2022 UPDATE: REGIONAL SPECIES OF GREATEST CONSERVATION NEED IN THE MIDWESTERN UNITED STATES

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INTRODUCTION

The Midwest Landscape Initiative (MLI) 2020-2021 effort 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. 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) that are supported primarily by Midwest waters and landscapes.

It creates a recognizable regional stewardship responsibility, implements proactive measures to prevent further declines of common species with conservation concerns and prioritizes imperiled species. The RSGCN list has the potential to spotlight species with population declines or emerging issues for collective conservation actions, fill data gaps, and enhance knowledge of species range-wide distribution, imperilment status, threats, and needed actions.

The objective of the 2022 effort was to take the next step of evaluating the existing data and identifying data gaps for RSGCN to fill priority gaps, update the database with the supplemental information, and then strategically discuss next steps and partnership opportunities for data gaps that remain.

APPROACH

In 2021, upon completion of a draft set of RSGCN lists, Terwilliger Consulting Inc. (TCI) created a Microsoft Access database of limiting factors and vulnerabilities of RSGCN and Proposed RSGCN. TCI pre-populated as much of the database as possible 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 for each species, including data fields on S-Ranks, state listing status, whether the species is a SGCN in their state, and whether the species occurs in their state (regardless of SGCN status). 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 understand that supplementary information on threats, limiting factors and climate as a threat multiplier was still needed, along with a need to identify remaining gaps in the database. The project

attempted to identify limiting factors for RSGCN. TCI worked with taxa experts and climate adaptation experts to formulate a survey that addressed climate-specific threat and limiting factor information for RSGCN. A draft of this survey was sent to taxa and climate adaptation experts in January 2022 for review. An edited, final survey was administered as a macro-enabled, clickable excel worksheet. RSGCN records were extracted from the database and separated into clickable, macro-enabled Microsoft Excel spreadsheets with pull-down lists for 10 taxonomic groups – mammals, fish, birds, herpetofauna, crayfish, mussels, Odonates (dragonflies and damselflies), bees, lepidoptera (butterflies, skippers, and moths), and EPT (mayflies, stoneflies, and caddisflies). Worksheets were pre-populated with RSGCN, proposed-RSGCN, and proposed-watchlist species by the above taxa groups and sent to taxa teams to populate in late February 2022.

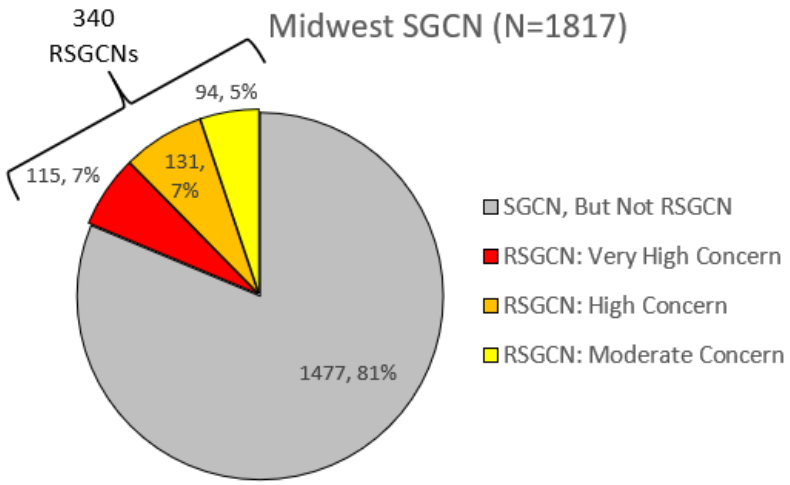
In May 2022, survey responses were merged into a database created by TCI with ongoing quality-control checks to identify duplicate records, correct misspellings, and update taxonomy. The survey asked threat information corresponding to CMP Threats (IUCN Conservation Measures Partnership – Level 3 Threat Categories: https://www.iucnredlist.org/resources/threat-classification-scheme)

In total, the database contained new information for approximately 475 RSGCN/Watchlist Species. Survey questions in their entirety are added in Appendix 1. Once QA/QC was complete, TCI merged survey information into the existing Midwest database and performed a gap analysis in R using count data of cells that were marked “unknown” or cells that were empty. TCI targeted data gaps from this analysis to fill using Natureserve, IUCN, or information from literature searches. The status of the database including new information is presented here.

2021 BACKGROUND INFORMATION - RSGCN

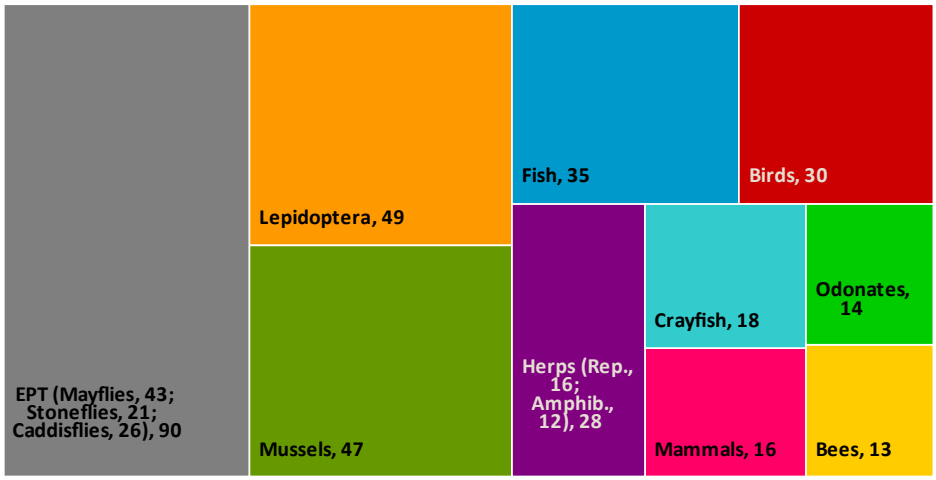
Of the 2740 Species of Greatest Conservation Need (SGCN) listed in Midwest Association of Fish and Wildlife Agencies' (MAFWA) 13 State Wildlife Action Plans (SWAP), teams of taxa experts evaluated 1817 species in 13 taxonomic groups – mammals, birds, reptiles, amphibians, fish, crayfish, mussels, Odonates (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 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 1. Number and percent of Midwest SGCN in evaluated taxa that are RSGCN, by Concern Levels.



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

Figure 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 3 and Table 1).

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

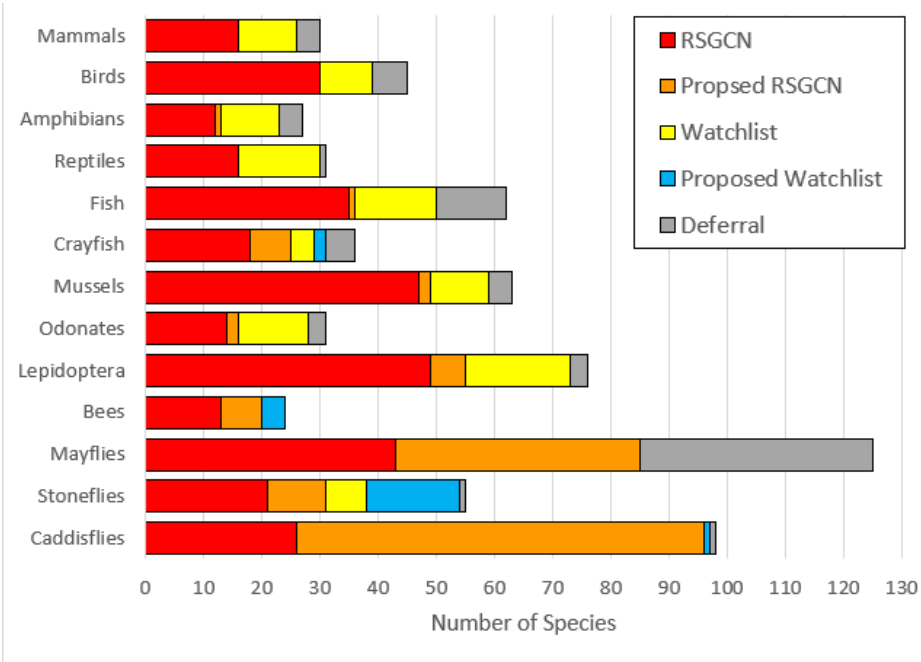


Table 1. Number of species that are RSGCN, Proposed RSGCN, RSGCN Watchlist, Proposed RSGCN Watchlist, and Watchlist Deferrals to adjacent regions, by taxa.

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**

RESULTS: 2022 SURVEY: FILLING PRIORITY DATA GAPS (THREATS, ACTIONS, LIMITING FACTORS)

The 2022 survey was sent to 165 taxa experts, and 38 survey responses were completed (23% response rate). All major taxa groups were accounted for and 100% of RSGCN have, at the minimum, information as to whether they are data deficient or, rather, if the information is unknown to the expert. **Survey questions are found in Appendix 1**. The survey topics contained questions that related to:

- Habitat related limiting factors and climate interactions
- Food related limiting factors and climate interactions
- Ecology, behavior and life history limiting factors and climate interactions
- Top 3 threats and climate interactions
- Research and monitoring needs
- Barriers to Management/Action

Table 2 shows the number of species on each survey by taxa and the states responding. It is important to note that bees, crayfish and EPT received few total responses from taxa experts, and that parts of the Midwest may therefore not be represented in the responses based on

availability of taxa expert time/availability to respond. The survey response rate is the percent of taxa experts we sent the survey to vs. those that responded, indicating, for example, 5% of bee experts were able to respond to this survey. The highest response rate was for herpetofauna, with 44% of taxa experts responding. We counted partial survey responses as responses. In total, new information was acquired for 475 out of 481 RSGCN/Proposed RSGCN/Watchlist/Proposed Watchlist species, although we include checkboxes of "data-deficiency" as new information.

Table 2. Number of 2022 Survey Responses (surveys returned with information, regardless of completeness) by state and taxa, number of species being responded to in some capacity, and percentage of species with at least 1 selection of data deficiency.

Taxa	Survey Response Rate	Total Responses	N Spp.	Percent Spp. Selected to be Data Deficient in ther Entirety
Bees	5	1	24	67
Mammal	27	4	26	67
Odonate	38	3	28	21
Cray	14	2	31	90
Bird	29	6	39	5
Fish	29	4	50	0
Herps	44	8	53	7
Mussel	20	3	59	100
Lep	24	6	74	7
EPT	8	1	97	100

*Note low survey totals for Bees, Crayfish, EPT (n<2)

RESULTS- KEY TAKEAWAYS

Results of the survey indicated that experts provided most information on classifying habitat, habitat related limiting factors questions, food limiting factor questions, and barriers to management action. For most taxonomic groups, experts readily distinguished "data deficiency" for the species in its entirety vs. their own uncertainty, and readily chose "unknown to me" for many individual questions, which allows us to better understand experts' opinions on opportunities for research and collaboration vs. opportunities for data-scraping from reputable sources.

Taxa experts were able to provide more information on top threats and whether they were aware of climate related amplifiers to these threats. Experts were also able to contribute knowledge on interactive effects of climate change on other limiting factors, although this was the least known subset of questions. Experts tended to err on the side of caution and stated if they were unsure due to the changing nature of the state of the science on climate change. This indicated that there is opportunity for regional efforts and discussion for taxa teams surrounding the topics of climate amplifiers, sources of uncertainty, and ways of addressing

uncertainty at regional levels, especially from states that are witnessing climate events at disparate frequency or severity. Taxa experts seemed to continuously note that there is a need/opportunity for coordinated effort on disseminating indirect and direct effects of climate on RSGCN to overburdened/time-deficient managers, but also that there is still much need surrounding basic information on many RSGCN and without this information, it is unrealistic to know climate related impacts without major uncertainty**.**

Certain taxa groups were deemed to be data deficient for most or all species contained within those taxa. This included EPT, mussels, and crayfish. Odonates had a relatively low selection of data-deficient species (21%), but experts also checked nearly 80% of the "unknown to me" boxes, indicating Odonates might be high ranking for data-deficiency. Mussel-related data deficiency was driven by expert's need for information related to host-fish interactions and ecology. EPT data-deficiency was driven by a lack of basic information, and basic research needs on ecology, life history, and distribution before being able to answer questions related to changing landscapes, limiting factors, and threats.

