes
Crayfishes	*Faxonius eupunctus*	Coldwater Crayfish	RSGCN	Yes	Yes

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Rivers and Streams?
Crayfishes	*Faxonius indianensis*	Indiana Crayfish	RSGCN	Yes	Yes
Crayfishes	*Faxonius kentuckiensis*	Kentucky Crayfish	RSGCN		Yes
Crayfishes	*Faxonius marchandi*	Mammoth Spring Crayfish	RSGCN		Yes
Crayfishes	*Faxonius margorectus*	Livingston Crayfish	RSGCN		Yes
Crayfishes	*Faxonius meeki meeki*	Meek's Crayfish	RSGCN		Yes
Crayfishes	*Faxonius neglectus chaenodactylus*	Gap Ringed Crayfish	Proposed RSGCN		Yes
Crayfishes	*Faxonius obscurus*	Allegheny Crayfish	Proposed RSGCN		Yes
Crayfishes	*Faxonius peruncus*	Big Creek Crayfish	RSGCN		Yes
Crayfishes	*Faxonius quadruncus*	St. Francis River Crayfish	RSGCN		Yes
Crayfishes	*Faxonius stannardi*	Little Wabash Crayfish	RSGCN		Yes
Crayfishes	*Faxonius williamsi*	Williams' Crayfish	RSGCN		Yes
Odonates	*Gomphurus ozarkensis*	Ozark Clubtail	Proposed RSGCN	Yes	
Odonates	*Hylogomphus viridifrons*	Green-faced Clubtail	RSGCN		Yes
Odonates	*Ophiogomphus acuminatus*	Acuminate Snaketail	Proposed RSGCN	Yes	Yes
Odonates	*Ophiogomphus howei*	Pygmy Snaketail	RSGCN	Yes	Yes
Odonates	*Ophiogomphus smithi*	Sioux Snaketail	RSGCN	Yes	Yes
Odonates	*Somatochlora ensigera*	Plains Emerald	RSGCN		Yes
Odonates	*Somatochlora ozarkensis*	Ozark Emerald	RSGCN	Yes	Yes
Fishes	*Ammocrypta clara*	Western Sand Darter	RSGCN	Yes	
Fishes	*Chrosomus cumberlandensis*	Blackside Dace	RSGCN		Yes

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Rivers and Streams?
Fishes	*Chrosomus neogaeus*	Finescale Dace	RSGCN	Yes	
Fishes	*Clinostomus elongatus*	Redside Dace	RSGCN	Yes	Yes
Fishes	*Etheostoma chienense*	Relict Darter	RSGCN		Yes
Fishes	*Etheostoma lemniscatum*	Tuxedo Darter	RSGCN	Yes	Yes
Fishes	*Etheostoma maculatum*	Spotted Darter	RSGCN		Yes
Fishes	*Etheostoma tecumsehi*	Shawnee Darter	RSGCN		Yes
Fishes	*Exoglossum laurae*	Tonguetied Minnow	Proposed RSGCN		Yes
Fishes	*Fundulus sciadicus*	Plains Topminnow	RSGCN	Yes	
Fishes	*Macrhybopsis tetranema*	Peppered Chub	RSGCN		Yes
Fishes	*Notropis anogenus*	Pugnose Shiner	RSGCN	Yes	
Fishes	*Notropis ariommus*	Popeye Shiner	RSGCN		Yes
Fishes	*Notropis heterolepis*	Blacknose Shiner	RSGCN	Yes	
Fishes	*Noturus placidus*	Neosho Madtom	RSGCN		Yes
Fishes	*Noturus stigmosus*	Northern Madtom	RSGCN		Yes
Fishes	*Percina macrocephala*	Longhead Darter	RSGCN		Yes
Fishes	*Pimephales tenellus parviceps*	Eastern Slim Minnow	RSGCN	Yes	Yes
Fishes	*Thoburnia atripinnis*	Blackfin Sucker	RSGCN		Yes
Freshwater Mussels	*Alasmidonta atropurpurea*	Cumberland Elktoe	RSGCN		Yes
Freshwater Mussels	*Anodontoides denigrata*	Cumberland Papershell	RSGCN	Yes	Yes
Freshwater Mussels	*Elliptio crassidens*	Elephantear	RSGCN		Yes
Freshwater Mussels	*Epioblasma curtisii*	Curtis Pearlymussel	RSGCN	Yes	Yes
Freshwater Mussels	*Epioblasma perobliqua*	White Catspaw	RSGCN	Yes	Yes

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Rivers and Streams?
Freshwater Mussels	*Epioblasma rangiana*	Northern Riffleshell	RSGCN		Yes
Freshwater Mussels	*Epioblasma triquetra*	Snuffbox	RSGCN		Yes
Freshwater Mussels	*Epioblasma walkeri*	Tan Riffleshell	RSGCN	Yes	Yes
Freshwater Mussels	*Hemistena lata*	Cracking Pearlymussel	RSGCN		Yes
Freshwater Mussels	*Lampsilis rafinesqueana*	Neosho Mucket	RSGCN		Yes
Freshwater Mussels	*Lampsilis teres*	Yellow Sandshell	RSGCN		Yes
Freshwater Mussels	*Lasmigona compressa*	Creek Heelsplitter	RSGCN		Yes
Freshwater Mussels	*Obovaria retusa*	Ring Pink	RSGCN	Yes	
Freshwater Mussels	*Pegias fabula*	Littlewing Pearlymussel	RSGCN	Yes	Yes
Freshwater Mussels	*Pleurobema clava*	Clubshell	RSGCN		Yes
Freshwater Mussels	*Pleurobema plenum*	Rough Pigtoe	RSGCN	Yes	
Freshwater Mussels	*Ptychobranchus subtentus*	Fluted Kidneyshell	RSGCN	Yes	Yes
Freshwater Mussels	*Quadrula fragosa*	Winged Mapleleaf	RSGCN	Yes	
Freshwater Mussels	*Simpsonaias ambigua*	Salamander Mussel	RSGCN	Yes	
Freshwater Mussels	*Theliderma cylindrica*	Rabbitsfoot	RSGCN	Yes	
Freshwater Mussels	*Toxolasma lividum*	Purple Lilliput	RSGCN	Yes	Yes
Freshwater Mussels	*Venustaconcha ellipsiformis*	Ellipse	RSGCN	Yes	

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?	Restricted to Rivers and Streams?
Freshwater Mussels	*Venustaconcha troostensis*	Cumberland Bean	RSGCN	Yes	Yes
Freshwater Mussels	*Villosa lienosa*	Little Spectaclecase	RSGCN		Yes
Freshwater Mussels	*Villosa ortmanni*	Kentucky Creekshell	RSGCN	Yes	Yes
Reptiles	*Nerodia erythrogaster neglecta*	Plain-bellied Watersnake (Copperbelly pop.)	RSGCN	Yes	

HABITAT SYNTHESIS

Undeniably, the greatest threat to river and stream habitats is the construction of dams and impoundments. These features completely alter flow regimes, change riverine habitat into lacustrine, and fragment rivers and streams into multiple sections. According to the taxa team members, this changes the function of entire rivers and streams and can make them unsuitable for many species that exist in metapopulations along the waterway.

Pollution is another major concern in riverine systems. The taxa teams identified a number of pollution sources, including agricultural runoff, industrial waste, sewage, chemical spills, and mining effluents. These can all have dramatic effects on water quality. Sedimentation, especially from agricultural runoff, is also detrimental, changing the water clarity and substrate composition of the stream or riverbed.

The final major threat the taxa teams identified is climate change. Increased droughts as a result of climate change could exacerbate habitat fragmentation and isolation and may raise water temperatures above acceptable levels. Warmer waters are also not able to hold on to as much dissolved oxygen, completely change the nature of the river or stream. Extreme weather events could also be of concern, causing scouring of the riverbed and deposition of large amounts of sediment.

BIG RIVERS

DESCRIPTION

Some rivers are so large that they function significantly differently than other riverine habitats, supporting a unique faunal community that is not found in smaller bodies of water. Big rivers are influenced more by the rainfall and runoff of the local area than by other local conditions. Flow tends to be swift and constant throughout the year, with less seasonal fluctuations than are observed in smaller rivers and streams. Big rivers tend to be more turbid, as the faster flows can keep sediments suspended in the water column longer. As a result, channel bottoms tend to shift frequently as sand, gravel, and silt is moved and deposited. In the Midwest, the Missouri and Mississippi Rivers are considered Big Rivers, while other riverine habitat is grouped into Rivers and Streams.

SPECIES OVERVIEW

The taxa teams identified 60 RSGCN that utilize big river habitats (Appendix N, Table N-11). This includes 28 freshwater mussels, 11 mayflies, ten fish, four stoneflies, four dragonflies and damselflies, three birds, and one amphibian (Figure 34). Eleven of these RSGCN are considered habitat specialists (Table 51). Four big river RSGCN species occur only in this habitat type, all freshwater mussels: Spectaclecase (*Cumberlandia monodonta*), Higgins Eye, White Wartyback (*Plethobasus cicatricosus*), and Ebonyshell (*Reginaia ebenus*).