An example of the lack of information or status of taxa experts' knowledge about climate change on their taxa groups is demonstrated in below responses to the survey:

EPT: "Data are deficient for every single species. The larva is unknown for many species, and specific larval life history data are unknown for nearly all of them. Thus, we are left with only rudimentary associations between adults and the habitats that they have been collected. Likewise, comparing contemporary distributions with historical distributions is challenging due to unclear and unequal sampling effort, loss or destruction of specimens, or other uncertainty (e.g., misidentification) about the validity of records. Most of the drop-down menus on the spreadsheet either don't apply or else reflect data that are not known. Thus, I have ignored nearly all of them and instead condensed known distribution data in the 'additional comments' section. Many of the distribution data are taken from published sources. Additional distribution data from various unpublished databases are included in a 'supplemental data' spreadsheet. If we are serious about EPT conservation, then we need to get serious about funding the studies that provide the data necessary to do it properly. Substantial basic distribution studies are still needed, as are studies on larval association, life history, and habitat requirements."

Birds: "Regarding climate change slant to some of the questions – I think that we cannot escape that climate change is an important concern. However, habitat loss remains the number one concern for many birds and other species of concern. And, the more habitat loss, the more loss of carbon sinks, and the more it contributes to climate change. But in some cases, climate change may not matter for certain species if critical habitat is gone. Invasive pest species on native vegetation are a major concern for many habitats – again, most of these threats are immediate and continuing to spread because of global change/global transportation of these

species, and I'm not sure how much climate change is contributing to some of these issues in the short-term, and the long-term impacts are potentially hard to predict. However, this is outside my expertise."

Mussels: "A general lack of data on this species' ecology makes it difficult to predict how climate change will impact this species directly, or via its interactions with fish hosts."

RESULTS – DATA IMPROVEMENTS AND DATA GAPS

Surveys were aggregated, QA/QC checked, and entered into the MW database. This allowed us to update and further analyze results to better visualize current data gaps and opportunities for collaboration and continuous data improvement. The bar charts below represent the current amount of information for taxa groups and are a representative sample of the major subjects/questions in the database. Current amounts of knowledge on these subjects correlate to finer information about habitats, ecology, limiting factors, etc.

Key takeaways: primary habitat classification exists in the database for nearly every RSGCN, proposed RSGCN, and proposed watchlist species. Knowledge on secondary and tertiary habitat classifications varied by taxa and reflect taxa that are broader in the habitat types they utilize. For instance, mussels have few selected tertiary habitat types, but they only inhabit aquatic environments.

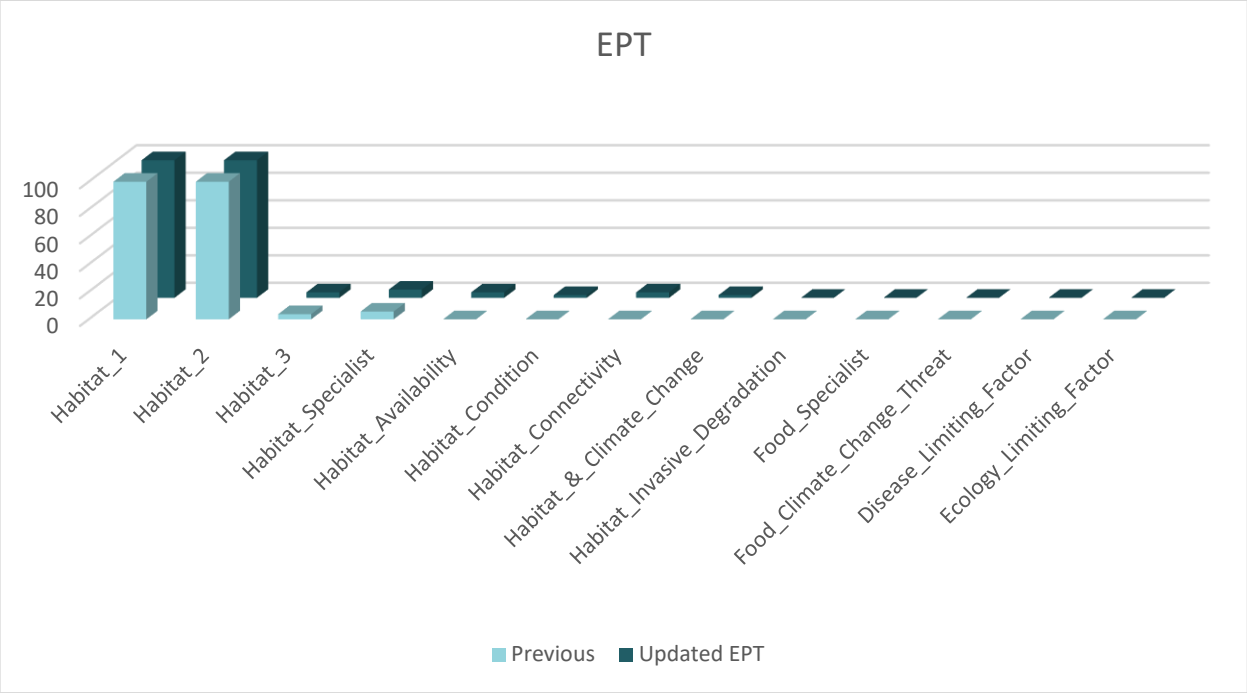
Habitat related questions remain the most populated component of the RSGCN database, with taxa experts filling data gaps on average, 60-80% of information on questions about habitat specialization, availability, condition, and connectivity. The least answered questions were related to complicated climate-interactions or climate and management.

The survey contributed most to an increase in knowledge about climate-related interactive effects on threats or limiting factors, with all taxa groups seeing improvements related to food specialization and climate change, disease as a limiting factor, and ecological relationship related limiting factor questions. More information was provided for questions about invasive species and interactive effects of climate change and habitat, as well as primary threats, most important management actions, maladaptive management, and barriers to action.

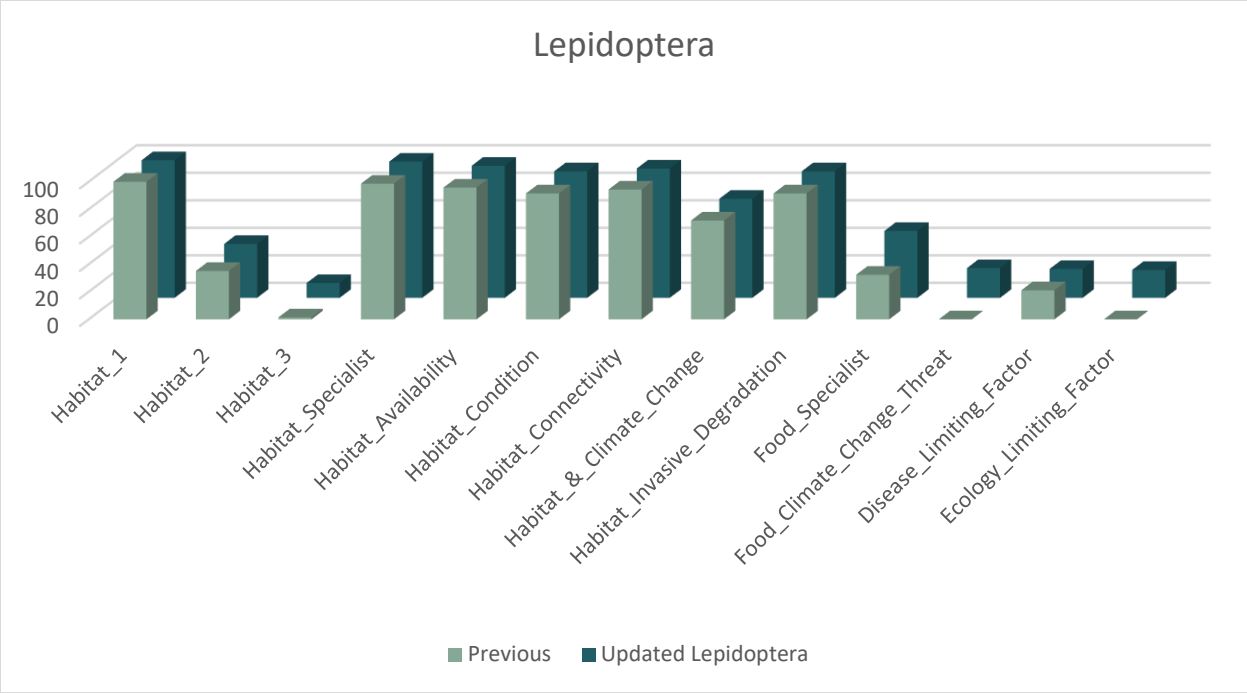
Key data gaps remain:

All taxa: data gaps remain regarding emerging climate-related disease/pest/pathogens and the alteration of native disease/pests/pathogens. Ecological questions remain for all taxa regarding the decoupling of food/nectar resources, host resources, phenological changes, and emerging competition from climate migrants. Taxa experts tended to comment on habitat degradation, connectivity, and loss as amplified by climate change.

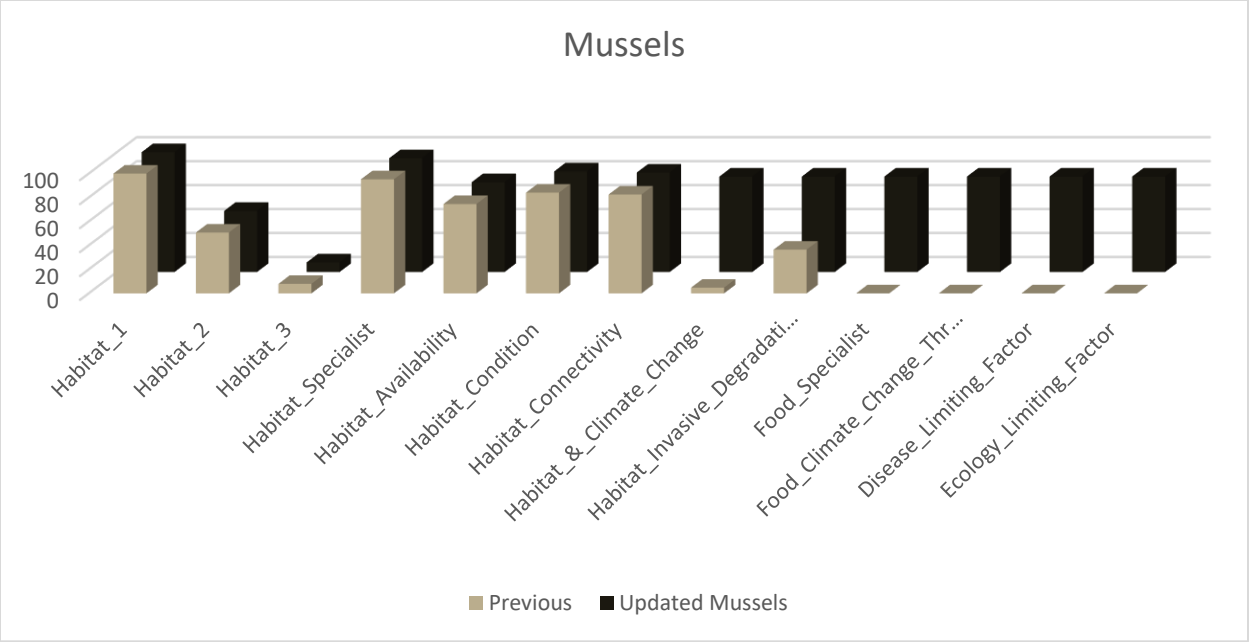
Figures 4-14. Percent of Key Limiting Factor Data Filled in Midwest Database by Taxa Group. Bars represent the percentage of information accounted for in the database for all the RSGCN of that taxa group. For example 80% = "80/100 species have an answer for whether they are a habitat specialist, etc." Figures are presented by greatest to least number of RSGCN per taxa as per Figure 2.



EPT: EPT remain the most data-deficient taxa group, with experts commenting that basic information on distribution and ecology is needed above and beyond anything related to shifting stressors, habitat or climate. Experts did note that preserving upstream habitats was vital. There is potential coordinated opportunity for EPT to serve as an indicator of large scale riparian connectivity and health. A taxa expert noted: "Nearly all perceived threats to conservation are best educated guesses. We lack rigorous data on diet, life history, specific habitat needs, predators, parasites, fecundity, dispersal corridors, phenotypic plasticity, responses to individual pollutants, etc. for vitually all caddisfly species. Thus, conservation assessments are based primarily on general distribution data, the specific types of habitats where species have been found, and anecdotal observations. The common overarching threats to nearly every species are aquatic pollution, modifications to the riparian corridor, and (probably most importantly) upstream habitat loss." TCI performed a basic Web of Science literature search for EPT RSGCN, and opportunity exists to find additional information on ecology, limiting factors, and threats.

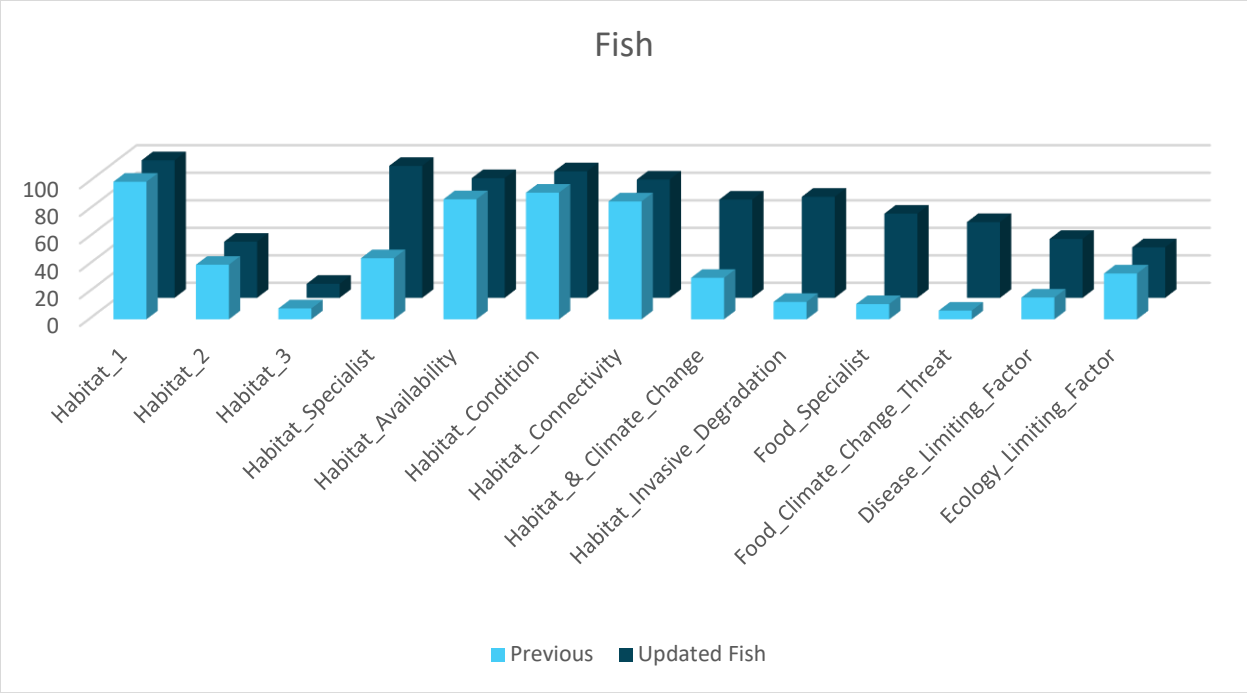


Lepidoptera: Experts commented on the lack of knowledge regarding indirect climate effects. For example, host plant population dynamics and altered habitat from changing fire regimes and development, or invasive plant migration causing habitat degradation. Fine-scale habitat components, including soil and host plant phenology were mentioned as uncertain stressors. Basic information on distribution, ecology, changing climate envelopes, population reaction from fire management or succession, and fragmented populations was mentioned. Comments also included potential "bright spots" regarding human behavioral change and conservation of pollinators through education and community programs. Stressors related to both long and short distance migration/connectivity were mentioned for birds, herps, and lepidoptera.

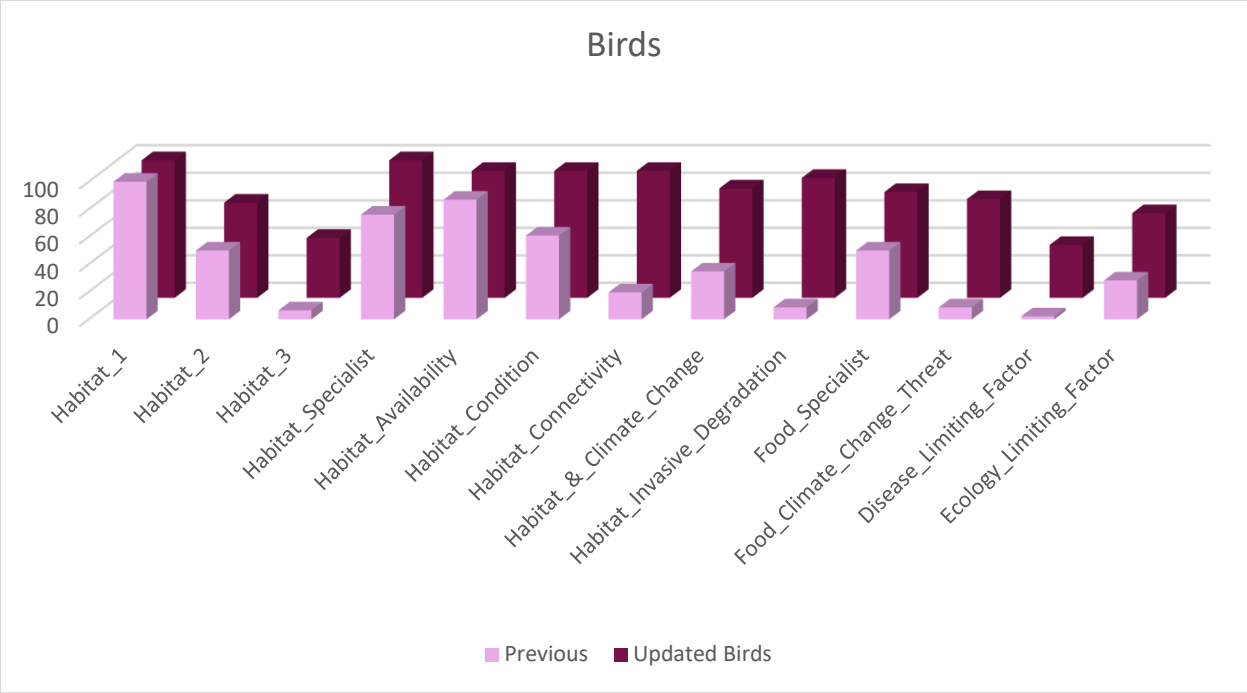


Mussels: Although mussel data have improved due to the additional survey effort, experts commented on their lack of knowledge regarding indirect climate effects on mussels. Much information is still needed about species' ecology including habitat requirements, interactions with fish hosts, susceptibility to changes in water conditions, and potential interactions with pathogens/invasive competitors. For example, knowledge on host fish population dynamics and physiological thresholds/cold water refugia, or climate envelopes changing and allowing for invasive species to alter host fish population dynamics. Dense housing & urban areas, commercial & industrial areas, and low-density housing areas were mentioned as important aspects of conservation.

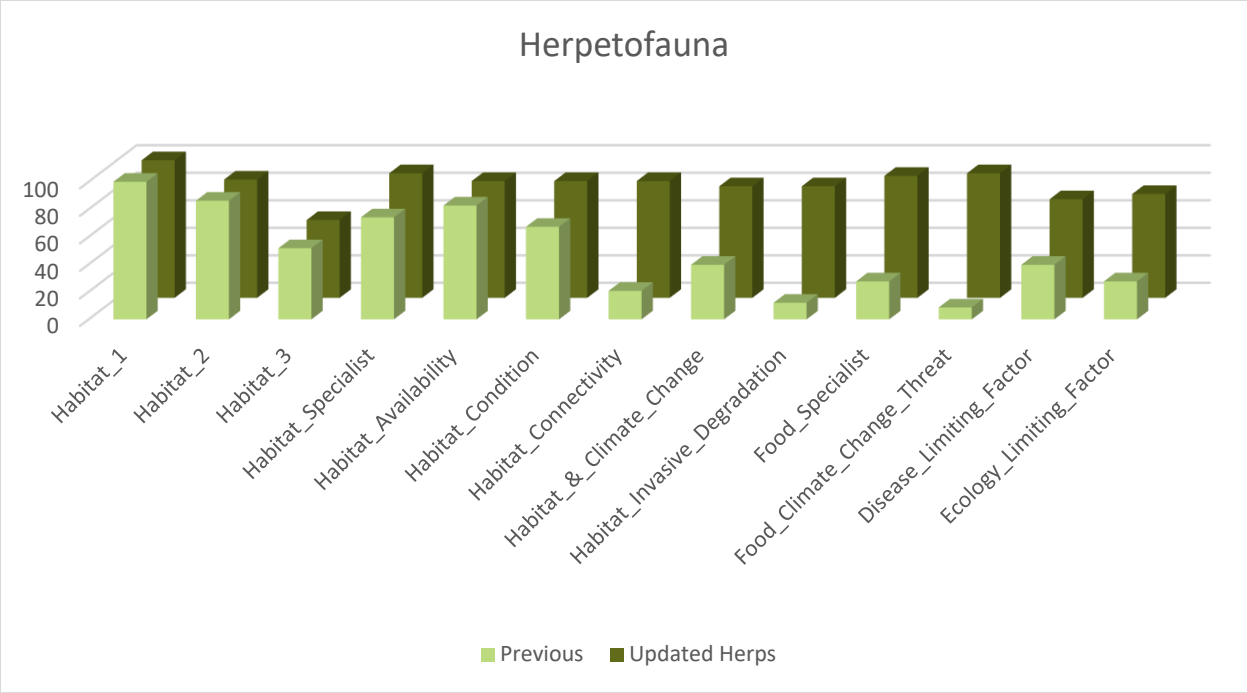
One expert noted: “My work has indicated lower priority threats include % of catchment area classified as crop land use within 100m buffer of rivers/streams, mean surface runoff within stream catchments, and road crossings at watershed and catchment-level spatial scales. My work has found that percent low intensity/open land use within 100m buffers of streams/rivers, as well as watershed mine and canal/pipeline/ditch densities, are highly influential on mussel occurrence (across multiple mussel species). Factors that either reduce % low intensity/open land use or increase mine/canal/pipeline densities should be considered additional threats”. Priority management needs/opportunities included survey/sampling and data collection methods standardized across the region, maintaining open- to low-intensity land use within 100m of streams/rivers, managing chemical runoff from agriculture/mining, managing flow during low precipitation periods, and managing habitat connectivity. Experts recommended focusing on regional approach to species management, then on stream-specific populations. Data deficiency on species' ecology is a huge detriment to effective conservation of mussels.