The taxa teams identified ten Proposed RSGCN that can be found in big rivers (Appendix N, Table N-11). Only two, the Ozark Clubtail and Catspaw, are considered habitat specialists. Two species are restricted to big rivers: Leopard Crayfish and Catspaw.

Figure 34. Distribution of the different RSGCN taxa that utilize big river habitats.

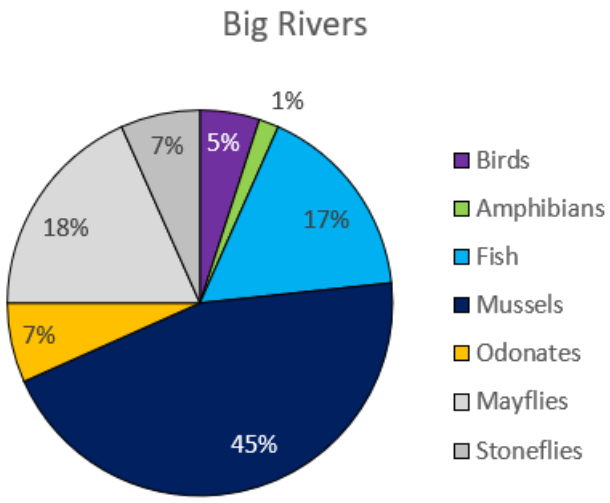


Table 51. Big RIver RSGCN and Proposed RSGCN that are habitat specialists or utilize only these areas.

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist ?	Restricted to Big Rivers?
Birds	*Charadrius melodus*	Piping Plover (Great Lakes pop.)	RSGCN	Yes	
Birds	*Charadrius melodus*	Piping Plover (Northern Great Plains pop.)	RSGCN	Yes	
Birds	*Sternula antillarum athalassos*	Interior Least Tern	RSGCN	Yes	
Crayfishes	*Faxonius pardalotus*	Leopard Crayfish	Proposed RSGCN		Yes
Odonates	*Gomphurus ozarkensis*	Ozark Clubtail	Proposed RSGCN	Yes	
Fishes	*Ammocrypta clara*	Western Sand Darter	RSGCN	Yes	
Freshwater Mussels	*Cumberlandia monodonta*	Spectaclecase	RSGCN	Yes	Yes
Freshwater Mussels	*Epioblasma obliquata*	Catspaw	Proposed RSGCN	Yes	Yes
Freshwater Mussels	*Lampsilis higginsii*	Higgins Eye	RSGCN		Yes

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist ?	Restricted to Big Rivers?
Freshwater Mussels	*Obovaria retusa*	Ring Pink	RSGCN	Yes	
Freshwater Mussels	*Plethobasus cicatricosus*	White Wartyback	RSGCN	Yes	Yes
Freshwater Mussels	*Pleurobema plenum*	Rough Pigtoe	RSGCN	Yes	
Freshwater Mussels	*Quadrula fragosa*	Winged Mapleleaf	RSGCN	Yes	
Freshwater Mussels	*Reginaia ebenus*	Ebonyshell	RSGCN		Yes
Freshwater Mussels	*Simpsonaias ambigua*	Salamander Mussel	RSGCN	Yes	
Freshwater Mussels	*Theliderma cylindrica*	Rabbitsfoot	RSGCN	Yes	

HABITAT SYNTHESIS

Big rivers face many of the same threats as rivers and streams. Dams, pollution, and sedimentation were the primary threats the taxa teams discussed for this habitat. Dams may be even more influential in big rivers, as many of the species that utilize this habitat require significant distances of unrestricted river channel for migration.

Channelization is also thought to be detrimental, changing flow patterns and altering riverbed composition in these areas. By nature of their size, big rivers are less susceptible to climate change than smaller rivers and streams; the volume of water helps resist temperature changes, and flooding events are tempered by the large floodplains that surround the habitat.

LAKES AND PONDS

DESCRIPTION

Lakes and ponds are naturally enclosed bodies of standing water. The lack of a current in these features provides habitat for species not found in riverine habitats. Lacustrine habitats tend to be deeper than riverine habitats, resulting in the formation of separate zones. The shallow areas adjacent to shore are able to support rooted aquatic plants and the open water of a lake

or pond is referred to as the limnetic zone. These features differ from impoundments in that they are naturally occurring, rather than constructed.

Generally, ponds are smaller than lakes. Many ponds are shallow enough that the entire body is within the littoral zone. As a result, ponds tend to be warmer, with temperatures consistent throughout and sensitive to changes in air temperature. Oxygen levels can fluctuate in response to the changing temperatures as well. Most ponds do not experience much wave action, so emergent plants can encircle the shoreline.

Lakes are larger, allowing for the formation of distinct zones. Sunlight usually cannot penetrate to the bottom of a lake. Deeper lakes also form thermoclines, layers of progressively cooler water that form at greater depths. As a result of the greater water volume, temperatures – and thus oxygen levels – tend to be more stable. The larger area of a lake also allows winds to creates waves; the repeated ebb and flow of water creates sandy or rocky shorelines with relatively few aquatic plants.

SPECIES OVERVIEW

A total of 24 RSGCN species utilize lakes and ponds (Appendix N, Table N-12). This includes nine fishes, four caddisflies, four reptiles, three amphibians, two odonates, two freshwater mussels, and one crayfish (Figure 35). The taxa teams identified eleven RSGCN as habitat specialists (Table 52). Two RSGCN Fish species are restricted to lake habitats; Siskiwit Lake Cisco and Ives Lake Cisco. An additional seven Proposed RSGCN utilize lakes and ponds (Appendix N, Table N-12); none of these species are habitat specialists, nor are the restricted to lacustrine habitats.

Figure 35. Distribution of the different RSGCN taxa that utilize lacustrine habitats.

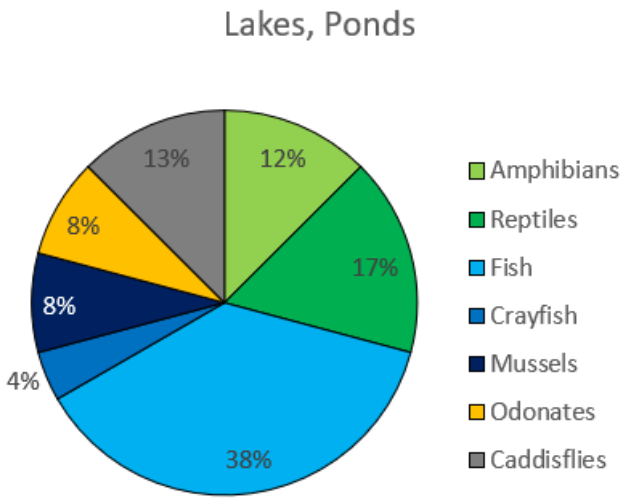


Table 52. Lake and pond RSGCN and Proposed RSGCN that are habitat specialists or utilize only lacustrine areas.

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist ?	Restricted to Lakes and Ponds?
Amphibians	*Ambystoma sp.*	Unisexual Ambystoma Complex	RSGCN	Yes	
Odonates	*Rhionaeschna mutata*	Spatterdock Darner	RSGCN	Yes	
Fishes	*Chrosomus neogaeus*	Finescale Dace	RSGCN	Yes	
Fishes	*Notropis anogenus*	Pugnose Shiner	RSGCN	Yes	
Fishes	*Notropis heterolepis*	Blacknose Shiner	RSGCN	Yes	
Fishes	*Coregonus hubbsi*	Ives Lake Cisco	RSGCN	Yes	
Fishes	*Coregonus zenithicus bartletti*	Siskiwit Lake Cisco	RSGCN	Yes	Yes
Freshwater Mussels	*Simpsonaias ambigua*	Salamander Mussel	RSGCN	Yes	
Freshwater Mussels	*Venustaconcha ellipsiformis*	Ellipse	RSGCN	Yes	
Reptiles	*Nerodia erythrogaster neglecta*	Plain-bellied Watersnake (Copperbelly pop.)	RSGCN	Yes	
Reptiles	*Emydoidea blandingii*	Blanding's Turtle	RSGCN	Yes	
Reptiles	*Kinosternon flavescens*	Yellow Mud Turtle (Illinois/Missouri/Iowa pop.)	RSGCN	Yes	

HABITAT SYNTHESIS

Like other aquatic ecosystems, lakes and ponds are very sensitive to pollution and sedimentation. Generally, water does not flow freely through the system, potentially resulting

in chemical and sediment build up. Taxonomic experts pointed out that sedimentation can be particularly harmful when it settles onto shoals and fish spawning areas.

Lakeshore development was identified as a major threat to lake habitats. Development can result in the destruction of riparian and wetland communities, loss of emergent vegetation, and eutrophication. Eutrophication may be particularly detrimental if it results in algal blooms (Chislock et al. 2013; Wurtsbaugh et al. 2019). The algae grow quickly in response to the ready availability of nutrients before dying off. Once dead, they decompose, removing oxygen from the water. This can result in fish die-offs, especially during warmer months when oxygen levels are already depleted (Chislock et al. 2013).