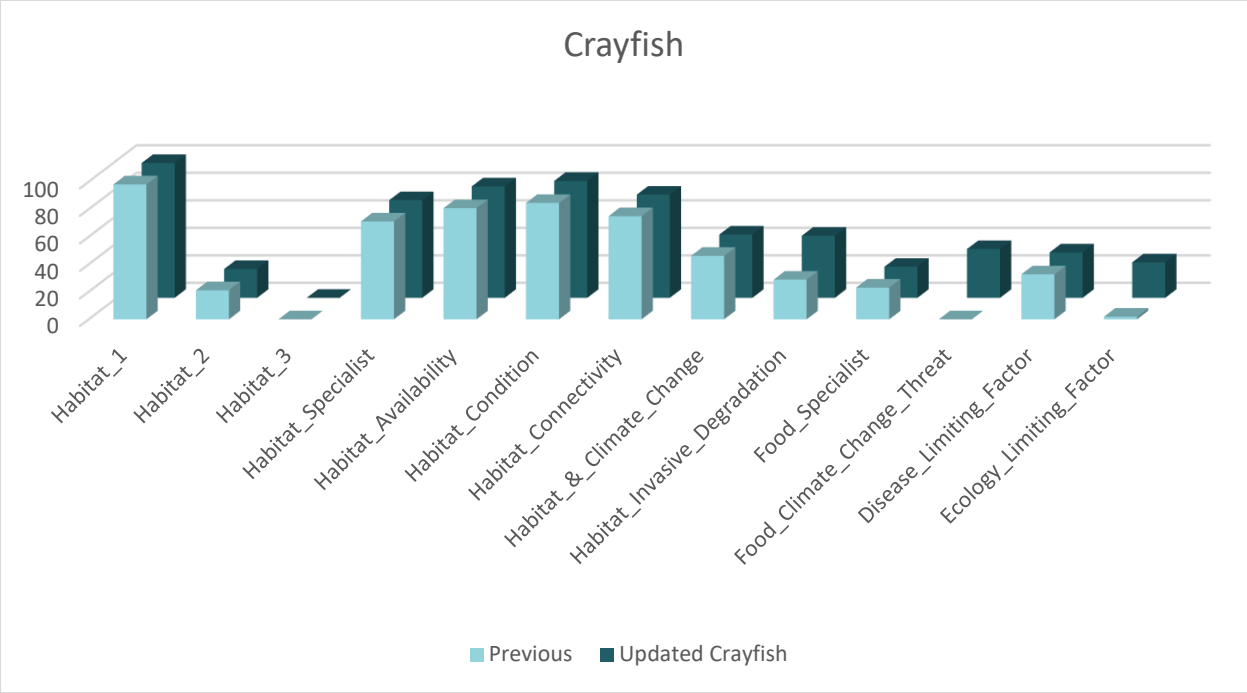
Fish: Experts commented on barriers to conservation being data deficiency, uncertainty of pace/type/magnitude of climate impacts, and a general lack of resources. One expert commented that many species are “data limited – a lack of standardized surveys to look at population trends, habitat preferences, food source availablility” and “a lot of these questions are difficult to answer as there is such a lack of information on many of the species listed to assess potential impacts,threats, and management strategies”. Experts suggested region-wide opportunity to implement/standardize BMP's within riparian areas, reduce stocking strategies for sportfish, ensure instream diverse habitats, and maintain base streamflows. Major threats mentioned were related to water management using culverts, drainage in agricultural environments, withdrawal of groundwater, and factors associated with removal of forest. Experts noted that most of these were exacerbated by climate change.



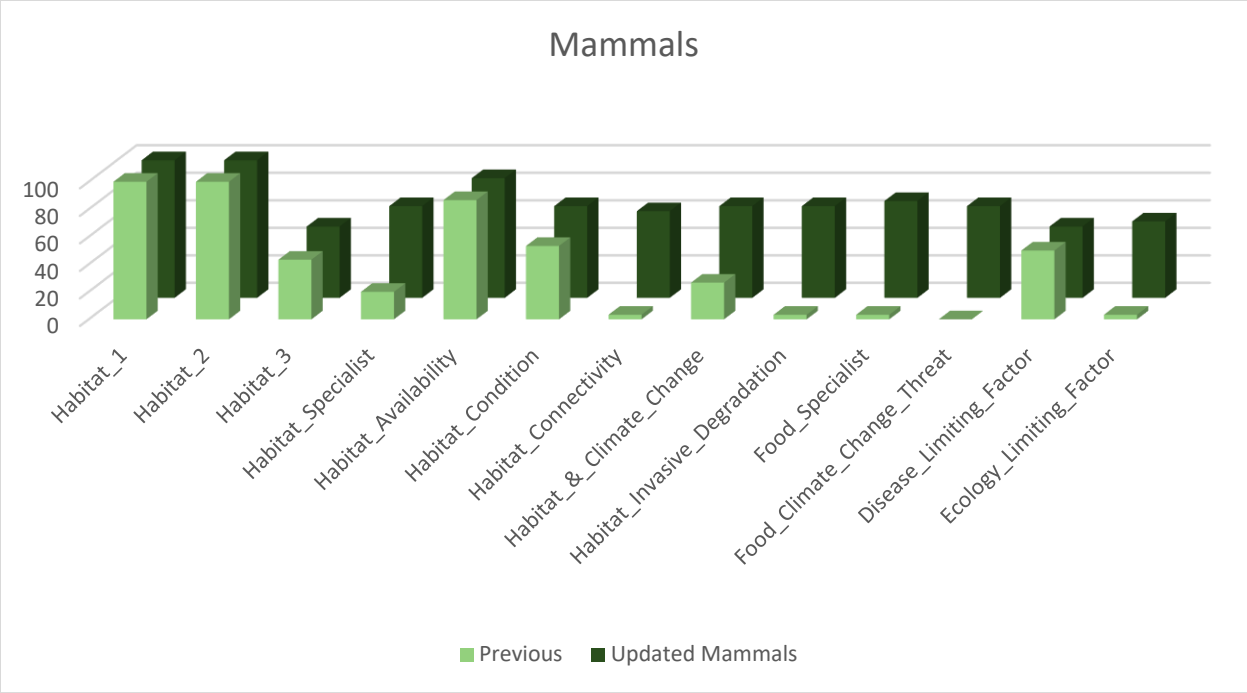
Birds: regional opportunity exists in discussion and conservation of the unique needs of neotropical migrants, specifically, management of breeding, migratory stopover, and non-breeding habitats, including bird-safe cities. Priority monitoring needs included nest occurrence and productivity, causes of nest loss, and habitat utilization in urban areas. Major sources of uncertainty included predation and nest parasitization changes, basic ecology of secretive marsh/grassland birds, effects of grassland stressors and management on nesting and brood-rearing, and annual variations in nesting colony locations. Barriers to conservation were incredibly varied and included: loss of natural flow regimes on rivers; competing uses of rivers; water pollution that may affect prey fish, nesting locations and success/fidelity, nesting along Missouri River competes with other reservoir uses, such as irrigation, flood control and recreation, multiple use of many grouse nesting areas; conflicts with livestock grazing needs, especially during droughts. Two comments to note are: “this species is not rare enough to generate much interest in much of its range”, and “many migratory stopovers on private land that are not always accessible for monitoring the birds' safety”.



Herpetofauna: Herpetofauna were one of the most diverse taxonomic groups in terms of threats, management actions, and sources of uncertainty. Experts were engaged and provided the most responses of any survey group. Examples of noted management actions included: maintain ephemeral ponds, stop farm runoff and subsidized predators (raccoons), educating puplic not to kill, reduce/stop erosion, maintain water tables, keep sand areas open. Climate amplified nearly all stressors, including emerging diseases like Ranavirus and Chytrid, habitat fragmentation (especially the vulnerability of emphemeral pools and grasslands), and thermal refugia. Human disturbance was largely commented on for this species moreso than any other, including road/recreational trail mortality, habitat encroachment, collection for the pet trade, and mortality caused from pets. Experts noted there is great need for regional platforms for communication about fragmented populations and behavioral/population changes and conservation efforts that can be leveraged at regional scales.



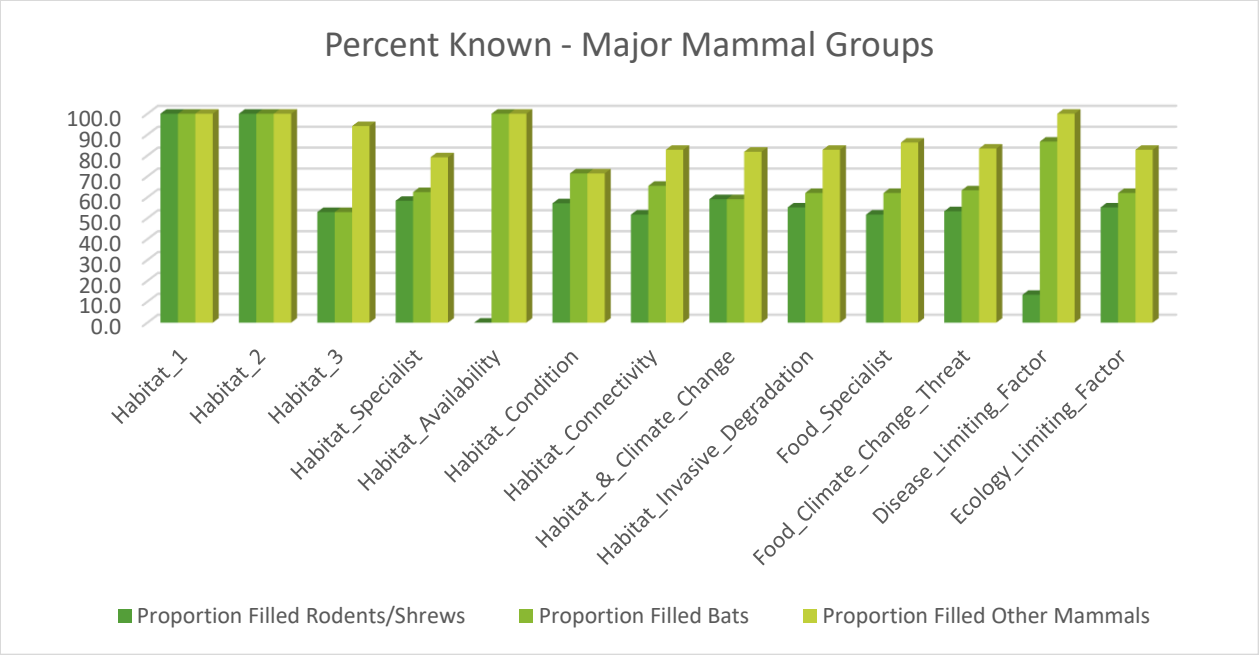
Crayfish: Additional opportunities exist to improve base knowledge for crayfish related to interactions of climate on ecological relationships, climate and habitat degradation on physiology and base knowledge on invasive species, distributions and ecology. Major threats were the displacement of native species by an invasive crayfish (*Faxonius hylas*), and concern about drought-induced reduction of small and intermittent streams. Management and conservation concerns noted were riparian protection, coordinated effort on “best management practies" designed to reduce inputs of silt and fine sediments to stream, water table management, warming temperatures (from climate or runoff/anthropogenic sources/changes in stream hydrology or loss in forest cover).



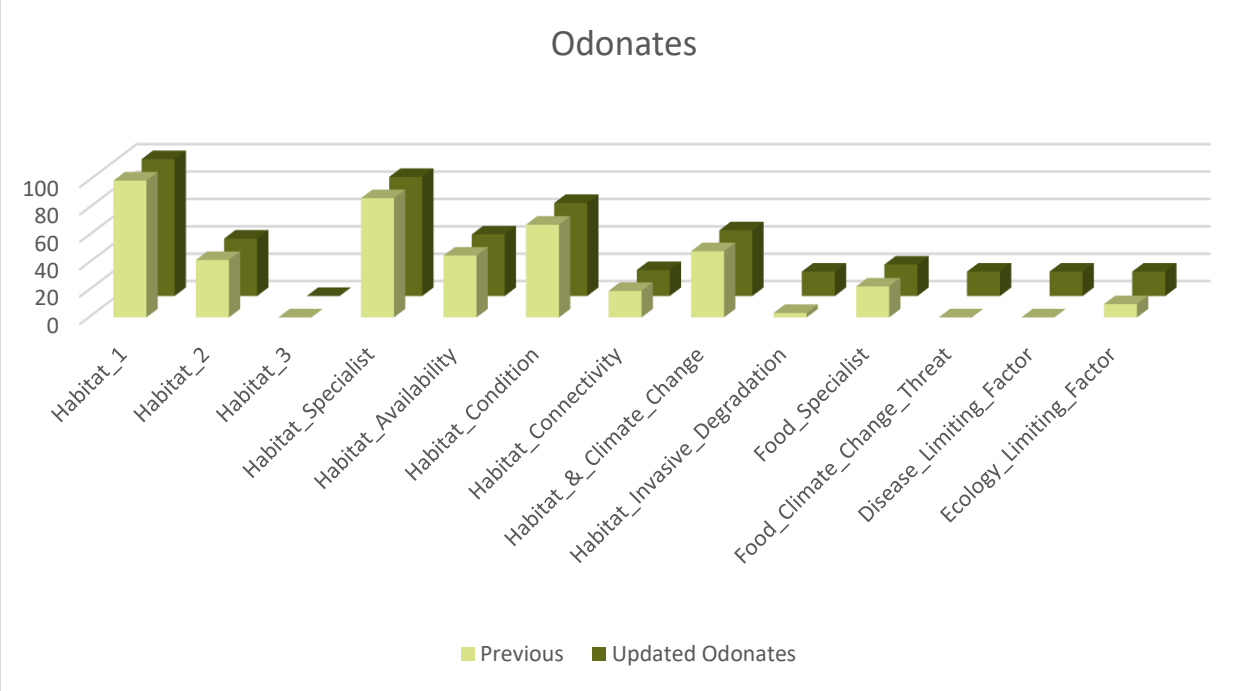
Mammals: information provided remains low in non-habitat related data. The majority of this data gap reflects uncertainties about small-mammal ecology including bats, especially as it relates to climate change, population cycles/population dynamics, climate refugia, and disease/pests/pathogens.

Experts noted a need for coordinated effort on abundance of riparian corridors at landscape levels, regional communication on cave vulnerabilities (stable temperatures, human encroachment), and forest health analysis for specific habitat structural components such as down and dead woody debris, and large tracts of forest. There may be opportunity for regional discussion on leveraging conservation efforts directed at large mammals and the secondary provision of climate connectivity/refugia, as major ongoing active management activities including maintaining connectivity, vegetative control, and protecting climate refugia.

Experts also commented on climate change exacerbating invasive species in grasslands, and a proactive approach needed to address climate migration to cooler caves in bat populations, and the potential to spread disease. Climate change exacerbated the main threats listed for most mammals, notably changes related to forest cover and habitat loss. Priority monitoring needs were the assessment of distributions and seasonal movement changes/abilities with a changing landscape, and the monitoring and protection of hibernacula. Management barriers included competing demands on managers, lack of resources, uncertainty of the pace/type/magnitude of climate impacts. One expert noted: “the simple lack of financial resources to hire staff, conduct proper surveys and inventories, and purchase materials needed for proper landscape/habitat management” as a major issue.

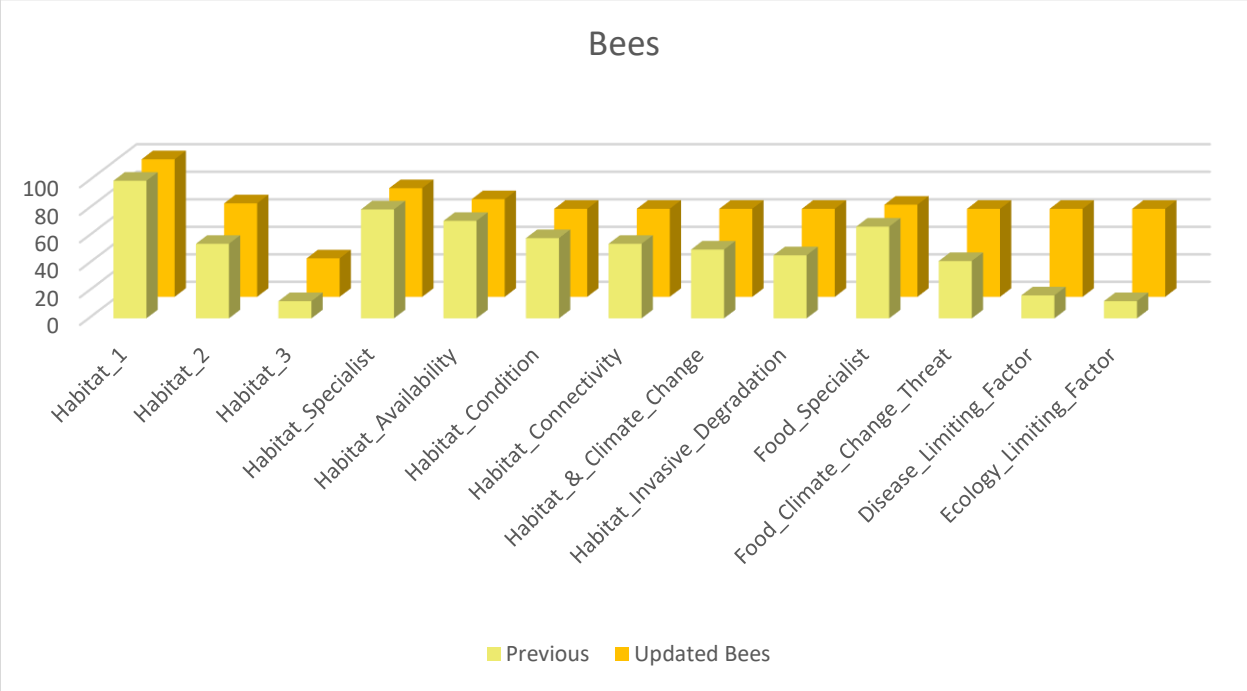


Further breakdown of the current data gaps in mammals, grouped by bats, small mammals and others (skunks, foxes, rabbits) shows the biggest data gaps remain in small mammals and ecology, disease as a limiting factor, and habitat information.



Odonates: Odonates continue to have opportunities to improve base knowledge related to interactions of climate on ecological relationships, climate and habitat degradation on physiology and base knowledge on invasive species and ecology. For Odonates, experts noted

more research is needed on specific habitat components and vulnerabilities of wet seeps in forested areas and vulnerabilities associated with bogs and fens. Major issues compounding threats addressed were continued population fragmentation or scattered populations. Odonates are second only to EPT on data needs.



Bees: A suite of fine-scale habitat components plus high-site fidelity and small home ranges outside of migration uniquely separate the lepidoptera and bee threats/limiting factors from other taxa groups, for example: “composite specialists, sand obligates, grasslands with abundant floral resources spring thru fall, areas rich in legume species, grassland/savanna with Dalea plant species, gravelly/sandy, older glacier habitats”. Regional opportunity exists in coordinating high-quality prairie remnant-dependent pollinator conservation. Experts commented on the lack of knowledge regarding indirect climate effects. For example, host plant population dynamics/phenological changes and altered habitat from changing fire regimes and development, or invasive plant migration causing habitat degradation and endangerment of pollen-dependent hosts. Vegetation succession, terrestrial plants, and herbicides & pesticides were the main listed threats. Major barrier comments included: *“more resources needed for management (protecting and increasing habitat with floral resources throughout the season) and surveys/monitoring/research, and the tracking of commercial bumble bee placement in states with extant B. affinis populations; working with EPA to reduce harmful pesticides.”*

RESULTS- KEY TAKEAWAYS - HABITAT

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. Survey results mirrored previous categories of taxonomic groups and habitats.

Of the **terrestrial habitat** types, grasslands and forests support the greatest number of RSGCN taxa, while soil and shrublands support the fewest (Figure 15). 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).

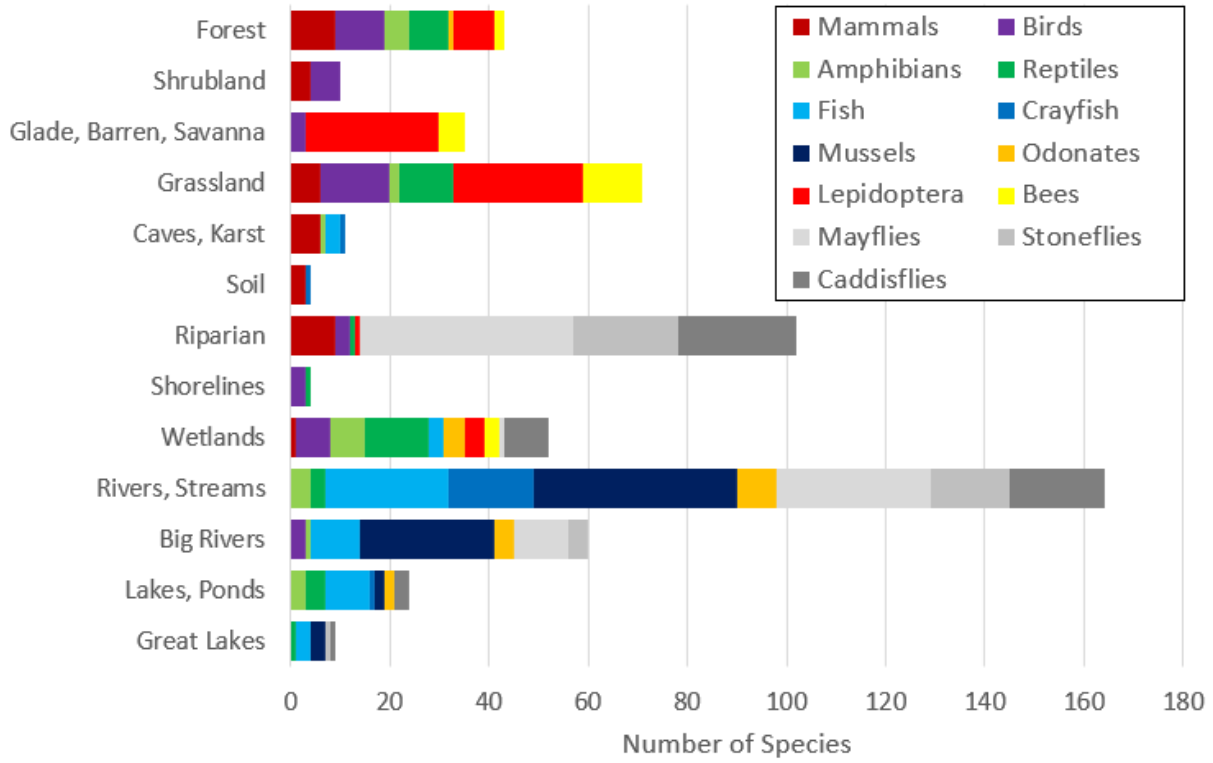
All of the **aquatic habitat** types are diverse, with rivers and streams supporting the most RSGCN diversity (Figure 15). Thirty-three of these RSGCN are considered habitat specialists, with nearly one third of the RSGCN species occurring only in river and stream habitats. The taxa teams identified 102 RSGCN that utilize riparian habitats, many of which are benthic macroinvertebrates.