The other major threat the taxa teams discussed was the presence of invasive species. Of particular concern are Zebra mussels and Quagga mussels. These two mussels reproduce prolifically, attaching themselves to every hard surface they can find. This severely impacts mussel beds, fish spawning shoals, and any organism they attach to. Due to their prolific nature, these invasive mussels can completely change the structure of the lake or pond; the excessive number of shells produced, both live and dead, can completely cover the substrate that is present. Moreover, adding so many filter feeders to the system can alter water clarity and change the availability of phytoplankton and other microorganisms.

GREAT LAKES

DESCRIPTION

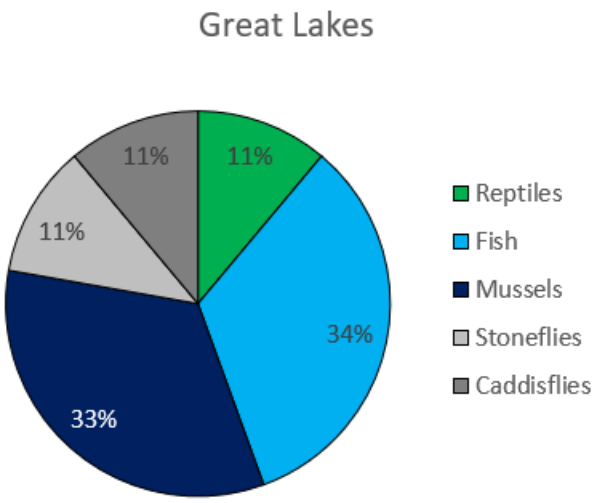
As was the case with big rivers, the Great Lakes are so much larger than most lakes that they act differently, supporting plant and animal communities not found in smaller water bodies. They are so much larger that they act more like inland seas; the large surface area helps create stronger, more sustained winds, which result in rolling waves and strong currents. The Great Lakes are also large enough to have an impact on the surrounding land; they moderate temperatures, increase precipitation, and cause lake-effect snowfall.

SPECIES OVERVIEW

Nine RSGCN species are found in the Great Lakes (Appendix N, Table N-13). Fishes and freshwater mussels were the most common, with three species each, in addition to a single caddisfly, stonefly, and reptile (Figure 36). The taxa teams did not indicate that any of these species are habitat specialists, nor are any restricted to Great Lakes habitats.

Only one Proposed RSGCN, the Maine Stone, is known to occur in the Great Lakes. This species is not considered a specialist, nor is it restricted to this habitat.

Figure 36. Distribution of the different RSGCN taxa that utilize Great Lakes habitats.



HABITAT SYNTHESIS

The Great Lakes face many of the same threats smaller lakes and ponds do. With so much development surrounding the lakes, pollution, sedimentation, and eutrophication are all major concerns. Pollution can be particularly concerning in the Great Lakes as the water turnover rate is so low, allowing persistent toxins to build up over time. Some of these toxins have settled to the bottom where they are relatively inert once covered in sediments but can easily be released by dredging. Similarly, low turnover rates contribute to large buildups of nutrients, which can result in harmful algal blooms.

Invasive species are particularly pervasive in the Great Lakes; estimates suggest at least 180 invaders are present (NOAA 2021). This includes fish, invertebrates, microorganisms, and plants. Some of these invasive species alter the structure or function of the Great Lakes ecosystems, while others prey on or outcompete native species.

Climate change is also a major threat to the Great Lakes. The effects of climate change are varied, but could include reduced water levels, increased storm frequency, and altered water temperatures. The effects of these changes include loss of suitable habitat for certain species, such as coldwater fish, and more suitable conditions for invasive species and harmful algal blooms.

ANTHROPOGENIC HABITATS

Humans have an inordinate influence on the landscape around them. Some anthropogenic habitats can mimic the structure and function of natural habitats, such as an impoundment being fairly similar to a lake or pond. Other anthropogenic habitats, such as developed areas, are completely unique and have no natural complement. The key defining feature of an anthropogenic habitat is that it is created, or at least influenced, by human activities. The habitat types in this category are differentiated by the purpose for which they are used, which for many has an influence on the vegetation that grows there.

Generally, anthropogenic habitats are less preferable to RSGCN species. Plant and animal communities in these areas tend to be less diverse, and often include invasive species (DeStefano and DeGraaf 2003). These areas are frequently disturbed, and human activity levels are elevated. Additionally, their proximity to human-managed areas can expose these habitats to elevated levels of chemicals and pollutants. There are a few anthropogenic habitats that are hugely beneficial for certain species, such as old, abandoned mines for bats; these habitats may require protection in order to maintain their value for RSGCN species.

Three taxonomic groups are absent from anthropogenic habitats - caddisflies, mayflies, and stoneflies - reflecting the high sensitivity of these taxa to environmental contamination (Figure 37, Table 53). Mines are dominated by mammals, as was the case for caves above. Reptiles are most common in annual cropland. Impoundments, the one aquatic anthropogenic habitat discussed, are heavily utilized by fish and freshwater mussels. Birds make significant use of silvicultural land and orchards and perennial cropland. Bees are surprisingly common in developed areas.

Figure 37. Number of RSGCN occurring in each anthropogenic habitat type.

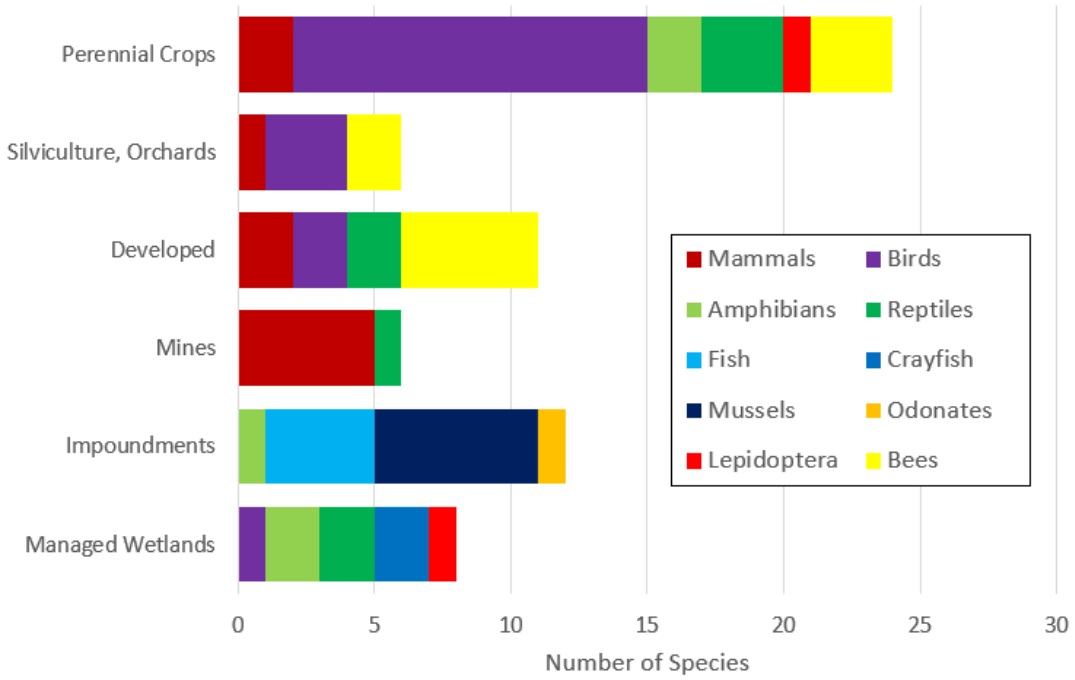


Table 53. Number of RSGCN from each taxonomic group occurring in each anthropogenic habitat type.

	Annual Crops	Perennial Crops	Developed	Impound-ments	Managed Wetlands	Mines	Silviculture/ Orchards
Mammals	0	2	2	0	0	5	1
Birds	1	13	2	0	1	0	3
Amphibians	1	2	0	1	2	0	0
Reptiles	4	3	2	0	2	1	0
Fishes	0	0	0	4	0	0	0
Crayfishes	0	0	0	0	2	0	0
Freshwater Mussels	0	0	0	6	0	0	0
Odonates	0	0	0	1	0	0	0
Lepidoptera	0	1	0	0	1	0	0
Bees	0	3	5	0	0	0	2
Total	**6**	**24**	**11**	**12**	**8**	**6**	**6**

AGRICULTURAL - ANNUAL CROPS

DESCRIPTION

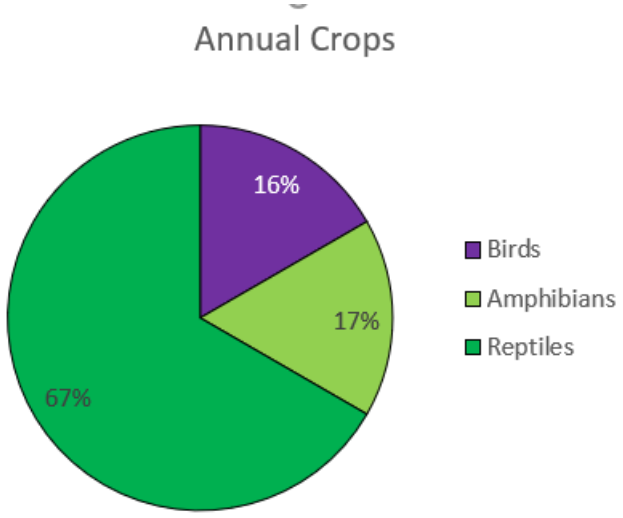
For our purposes, this category encompasses areas used for the production of any herbaceous crop, including grains, corn, soybeans, tobacco, cotton, or vegetables. These crops are either annuals, or they are grown as an annual to reduce pests and diseases. Annual crops do not include woody species, such as timber plantations, orchards, or vineyards; these areas are grouped under Silviculture/Orchards. It also does not include pastures and hayfields; these areas are grouped under Perennial Crops. In many ways, annual cropland is structurally similar to grasslands, though the fields are usually monocultures, rather than biodiverse, and affected by agricultural methods rather than fire.