Rivers and streams, riparian and wetland habitats have been specifically mentioned in taxa expert comments regarding management and coordinated effort, with potential for functional assemblages to be used as a strategic climate-smart management planning tool. A range of landscape and local environmental factors, including invasion, interact with species functional diversity and trait composition to shape biodiversity patterns and ecosystem function of wetlands. A trait-based, mechanistic understanding of community assembly and potential resiliency of actors holds promise for linking rivers and streams, riparian and wetland habitats. This linkage can be threat-focused, and species focused to provide conservation portfolios as threats become amplified or better known.

Grassland habitats have been mentioned at length in taxa expert comments about vulnerabilities, monitoring needs, management uncertainty, and climate-amplified threats of birds, herpetofauna, lepidoptera, bees and mammals. Grasslands in the Midwest may also have great potential for using functional assemblages to be used as a strategic climate-smart management planning tool.

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.

Figure 15. Number of RSGCN (by taxa) associated with each natural habitat type.



RESULTS- KEY TAKEAWAYS - THREATS AND MANAGEMENT

This additional follow up step in the project attempted to further identify limiting factors, interactions between limiting factors and climate change, major threats, and management barriers and actions for RSGCN through the survey instrument. However, this effort was limited by available time and capacity of taxa experts. The survey attempted to further identify specific threats using the Conservation Measures Partnership Level 3 Threat Categories.

Threat trends varied greatly by taxonomic group (Appendix 2). The summary table below indicates that drought, changes in vegetation/vegetative succession, and herbicides/pesticides were considered relatively more important factors limiting terrestrial RSGCN, whereas soil erosion/sedimentation, removal of forest vegetation, and agricultural drainage were considered relatively more important for aquatic species (Figure 16 and Appendix 2). Categories in Figure 16 represent threats that affect the most taxa groups (N columns within each threat category), and threats that are considered high within taxa groups (height of columns). These can also be envisioned as threat assemblages, or major taxa groups affected by the same threats. Herpetofauna and birds had the most threat categories listed (Table 3).

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.

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.

Figure 16. Major CMP Threat Categories identified by the taxa experts for each of the taxonomic groups. Percentages indicate the relative frequency of selected threat categories for each taxonomic group. Due to some surveys having low responses, values for bees, crayfish, mussels, and Odonates may be inflated or change with more complete information. Note that EPT are not included in this list, as no threat information was provided directly.

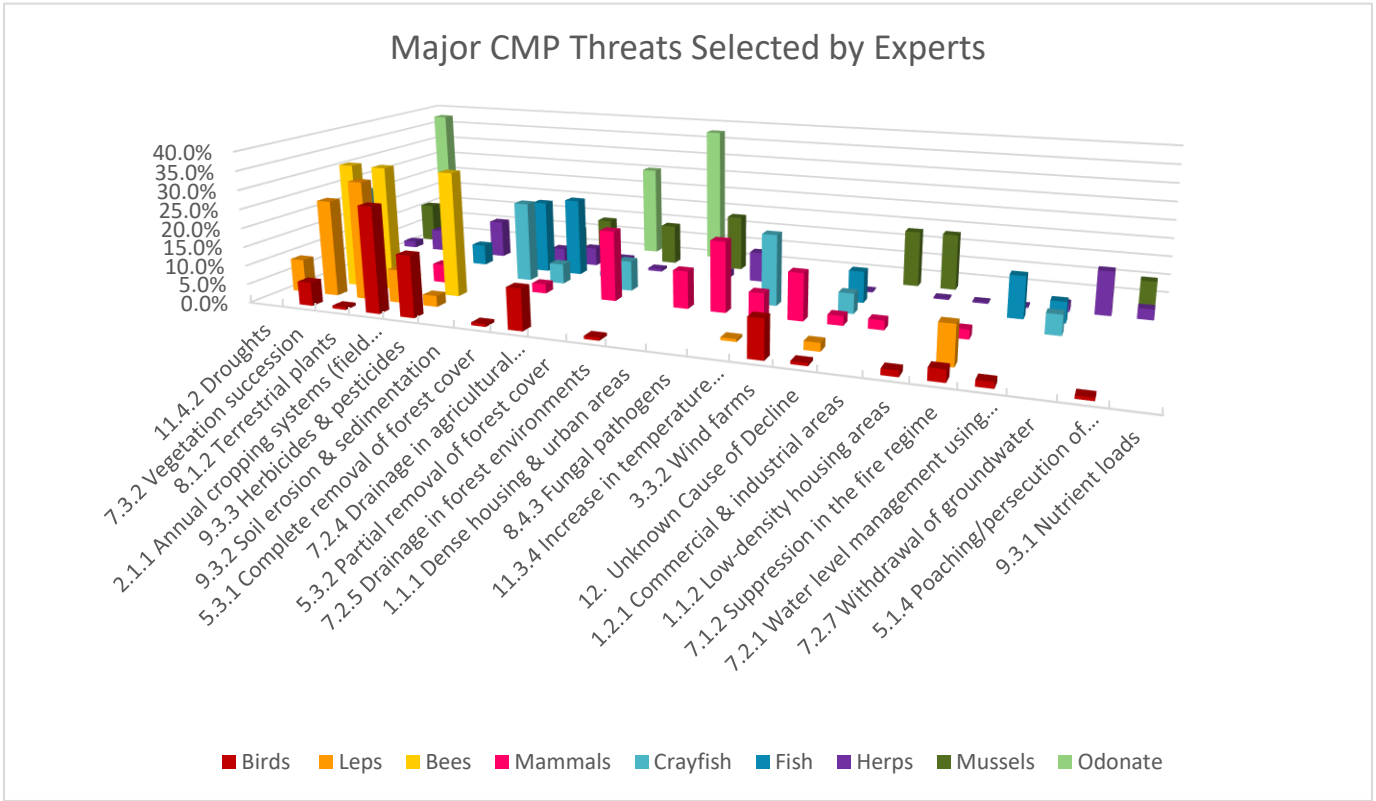


Figure 17. All Reported CMP Threat Categories identified by the taxa experts for each of the taxonomic groups. Percentages indicate the relative frequency of selected threat categories for each taxonomic group. Due to some surveys having low responses, values for bees, crayfish, mussels, and Odonates may be inflated or change with more complete information. Note that EPT are not included in this lists no threat information was provided directly.

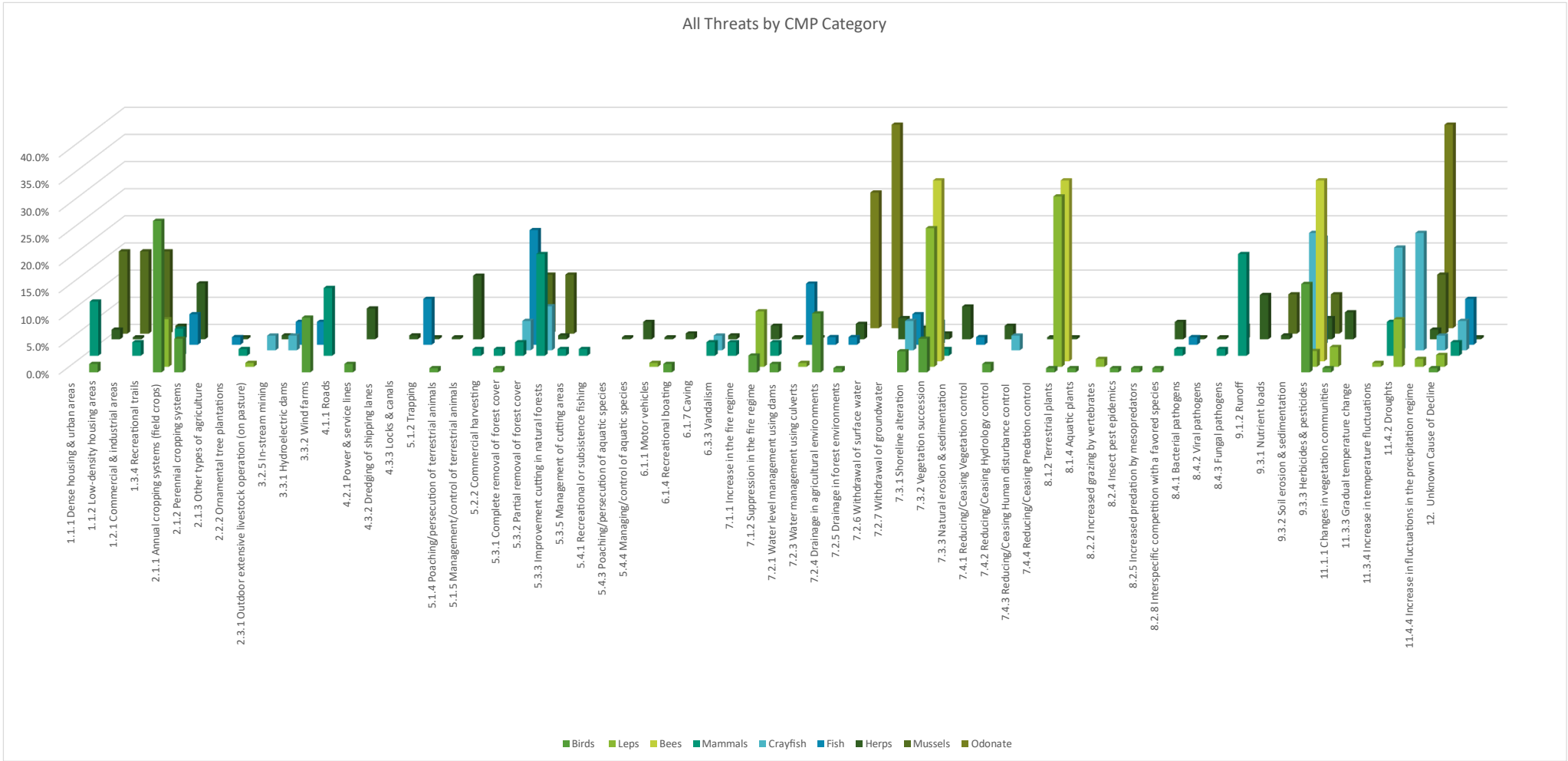


Table 3. Total number of CMP Threat Categories selected by taxa experts for each taxonomic group. Herpetofauna, Birds and Mammals had high numbers of differing threats. A complete list of threat categories is in Appendix 2.

Taxa Group	N Threat Categories Selected
Herps	41
Birds	23
Mammals	21
Fish	15
Leps	14
Crayfish	12
Mussels	9
Bees	3
Odonate	3

DISCUSSION

We have identified several key taxa groups, habitats and threats that are reasonably high priority for regional efforts or regional opportunities:

1. Taxa specific:
    a. All aspects of EPT ecology and distribution, mussel ecology with host fish, and Odonate ecology
    b. Mammals: small mammal communities in grasslands and their threats: discussions on summer burns as maladaptive and invasive species. Bat movement, thermal refugia and disease ecology. Large scale connectivity and leveraging conservation efforts with climate refugia for other species/taxa.
    c. Coordinated effort on large and small-distance migratory assemblages: For example, taxa experts identified opportunities for coordinated efforts on prairie remnants and migratory butterflies and grassland-obligate bird species, herpetofauna that migrate to very different habitat-types seasonally, fish assemblages and thermal refugia.
    d. Leveraging multiple conservation goals across taxa groups using large-scale, climate-smart connectivity
2. Management specific:
    a. In the face of climate uncertainty and threat multipliers, a thoughtful and robust regional discussion on maladaptive management practices moving forward, and the suites of species under similar barriers to management action.
    b. Public-facing efforts from bee and butterfly conservation success stories could be scaled for herpetofauna communication-specific threats.

Lastly, we have measured importance based on data needs and based on shared priority species between conservation entities. A third category of priority can be ecologically based (using functional assemblages).