SPECIES OVERVIEW

The taxa teams identified six RSGCN that utilize annual cropland (Appendix N, Table N-14). This group included one amphibian, one bird, and four reptiles (Figure 38): Illinois Chorus Frog, Whooping Crane, Timber Rattlesnake, Plains Hog-nosed Snake (*Heterodon nasicus*), Blanding's Turtle, and Wood Turtle. Both turtles and the Illinois Chorus Frog are considered habitat specialists but have been found in and around agricultural areas as their natural habitats are diminished or converted. The two turtles are specialists in that they require a matrix of various habitats in conjunction with one another; both species have been known to utilize agricultural fields for nesting. The Illinois Chorus Frog requires sandy soils where they can burrow; they are sometimes able to find these conditions near the edges of farm fields.

The taxa teams did not identify any Proposed RSGCN that use annual cropland.

Figure 38. Distribution of the different RSGCN taxa that utilize annual cropland habitats.



HABITAT SYNTHESIS

Taxonomic experts suggest that, while anthropogenic habitats are generally less preferred than natural habitats, the small number of RSGCN that are able to utilize annual cropland compared to the total number of RSGCN that utilize grasslands suggests that the intensive management practices used in these areas make them particularly unsuitable. The frequent disturbance is likely enough to deter some species, while certain agricultural practices may contribute to mortality of some species.

A key characteristic of annual croplands is that many of the fields are actively tilled. Tilling can have significant impacts on the soil, including altering the profile by mixing soil layers, compaction, loss of organic matter and soil organisms, and increased erosion. As tilling and other active management practices often occur through the wintering or breeding seasons, these may also cause direct mortality of any ground-nesting or hibernating species, which includes the Illinois Chorus Frog and Plains Hog-nosed Snake.

Combined with the use of herbicides and other mechanized agricultural methods, cultivated crop fields are often inhospitable to many of the native grassland plants RSGCN species depend on. This is especially detrimental to the RSGCN bees and lepidopterans, many of which have specific plant host relationships. Pesticide use is also detrimental to these insects and can indirectly affect many of the other taxonomic groups. Insectivorous species could ingest the toxins as well, some of which could build up to toxic levels and impact survival.

AGRICULTURAL - PERENNIAL CROPS

DESCRIPTION

Perennial crops primarily refer to areas of grasses, legumes, or a mixture of the two that are grown for seed production, hay, or livestock feed. This includes pastures and rangeland, where livestock are allowed to graze, as well as strip-managed areas maintained for certain gamebirds. These species growing in these areas tend to be perennial, rather than annual. Many of these perennial croplands are either mowed annually to harvest a crop or grazed to maintain the herbaceous nature of the landscape. In many ways, perennial cropland is similar to grassland habitat; a large area of herbaceous growth that exclude woody plants. In some cases, such as pasture, they may be more similar to glades, barrens and savanna; patches of grasses interspersed with bare ground and occasional trees and shrubs.

SPECIES OVERVIEW

Twenty-four RSGCN species are known to utilize perennial cropland (Appendix N, Table N-15). This includes 13 birds, three bees, three reptiles, two amphibians, two mammals, and one butterfly (Figure 39). Seven of these species are considered habitat specialists (Table 54).

The taxa teams did not identify any Proposed RSGCN that use perennial cropland.

Figure 39. Distribution of the different RSGCN taxa that utilize perennial cropland and pasture habitats.

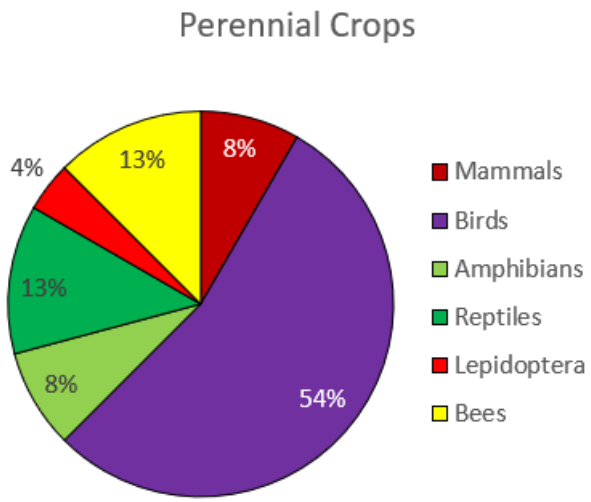


Table 54. Perennial cropland and pasture RSGCN and Proposed RSGCN that are habitat specialists.

Taxa	Scientific Name	Common Name	RSGCN Status	Habitat Specialist?
Amphibians	*Lithobates areolatus*	Crawfish Frog	RSGCN	Yes
Amphibians	*Pseudacris illinoensis*	Illinois Chorus Frog	RSGCN	Yes
Bees	*Bombus fraternus*	Southern Plains Bumble Bee	RSGCN	Yes
Bees	*Bombus pensylvanicus*	American Bumble Bee	RSGCN	Yes
Birds	*Tympanuchus cupido*	Greater Prairie-Chicken	RSGCN	Yes
Reptiles	*Emydoidea blandingii*	Blanding's Turtle	RSGCN	Yes
Reptiles	*Glyptemys insculpta*	Wood Turtle	RSGCN	Yes

HABITAT SYNTHESIS

Nearly all the species that utilize perennial cropland are considered grassland species, suggesting that it can be a suitable proxy for some RSGCN when native grasslands are rare or unavailable. However, there were 71 RSGCN that utilize native grasslands, and only 24 that are able to make use of perennial cropland. While this is better than the rate we saw with annual cropland, it shows that the management methods used on perennial crops are also deterrents for many RSGCN species.

Mowing may be the most disruptive of these practices. In many ways, mowing can imitate the effect of fire in grassland habitats. It prevents encroachment of woody plants, removes dead plant material, and stimulates new growth. However, mowing can also result in significant mortality in certain taxa, especially birds. If mowing takes place while they are nesting, the adults may be able to escape, but the nest, eggs, and chicks cannot.

Grazing is another activity that can be both beneficial and detrimental to RSGCN species. Livestock may be able to imitate the effect of large native grazers, such as Bison (*Bison bison*), on a landscape, but this effect is tempered by the underlying conditions of where they graze. While pastures are more ecologically diverse than annual cropland, they are less diverse than native grasslands and often include non-native plant species. Trampling can be a risk for some RSGCN as well.

It is also worth noting that, even when a species can make use of this anthropogenic habitat, survival and reproductive success rates may be impacted. For example, the taxa experts said there is some evidence that Northern Bobwhite success is higher in natural grasslands than it is in intensive agricultural and managed areas (Potter et al. 2011).

SILVICULTURE AND ORCHARDS

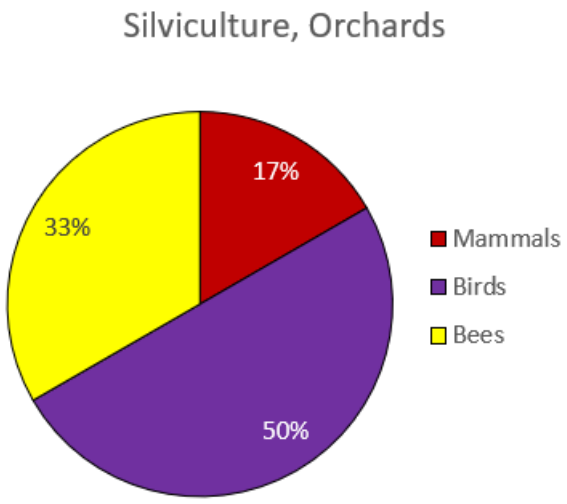
DESCRIPTION

Silviculture and Orchards are a unique agricultural class in that they involve woody, rather than herbaceous, species. This class includes orchards, vineyards, and tree plantations. The crop harvested could be the fruit of the plant, such as apples, nuts, or grapes, or the tree itself, as is the case in timber plantations.

SPECIES OVERVIEW

Six RSGCN are known to make use of silvicultural areas and orchards (Appendix N, Table N-16). This includes Red-headed Woodpecker, Rusty Blackbird, Migrant Loggerhead Shrike, Rusty-patched Bumble Bee, Gypsy Cuckoo Bee, and Eastern Red Bat (Figure 40). None of these species are considered habitat specialists. The taxa teams did not identify any Proposed RSGCN that use this habitat type.

Figure 40. Distribution of the different RSGCN taxa that utilize silviculture and orchard habitats.



HABITAT SYNTHESIS

These areas share some structural similarities to forests, but are generally shorter, less dense, and do not contain an understory or multiple canopy layers. Most of these habitats consist of a single age class, limiting the structural complexity of the area. Additionally, this habitat type tends toward monocultures, though an orchard or vineyard may have multiple varieties of a single species. Generally, this reduced complexity results in fewer available niches for species to exploit, which may explain why so few RSGCN utilize this habitat.

Similar to annual cropland, use of pesticides and herbicides in some orchards and vineyards may be high. This can directly impact RSGCN species or can create indirect impacts by affecting the availability of food resources.

DEVELOPED

DESCRIPTION

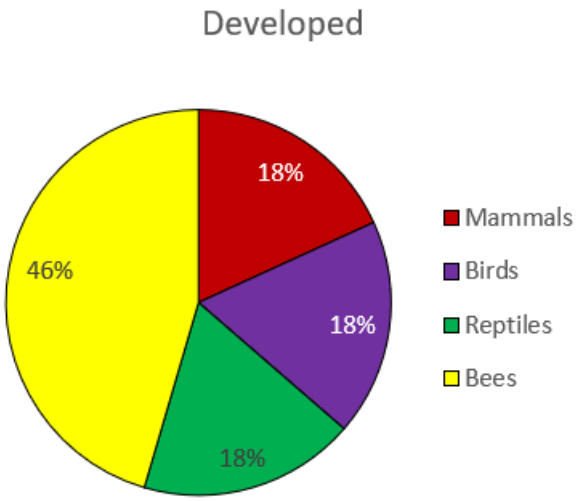
This category is perhaps the one most drastically impacted by human activity. Though these areas may contain some vegetation, they are generally dominated by constructed materials such as buildings and roads. Generally, an area is considered developed if impervious surfaces account for more than 20% of the total area. This habitat type encompasses a variety of uses, including cities and towns, residential areas, commercial centers, transportation and utility corridors, and industrial complexes. It can also include other intensively used open areas such as golf courses, parks, and landfills.

SPECIES OVERVIEW

A total of eleven RSGCN species make use of developed areas: Rusty-patched Bumble Bee, Gypsy Cuckoo Bumble Bee, Southern Plains Bumble Bee, Yellow-banded Bumble Bee, *Svastra compta*, Chimney Swift, Interior Least Tern, Little Brown Myotis, Tricolored Bat, Kirtland's Snake, and Butler's Gartersnake (*Thamnophis butleri*) (Figure 41). Three species are considered habitat specialists; Southern Plains Bumble Bee, Interior Least Tern, and Kirtland's Snake. The Southern Plains Bumble Bee is known to be a prairie-remnant specialist but may forage in urban gardens if they adjoin suitable habitat. Interior Least Tern prefers to nest on sandbars in large rivers but have been observed in gravel quarries and on gravel rooftops. Kirtland's Snake is closely associated with wetland habitat, but surveys consistently find them on vacant, inner-city lots that are associated with streams.

A single Proposed RSGCN, Macropis Cuckoo Bee, is known to utilize developed habitats. The distribution of this species is limited only by the presence of its hosts, *Macropis* bees. As such, it is not considered a habitat specialist.

Figure 41. Distribution of the different RSGCN taxa that utilize developed habitats.



HABITAT SYNTHESIS

Developed habitats are unique among the anthropogenic habitats in that they often do not have a corresponding natural habitat. Generally, RSGCCN species cannot make use of all developed habitats; they are only able to exploit certain types and characteristics that imitate natural structures. For example, Chimney Swifts are highly dependent on developed areas despite being primarily a forest species. They require large structures for colonies to nest in. Historically, this need was met by large, hollow trees, which are now rare in natural systems. Chimney Swifts have adapted by making significant use of chimneys, abandoned buildings, and other man-made structures.

This ability to selectively utilize features is common across many of the RSGCN identified by the taxa teams as occurring in developed areas. Bees forage in gardens and parks, bats roost in old buildings, birds nest on rooftops, and snakes inhabit vacant lots. While these habitats are used, they are generally not preferred. Moreover, developed areas undergo rapid changes, which may eliminate necessary features. Combined with the constant threat of human disturbance and environmental pollution, developed habitats may be too unstable for the long-term conservation of RSGCN species unless required features are protected, providing an outreach opportunity in urban areas.

Developed areas may play an important outreach and education role in fish and wildlife conservation. Although they likely cannot provide sustainable habitats for healthy, native fish and wildlife populations, their proximity to human populations reaches a broader citizenry. These habitats offer opportunities for increasing viewing, exposure and awareness, which address both the proposed Recovering America's Wildlife Act (RAWA) and Relevancy Roadmap priorities (AFWA and The Wildlife Management Institute 2019).

MINES

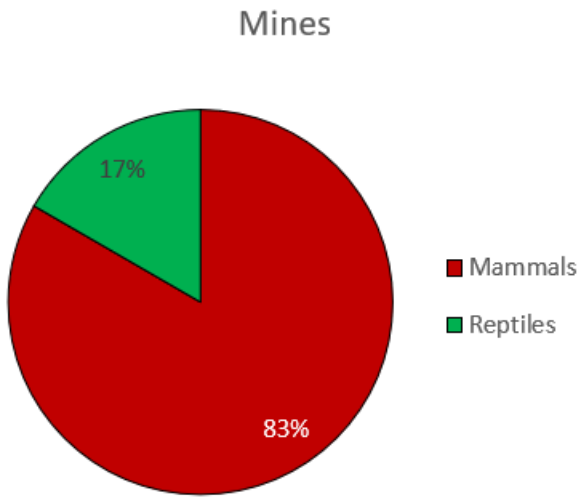
DESCRIPTION

A mine describes a location where humans extract valuable minerals or other geological materials from deposits in the ground. There are different styles of mines, but for our purposes here we are referring specifically to underground mines, especially those that have been abandoned. In the Midwest, mining operations are generally for coal or various precious and heavy metals. In many ways, mines function like small caves, with stable temperatures and humidity year-round, low light conditions, and small microclimates that appeal to a number of species (Belwood and Waugh 1991).

SPECIES OVERVIEW

Only six RSGCN utilize mines (Appendix N, Table N-18). This includes the five cave-hibernating bat species – Gray Myotis, Little Brown Myotis, Northern Long-eared Bat, Indiana Myotis, and Fringe-tailed Myotis (*Myotis thysanodes pahasapensis*) – and Timber Rattlesnake (Figure 42). None of these species are considered habitat specialists, though they all require suitable hibernacula. Mines – especially those that have been abandoned and face limited disturbance – can be suitable hibernacula, as long as they have appropriate temperature and humidity levels.

Figure 42. Distribution of the different RSGCN taxa that utilize mine habitats.



HABITAT SYNTHESIS

While mines and caves share several key features, there is one major difference between the two: hydrology. Caves and karsts are shaped by groundwater movement, and groundwater continues to feed the pools and streams within these habitats. Mines are manmade, and don't necessarily have consistent groundwater flow through them. This is perhaps reflected in the fact that the taxa teams did not indicate that any cave-occurring RSGCN crayfishes or fishes utilize mines.

Depending on the age and purpose of the mine, many toxins – byproducts of the mining process, or the ores being excavated – can be present at the site. Taxa team members indicated that these toxins are harmful to both subterranean species, who are generally sensitive to changes in water quality, and to surface-dwelling species downstream of the site.

Human disturbance can have both negative and positive effects on mine species. Generally, mines have higher trophic levels than natural caves, a result of the decomposition of wood and other materials brought into the mine for stabilization (Isaia et al. 2011, Mammola 2019). On the other hand, frequent visitation can affect mines in the same way it impacts natural caves, altering the temperature and humidity levels (Isaia et al. 2011). Increased human activity can also deter mine-dwelling species; taxa team members indicated the Gray Myotis is particularly sensitive and will often abandon sites with human presence.

Mines may be particularly important for the RSGCN bats. In many cases, bats do not appear to differentiate between natural and man-made sites, as long as the temperatures and humidity are at an appropriate level. Over half of North America's 45 bat species have been documented using abandoned underground mines (Watkins 2002), including the five cave-hibernating RSGCN species in the Midwest. For some, mines are crucial to their survival; up to 95% of hibernating bats in Wisconsin utilize abandoned mines (Belwood and Waugh 1991), and the largest known colony of Little Brown Bats in the United States roosts in mines in New York (Watkins 2002). Because of this dependence on mine habitats, bats may be particularly sensitive to reclamation activities. If the entrances are completely blocked, bat populations can be excluded from that mine, or may even be trapped inside (Watkins 2002). This was not brought up by the taxa teams as a particular concern in the Midwest, likely because they do not have the large number of abandoned mines found further west. However, it is a potential concern in any location that is being considered for reclamation. As in natural caves and karst habitat, climate change likely exacerbates existing threats and threatens to degrade cool, moist habitat requirements.