NEXT STEPS/RECOMMMENDATIONS

Key Partnership Opportunities:

EPT and Odonates: Jason Bried from the University of Illinois has put forth a proposal to integrate Midwest CASC priorities with the recently launched Midwest Landscape Initiative and Midwest Drought Early Warning System to improve understanding of biological consequences, and identify potential bioindicators, of precipitation extremes across the region. This will go far to improve data gaps for target invertebrate taxa (although not all MWRSGCN) (freshwater mussels, crayfish, mayflies, stoneflies, caddisflies, dragonflies) for distribution records, vulnerability traits, and climate variables. This is an important step towards filling those important aquatic invertebrate gaps but there is more to be done as indicated by the gap analyses.

Other Priorities moving forward include:

1. Data gaps in the RSGCN database should be filled to analyze species conservation need via habitat and threats, while also searching for more life history information on data deficient species. Priority data gaps can be addressed data scraping of literature, species status assessments, IUCN data, and published workplans. A soft literature search provided information related to climate-interactive effects on EPT and freshwater mussels and mussel hosts, as well as phenology and range shifts with pollinator-host relationships. Several options exist to research and compile these data and finding the best experts available to accomplish this is one of the first steps.

2. Using these targets, species, and habitats along with their known threat information to design the most effective actions with climate change in mind. The current state of the database is such that it can be used to create formulas for suggested action and emulate efforts like Jason Bried's proposal. We see this potential in ecoregions within the Midwest, for example, Great Lakes States, prairie remnant states, and climate corridor regions using some of the targets listed in the discussion, and a consortium of taxa-experts, climate experts, and social scientists. States can identify opportunities to collaborate with neighboring states on shared RSGCN. Indiana and Illinois have the highest number of RSGCN 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. 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.

3. Refining a method to track conservation status changes over time within the RSGCN process with taxa expert confirmation will be important. The deferral categories and USGS workplan species also indicate the need for follow up and coordination across the regions and their conservation priorities. Building an action tracking method that is informed by changing conservation status, threats, and management could mobilize the region under an adaptive management framework while tracking what conservation actions are working most effectively.

4. Developing a scoring system for priority species based on gaps in available knowledge, the number of workplans the species is listed under, known threat levels, and ecological or ecological service roles could be explored. 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. 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**. Efforts could also focus on shared great lakes assemblages, shared grassland/tallgrass prairie connectivity, and region-wide assemblages of “fine-filter” species: those that are resource specialists; and functional assemblages: described here as species that perpetuate the structure and functioning of ecosystems to maintain ecological resilience and niche diversity.

Lastly, it is vital to include partners like MWCASC and others (MWPARC, Joint Fire Science Consortium, Partners in Flight, TWS/AFS regional chapters and universities) to help prioritize climate change threats and actions, build adaptive capacity for species resilience, and working with invertebrate experts to bolster the information needed to conserve invertebrates regionally.

Meanwhile focusing on subgroups such as small mammals can ensure conservation uniformity within taxon. Building the data, expertise, and tools needed so taxa groups are more proportionately represented remains a priority. There is a continuing need to develop web-enabled platforms for data access to the RSGCN list and supportive data. Communication

between and across regions is needed so that deferred species conservation is effectively coordinated. Lastly, continued refinements and improvements to the RSGCN process, and better communication of results and information is needed so that the Midwest continues to be a leader of regional conservation. These needs reflect lack of capacity of both funding and expertise for states to be RAWA ready and to address the full complement of fish and wildlife diversity in the Midwest.

APPENDIX 1: SURVEY QUESTIONS

Below are the questions associated with RSGCN species for the Midwest. Answers were recorded in a paired Excel worksheet, with columns representing the questions below. Taxa experts could copy and paste answers on this worksheet if they applied to more than one species. If taxa experts had limited knowledge of or if the species was data deficient, they were asked to note it with checkboxes.

There were a few questions where multiple answers were enabled. They were labeled below with bold **red** font and on the worksheet with "Multi Select" after the question in the column header. To select more than one response for these, taxa experts could simply click an answer, pull the list down again and select again and it would create a comma separated list.

SPECIES

A. EGT_ID [Already populated, unique species identifier, you can ignore this and the column is hidden]
B. Sub-taxa group [Already populated, in case you want to sort/filter by subgroup]
C. Scientific Name [Already populated]
D. Common Name [Already populated]

E. Indicate if you are not familiar enough with this species to answer questions about its habitat, limiting factors and threats [CHECKBOX]

F. Indicate if this species is generally data deficient for the Midwest, and you are therefore unable to answer questions about its habitat, limiting factors, and threats? (per IUCN: data deficient meaning insufficient information for a proper assessment of conservation status to be made) [CHECKBOX]

HABITAT

G. Is this species a habitat specialist?

H., I., J. Which habitat types are most important to this species? [select up to 3 from dropdown list] [Forest, Shrubland, Grassland, (Glades/Barrens/Savanna), Caves and Karst, Soil, Wetlands, Riparian, Shoreline, Rivers and Streams, Big Rivers, Lakes and Ponds, Great Lakes]. Helpful definitions are below:

1. Forest - Woody vegetation at least 5 m tall (usually much taller); tree canopy averaging 25 percent or greater.

2. Shrubland - Vegetation composed of shrubs (many-stemmed woody plants, generally less than 5 m tall).
3. Grassland - Habitat dominated by grasses, forbs, or ferns; trees and shrubs very widely scattered, if present; includes prairies, pastures, and hayfields.
4. Glades/Barrens/Savanna - Mosaic of trees and shrubs and grassland, often with many forbs and some shrubs; tree cover 10 to 25 percent.

K. What ongoing active management to maintain suitable conditions for this species does this habitat require, if any? [**Multi-select is available for this dropdown list**: vegetation control (e.g., prescribed fire, removal of invasive species, maintenance of early successional vegetation), hydrology control (e.g., waterfowl impoundments, dam flow regimes), human disturbance control (e.g., bat gates, seasonal beach closures to ORV, fencing to rope off nesting areas), predation control (e.g., predator exclosures on shorebird nests, Animal and Plant Health Inspection Service (APHIS) activities), planting thermally tolerant species, maintaining connectivity, protecting climate refugia, other management activities (e.g., fisheries seasons and harvest limits, seasonal limitations for ecosystem modifications).

L. Please explain ongoing active management further (e.g. fire frequency, type or seasonality, and explain “other” here).

M. Is the availability of any of these habitat type(s) impacting the species? [Y/N/UNKN TO ME/DD]

N. Is the condition of this habitat type impacting the species? [Y/N/UNKN TO ME/DD]

O. Is the ability to reach any of these habitat types impacting the species (e.g. connectivity or corridor issues)? [Y/N/UNKN TO ME/DD]

P. Is habitat condition or availability for this species threatened by climate change? [Y/N/UNKN TO ME/DD]

Q. Is habitat condition or availability for this species threatened by invasive species? [Y/N/UNKN TO ME/DD]

R. Please comment on special habitat components this species needs (e.g. specific features, substrates, or other characteristics) [Comment]

S. Please provide additional information or make any additional comments regarding the species' habitat. [Comment]

FOOD

T. Is this species a food specialist? [Y/N/UNKN TO ME/DD]

U. Is this species limited by availability of food? [Y/N/UNKN TO ME/DD]

V. Is availability of food threatened by climate change? [Y/N/UNKN TO ME/DD]

W. Please provide additional information or make any additional comments regarding the species' food habits and food-related vulnerabilities.

ECOLOGY, BEHAVIOR AND LIFE HISTORY

X. Does the species have high site fidelity (for example, anadromous fish that return to specific spawning regions, or bald eagles returning to same nesting site each year)? [Y/N/UNKN TO ME/DD]

Y. If yes, please explain the species high site fidelity further [Comment]

Z. Please comment on whether seasonal wintering/breeding/migratory habitat outside of the Midwest region is a limiting factor (e.g. deforestation in tropical regions reducing wintering habitat availability, overharvesting in marine environments of American eel) [Comment]

AA. Are important (native or non-native) predator, competitor, or interdependent species' population dynamics or ranges expected to shift in response to climate change? Interdependent species examples could include mussel glochidia hosts, pollinator host plants, klepto- and brood-parasites. **Multi Select is available for this dropdown list.** [Projected to have a range shift out of the region, a range shift into the region, projected to increase, decrease, no impact, unknown to me, data deficient]

AB. Please comment on or list important predators, competitors, or interdependent species, their status as native/non-native/invasive, and projected climate change responses known to you

AC. Are important disease/pest/pathogen (native or non-native) population dynamics or ranges expected to shift in response to climate change? **Multi Select is available for this dropdown list.** [Projected to have a range shift out of the region, a range shift into the region, projected to increase, decrease, no impact, unknown to me, data deficient]

AD. Please comment on or list important disease/pests/pathogens, their status as native/non-native/invasive, and projected climate change impacts known to you

AE. Are important aspects of this species' phenology, range and population dynamics projected to be impacted from climate change? **Multi-select is available in this dropdown list**. [Phenological mismatch: cues, phenological mismatch: event timing, projected to have a range shift out of the region, projected to have a range shift into the region, population projected to increase, decrease, no impact, data deficient, unknown to me]

AF. Please add any additional comments about the species' ecology/life history/behavior, especially relating to limiting factors/vulnerabilities.

THREATS

We would like to specifically identify top threats within the standard Conservation Measures Partnership Threat Classification system – ***The list in its entirety is TAB 2***

AG., AI., AK. Please list the top three threats, in order of importance, you feel are most impactful to this species.

AH., AJ., AL. Select the effects of climate change, if any, on this threat [climate change exacerbates this threat, climate change mitigates/diminishes this threat, UNKN TO ME,DD]

AM. Please comment on any other lower priority threats (climate/non-climate) that should be known about this species but are not captured in your top three.

AN. Please add any additional comments about threats here that have not been covered in other sections, especially thoughts on indirect or interactive threats from climate change.

RESEARCH AND MONITORING

AO. List priority monitoring needs for this species (e.g., assessment of distribution, seasonal movements, nesting success, management intervention success).

AP. Is there a standard monitoring protocol for this species? (This can be multi-state, regional, or state-wide protocols) [Y/N/UNKN TO ME]

AQ. Please list the citation for the standard monitoring protocol for this species.

AR. Comment on any major sources of uncertainty, research, or critical data needs regarding threats, limiting factors, and/or management for this species.

MANAGEMENT

AS. Comment on the most important management practices that you would recommend for the conservation of this species.

AT. Comment on any maladaptive management actions that should be avoided for this species.

AU. In your opinion, what is the most relevant geographic scale for managing this species into the future?

AV. In your opinion, what is the most relevant time scale for managing this species into the future?

AW. Are you adjusting (or have you adjusted) management or monitoring practices to account for shifts from climate change outside historical ranges of variability? [Yes, No – there is a barrier I will elaborate on later in this section, No – management/monitoring is not affected by climate change at this time]

AX. If you answered "yes" to adjusting management/monitoring to account for climate change, please explain the management or monitoring actions, and what climate frameworks or "out of the box" thinking you may have used.

AY. What are the major barriers to conservation action for this species? **Multi-select is available for this dropdown list.** [data deficiency, uncertainty of pace/type/magnitude of climate impacts, unclear responsibility, competing demands on managers, lack of resources (funding, capacity, etc.), other]

AZ. If you selected any barriers to conservation, please explain further.

BA. If appropriate, provide additional information or make any additional comments regarding management.