IMPOUNDMENTS

DESCRIPTION

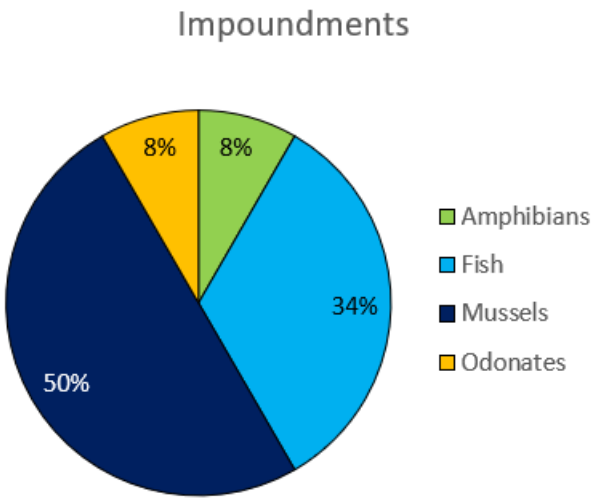
Impoundments are human-created bodies of still water. They often are the result of constructing a dam across a river or stream, preventing the flow of water. Water fills in the space behind the dam, creating an impoundment or reservoir. Impoundments act much like lakes and ponds in that they are a body of stationary water where temperatures are generally higher than in the source river or stream, and sediments are able to settle out of the water column.

SPECIES OVERVIEW

Twelve RSGCN species were identified as able to utilize impoundments by the taxa teams (Appendix N, Table N-19). This included six freshwater mussels, four fishes, one odonate, and one amphibian (Figure 43). Only two species, Finescale Dace and Spatterdock Darner, were identified as habitat specialists. For the dace, cold temperatures are required, while the darner needs slow-moving waters free of fish.

Two Proposed RSGCN can be found in impoundments, Western Tiger Salamander and the mayfly *Waynokiops dentatogriphus*. Neither is a habitat specialist, able to utilize most slow-moving or standing water bodies.

Figure 43. Distribution of the different RSGCN taxa that utilize impoundment habitats.



HABITAT SYNTHESIS

Impoundments share a number of superficial similarities with lakes and ponds. However, impoundments tend to be smaller, shallower, and have faster turnover rates (Whittier et al. 2002). The smaller size generally results in higher temperatures and lower oxygen levels, while higher turnover prevents sediments from settling out of the water column, resulting in turbid, cloudy water (Hayes et al. 2017). As impoundments are also often in more developed areas, they tend to contain more contaminants and nutrients as well (Whittier et al. 2002). As a result, the community within an impoundment contains more species tolerant of pollution and sedimentation, as well as more non-native species (Whittier et al. 2002). Many of these species are introduced intentionally to provide fishing opportunities and tend to be predatory species that prey on native RSGCN.

Water levels within an impoundment are controlled by the presence of a dam, rather than natural geology. Periodic drawdowns can result in significant fluctuations in the water levels. This could leave portions of the bank exposed, stranding aquatic species above the water and drying out areas that are usually inundated. This can be particularly harmful to the near-shore emergent vegetation, which usually prefers to be submerged. Depending on how often the vegetation is exposed, it may not be able to survive, reducing available cover for aquatic species.

MANAGED WETLANDS

DESCRIPTION

This final anthropogenic category encompasses artificially created or maintained wetlands. These wetlands may be constructed for a variety of purposes, including water storage, irrigation, aquaculture, wastewater treatment, runoff catchments, and ditching. Similar to natural wetlands, these areas are characterized by soils that are saturated with water, and can vary widely in their water chemistry, soil type, plant community, and overall hydrology.

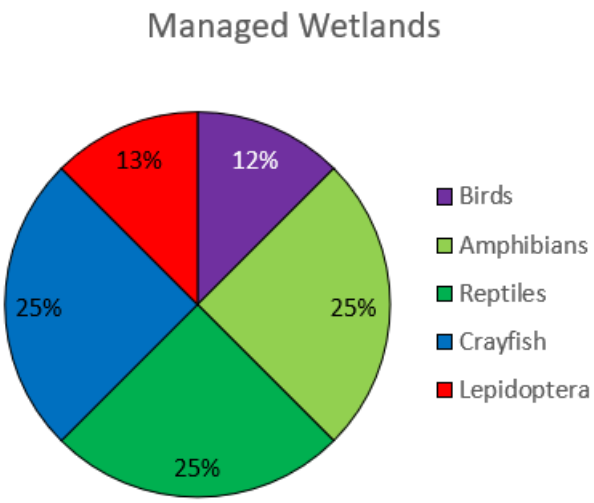
SPECIES OVERVIEW

The taxa teams identified eight RSGCN species that make use of managed wetlands (Appendix N, Table N-20). This included two amphibians, two reptiles, two crayfishes, one bird, and one butterfly (Figure 44). Three were identified as habitat specialists: Crawfish Frog, Illinois Chorus Frog, and Kirtland's Snake.

One Proposed RSGCN, Dusky Mudbug, was identified by the taxa teams. Generally, this species is considered a specialist dependent on seeps, but some managed wetlands are sufficient. Lack

of habitat data or expertise for many invertebrate taxa may be the reason for low species numbers assigned to this habitat, or by the small size and lower quality of managed wetlands.

Figure 44. Distribution of the different RSGCN taxa that utilize managed wetland habitats.



HABITAT SYNTHESIS

Managed wetlands are similar to natural wetlands in that they are highly variable from one another. However, managed wetlands are far more impacted by human activity. Most managed wetlands are prone to more pollution and sedimentation than natural wetlands due to this proximity. As these systems are not usually fed by groundwater, the hydrology of these systems may be inconsistent, resulting in periods of drought or flooding.

Some managed wetlands, such as runoff ponds and ditches, are smaller than most natural wetlands. These areas may be unsuitable for most wetland species as they are too small, which restricts the biodiversity and niche availability within the patch. These areas may also be isolated from other habitats, making it more difficult for individuals to disperse to – or away from – these areas (Moreno-Mateos et al. 2012).

DISCUSSION

THE MIDWEST PROCESS ADVANCEMENTS

The Midwest RSGCN process represents an evolution and advancement of the RSGCN list development by incorporating efficiencies in data management, prescreening, and the establishment of several additional categories to identify species warranting attention, both SGCN and non-SGCN. These additional listing categories represent a step toward proactive and inclusive prioritization of species. Although the Southeast RSGCN analyses included a Watchlist, the final product was not as comprehensive as this Midwest effort for multiple reasons, most notably, the number of species and taxa groups included. The additional categories bring to light that the number of species for which attention is needed is more than double that of the RSGCN list alone. This revelation provides a more informed and vetted foundation for future versions of SWAPs and partners' work planning.

Broadening the method and process allowed the incorporation of additional species and partners:

Proposed RSGCN/Watchlist categories:

- Proposed RSGCN that meet the RSGCN criteria but were not SGCN in any Midwest SWAP;
- Watchlist categories for those species that do not meet the RSGCN criteria for multiple reasons, but enough evidence suggests they need attention;
- Deferred list – now that three AFWA regions have identified RSGCN, this allows regions to assign primary RSGCN lead where most appropriate; and
- Most proposed RSGCN/Watchlist species were invertebrates for which there is relatively less data and expertise, lessening the probability of being listed in state SWAPs.

Additional RSGCN criteria filters and data sources:

- State level protection and S3- rounded S ranks.
- Additional bird JVs, PIF, FHP, and other source data on temporal and spatial range; and
- Crosswalk of RSGCN and SGCN with the JVs, Birds of Conservation Concern, and other Midwest bird efforts; by crosswalking the RSGCN and SGCN to each of the JVs, Birds of Conservation Concern, and MSCI, this informs each of those efforts and provides state/MLI RSGCN priorities.

Additional partners included in the RSGCN process:

- Collaboration between states and the USFWS offered broader program and partner input, since multiple USFWS program staff were involved in the methodology development and taxa teams.

The overlap of states representing two AFWA regions offered both a challenge and an opportunity. This allowed us to develop an approach for how to deal with species that occurred more predominately in adjacent regions, while still recognizing their significance to the Midwest. This was true with both the Southeast (KY, MO) and the West (ND, SD, NE, KS). Midwest taxa teams determined that multiple species are more ecologically aligned with the Southeast than the Midwest and chose to defer RSGCN status to SEAFWA. We took the opportunity to address, acknowledge, and minimize any complication by considering predominant ecoregions and suggest assignment to the region that best aligned with the habitats and needs of that species. For example, if a species was associated with the Appalachian region, it was deferred to either the Southeast or Northeast, while a western prairie species would be deferred to the West. In fact, patterns show that RSGCN numbers appear to decline in the western portion of the region. These western Midwest states may contain more species that may be considered RSGCN in the West but were not considered in Midwest due to low regional responsibility. These patterns could be explored for more comparisons of numbers of RSGCN shared across regions.

The taxa included (and excluded) in the RSGCN selection process reflect the availability of data and expertise or lack of time and team capacity (MLI/taxa teams/TCI), *NOT* necessarily the lack of occurrence or importance in that region. More taxa were included than were planned in the project scope. This was a result of the opportunity presented by Midwest experts to conduct a more thorough RSGCN review of all three EPT taxa. This had not yet been possible in any other region and was facilitated by key national and international experts located in the Midwest. Their commitment to the resource, expertise of the taxa rangewide, and willingness to share their datasets informed both the concern level and regional responsibility criteria. Specifically, the leadership and efforts of Dr. Ed DeWalt, Illinois Natural History Survey, made the review of these taxa possible. These taxa complemented the other aquatic taxa to tell a more robust story of regional aquatic resources and their vulnerabilities.

Additional taxa should be included when the data and expertise become available and prioritized by emerging threats or other habitat or threat theme groups that make it most efficient and effective to include them. Taxa assessments should be prioritized and conducted for as many taxa as feasible, using the guidance of the RSGCN and Watchlist data, and included when possible.

One further complicating factor is that some state fish and wildlife agencies lack expertise and authority for insects. A general need for additional distribution and abundance information was noted for most invertebrate taxa.

DATA GAPS OUTLINE NEXT STEPS

Throughout the data analyses, it became apparent that data were lacking for some species, taxa, habitats, and limiting factors (Appendix O). This was the result of multiple factors, including lack of information or expertise available for these taxa, or the lack of taxa expert time or response during this process. Data gaps were more often associated with the lesser-known species and invertebrate taxa for which these was a general paucity of data. **These data gaps represent focused opportunities for next steps and priority actions to be taken to strategically fill these data gaps.** If data are generally deficient for certain taxa, then focused assessments and data collection can be designed to fill those gaps. Prioritizing them by habitat, threat, action, or another targeted theme could prove effective.

IMPORTANCE OF THE KEY MIDWEST HABITATS

Grassland RSGCN and habitat. The importance of this iconic Midwest habitat and the RSGCN it supports were consistently mentioned by taxa teams. They cited conversion of native prairies and other natural habitats to agriculture, especially row crops, has impacted grassland species as their natural habitat declines.

Aquatic RSGCN and habitat. Taxa experts suggested that habitat modification may be the most significant cause of declines for this group. Dams and similar structures were of particular concern, but other sources of modification include channelization, dredging, agricultural expansion, and development. These can all directly destroy RSGCN habitat and the associated increases in pollution and sedimentation are also of high concern.

PRESCREENING EFFECTIVENESS

Table 55 shows that 89% of the species that were pre-screened as not likely to be RSGCN were in fact not identified as RSGCN. There were also Probable and Possible RSGCN pre-screening categories, and those selection rates were exactly where we would hope they would be, with more of the Probable RSGCN being identified as final RSGCN than the Possible RSGCN. Ultimately, this finding supports the Selection Methodology that the pre-screening is based on, for identifying Midwest RSGCN. It further highlights how important the roles of the taxa teams are to make the final recommendations.

Table 55. Comparison of number of species with each prescreened RSGCN status with final RSGCN status (with % accuracy).

Pre-screening Category	Final RSGCN	Final Watchlist	Final Not RSGCN	Final Deferral
Predicted RSGCN (118 SGCN)	83 (70%)	5 (4%)	18 (15%)	12 (10%)
Probable RSGCN (230 SGCN)	70 (30%)	30 (13%)	122 (53%)	8 (3%)
Possible RSGCN (130 SGCN)	17 (13%)	15 (12%)	96 (74%)	2 (2%)
Not RSGCN (595 SGCN)	16 (3%)	33 (6%)	531 (89%)	15 (3%)

CROSS-REGIONAL OPPORTUNITIES

MAFWA, NEAFWA, and SEAFWA have identified RSGCN, creating an opportunity for prioritization of conservation efforts within and between regions. A cursory comparison between the RSGCN for the three regions that have identified RSGCN reveals the importance of addressing threats to key aquatic habitats and improving invertebrate assessment. More specific highlights are bulleted below:

- Midwest RSGCN: 340 species, about one-third are vertebrates, more than half are aquatic
- Northeast RSGCN: 358 species, about one-third are vertebrates, about half are aquatic
- Southeast RSGCN: 960 species, about two-thirds are vertebrates, about three-fourths are aquatic

The Midwest and Northeast have similar RSGCN totals, but different taxa are represented (Table 56). The Northeast region has more terrestrial invertebrates, while the Midwest has more aquatic invertebrates, primarily because all EPT were included in the Midwest RSGCN when the Northeast only included Stoneflies (Plecoptera). More data and expertise were available to facilitate inclusion of these three aquatic invertebrate taxa in the Midwest RSGCN. The Northeast, on the other hand, included marine vertebrate fauna that do not occur in the Midwest; otherwise the vertebrate RSGCN totals are similar between the two regions.

Although the three regions have approximately the same number of states (13 to 15), the Southeast region (>975,000 square miles) is larger than the Midwest or the Northeast regions in geographic size – 13% larger than the Midwest (>862,000 square miles) but nearly four times as large as the Northeast (>263,000 square miles). When the RSGCN totals are standardized for

area, the Midwest has the fewest RSGCN per 10,000 square miles of the three regions, about 3.9, compared to about 9.8 in the Southeast and 13.6 in the Northeast.

Table 56. The number of RSGCN by taxonomic group in the Midwest (MAFWA), Northeast (NEAFWA), and Southeast (SEAFWA) regions of the U.S. (NR = not reviewed, n/a = not applicable)

Taxonomic Group	Midwest RSGCN	Northeast RSGCN	Southeast RSGCN
Invertebrates:			
Butterflies and Skippers	21	29	NR
Moths	28	44	NR
Bumble Bees	6	6	5
Solitary Bees	7	12	NR
Odonates	14	23	NR
Crayfish	18	18	172
Freshwater Mussels	47	28	136
Terrestrial Snails	0	26	NR
Tiger Beetles	0	8	NR
Stoneflies	21	33	NR
Mayflies	43	NR	NR
Caddisflies	26	NR	NR
Vertebrates:			
Freshwater Fish	35	35	275
Marine Fish	n/a	24	30
Diadromous Fish	n/a	4	6
Reptiles	16	11	85
Marine Reptiles	n/a	6	5
Amphibians	12	13	105
Birds	30	17	74
Mammals	16	20	61
Marine Mammals	n/a	1	6
Total	**340**	**358**	**960**

The Southeast region has more than three times as many SGCN as the Midwest or Northeast, starting with a much higher number of eligible species to consider for RSGCN. Many of these Southeast SGCN are aquatic species, with freshwater and marine fish, mussels, and crayfish included. The Southeast region is a global biodiversity hotspot for crayfish, which is reflected in the region's RSGCN. Freshwater mussels and crayfish are the only invertebrate taxa evaluated for RSGCN status in the Southeast, whereas the Midwest and Northeast have included several

other invertebrate orders. While this can identify data gaps in cross-regional comparisons, this also can result in a comparison of the RSGCN totals being misleading because the regions did not include the same number of invertebrate taxa.

A comparison of the RSGCN from the Midwest, Northeast, and Southeast regions identifies 28 species identified as RSGCN or RSGCN Watchlist in all three regions (Table 57). Mammals are the most shared taxonomic group, with seven shared RSGCN, six of them bats. Five shared RSGCN are birds, four are freshwater mussels, and four are bees.

Another six species are identified by the Midwest region as Watchlist Deferral species to the Northeast (1), Southeast (2), or both regions (3), and all six are already identified as shared RSGCN by the other two regions. Identification of these six species as being of regional concern by taxa teams in all three regions reflects another opportunity for cross-regional conservation. These species include three mammals (Virginia Big-eared Bat, Allegheny Woodrat, and Long-tailed or Rock Shrew), two birds (Red Knot and Black Rail), and one fish (Diamond Darter).

Table 57. Species that have been identified as RSGCN by all three regions – the Midwest (MAFWA), Northeast (NEAFWA), and Southeast (SEAFWA).

Taxa	Species
Amphibians	Green Salamander (*Aneides aeneus*)
Amphibians	Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*)***
Birds	Piping Plover (*Charadrius melodus*)**,***
Birds	Wood Thrush (*Hylocichla mustelina*)
Birds	Loggerhead Shrike (*Lanius ludovicianus* (inc. *migrans*))
Birds	Cerulean Warbler (*Setophaga cerulea*)
Birds	Golden-winged Warbler (*Vermivora chrysoptera*)*
Fishes	Spotted Darter (*Etheostoma maculatum*)
Fishes	Longhead Darter (*Percina macrocephala*)
Invertebrates: Bees	Rusty-patched Bumble Bee (*Bombus affinis*)***
Invertebrates: Bees	American Bumble Bee (*Bombus pensylvanicus*)
Invertebrates: Bees	Yellow-banded Bumble Bee (*Bombus terricola*)
Invertebrates: Bees	Variable Cuckoo Bumble Bee (*Bombus variabilis*)

Taxa	Species
Invertebrates: Crayfishes	Big Sandy Crayfish (*Cambarus callainus*)**
Invertebrates: Freshwater Mussels	Pink Mucket (*Lampsilis abrupta*)***
Invertebrates: Freshwater Mussels	Clubshell (*Pleurobema clava*)***
Invertebrates: Freshwater Mussels	Fluted Kidneyshell (*Ptychobranchus subtentus*)***
Invertebrates: Freshwater Mussels	Rabbitsfoot (*Theliderma cylindrica*)
Mammals	Hoary Bat (*Lasiurus cinereus*)
Mammals	Eastern Small-footed Myotis (*Myotis leibii*)
Mammals	Little Brown Myotis (*Myotis lucifugus*)*
Mammals	Northern Long-eared Bat (*Myotis septentrionalis*)**
Mammals	Indiana Bat (*Myotis sodalis*)***
Mammals	Tricolored Bat (*Perimyotis subflavus*)*
Mammals	Eastern Spotted Skunk (*Spilogale putorius*)
Reptiles	Spotted Turtle (*Clemmys guttata*)*
Reptiles	Timber Rattlesnake (*Crotalus horridus*)
Reptiles	Eastern Box Turtle (*Terrapene carolina*)

* Under Review; ** Federally threatened; *** Federally endangered

RECOMMENDATIONS

Conclusions and Recommendations. Throughout the one-year process, observations were captured as to how to improve development and implementation of the RSGCN list for the Midwest. These observations are compiled here in the form of recommendations.