APPENDIX 2: CMP THREATS BY TAXA GROUP, PERCENTAGES INDICATE THE RELATIVE FREQUENCY OF THREAT CATEGORIES FOR EACH TAXONOMIC GROUP AS SELECTED BY TAXA EXPERTS

CMP Threat	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
11.4.2 Droughts		8.8%			21.6%		1.8%	10.9%	37.5%	5	81%
7.3.2 Vegetation succession	6.2%	25.5%	33.3%	1.3%			6.0%			5	72%
8.1.2 Terrestrial plants	0.8%	31.4%	33.3%							3	65%
2.1.1 Annual cropping systems (field crops)	27.9%	8.8%		5.0%		5.6%	10.3%			5	58%
9.3.3 Herbicides & pesticides	16.3%	2.9%	33.3%				5.0%			4	57%
9.3.2 Soil erosion & sedimentation					21.6%	19.7%	3.9%	7.3%		4	53%
5.3.1 Complete removal of forest cover	0.8%			2.5%	5.4%	21.1%	5.0%	10.9%		6	46%
7.2.4 Drainage in agricultural environments	10.9%					1.4%	2.8%		25.0%	4	40%
5.3.2 Partial removal of forest cover				18.8%	8.1%		0.7%	10.9%		4	38%
7.2.5 Drainage in forest environments	0.8%								37.5%	2	38%
1.1.1 Dense housing & urban areas				10.0%			1.8%	15.2%		3	27%
8.4.3 Fungal pathogens				18.8%			8.2%			2	27%

CMP Threat	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
11.3.4 Increase in temperature fluctuations		0.7%		6.3%	18.9%					3	26%
3.3.2 Wind farms	10.1%			12.5%						2	23%
12. Unknown Cause of Decline	0.8%	2.2%		2.5%	5.4%	8.5%	0.4%			6	20%
1.2.1 Commercial & industrial areas				2.5%				15.2%		2	18%
1.1.2 Low-density housing areas	1.6%						0.4%	15.2%		3	17%
7.1.2 Suppression in the fire regime	3.1%	10.2%		2.5%			0.4%			4	16%
7.2.1 Water level management using dams	1.6%					11.3%	0.4%			3	13%
7.2.7 Withdrawal of groundwater					5.4%	5.6%	2.1%			3	13%
5.1.4 Poaching/persecution of terrestrial animals	0.8%						11.7%			2	12%
9.3.1 Nutrient loads							2.8%	7.3%		2	10%
7.3.1 Shoreline alteration	3.9%					4.2%	1.1%			3	9%
4.3.3 Locks & canals						8.5%	0.4%			2	9%
9.1.2 Runoff							0.7%	7.3%		2	8%

CMP Threat	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
3.2.5 In-stream mining					2.7%	4.2%				2	7%
2.1.2 Perennial cropping systems	6.2%									1	6%
6.1.7 Caving				2.5%	2.7%		0.7%			3	6%
4.1.1 Roads							5.7%			1	6%
11.1.1 Changes in vegetation communities	0.8%	3.6%								2	4%
7.4.2 Reducing/Ceasing Hydrology control	1.6%				2.7%					2	4%
3.3.1 Hydroelectric dams						4.2%				1	4%
11.4.4 Increase in fluctuations in the precipitation regime		1.5%			2.7%					2	4%
2.3.1 Outdoor extensive livestock operation (on pasture)		0.7%			2.7%		0.7%			3	4%
8.2.5 Increased predation by mesopredators	0.8%						3.2%			2	4%
7.2.6 Withdrawal of surface water							3.9%			1	4%
8.2.8 Interspecific competition with a favored species	0.8%			1.3%		1.4%	0.4%			4	4%
1.3.4 Recreational trails				1.3%			2.5%			2	4%

CMP Threat	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
8.4.2 Viral pathogens				1.3%			2.5%			2	4%
5.4.3 Poaching/persecution of aquatic species							3.2%			1	3%
6.3.3 Vandalism				2.5%						1	3%
7.1.1 Increase in the fire regime							2.5%			1	2%
7.4.1 Reducing/Ceasing Vegetation control							2.5%			1	2%
7.2.3 Water management using culverts		0.7%				1.4%				2	2%
6.1.1 Motor vehicles		0.7%					1.1%			2	2%
2.1.3 Other types of agriculture						1.4%	0.4%			2	2%
4.2.1 Power & service lines	1.6%									1	2%
6.1.4 Recreational boating	1.6%									1	2%
8.2.2 Increased grazing by vertebrates		1.5%								1	1%
7.3.3 Natural erosion & sedimentation						1.4%				1	1%
2.2.2 Ornamental tree plantations				1.3%						1	1%

CMP Threat	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
5.1.5 Management/control of terrestrial animals				1.3%						1	1%
5.2.2 Commercial harvesting				1.3%						1	1%
5.3.3 Improvement cutting in natural forests				1.3%						1	1%
5.3.5 Management of cutting areas				1.3%						1	1%
11.3.3 Gradual temperature change							1.1%			1	1%
8.1.4 Aquatic plants	0.8%									1	1%
8.2.4 Insect pest epidemics	0.8%									1	1%
4.3.2 Dredging of shipping lanes							0.7%			1	1%
5.1.2 Trapping							0.4%			1	0%
5.4.1 Recreational or subsistence fishing							0.4%			1	0%
5.4.4 Managing/control of aquatic species							0.4%			1	0%
7.4.3 Reducing/Ceasing Human disturbance control							0.4%			1	0%
7.4.4 Reducing/Ceasing Predation control							0.4%			1	0%

CMP Threat	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
8.4.1 Bacterial pathogens							0.4%			1	0%

APPENDIX 3: CMP THREATS BY THREAT CATEGORY (IUCN - CONSERVATION MEASURES PARTNERSHIP), PERCENTAGES INDICATE THE RELATIVE FREQUENCY OF THREAT CATEGORIES FOR EACH TAXONOMIC GROUP AS SELECTED BY TAXA EXPERTS

CMP Threat Level 1	CMP Threat Level 3	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
1 Residential & commercial development	1.1.1 Dense housing & urban areas				10.0 %			1.8 %	15.2 %		3	27 %
	1.1.2 Low-density housing areas	1.6 %						0.4 %	15.2 %		3	17 %
	1.2.1 Commercial & industrial areas				2.5 %				15.2 %		2	18 %
	1.3.4 Recreational trails				1.3 %			2.5 %			2	4%
2 Agriculture & aquaculture	2.1.1 Annual cropping systems (field crops)	27.9 %	8.8 %		5.0 %		5.6 %	10.3 %			5	58 %
	2.1.2 Perennial cropping systems	6.2 %									1	6%
	2.1.3 Other types of agriculture						1.4 %	0.4 %			2	2%

CMP Threat Level 1	CMP Threat Level 3	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
	2.2.2 Ornamental tree plantations				1.3 %						1	1%
	2.3.1 Outdoor extensive livestock operation (on pasture)		0.7 %			2.7 %		0.7 %			3	4%
3 Energy production & mining	3.2.5 In-stream mining					2.7 %	4.2 %				2	7%
	3.3.1 Hydroelectric dams						4.2 %				1	4%
	3.3.2 Wind farms	10.1 %			12.5 %						2	23 %
4 Transportation & service corridors	4.1.1 Roads							5.7 %			1	6%
	4.2.1 Power & service lines	1.6 %									1	2%
	4.3.2 Dredging of shipping lanes							0.7 %			1	1%
	4.3.3 Locks & canals						8.5 %	0.4 %			2	9%
5 Biological resource use	5.1.2 Trapping							0.4 %			1	0%
	5.1.4 Poaching/persecution of terrestrial animals	0.8 %						11.7 %			2	12 %
	5.1.5 Management/control of terrestrial animals				1.3 %						1	1%
	5.2.2 Commercial harvesting				1.3 %						1	1%

CMP Threat Level 1	CMP Threat Level 3	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
	5.3.1 Complete removal of forest cover	0.8 %			2.5 %	5.4 %	21.1 %	5.0 %	10.9 %		6	46 %
	5.3.2 Partial removal of forest cover				18.8 %	8.1 %		0.7 %	10.9 %		4	38 %
	5.3.3 Improvement cutting in natural forests				1.3 %						1	1%
	5.3.5 Management of cutting areas				1.3 %						1	1%
	5.4.1 Recreational or subsistence fishing							0.4 %			1	0%
	5.4.3 Poaching/persecution of aquatic species							3.2 %			1	3%
	5.4.4 Managing/control of aquatic species							0.4 %			1	0%
6 Human intrusions & disturbance	6.1.1 Motor vehicles		0.7 %					1.1 %			2	2%
	6.1.4 Recreational boating	1.6 %									1	2%
	6.1.7 Caving				2.5 %	2.7 %		0.7 %			3	6%
	6.3.3 Vandalism				2.5 %						1	3%
7 Natural system modifications	7.1.1 Increase in the fire regime							2.5 %			1	2%
	7.1.2 Suppression in the fire regime	3.1 %	10.2 %		2.5 %			0.4 %			4	16 %

CMP Threat Level 1	CMP Threat Level 3	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
	7.2.1 Water level management using dams	1.6 %					11.3 %	0.4 %			3	13 %
	7.2.3 Water management using culverts		0.7 %				1.4 %				2	2%
	7.2.4 Drainage in agricultural environments	10.9 %					1.4 %	2.8 %		25.0 %	4	40 %
	7.2.5 Drainage in forest environments	0.8 %								37.5 %	2	38 %
	7.2.6 Withdrawal of surface water							3.9 %			1	4%
	7.2.7 Withdrawal of groundwater					5.4 %	5.6 %	2.1 %			3	13 %
	7.3.1 Shoreline alteration	3.9 %					4.2 %	1.1 %			3	9%
	7.3.2 Vegetation succession	6.2 %	25.5 %	33.3 %	1.3 %			6.0 %			5	72 %
	7.3.3 Natural erosion & sedimentation						1.4 %				1	1%
	7.4.1 Reducing/Ceasing Vegetation control							2.5 %			1	2%
	7.4.2 Reducing/Ceasing Hydrology control	1.6 %				2.7 %					2	4%
	7.4.3 Reducing/Ceasing Human disturbance control							0.4 %			1	0%
	7.4.4 Reducing/Ceasing Predation control							0.4 %			1	0%

CMP Threat Level 1	CMP Threat Level 3	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
8 Invasive & other problematic species, genes & diseases	8.1.2 Terrestrial plants	0.8 %	31.4 %	33.3 %							3	65 %
	8.1.4 Aquatic plants	0.8 %									1	1%
	8.2.2 Increased grazing by vertebrates		1.5 %								1	1%
	8.2.4 Insect pest epidemics	0.8 %									1	1%
	8.2.5 Increased predation by mesopredators	0.8 %						3.2 %			2	4%
	8.2.8 Interspecific competition with a favored species	0.8 %			1.3 %		1.4 %	0.4 %			4	4%
	8.4.1 Bacterial pathogens							0.4 %			1	0%
	8.4.2 Viral pathogens				1.3 %			2.5 %			2	4%
	8.4.3 Fungal pathogens				18.8 %			8.2 %			2	27 %
9 Pollution	9.1.2 Runoff							0.7 %	7.3 %		2	8%
	9.3.1 Nutrient loads							2.8 %	7.3 %		2	10 %
	9.3.2 Soil erosion & sedimentation					21.6 %	19.7 %	3.9 %	7.3 %		4	53 %
	9.3.3 Herbicides & pesticides	16.3 %	2.9 %	33.3 %				5.0 %			4	57 %

CMP Threat Level 1	CMP Threat Level 3	Birds	Leps	Bees	Mammals	Crayfish	Fish	Herps	Mussels	Odonate	N Groups	Sum
11 Climate change & severe weather	11.1.1 Changes in vegetation communities	0.8 %	3.6 %								2	4%
	11.3.3 Gradual temperature change							1.1 %			1	1%
	11.3.4 Increase in temperature fluctuations		0.7 %		6.3 %	18.9 %					3	26 %
	11.4.2 Droughts		8.8 %			21.6 %		1.8 %	10.9 %	37.5 %	5	81 %
	11.4.4 Increase in fluctuations in the precipitation regime		1.5 %			2.7 %					2	4%
12 Other options	12. Unknown Cause of Decline	0.8 %	2.2 %		2.5 %	5.4 %	8.5 %	0.4 %			6	20 %