Update the RSGCN list at regular intervals to maintain valuable current information for actions at the regional scale. Repeating the process between SWAP revisions can inform SWAPs and be informed by SWAPs. Improvements and refinements to the process and methods are encouraged to capture additional criteria and emerging issues that are important to each region, and to share and apply for consistency between regions. We recommend these actions:

- Comprehensively review/revise the RSGCN list every 5-10 years with interim minor revisions as needed.
- Maintain the RSGCN list online for reference and access, and link to all partner websites.
- Create a standing item on the MLI and WDC workplan agendas each year for discussion and progress evaluation.

Taxa teams identified extensive conservation needs that reflect an overwhelming need for additional resources (funding, staff, expertise) to allow state agencies to effectively address the breadth and depth of fish and wildlife diversity conservation needs in the Midwest. This RSGCN list can be used to support that:

- Use the RSGCN list as a focus to leverage support and funding from diverse partners and stakeholders with shared objectives.
- Coordinate and communicate RSGCN data priorities, data gaps and needs. Most RSGCN taxa – particularly invertebrates – have critical data gaps that, if filled, would inform more effective on-the-ground conservation and monitoring of success.
- Leverage opportunities if RSGCN species are affected by a particular land use or impact theme (agriculture, energy, transportation, land management, etc.) as industry, agency, stakeholder, and conservation practitioners' resources can be applied strategically to address and mitigate impacts.
- Use the RSGCN list to prioritize RAWA and Relevancy Roadmap support and funding (as available) to include more biodiverse natural communities and engage a diversity of people.
- Use the RSGCN list as justification for Competitive State Wildlife Grant, Multistate Grant, and other conservation grant programs.

Incorporate the RSGCN into all relevant agency and partner plans. All 13 Midwest states can use the information about the RSGCN/Watchlist species and their associated habitats and limiting factors to inform their next SWAP revision. This in turn can promote and generate more effective local conservation actions taken with a regional landscape lens. The lists of both

RSGCN and Watchlist species provides a broader, proactive, consistent, and easily accessible foundation for state and partner planning and application.

The list can be used to communicate joint MLI and state fish and wildlife diversity conservation priorities to their many conservation partners:

- USFWS can use the RSGCN list in its workplan development and schedule or for identifying At-Risk species.
- The Natural Resource Conservation Service can use the list to identify and fund focal species.
- The U.S. Forest Service can use the list to identify and conserve sensitive species.
- NatureServe and their state affiliates can prioritize rank updates for the highest concern species, particularly if emerging threats have been identified.
- All federal and state agencies can incorporate the RSGCN list into their planning and permitting systems.
- Non-governmental organizations and local and state land use planning and managing entities can incorporate RSGCN into their projects and outreach.

This list can also be used to focus and foster increased communication and collaboration between state agencies, universities, natural heritage programs, land trusts, and other conservation partners.

Use all categories of the Regional Species of Greatest Conservation Need list to direct and facilitate MLI/MAFWA Wildlife Diversity Committee's ability to work collaboratively to sustain populations of iconic and imperiled Midwest species. Regional work can enhance efficiency and conservation effectiveness to promote recovery and prevent the need to list species as endangered or threatened where possible.

Data gaps identified in this RSGCN process for all taxa can guide consistent, targeted data collection and analysis and improve regional information availability. This, in turn, can guide the development of standard, consistent protocols, methods, and practices for priority RSGCN/Watchlist species.

Include additional taxa to prepare for RAWA. The inclusion/exclusion of taxa in this process reflects the availability of data and expertise or lack of time/team capacity (MLI/TCI), *not* the lack of occurrence/importance in the region. Additional taxa should be included when the data/expertise become available and prioritized by emerging threats or other habitat/theme groups that make it most efficient and effective to include them. Taxa assessments should be prioritized and conducted for as many taxa as feasible, using the guidance of the RSGCN/Watchlist data and included when possible.

Add and improve habitat data. This project's scope and timeline only allowed the identification of coarse level habitats. We were fortunate to work with the MLI Habitat Working Group which

was in the process of developing a more robust, regional habitat classification. Additional finer scale habitat information could be pursued to provide more meaningful RSGCN conservation efforts. Taxa teams could be reengaged to link finer scale habitats to RSGCN.

Develop Conservation Opportunity Areas for the Midwest. Conservation Opportunity Areas (COAs) across the region can represent spatially explicit locations with the greatest opportunity to conserve RSGCN with a landscape and watershed lens. Developing and depicting COAs was considered a best practice in the 2015 SWAP revisions, although it was also acknowledged that there is no standard methodology for this (AFWA et al. 2012). However, most Midwest SWAPs contain COAs or other priority habitats in some form and present opportunities to be refined across state boundaries. Enhanced regional COAs could connect prioritized waters and landscapes.

Improve the limiting factors data to inform identification of key Midwest threats and actions. The limiting factor information collected during this project was cursory for the purpose of identifying the most important needs of RSGCN to allow grouping of species by threat theme for more effective conservation. Because limiting factors can be crosswalked to threats, this provides a valuable means to develop actions that address multiple species across taxa that share similar threats. We recommend the IUCN-based conservation actions Conservation Measures Partnership (CMP) taxonomy (Salafsky et al. 2008) for both threats and actions, as did the Northeast Lexicon (Crisfield and NEFWDTC 2013).

Once limiting factors are crosswalked to identify key threats, priority conservation actions can be developed and linked to each of the key threats. These threats in turn are directly linked to RSGCN and their habitats. Paskus et al. (2016) further recommended that the Midwest adopt a repeatable ranking process for prioritizing conservation actions that could be expanded and prioritized to address the key conservation needs of targeted RSGCN (https://www.conservationgateway.org/Files/Pages/action-planning-cap-handb.aspx).

Engage the RSGCN taxa teams to support the existing MLI and WDC organization as needed. The taxa teams could be engaged annually (or intervals deemed most appropriate) to identify emerging threats, status changes, or other issues that need attention for their taxa. Specific suggestions include maintaining updated lists for birds or other taxa (e.g., JV, PIF, MWPARC, AFS, FHP, etc.)

Approach implementation of RSGCN conservation strategically. The RSGCN process/list was effective in identifying regional priorities from almost 3000 SGCN down to 340 RSGCN, 147 Proposed RSGCN, and 364 additional Watchlist species. This still represents a significant number of species. To address this, these priority species can be grouped by habitat, limiting factors, and other strategic ways to represent a more cross-taxa or ecosystem approach. Specific examples of this include:

- Identify functional groups of species that align with the missions and conservation strategies of various agencies and stakeholders. The RSGCN and Watchlist species can be grouped and addressed together by themes, habitat, threats, geography, etc.
- Use RSGCN status and regional responsibility ranks to prioritize conservation action development and implementation. Lower ranks can be a good fit for proactive conservation efforts, often with opportunities for inclusion of more constituencies (e.g., citizen science or landowners) who are engaged and willing to assist.
- Narrow range endemics: support those single/few states in their conservation of endemic species and ask for status, progress, and outcomes annually to show regionally and support for locally implemented conservation of these important species to maintain support for those actions.
- Prioritize shared species by functional groupings (habitat, themes, threats, etc.) and identify the most appropriate entities to implement conservation/ management needs.

Develop consistent, coordinated conservation actions to be applied regionwide. Best management practices, standardized data collection, protocols, procedures, policy, regulation, or law enforcement can be developed at a regional scale and collaboratively implemented. Examples include the development of consistent protocols for:

- Survey/inventory/assessment
- Disease/health/safety
- Collection/handling
- Research and monitoring
- BMPs and other conservation actions

Increased survey and monitoring effort for high concern species is needed, ideally with long-term funding and more consistent protocols. This was an identified need for invertebrate taxa as well as small and meso-mammals in the Midwest, Southeast, and Northeast Regions. Special efforts focused on low detection species and genetic assessments are also needed.

Finally, we recommend the MLI continue its collaborative approach toward RSGCN and wildlife diversity conservation with continued communication amongst its teams and partners. Biweekly communication with our project workgroup was incredibly helpful to maintain input and feedback, and quarterly presentations to other groups including the WDC, MLI Steering Committee, and MLI Habitat Working Group were also very important to provide updates and solicit input. The MLI teams, WDC, and SWAP coordinators maintain regular, effective regional collaboration to promote and sustain a robust, science based, regional conservation network for the Midwest. Valuable outcomes of regional collaboration are further highlighted in the Northeast Conservation Synthesis and Northeast SWAP Synthesis (Terwilliger Consulting, Inc. and NEFWDTC 2013, 2017).